NONDECELERATIVE UNIVERSE MODEL

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Abstract

In the present paper, the model of Expansive Nondecelerative Universe is analysed. The model involves an assumption of the nonexistence of big bang, inflation phase of expansion, dark energy, and extradimensions. Utilizing the model allows localize the energy of gravitation field, quantify the gravitation field and establish the Universe wavefunction. The exact value of the mass of the Higgs boson (m_H = 125.39 GeV) and the axion (m_{ax} = 1.28 $\times 10^{-6}$ eV) is calculated. The value of the neutron dipole moment (1.8 $\times 10^{-30}$ e·cm) is predicted.

INTRODUCTION

In spite of undisputable progress having been achieved in current cosmology still new challenges are posed to scientists and new questions, looking for definite answers are emerging. As a few examples, the issues of dark matter, dark energy, initial conditions of the Universe creation, hypothesized Universe expansion deceleration and acceleration may be mentioned. The questions call for investigation in the field both of experiments and observation, and theoretical approaches. There are numerous attempts to offer the answers, to provide the ultimate solution shall require a long way. One of the approaches leading to conclusions which couly with all the known physical laws and do not contradict observations is the approach based on the postulate of the Universe expansion by the constant velocity equals to the velocity of light. This approach, the essence of which has been published in our previous papers, is called Expansive Nondecelerative Universe (ENU). In the present paper we will document the ability of the ENU to offer sound conclusions related to the Universe, its development and structure, including the characteristics and properties of such investigated particles as Higgs boson and axion.

NONDECELERATIVE UNIVERSE

1: CHARACTERISTICS

Our model of the Universe (Expansive Nondecelerative Universe, ENU) [1],[2],[3], is based on a simple premise that the rate of the Universe expansion is constant and equal to the speed of light. Moreover, the Universe mean energy density is identical to its critical energy density. There are three limiting conditions characterizing the ENU model, namely

$$\Lambda = 0 \qquad (1)$$

where Λ is the cosmological constant,

$$k = 0 \qquad (2)$$

where k is the curvature, and

$$a = c\,t_U \qquad (3)$$

where a is the scale factor, c is the speed of light in the vacuum, t_U is the cosmological time. Their present ENU-based values are following: $a = 1.229 \times 10^{26}$ m; $t_U = 1.373 \times 10^{10}$ yr.

Within the classic models of the Universe, the flat Universe is required to gradually decelerate its expansion. It is a case where the gravitational force affects the Universe GLOBALLY. Contrary, in the ENU, the gravity affects it only LOCALLY.

The dynamic nature of the ENU is described by Friedman equations. Introducing a dimensionless conform time η, the equations can be expressed as follows:

$$\frac{d}{d\eta}\left(\frac{1}{a}.\frac{da}{d\eta}\right)=-\frac{4\pi G}{3c^4}a^2(\varepsilon+3p) \tag{4}$$

$$\left(\frac{1}{a}.\frac{da}{d\eta}\right)^2=\frac{8\pi G}{3c^4}a^2\varepsilon-k \tag{5}$$

where ε is the energy density, p is the pressure and the scale factor a is expressed as

$$a=\frac{da}{d\eta} \tag{6}$$

Introducing the conditions (1) to (3) into relations (4) and (5), we get

$$\varepsilon=\frac{3c^4}{8\pi G a^2} \tag{7}$$

$$p=-\frac{\varepsilon}{3} \tag{8}$$

The energy density can be expressed also in the form

$$\varepsilon=\frac{3m_U c^2}{4\pi a^3} \tag{9}$$

where m_U is the mass of the Universe ($m_U \cong 8.673x10^{52}$ kg).
Combining of (7) and (9) one obtains

$$a=\frac{2G m_U}{c^2} \tag{10}$$

It follows directly from (10) that a time evolution of the matter must occur. An amount of the mass created in one second is δ

$$\delta=\frac{dm_U}{dt}=\frac{m_U}{t_U}=\frac{c^3}{2G} \tag{11}$$

It means that an amount of the matter created in our Universe in a second is equal to about 10^5 Sun mass. In the inflationary model, the same amount of matter is emerging from beyond the horizon. It is not too much matter if the Universe dimensions are taken into accout. For the sake of illustration, it represents a proton in a cube of 1 km^3 within a year. There is no global scale gravity in the ENU which could decelerate the Universe expansion.

The ENU model is this in compliance with a Hawking's statement that the total mass-energy of our Universe must equal precisely to 0. It means that the matter, representing the positive component of the energy, is just compensated with the gravitational field, representing the negative component of the energy. The conservation laws are therefore obeyed. If the Universe is considered an absolute system, all its physical characteristics must be equal precisely zero. In a hypothetical case, the Universe has a certain measurable quantity of non-zero value, only an observer located outside of the Universe could observe it. And this is in a contradition with the reasoning on the Universe as an absolute system.

2: A POSSIBLE MECHANISM OF BARYONIC MATTER CREATION

At the kaon decay, and due to an unavoidable existence of the neutron dipole moment, T-symmetry is violated. Let us imagine a particle bearing the dipole moment (e.g. with dipole orientation and rotation as shown in Fig. 1). In case the passage of time becomes reverse, the station shall be changed but in order to preserve physical laws, also the rotation by 180° would have to happen. The rotation direction would be preserved but dipole moment orientation would be changed. It this really happen, we could expect the reverse passage of time. For the corresponding direction of the rotations, see Fig. 1.

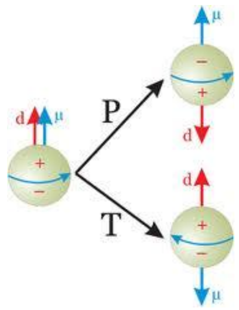

Fig.1: Left side – the original dipole moment orientation, right side down – the state after time inversion, right side up – the state after the complete inversion of time and space and rotation by 180°. The time inversion means the change in the neutron dipole moment orientation.

It means that the given passages of time are distinguishable (non symmetric). This is the essence of T- symmetry violation. Since the time symmetry and the energy conservation are connected, violation of time symmetry means also violation of energy conservation law.

In order to preserve the fundamental physical laws, in other words to preserve values of dimensionless constants of fundamental physical interactions, some of the other „constants“ would have to undergo changes. For example, a reduction of elementary particle masses (inverse to the square root of cosmological time) would lead to adequate chase in the Boltzmann constant. At the same time, the gravitational constant and Fermi constant would have increase (linearly with cosmological time). Such changes must occur in order to preserve physical laws.

The neutron dipole moment must be very small. At extremely short distances, unification of physical interactions happens. For example, unification of gravitational and electromagnetic interactions occurs at the 10 times Planck length. This is why the own neutron gravitational field can change to electromagnetic field (it depends on the distance between the charges in the neutron). Such a field can change the neutron dipole direction and thus violate T-symmetry.

Based on the ENU model, the probability of neutron creation is known. It then follows that its dipole moment value can be easily obtained.

At the wavelength λ_X

$$\lambda_X = \frac{l_{Pc}}{\sqrt{\alpha_e}} \tag{12}$$

the Newton and Comlomb laws become unified (l_{Pc} is the Planck length, α_e is the fine structure constant, λ_X is the lowest possible distance between two electric charges). In case of T-symmetry violation, the probabality P of the creation of a new neutron is

$$P = e^{-\frac{d\sqrt{\alpha_e}}{l_{Pc}}} \tag{13}$$

where d is the distance of the charges in neutron. The ENU model leads also to a simple probability of the neutron creation

$$P = \frac{\lambda_n}{a} \tag{14}$$

where λ_n is the Compton length of the neutron, a is the Universe gauge factor.
Putting (13) and (14) equal, the distance d and subsequently the value of neutron dipol moment p(n) is obtained

$$p(\mathrm{n}) = 1.8 \times 10^{-30}\ \mathrm{e{\cdot}cm} \tag{15}$$

This value represents an average of values predicted both by the standard model and SUSY.

This value allows to determine the energy required to change the neutron dipole moment direction as the energy of a photon with $\lambda = 10^5$ m which is exactly equal to the wavelength of the neutron graviton. Gravitational field will change into electromagnetic field with some probability and this, in turn, will cause a change in the dipole moment direction. T-symmetry is thus violated and and a new neutron may be created. In order to satisfy the above requirements, the dipole moment value must be 1.8 × 10^{-30} e·cm. Current measurements approach the value of 10^{-27} e·cm. The value obtained using the ENU model might be experimentally measured within 15 – 20 years.

It is worth mentioning that at the above mentioned changes in constants, no violation of conservation laws occurs. The creation of new neutrons is compensated by a decrease in the neutron mass. Since this decrease as well as the changes in other constants cannot be registered, such a creation of new particles is understood as creation of new matter – energy. In the ENU is thus positive energy of matter compensated by negative gravitational field and the total energy of the Universe is kept always zero.

3: THERMODYNAMICS

The thermodynamics of the Universe investigates the evolution of changes in its energy density, temperature and pressure. In this part, the Universe thermodynamics will be evaluated from the viewpoint of both the inflationary and the ENU models.

Till the end of radiation-dominated era it was not possible to differ these two models, however, situation changed in the matter-dominated era. According to the inflationary model, the Universe dimensions increased since the matter-dominated era about 1,000 times, the temperature decreased from about 3000 K to the present 2.74 K and the value of specific entropy, expressed as a ratio of photons and baryons numbers has kept constant (10^9). In the inflationary model it holds for the temperature T and energy density $\varepsilon_{\mathrm{rad}}$ of radiation

$$T \sim \frac{1}{a} \tag{16}$$

$$\varepsilon_{rad} = \frac{4\sigma T^4}{c} \sim \frac{1}{a^4} \tag{17}$$

The situation is different in the ENU model. The Universe dimensions increased about 10,000 times since the end of the radiation-dominated era, temperature decreases about 1,000 times, and this is why in this model

$$T \sim \left(\frac{1}{a}\right)^{\frac{3}{4}} \tag{18}$$

$$\varepsilon_{\mathrm{rad}} \sim \left(\frac{1}{a}\right)^{3} \tag{19}$$

The ENU model leads to the current temperature and radiation energy density values. Based on relations (18) and (19), specific entropy value S_{sp} depends on the Universe scale factor a as follows

$$S_{\mathrm{sp}} \sim \left(\frac{1}{a}\right)^{\frac{1}{4}} \tag{20}$$

Its value had to decrease from 10^9 at the end of the radiation-dominated era to the present value 10^8. Relations (18) to (20) differ due to the Universe mass creation and additional heating of Nonecelerative Universe.

A simple analysis documents that the observed dimensions of the Universe increased 10,000 times in the matter-dominated era which is in accordance with the ENU model. The inflationary model brings a conclusion that the Universe has decelerated its expansion due to gravity and its dimensions have increased actually only 1,000 times. As the Universe has decelerated its expansion, light has come from beyond the horizon from more and more distant galaxies and it seems to appear much larger as stems from its expansion.

This logic becomes to fail taking the existence of dark energy into account. Everything which has laboriously emerged during the deceleration of the Universe expansion, becomes hidden beyond the horizon during the subsequent acceleration of the Universe expansion. Situation is saved by a strange coincidence that we are living in a priviledged time when the consequences of the previous deceleration of expansion are just balanced by its present acceleration.

Situation concerning the inflationary model is even worse when analysing the specific entropy value. The majority of cosmologists supposes that our Universe has the critical mass density. We know the current Universe dimensions and temperature. At the temperature 3 K, there must be about 4×10^8 relic photons in a volume unit. Based on the observed Universe dimensions and supposed critical density it follows that at the time being there must be 4 protons in average in a volume unit. Dividing both the numbers we obtain the specific entropy value of 10^8 which corresponds to the ENU model. It means, the specific entropy value cannot be constant. It is not relevant, how much exotic forms of matter our Universe is composed of. The specific entropy can always be expressed by the number of relic photons to one baryon. The inflationary model relies on the fact that the present predicted and observed values of specific entropy differ „only“ by a factor 10. This difference can be attributed to deceleration and subsequent acceleration of the Universe expansion, or to an exotic form of matter. In the far future, when the specific entropy value will substantially decrease, the rationality of the inflationary model would become intolerable.

The last diference of the inflationary and our ENU models in the field of thermodynamics lies in the assumption that the ENU model hypotheses the non-existence of B-modes of polarisation of the relic radiation, or a negligible and unimportant level of this kind of polarisation that might arise through the influence of gravitational waves on photons due to the inflation.

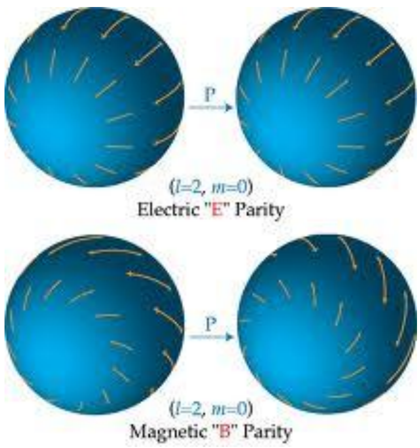

Fig.2 Upper part: E mode of polarisation, lower part: B mode.

4: METRICS

When dealing with cosmological issues, a choice of the metric is of a crucial importance. In previous parts of this contribution it is postulated that in the ENU model, the matter is compensated by the gravitational field and thus the total mass-energy of the Universe is zero. This hypothesis postulated also by Hawking [4] and it seems to be generally accepted. Based on the known matter-based energy density, the next step lies in calculation the energy density of gravitational field. As a starting point, Einstein equation

$$R_{ik} - \frac{1}{2} g_{ik} R = \frac{8\pi G}{c^4} T_{ik} \tag{21}$$

is taken. Divergence of this equation leads to gravitational energy density ε_g in the form

$$\varepsilon_g = -\frac{c^4}{8\pi G} R \tag{22}$$

where R is the scalar curvature. When applying Schwarzschild metric for vacuum, R becomes equal to zero. In the ENU model, matter is created and thus Vaidya metric [5] should be used. In this metric the line element is expressed as

$$ds^2 = \left(\frac{d\Psi}{c\,dt}\right)^2 \frac{1}{f^2_{\ m}}\left(1-\frac{2\Psi}{r}\right)c^2 dt^2 - \\ -\left(1-\frac{2\Psi}{r}\right)^{-1} dr^2 - r^2\left(d\theta^2+\sin^2\theta\, d\varphi^2\right) \tag{23}$$

where f_m is an arbitrary function and Ψ is

$$\Psi = \frac{G\,m}{c^2} \tag{24}$$

At the same time, in the ENU model must be

$$\frac{d\Psi}{c\cdot dt} = \frac{\Psi}{a} \tag{25}$$

Using relations (23) to (25), scalar curvature *R* is obtained as

$$R = \frac{6G}{c^3 r^2}.\frac{dm}{dt} = \frac{3r_{\mathrm{g}}}{a\,r^2} \tag{26}$$

where r_g is the gravitational radius of a body with the mass *m*.

It is possible therefore to localize the energy density of weak gravitational field. Stemming from relations (22) and (26) one can obtain

$$\varepsilon_{\mathrm{g}} = -\frac{3m\,c^2}{4\pi a\,r^2} \tag{27}$$

The relation (27) expresses the energy density of gravitational field of a body with the mass *m* in the distance *r*. It is obvious that in the ENU model the matter-based energy and gravitational field energy are exactly compensated in the scale of the whole Universe and the total energy of the Universe is thus zero.

Gravitational force being a far-reaching force acts in principle up to infinity, it is measurable, however, only to a certain distance called effective range r_{ef}. Its meaning lies in a postulate that in the ENU, the effect of gravitation can be displayed only in such a distance, in which the absolute value of the gravitational energy density is higher than the critical energy density of the Universe. The effective range can be expressed through the identity of the relations (7) and (27)

$$r_{\mathrm{ef}} = \left(r_{\mathrm{g}} a\right)^{\frac{1}{2}} \tag{28}$$

Non-relativistic gravitation potential can be thus express as

$$\Phi = \Phi_0 \exp\left(\frac{-r}{r_{\mathrm{ef}}}\right) \tag{29}$$

where

$$\Phi_0 = -G\int \frac{\rho}{r} dV = -\frac{G\,m}{r} \tag{30}$$

Within the distances shorter that the effective range, this potential is almost identical to Newton potential. At distances $r > r_{\mathrm{ef}}$, the potential approaches zero value.

It can be proved that the scalar curvature may be calculated in case of Yukawa potential using tha classical metrics too. It holds

$$R = -\frac{2\Delta\Phi}{c^2}\left(1-g_{\alpha\alpha}\right) \tag{31}$$

where $\alpha =$ 1,2,3 and g is the metric tensor.

The vacuum scalar curvature is equal zero in flat space, in weak fields it acquires of nonzero value even without applying the Vaidya metric. Yukawa potential leads thus to a mild modification of the Newton theory, the general relativity is not, however, altered.

The hierarchical structure of astronomical objects is well known beginning with star systems as the smallest objects, passing through galaxies, galaxy cluster up to superclusters as the largest assemblies of matter. In the mentioned order, the mean energy density decreases. In the ENU model it is supposed that the largest objects such as superclusters or giant eliptic galaxies have a limited size since their gravitational energy density approaches nearly critical density. Their dimensions reach almost the size of effective radius. Therefore, if we put their dimensions and their effective range identical, we are able to determine exactly the amount of matter (dark matter including) they contain. It is noteworthy that we can do it directly without complicated measurements of rotational velocities of these objects.

5: BLACK HOLES

The issue of black holes may be considered and understood from various viewpoints [6]. We present here an approach based on the ENU model. If a black hole forms part of a binary system with a star, it sucks the star matter through gravitation. The star gas is drawn into the black hole, its pressure increases, it is decelerated due to viscous friction, and turbulences and shock waves may appear. All these actions cause the gas heating to a high temperature resulting, in turn, in emission of infrared, visible, ultraviolet and even X-ray radiation. This phenomenon is called accretion.

By means of the Vaidya metric, the gravitational energy density can be determined near the black hole horizon. It is logical that the energy density of the accretion radiation ε_{rad} can approach but cannot exceed the absolute value of the gravitational energy density of the black hole, i.e. as a maximum

$$\varepsilon_{\text{rad}} \sim |\varepsilon_g| \qquad (32)$$

Putting relations (17) and (24) identical, the maximum temperature of the accretion disc in the vicinity of black hole can be determined. This temperature depends on the mass of black hole. As for the lightest black holes (with a mass of some Suns) the temperature is of the order 10^7 K, for medium-mass black holes it is 10^6 and for the heaviest black holes it is 10^5 K. These values comply well with experimental observations.

One of the characteristic features of the ENU model is a matter creation. Due to the space-time closing of black holes, the creation must take place under their horizon. Taking the absolute value of gravitational energy density on the black hole horizon, integrating over the whole black hole volume and subsequently differentiating to time, we obtain the value of the gravitational energy output of black hole P_{g} as

$$|P_{\text{g}}| = \frac{d}{dt}\int \frac{c^4}{8\pi G} R.dV = \frac{m_{\text{BH}} c^2}{t_{\text{U}}} \qquad (33)$$

This gravitational output informs also on the amount of matter-energy formed in the black hole in one second.

Evaporation output of black hole, P_{evap} is

$$P_{\text{evap}} = \frac{h c^2}{2\pi r_{\text{BH}}^2} \qquad (34)$$

where r_{BH} is the gravitational radius of black hole.

The heavier a black hole is, the more matter it produces within creation and the less is its evaporation. Taking into account still smaller and smaller black holes, their creation decreases and evaporation increases. Putting (33) and (34) equal, one obtains

$$m_{\text{BH(min)}} = \left(\frac{h c^4 t_{\text{U}}}{8\pi G^2}\right)^{\frac{1}{3}} = 10^{12}\,\text{kg} \qquad (35)$$

The term $m_{BH(min)}$ is the mass of a primordial black hole, in the conception of the ENU model it represents, however, the lighest black hole which may exist at present. Lighter black holes do not exist and in case of heavier ones, the creation overcomes their evaporation. This is why the ENU model does not allow evaporation of a black hole. The black hole entropy cannot decrease and the information contained in the black hole may not be lost.

6: DARK ENERGY

In physical cosmology and astronomy, dark energy is a hypothetical form of energy that permeates all of space and tends to increase the rate of expansion of the universe. In the standard model of cosmology, dark energy currently accounts for 73% of the total mass-energy of the universe. Two proposed forms for dark energy are the cosmological constant, a *constant* energy density filling space homogeneously, and scalar fields such as quintessence.

Based on the information provided on the ENU model, the issue of dark energy can be solid as follows.

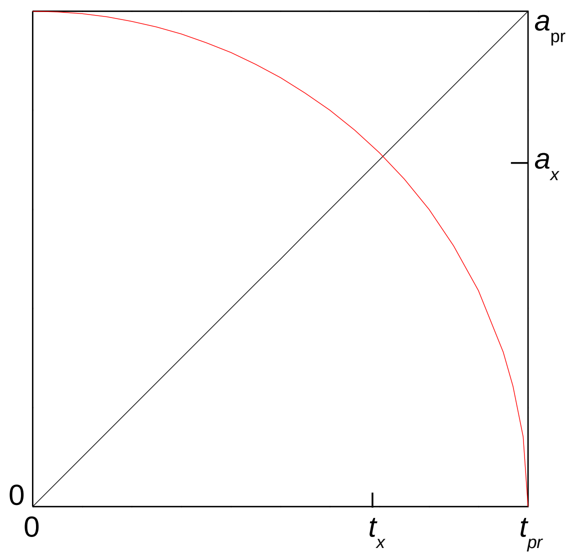

Fig. 3 *A plot of the Universe scale factor (y axis) and cosmological time (x axis) - straight lines - and the line of observation (curved). The crossing point (t_x , a_x) represent the state at the red shift value Z = 1.4 (for details, see text).*

Figure 3 illustrates a time dependence of the nondecelerative Universe dimension in the form of a light cone in two-dimensional projection. The straight line represents the Universe expansion according to the ENU. The present radius (scale factor a_{pr} of the Universe) corresponds to the present time t_{pr}. The curve initiating in t_{pr} represents the line of observation. The farther the distance viewed by an observer is, the farther objects he can see. The farther are the objects observed, the higher their velocity related to the observer. However, at the same time, the observer observes a deeper past when the Universe was smaller than it is at present. This is the reason of why the curve of observation crosses the line of the light cone in a point t_x, a_x.

As for the light cone (putting $c = 1$)

$$x = y \tag{36}$$

Observing an object at the distance y it holds in the ENU model

$$y = k \cdot a_{pr} \tag{37}$$

where

$$k = \frac{v}{c} \tag{38}$$

Using Lorentz transformation, corresponding time parameter x can be expressed as follows

$x = (1 - k^2)^{1/2} \cdot t_{pr}$ (39)

In the cross-section point it holds

$k \cdot a_{pr} = (1 - k^2)^{1/2} \cdot t_{pr}$ (40)

Due to the normalization of the axes ($a_{pr} = t_{pr}$) we obtain

$k = (0.5)^{1/2} = 0.7071067$ (41)

This is the value corresponding to the red shift $z = 1.4$

$$z = \frac{(1+k)^{\frac{1}{2}}}{(1-k)^{\frac{1}{2}}} - 1 = 1.4 \qquad (42)$$

Inspecting Fig. 3 it is now clear that any interval from the region ($0 - t_x$) will display itself in the region ($a_x - a_{pr}$) as SMALLER interval. It means that any objects, e.g. type 1a supernovae will appear as relatively brighter (i.e. ostensibly closer). Contrary, closer supernovae will seem relatively fainter. Any interval from ($t_x - t_{pr}$) will display itself in the region ($t_{pr} - a_x$) as an interval LARGER (the supernovae will appear less brighter). The inversion point of such relative luminosities is at the red shift $z = 1.4$. This fact was proved in 2004 [7]. In the ENU model it corresponds to three quarters of cosmological time. Based on the ENU model, dark energy is only an unnecessarily illusion [8].

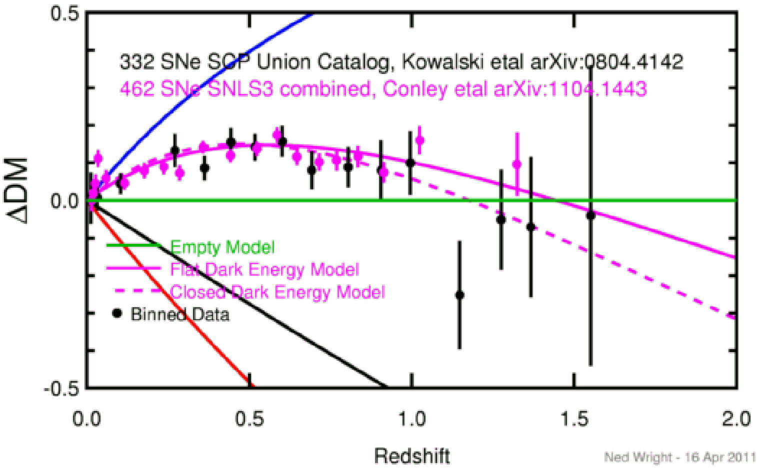

Fig. 4 *Pink curve represents a change in relative luminosities close to z = 1.4.*
(from: Conley at all arXiv:1104.1443, 2011)

QUANTUM GRAVITY

7: QUANTUM COSMOLOGY

In 1968, Wheeler–de Witt equation of the Universe was proposed [9]. This equation has been, however, solved only in a general form as a Universe wave function and has not provided us with details on our Universe. Other unpleasent feature lies in the fact that this general solution contains infinity members.

It is necessary to find a special solution of Wheeler – de Witt equation, i.e. a solution corresponding to our observed Universe and providing exact and scientifically verifiable predictions. This was an essence of Hartle's and Hawking's approach [4] based on Feynmann attitude to quantum mechanics. Feynmann stated that it was possible to express the probability amplitude (wave function) of transition from the initial state to the final state as a sum of contributions from all possible classic histories of the systems under consideration.

Current expression of the wave function of the Universe can be thus understood as a sum of all its histories. More probable past situations have a greater weight as those improbable and summing over all possible histories we should obtain our present and known Universe. According to Hawkings, the Universe wave function is extended over all existing universes, also over those not complying with known physical laws. For our Universe, the value of the wave function is very large, for the other universes is of negligible value (their existence is of very low probability).

The Feynmann attitude to the wave function, as a sum of histories, can be exploited also within the ENU model. Identifying the whole energy of the Universe matter and integrating over the whole cosmological time, the Universe wave function is obtained in the form

$$\Psi_{\mathrm{U}} = \sum e^{-\left(\frac{2\pi}{h}\right)\int_0^t E_{\mathrm{U}} dt} \tag{43}$$

Fig. 5 documents a dependence of the Universe dimension (y axis) on the cosmological time (x axis). The expansion started in zero point, the present time is t_{pr} and scale factor is a_{pr}. The angle between the x axis and a line beginning in point 0 and ending in a_{pr} is denoted φ .

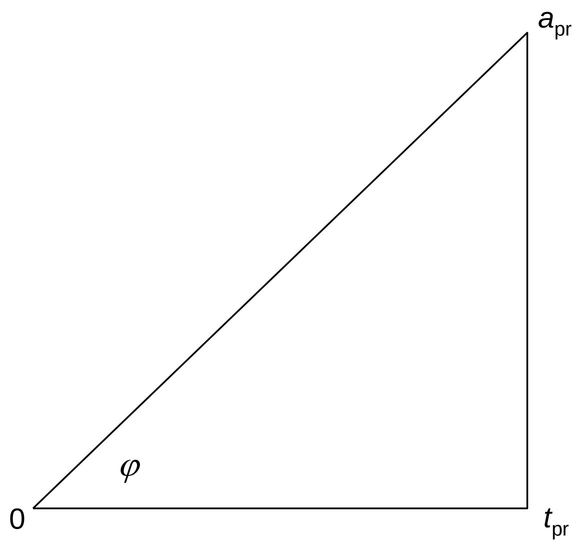

Fig. 5: Dependence of the Universe dimension (y axis) on the cosmological time (x axis)

It is obvious that the sum of histories is equal to the sum of all configuratons which the all elementary particles of the Universe might adopt. It equals to the sum of areas (S) of triangles with apexes in the points 0, t_{pr} , and a_{pr}.

The Universe wave function can be expressed also in other form, such as

$$\Psi_{\mathrm{U}} = \sum e^{-S} \tag{44}$$

The area S can be expressed as

$$S = \cot\mathrm{g}\varphi \left(\frac{a_{\mathrm{pr}}^2}{2 l_{\mathrm{Pc}}^2} \right) \tag{45}$$

where l_{Pc} is the Planck length. As for cotgφ, it holds

$$\cot\mathrm{g}\varphi = \frac{c\, t_{\mathrm{pr}}}{a_{\mathrm{pr}}} \tag{46}$$

The relations (44) to (46) are normalized so as the area S is a dimensionless quantity. All improbable histories mutually cancelled in the relations (43) and (44) remaining thus only actual possibilites. We get relation

$$\cot g\varphi = \frac{r_{g(\text{U})}}{a_{\text{pr}}} \tag{47}$$

in which $r_{g(U)}$ is the gravitational radius of the Universe. This is of particular interest since cotangens of the angle φ expressed in such a way characterizes exactly a given type of the Universe and determines its future. This conclusion will be evidenced by some specific examples.

In case of φ = 45°, cotgφ = 1.

This is the Universe which neither decelerates nor accelerates its expansion rate. Its dimension increases with constant velocity *c* (speed of light), i.e. this situation represents our nondecelerative Universe.

If φ < 45°, cotgφ > 1.

This situation describes the Universe of supercritical matter density and space has positive curvature. Under this scenario, the Universe decelerates its expansion. In the language of Fridmann cosmic deceleration parameter *q*, this is the case of q > 0.5.

If φ > 45°, cotgφ < 1,

the Universe has subcritical matter density, negative curvature and accelerates its expansion.

In the language of Fridmann cosmic deceleration parameter *q*, this is the case of q < 0.5.

If $\varphi \to 0$, cotg$\varphi \to \infty$.

Dimensions of the Universe approach zero value, cosmological time dilates, this scenario represents gravitational colaps of the Universe (big crunch).

If φ = 90°, cotgφ = 0.

It represents an infinite rate of the Universe expansion, i.e. inflationary phase.

It is obvious that the knowledge of cotgφ value means also the knowledge of the Universe dynamics. The Universe dynamics is, however, describes via Friedmann equations stemming from the Einstein theory of relativity. Provided that we know the ratio of the actual Universe mass and its critical density, we are able to solve the equations and determine the type of the Universe. We are able to do the same using two expressions of the Universe wave function and cotgφ value. The principal difference lies in the fact that we did not start from general theory of relativity but from quantum mechanics and come to identical results. This conclusion may suggest that there is a bridge between the general relativity and quantum mechanics, being up to now incompatible theories.

8. MOMENTUM-ENERGY TENSOR

The problems linked to the localization of energy density of gravitational field have been mentioned above. Using the Vaidya metric and the ENU model, this energy density can be expressed for weak fields by equation (27). This equation can be derived also applying Feynmann approach. Putting the exponents of equations (43) and (44) divided by the volume *V* equal, integrating over time *t* = *r*/*c* and multiplying the exponent in (44) by the number –1 (which is the component g_{00} of the metric tensor in case of weak fields), it results

$$\left(\frac{2\pi}{h}\right)\int_0^t \varepsilon_{\text{g}} dt = \frac{g_{00} r^2 \cot g\varphi}{2 l_{\text{Pc}}^2 . V} \tag{48}$$

Substituting

$$\cot g\varphi = \frac{r_{\text{g}(m)}}{a_{\text{pr}}} \tag{49}$$

(where $r_{g(m)}$ is the gravitational radius of a body with the mass *m*), then combining (49) and (48) we obtain relation (27).

Applying relation (48) for strong gravitational fields, it follows

$$S_{\text{ik}} = \frac{(g_{\text{ik}})^l m^l c^2}{4\pi r^2} \tag{50}$$

where S_{ik} is the energy-momentum tensor. In case of the ENU, $m^{/} = m/a_{pr}$ and $(g_{ik})^{/}$ are the components of metric tensor of the Vaidya metric affecting $m^{/}$. This metric is expressed in Kerr–Schild carthesian coordinates as follows

$$ds^2 = i^2dt^2 + dx^2 + dy^2 + dz^2 + 2m^{/}\left[idt + \left(\frac{1}{r}\right)(xdx + ydy + zdz)\right]^2 \qquad (51)$$

The components $(g_{ik})^{/}$ are obtained squaring the expresion in brackets in relation (51). When applying the metric (51), we will stick to the convention $G = c = 1$. Taking the convention into account we are able to enumerate all the components of the tensor S_{ik}.

It follows from (50) and (51) that

$$S_{00} = \frac{-m^{/}c^2}{4\pi r^2} \qquad (52)$$

For the sake of simplicity, we will substitute $\frac{1}{4\pi r^2} = \chi$ and obtain

$$S_{01} = S_{10} = \left(\frac{ix}{r}\right)m^{/}c^2\chi \qquad (53)$$

$$S_{02} = S_{20} = \left(\frac{iy}{r}\right)m^{/}c^2\chi \qquad (54)$$

$$S_{03} = S_{30} = \left(\frac{iz}{r}\right)m^{/}c^2\chi \qquad (55)$$

$$S_{11} = \left(\frac{x^2}{r^2}\right)m^{/}c^2\chi \qquad (56)$$

$$S_{12} = S_{21} = \left(\frac{xy}{r^2}\right)m^{/}c^2\chi \qquad (57)$$

$$S_{13} = S_{31} = \left(\frac{xz}{r^2}\right)m^{/}c^2\chi \qquad (58)$$

$$S_{22} = \left(\frac{y^2}{r^2}\right)m^{/}c^2\chi \qquad (59)$$

$$S_{23} = S_{32} = \left(\frac{yz}{r^2}\right)m^{/}c^2\chi \qquad (60)$$

$$S_{33} = \left(\frac{z^2}{r^2}\right)m^{/}c^2\chi \qquad (61)$$

It is obvious that the tensor S_{ik} is a symmetric tensor with its trace equal to zero. In strong gravitational fields where all distances approaching zero, all components of our tensor will lead to infinite values. Executing diagonalization and subsequent contraction of the tensor leads, however, to zero. This is known in the ENU. It documents that the tensor S_{ik} describes both the spacetime and the matter. In strong fields, all infinite values are mutually cancelled and the singularity does not thus represent any problem for the ENU. The tensor S_{ik} provides similar results to those obtained from Einstein or Tolman pseudotensor (providing that we work with the Vaidya metric). These components, which are imaginary in the ENU, are antisymmetric in Einstein or Tolman pseudotensor.

Now, the behaviour of our tensor in strong gravitational fields near a black hole horizon will be examined, stemming from the situation where $z = 0$ a $x \sim r_{BH}$. Our task lies in finding y using the equation

$$\int S_{22} dV = \frac{hc}{2\pi r_{BH}} \qquad (62)$$

Relation (62) describes the evaporation quantum of a black hole. It follows from (59) and (62) that

$$y = \left(\frac{h a_{pr}}{2\pi m c} \right)^{\frac{1}{2}} \qquad (63)$$

Everything indicates that (63) is a universal relation expressing the wavelength of a graviton of a corresponding body (a_{pr} ~ 1.3 × 10^{26}m). The relation (63) allows therefore to determine the graviton wavelength based on the mass of a given body.

For example, the wavelength of a graviton of the Universe as a whole is equal to the Planck length. The wavelength of the gravitons of the Earth is about 10^{-20} m and that of the proton is about 100 km. This conclusion might be of importance for experimenters dealing with a change in gravitational influence at very short distances aimed at submitting an evidence on the existence of an extradimension.

Logically, one can assume that a body may affect gravitationally only at distances longer than the wavelength of gravitons. Other condition states that at the same time, the distance must be shorter than the corresponding effective action range. A simple calculation shows that the object can have a gravitational action radius only if its mass is higher or equal to Planck mass (of the order 10^{-8} kg).

The final note will be devoted to the interesting symmetry between the tensor trace *S* and cosmological time t_U. Their product is always constant or equal to zero. In case of weak fields, only the first tensor component S_{ik} is identified. This component is inversely proportional to the cosmological time and thus $S \times t_U$ is a constant.

In strong fields, e.g. at the black hole horizon, the tensor trace S is equal to zero. It means that the direction of the passage of time is not determined in such strong fields. The same conclusion is valid for quantum mechanics too.

We are aware that it is not actual for our model, but let us put a purely hypothetical question. What would happen if the Universe expansion stops in a future and the Universe will begin to collapse? (This is a scenario with overcritical density). To retain the value of the product $S \times t_U$ constant, the direction of the passage of time would have to change. This might happen only in case of decreasing the Universe entropy. It is conditioned by a decrease in the Universe mass during the collapse (a reverse process to creation). It cannot be definitely rid off if a proportion between mass, space and time is taken into account.

It is not logical that space dimensions will decreased, time dimensions increased and mass remains constant. An idea of squeezing the Universe with the actual mass into Planck dimensions can be ruled out logically and physically. Such an idea is an absurdity and cannot be eliminated even by another absurdity, i.e. singularity.

9: GRAVITATIONAL FIELD QUANTISATION

Motivation for quantifying gravitational field lies in the finding of wave function of gravitational field expressed through a metric. A given wave function must represent a meaningful solution of the Schrödinger wave equation.

We express the absolute value of Einstein – Hilbert action in a dimensionless form using the Vaidya metric and the postulates of the ENU model.

$$|S| = \frac{c^3}{8Gh} \int R \left(-g\right)^{\frac{1}{2}} d^4x = \frac{r^2}{2\lambda_g^2} \qquad (64)$$

where λ_g is

$$\lambda_g = \left(\frac{h a}{2\pi m c} \right)^{\frac{1}{2}} \qquad (65)$$

Now we can establish two wave functions. For classic retarded waves it holds

$$\Psi = \exp\left(\frac{i r^2}{2\lambda_{\mathrm{g}}^2}\right) = \exp\left(\frac{i c^2 t^2}{2\lambda_{\mathrm{g}}^2}\right) \tag{66}$$

From time-depended Schrödinger equation, the total energy of retarded waves E_{ret} emerges as

$$E_{\mathrm{ret}} = \frac{m c^2 r}{a} = E_{\mathrm{g}} N \tag{67}$$

where E_{g} is the energy of a gravitational quantum and N is the number of gravitational quanta passing through the area $4\pi r^2$. It holds

$$E_{\mathrm{g}} = \frac{h c}{2\pi \lambda_{\mathrm{g}}} \tag{68}$$

$$N = \frac{r}{\lambda_{\mathrm{g}}} \tag{69}$$

For advaced waves it holds

$$\Psi^* = \exp\left(-\frac{i r^2}{2\lambda_{\mathrm{g}}^2}\right) = \exp\left(-\frac{i c^2 t^2}{2\lambda_{\mathrm{g}}^2}\right) \tag{70}$$

The total energy of advanced waves E_{adv} is obtained from time-dependent Schrödinger equation

$$E_{\mathrm{adv}} = -\frac{m c^2 r}{a} = -E_{\mathrm{g}} N \tag{71}$$

A body B1 emits retarded waves by the speed of light. If the waves are trapped by a body B2, it emits advanced waves reaching immediately the body B1. This is why the velocity of gravitational influence depends only on the velocity of retarded waves and is equal to speed of light. Standing waves composed from advanced and retarded waves are formed between the both bodies and it allows to transfer the momentum and energy, and thus also gravitational influence. In addition, it holds

$$P = \int \Psi^* \Psi dV = 1 \tag{72}$$

For the potential energy between the both bodies U_{g} we obtain based on eq. (71)

$$U_{\mathrm{g}} = -\frac{E_{\mathrm{g}} N r_{\mathrm{ef(B2)}}^2}{4r^2} = -\frac{G m_1 m_2}{2r} \tag{73}$$

where $r_{\mathrm{ef(B2)}}$ is the effective gravitational cross-section of the body B2, being proportional to the square of its effective range (see eq. (28)).

The body B2 exerts the same impact to the body B1 and thus the total potential gravitational energy between these two bodies is $2U_{\mathrm{g}}$.

Stemming from (69) it follows that $r \geq \lambda_{\mathrm{g}}$, and at the same time it must hold $r \leq r_{\mathrm{ef}}$. Both the conditions are satisfied for the mass $m \geq m_{\mathrm{Pc}}$, where m_{Pc} is Planck mass. For black holes $r_{\mathrm{BH}} \geq \lambda_{\mathrm{g}}$. In case of equality, a mass of the currently lightest black hole is obtained, approaching 10^{12} kg.

Now, the total energy of advanced and retarded waves is derived using the tensor S_{ik}. It holds

$$E_{\mathrm{adv}} = \int S_{00} dV \tag{74}$$

$$E_{\mathrm{ret}} = \int S_{\alpha\alpha} dV \tag{75}$$

where α = 1, 2, 3.

Based on (67), (71), (74) and (75) it follows

$$\Psi^* = \exp(-\frac{2\pi}{ih}\int dt \int S_{00} dV) \tag{76}$$

$$\Psi = \exp(-\frac{2\pi}{ih}\int dt \int S_{\alpha\alpha} dV) \tag{77}$$

Both relations (76) and (77) can be expressed uniformly through a metric.

$$\Psi = \exp(-\frac{2\pi}{ih}\int dt \int g'_{ik} m' c^2 \chi \, dV) \tag{78}$$

In case i = k = 0, the situation represents the advanced waves, if $i=k \neq 0$, the retarded waves are described. (The tensor S_{ik} can be diagonalized and thus only 4 its elements are significant).

In relation (78), $m' = m/a$, $\chi = 1/4\,\pi\, r^2$ and g'_{ik} is the metric tensor of the Vaidya metric exerting its impact on m'.

Current quantum mechanics is based on Gibbs thermodynamic statistics trusting in the theory of random quantity. According to the quantum mechanics understood in such a way, the origin of complex structures, life including, is impossible. If, however, the advanced waves are considered, the feedback is obtained in which the our time may be influenced by both the past and the future. Instead of statistical quantum fluctuations we can expect chaotic fluctuations which permit the origin of complex and complicated forms. At the same time, this approach allows to explain some paradoxes of quantum mechanics, such as a double slit experiment, EPR paradox, or Schrödinger cat paradox.

Relation (69) documents that gravity cannot act in arbitrarily small dimensions and singularities thus cannot actually exist (gravitation cannot function in subplanck dimensions). Advanced and retarded waves are described as probability waves and gravitons only as virtual particles. Any energy and/or momentum transfer can be realized only subsequent a wave functions colaps followed by standing waves origination.

10: THE UNIVERSE WAVEFUNCTION AND WAVE EQUATION

In our ENU model it holds for the Universe wavefunction Ψ_U (when putting $\omega = 1/l_{Pc}$)

$$\Psi_U = \exp\left(-\frac{a^2}{2\, l_{Pc}^2}\right) = \exp\left(-\frac{a^2\omega^2}{2}\right) \tag{79}$$

Since the total energy of the Universe must be zero, it follows from Schrödinger equation that

$$\left(\frac{d^2}{da^2} + X\right)\Psi_U = 0 \tag{80}$$

Ψ_U depends on gauge factor *a.* It follows from (79) and (80) that

$$X = \omega^2 - \omega^4 a^2 \tag{81}$$

and substituting this relation into (80) the Universe wave equation is obtained in the form

$$\left(\frac{d^2}{da^2} - \omega^4 a^2 + \omega^2\right)\Psi_U = 0 \tag{82}$$

which is, in fact, Wheeler-de Vitt wave equation. This eqation can be written in several forms, its meaning is, however, identical.

There are two options in classical quantum gravitation.

1) To intergrate the square of wavefunction over all possible metrics (i.e. over all possible Universes). To increase an importance (weight) of such a metric as to reach high probability of our Universe and low probabilities of the other Universes. The wavefunction constructed in such a way would be arbitrary and inconclusive. This is a penalty for the big bang.

2) To find a classic and definite wavefunction and to integrate its square over the entire spacetime. This wavefunction will be obtained by raising the Euler number to the power of Einstein – Hilbert action. In case of the Vaidya metric its solution nonzero. Such a wavefunction will be of Gaussian shape and following its suitable normalization and integration the probability is equal to one. Integration from zero (big bang) to the infinity could be performed, the result will be a physical absurdity. In this case the big bang itself is an absurdity. The Universe must be timeless, with no boundaries in time and space.

There are two options again. In case of overcricital density of ther Universe, it is alternation of colaps and expansion. This, however, is not our case. Moreover, it doe not offer an answer to the question of primary cause of the Universe formation.

The second option is ethernal expansion of the Universe without the moment of its creation. It can be achieved easily through time changes in some constants preserving the fundamental physical laws. This change in constant values would be undetectable. Going to the past there is no frontier since the Planck quantities would continuously decrease. There would be no need to explain the big bang or initial conditions. The science is still science and religion is religion.

The Universe expansion itself could be attributed to an increase of the gravitational constant in time. The change in the constant would be interpreted as the Universe expansion.

Modifying our wavefunction (79) by substitution $a_x = a \,/\, a_{pr}$ and taking its logarithm, the following relation is obtained

$$\Psi_U = e^{-\frac{\log^2 a_x}{2}} \tag{83}$$

Its advantage lies in dimensionless nature of time and space scales. Moreover, due to high values of cosmological time and gauge factor, it is more illustrative to use logarithmic scale. In addition, the past time (a_x is propotional to time) is negative, the future time is positive and the present time is located in the centre and is of zero value. Substitution $\log a_x = z$ leads to

$$\frac{1}{(\pi)^{\frac{1}{2}}} \int_{-\infty}^{+\infty} \Psi_U^2 dz = 1 \tag{84}$$

In this mode the square of wavefunction may be integrated over the region from minus infinity to plus infinity. The wavefunction covers the entire time interval from the past to future, and its value is of highest value at present time. As time is passing, the wavefunction passes from the left to rigth side as retarded wave. Doing space inversion of the wavefunction, it follows that

$$\Psi_U = -e^{-\frac{\log^2 a_x}{2}} \tag{85}$$

It represents an advanced wave passing back in time. The advances waves represent the amplitude of probability of spacetime creation, the retarded wave the amplitude of probability of energy creation.

In such a situation the entire Universe could be understood as a black hole. We would live on a surface of the horizon, (holographic principle), inside the black hole is our past, outside is our future. Our space would be flat but related to surroundings (future) it would be positively curved (the retarded waves influence the future). Contrary, from the surroundings – future, we would accept the advanced waves which would lead to expansion of our space.

The form of wavefunction (83) can be applied to black holes too (if $a_x = r/r_{BH}$, no singularity exists and the whole reality is limited to the horizon surface, which holographic principle). Any black hole in our Universe can represents at the same time also the past Universe. Creation in black hole and associated increase in its horizon would be thus identical to ENU expansion. It should be pointed out that there are different units of time, space and mass. From the viewpoint of a black hole it would represents the expansion at the velocity of light. The universe can thus be not only potentially infinite but also really infinite, even if its local regions are limited by horizons. In this case also conditions suitable for life would last for ever. They will be associated with the existence of black holes.

Note:

To be clear, while the wavelength of gravitational field (78) is always local (located in a near space, in the field of effective gravitational influence), The wavefunction of the Universe (79) and(83) is always global (distributed in the entire timespace).

12: MATTER, SPACETIME AND GRAVITY

The ENU model is based on a pressumption stating the matter is created by retarded waves propagating in the x-direction from the left to right. Making a spatial inversion of these waves, advanced waves are obtained (propagating in the reverse time direction), the phase of them being shifted by a π. The waves do not interfere since they propagate oppositely in time.
Definition: Spacetime and matter are formed by advanced and retarded waves with a phase shift equal π. Gravity (and every other force influence) is an attempt to bring both wave kinds to a common single phase. Gravity, therefore, is able to cause a shift of both waves in a range $\alpha = (\pi - 0)$. There are three distinct cases possible:
i): there is no gravitation, $\alpha = \pi$. In such a case it must valid

$$\sin\frac{\alpha}{2} = 1 - \frac{2Gm}{rc^2} = 1 \tag{86}$$

For such situation it follows $m = 0$.
ii): there is an impact of gravitational, $\pi > \alpha > 0$. In such case, $0 < \sin\alpha/2 < 1$ and thus $m > 0$.
iii): An extreme impact of gravitation (formation of black holes), $\alpha = 0$. Then $\sin\alpha/2 = 0$ and which leads to $r = r_{grav}$. The advanced and retarded waves are in the equal phase and interfere. In this stage the time and space are closed which represents a black hole formation.
Using α and relation (86) it is possible to derive the metric tensor g_{ik}. It holds for weak fields

$$g_{00} = -\sin\frac{\alpha}{2} \tag{87}$$

$$g_{11} = g_{22} = g_{33} = \sin\frac{\alpha}{2} \tag{88}$$

Schwarzschild metric can be expressed in the form

$$ds^2 = -\left(\sin\frac{\alpha}{2}\right)c^2dt^2 + \left(\sin\frac{\alpha}{2}\right)^{-1}dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right) \tag{89}$$

It is supposed that at any force impact there is a resistance againts phase reduction. This resistance cen be identified with inertia.

We know four kind of physical interactions. As for electromagnetic interactions, their total energy is balanced due to a equal number of positive and negative charges. It is generally supposed that the energy of short-distance interactions is balanced due to the existence of supersymmetric particles. The energy related to the matter is balanced by spacetime (retarded and advanced waves). Gravity is not a real interaction, it is just a consequence of spacetime curvature. According to our definition, it is an effort to reduce phase shift between timespace and matter.

This is a reason of why our tensor S_{ik} represents the total field. It is a generator of matter and spacetime of the total zero energy. The possibility of the parallel existence of matter and spacetime is realized just due to an opposite phase of advanced and retarded waves which cannot interfere (the exemption are black holes).

At the end it seems to be worth mentioning the structure of matter as following from our model. Let us introduce tha factor K as

$$K = \cos\varphi \tag{90}$$

For the particles, $\varphi = 0$ i.e. (K = 1), for the antiparticles $\varphi = \pi$ (K = –1), for bosons and antibosons $\varphi = \pi/2$ (K = 0) and $\varphi = 3\pi/2$ (K = 0), respectively. The angle represents the rotation of retarded waves around *x*-axis. The sum of K for tha particle and antiparticle is 0 (annihilation), the sum of K for two particles and antiparticles is 2 and –2, respectively. It means, the corresponding particles are preserved at mutual interaction. The same conclustion is valid for the systems of boson + antiboson. The sum for two bosons (antibosons) is 0, i.e. bosons mutually do not interact. It is in accord with Feynmann diagrams. Theoretically, there might exist an advanced particle (boson) with $\varphi = \pi/2$ and $\varphi = 3\pi/2$ which would represent the tachyon and its antiparticle.

ELEMENTARY PARTICLES

12: WEAK INTERACTIONS AND THE AXION

The cross-section of weak interactions σ can be expressed in a simple mode as in [10]

$$\sigma \cong \frac{g_{\mathrm{F}}^2 E_{\mathrm{w}}^2}{\left(\frac{hc}{2\pi}\right)^4} \tag{91}$$

where g_{F} is the Fermi constant and E_{w} is the energy of weak interaction.
The relation (91) leads to

$$E_{\mathrm{w}} \cong \frac{r\, h^2 c^2}{4\pi^2 g_{\mathrm{F}}} \tag{92}$$

In limiting case, the Comptom length ($\lambda = r$) of vector bosons Z and W can be expressed as

$$\lambda = \frac{h}{2\pi\, m_{\mathrm{w}}\, c} \tag{93}$$

where m_{w} is the bosons mass.

The maximum energy of weak interactions E_{w} could reach

$$E_{\mathrm{w}} \le m_{\mathrm{w}}\, c^2 \tag{94}$$

The bosons mass can be expressed stemming from (92) to (94) as follows

$$m_{\mathrm{w}}^2 \cong \frac{h^3}{8\pi^3 g_{\mathrm{F}} c} \cong (100\ \mathrm{GeV})^2 \tag{95}$$

Let us try to unveil the common points of gravitational and weak interactions. We are trying to find a limiting mass at which the absolute value of the gravitational energy is equal to E_{w} , i.e.

$$\left|\int \varepsilon_g dV\right| = E_{\mathrm{w}} \tag{96}$$

Based on (92) and (96), the limiting mass is as follows

$$m_{\mathrm{lim}} \cong \frac{a_{\mathrm{pr}} h^2}{4\pi^2 g_{\mathrm{F}}} \tag{97}$$

Identifying this limiting value with Planck mass m_{Pc}, a value of the scale factor a_{x} appears

$$a_{\mathrm{X}} \cong \frac{4\pi^2 g_{\mathrm{F}} m_{\mathrm{Pc}}}{h^2} \cong 10^{-2}\ \mathrm{m} \tag{98}$$

To this scale factor, the cosmological time about 10^{-10} s corresponds, which is a time of separation of electromagnetic and weak interactions. Substituting a_{pr} for the shortest length l_{Pc} in (97), we obtain the minimum possible rest mass of an elementary particle approximately as 10^{-5} eV. We suppose the particle is the axion.

13: HIGGS BOSON MASS DETERMINATION

Stemming from the previous part, an interesting opportunity to come to a more general conclusions concerning the mass of particles is offered. Of the whole mass spectrum we know limiting masses, i.e. the lighest and heaviest particles. We might be able to develop a formula including the mass of all known and even currently unknown particles. We suggest, the formula might have the following form

$$m_{(N)} = m_{Pc} e^{KX_{(N)}} \quad (99)$$

where $m_{(N)}$ is the rest mass of a particle, m_{Pc} is the Planck mass, K is a constant and $X_{(N)}$ is the variable attributed to a corresponding particle. The value of $X_{(N)}$ is 0 for the Planck particle and 1 for the axion. Based on the known value of m_{Pc} and the estimated value of the axion, using the relation (99) we can determine the value of K (its estimated value is –77). It can hardly be a pure coincidence that the value of K is close to the numerical value of the natural logarithm of Planck constant, ln(h/2π). Putting K and ln(h/2π) identical, the exact value of K is obtained. Due its fundamental importance it deserves a special attention. Its value is

$$K = -78.23475 \quad (100)$$

An idea enters the mind. Theoretical physics is expecting appearance or theoretical evidence of a new particle called the Higgs boson. This boson must have a mass of some hundreds GeV, i.e. it should be heavier than bosons Z and W. Higgs boson is responsible for the existence of the mass of all elementary particles. It is justifiable to anticipate that the position of the Higgs boson should be somewhere in the geometric centre of the mass spectrum of all particles. This boson should be characterized by the value X = 0.5 in (99). Provided that it is a case, the relation (99) leads to its mass,

$$m_H = 125{,}39 \text{ GeV} \quad (101)$$

A close value was preliminary reached in CERN in December 2011 [11].

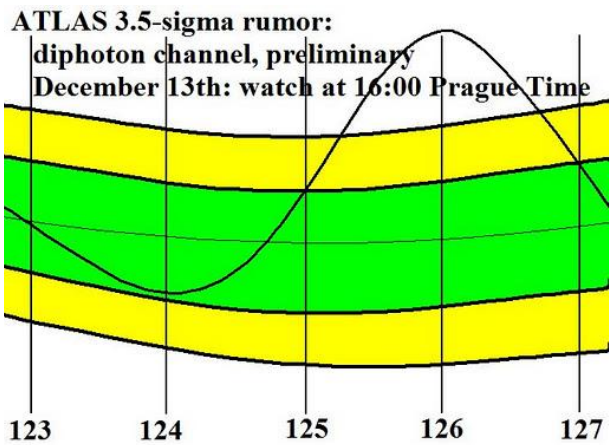

Fig. 6 *Preliminary results – CERN (from Motlsblogspot, December 2011)*

Taking the known value of K into account, the axion mass can be calculated as

$$m_{ax} = 1.28 \text{ x } 10^{-6} \text{eV} \quad (102)$$

This value is in good accord with predictions.

When considering the masses of the known particles, they approach to the geometrical center occupying by the Higgs boson. We may suppose the analogous mass spectrum distribution also on the other side following the Higgs boson mass (they might be supersymmetrical particles). This distribution looks like Gaussian normal distribution (in fact only a half of it since we do not know any particle with its mass higher than that of the Higgs boson). This is why one cannot excluded the situation that with the exception of Planck particle, Higgs particle and axion, the other particles will be theoretically non-estimatable. Their mass would be – of course in some limits – determined through random Hermitean matrix.

14. THE FUTURE OF THE UNIVERSE

The Universe development is illustrates in Figure 7. The axes *x* and *y* represent the cosmological time and the Universe dimensions, respectively. The beginning of the expansion lies in the point 0. Our current position is represented by the point P. The universe boundaries form a causal horizon in the form of a light cone.

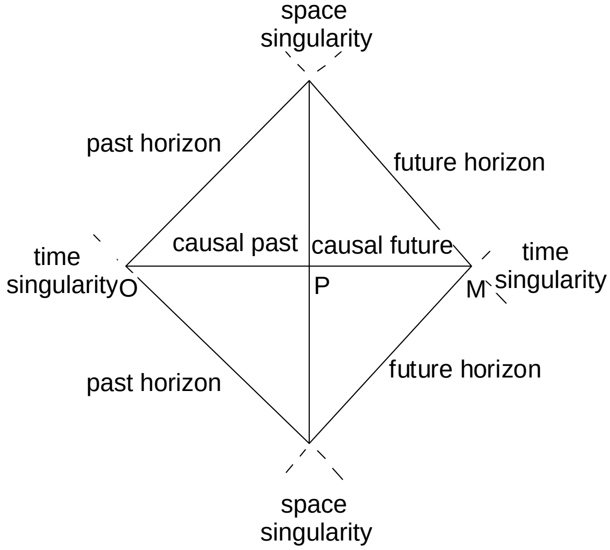

Fig. 7. *A chart of the Universe evolution*

The future causal horizon can be underwood as follows. At the time being, we are able to influence our nearest future. We may take a decision what to do tomorrow and fulfil the decision. The further is the scheduled future, the less possibility is to affect it. If the current Universe is governed by a single wish, it can be planned and influenced only up to the point M, which is a maximum cosmological time t_{max} for us. There is no meaning to evaluate the future beyond this limit.

The angle of a future causal horizon and the time axis is β. It must hold

$$\beta = \frac{a_{pr}}{ct_{max}} \tag{103}$$

We know that in the ENU, the scale factor is identical with the Universe effective range. It means that gravitational force does not effect or, in other words, its impact must be minimal. The extent of a minimal gravitational effect can be determined.

The lightest object able to exert a gravitational effect on its environment is the particle of Planck mass (~10^{-8} kg). If such a particle exerts its effect in a maximum possible distance (a_{pr}) we have a guaranted minimum gravitational influence on the Universe as a whole. This minimum effect may curve the worldline of photons and focus them into a single point. This point represents a future singularity, i.e. the end of the time (maximum cosmological time). The angle of the curving is, of course, β and relativistic solution of its calculation is

$$\beta = \frac{l_{Pc}}{a_{pr}} \tag{104}$$

Equations (103) and (104) lead to maximum cosmological time of the value about 10^{71} years.

The most interesting idea is that at the time being, 13.7 billions years after the Big Bang, we are just in the geometric centre between the beginning of the expansion of our Universe and the maximum cosmological time. It might seem that we are living in a priviledge time. We are, however, in a strong opposition to such privilege and in no case we believe in such an unbelievable coincidence. It seems that any observer in any time will perceive it in the same way. Any observer in the past and in the future will perceive identically as we do now. Any of them will seem to live just in the geometric centre between the Universe beginning and its end. It should be pointed out that for all observers the same physical laws are in force. If, however, the physical laws are unchangable, certain physical constants are to be changed or evolved. This idea has unimaginable consequences for our Universe and a deeper understanding of the physical reality.

The physical laws do not involve the time direction and thus, what is valid for the Universe end must be valid also for its begenning. Going back in time, the initial point of the Universe creation would evade into infinitely small dimensions and we could never see the Big Bang.

The Universe beginning is thus nothing but an illusion. The Universe has no beginning and will have no end. It is an eternal and objective reality. It is not possible to determine either the reason or the mechanism and initial conditions of its beginning. From the viewpoint of the ENU model, the question of the Universe origin does not represent an issue to be solved.

Let us inspect the dimensionless constants of the fundamental physical interactions.
The strong interaction constant α_s,

$$\alpha_s = 1 \tag{105}$$

Dimensionless constant of electromagnetic interaction α_{em} is

$$\alpha_{em} = \frac{e^2}{2\varepsilon_0 hc} = \frac{1}{137} \tag{106}$$

For the constant of the weak interaction α_w it holds

$$\alpha_w = \frac{8\pi^3 g_F m_p^2 c}{h^3} = 10^{-6} \tag{107}$$

Constant of the gravitational interaction α_g is

$$\alpha_g = \frac{2\pi G m_p^2}{hc} = 10^{-38} \tag{108}$$

In eqs. (107) and (108), m_p is the proton mass.

There are several possibilities of changing certain constants while preserving values of dimensionless physical constants. The simplest way on how to change the constants is to accept an increase of G and g_F in time and put the Boltzmann constant k and the rest mass of elementary particles time evolution as $(1/t)^{1/2}$.

This would explain the Universe with no beginning and no end. The proportions of the physical interactions would be preserved, Planck length and Planck time would increase and Planck mass would decrease. Such a change in the Planck quantities would shift the moment of the Universe origin in dependence of the observer position in the time axis. Such time axis would be thus relative. In case such changes are accomplished simultaneously, there is practically no possibility to register them. Some authors consider the change in constants too [12].

In the following part we explain the mode of realization of this unobservable change and its impact on the matter creation in the Universe.

15. CHANGE OF CONSTANTS AND THE UNIVERSE

As given in Fig. 8, when passing to the left, the number of particles decreases but their energy increases (to infinity in infinitesimally short time). Passing to the right, the energy of particles decreases but their number increases. The energy of the Planck particle is converted to the creation of new particles.

The level of creation depends on the cosmological time. At the initial part of the time axis the Planck partile energy decreases rapidly, i. e. an increase in the number of newly created particles is high. At the time being, the decrease of the curve is slower, i. e. the creation is slower. The distance of the gauge factor value from Planck length, is continuously increasing, still is, however, finite (it will become infinite in infinite time). The Planck particle is, however, during the whole cosmological time, characterized by the identical mass (10^{-8} kg) and length 10^{-35} m. We are not able register a decrease in its mass and increase in its length. What we are able to register is an increase in the number of particles and thus matter of the Universe. In infinity time the whole infinity energy of the Planck particle will be converted to infinity mass (an infinity number of light particles of the Universe).

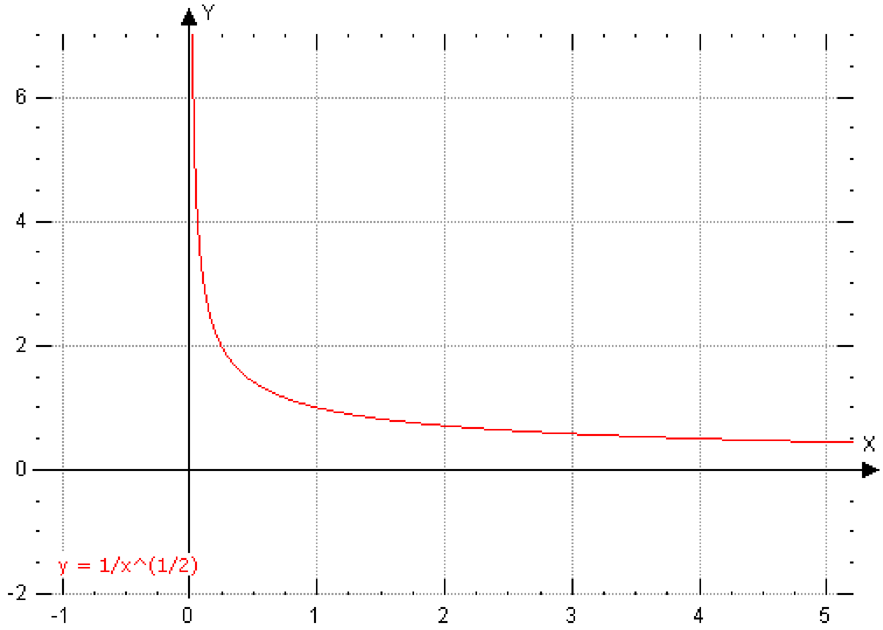

Fig. 8 *Dependence of the energy of Planck particle (and other elementary particles) on cosmological time (the particle energy is proportional to* $1/\sqrt{t_U}$ *).*

In the ENU model, the total Universe energy is equal to zero due to tha fact that the energy of matter is compensated by negative gravitational field at any moment.

Mechanism of constants change

The principle is that the decrease of the energy of elementary particles is just compensates by the energy of newly formed particles. The total energy is thus preserved. We can observe neither an increase in the units such as meter and second nor a decrese of kilogram. It happens in the same way as an increase of the Planck wavelength (and the wavelength of the other particles) which is also unobservable. The above mentioned units are relative. What we are able perceive is the Universe expansion and matter creation. In the ENU model, equation (10) holds. Inspecting the equation in more detail, it is obvious that e.g. 100 times higher observed increased the Universe dimentions is related to 100 times “increase” of its mass. The mass increase is, however, only ostensible. In fact, it is gravitational constant *G* which increases (and number of elementary particle increases). It is possible to suppose that the Universe expansion is only illusory.

We know that the creation is proportional to the cosmological time. As documented by Fig. 8, the creation is slower at the time being. The reason lies in a relative prolongation of second and simultanouos decrease of kilogram. A straight line representing the dependence of creation on time in the ENU model adopts the shape of curvature due to a prolongation of the time axis and shortening the mass axis. This curvature is identical to the curvature expressing dependence of the wavelength of elementary particles on cosmological time.

Note:

When $t_U \approx 10^{130}$ years, our present Universe with the following parameters 10^{26} m, 10^{18} s, 10^{53} kg, 2.7 K will be, due to changes in some unit values (kg, m, s) understood as Planck particle with the following parameters 10^{-35} m, 10^{-44} s, 10^{-8} kg and 10^{32} K). This scale evolution is of continuous nature. Any time in the future will be understood in a farther future as Planck time.

Note: Philosophical consequances of the ENU model
SCIENCE AND RELIGION

There is no space for big bang in the ENU model. A question arises here whether it is somehow associated with the faith in God. The question is supported by the fact that some people and scientists interpret the big bang as a God's intervention, since physics has not been able to explain it. In our opision, the nonexistence of big bang has no impact on the faith in God. All emerging scientific quastions will be solved by science. Science and religion are analoguos to two straight parallel lines. Their crossing is only illusion. Science should not comment to the issues of faith and faith should not try to dictate what is and what is not possible.

CONCLUSIONS

At the end of this contribution we propose our view of four fundamental physical paradigmas.
1: Physical laws are invariant – this is true.
2: The values of constants are invariant – false (some of them change, ther changes cannot be, however, verified).
3: Fundamental units such as s, m, kg, are invariant – false (once more, cannot be verified).
4: The Universe expands: is can be true. There is, however, also possibility that it is only illusion resulted from change of some constants. Then, the Universe "expansion" and matter "creation" would be the only (indirect) evidence of the change of the constants. It would mean that the Universe is just a simulation (a matrix, hologram, or software).

It seems to be worth summing the results obtained applying the ENU model and submitting some predictions which can be verified experimentally.

- The ENU model explain in a very simple way the existence of dark energy as a pure illusion;
- Axions are offered as a most suitable candidate for dark matter;
- A decrease of specific entropy in time is predicted;
- To describe the Universe, the Vaidya metric is applied, and Newton potential is replaced by Yukawa potential in case of weak fields;
- The ENU model documents the impossibility of the total evaporation of a black hole ensuring simultaneously the preservation of the information contained in the black hole;
- The ENU model establishes the Universe wave function.
- The ENU model provides an appropriate framework for quantum cosmology and quantum gravity;
- The ENU model allows to localize the energy of gravitational field and eliminates singularities;
- The ENU model determines the wavelength of gravitons and effective range of gravitational impact. It permits, at the same time, to formulate a prediction that in the Earth gravitational field there cannot be observed changes in gravitational law over 10^{-20} m;
- The ENU model predict the mass of the Higgs boson (125,39 GeV) and that of the axion ($1{,}28 \times 10^{-6}$ eV), as well as a value of the neutron dipole moment ($1{,}8.10^{-30}$ e·cm). This prediction is of fundamental importance for the ENU model.
- The ENU model anticipates a proportional change in time of certain constants eliminating thus a necessity to explain the Universe origin. The Universe is timeless, can be neither created nor disappeared;

At present, we are expecting the phase of key importance for physics and cosmology development. We will follow the LHC experiments performed in CERN, laser interferometer LIGO should finally trap gravitational waves, lauching of new space probes is under preparation to better understand the nature of dark matter and dark energy. Experts in string-related issues are proposing new ideas and conceptions. The research covering theory M, which might be, according to many of those enganged in the field, a dreamed and long time expected ultimate theory, is under way.

Appendix. Creation, change in constants, dark energy

In our model we suppose that, e.g. a 100 times increase in the gauge factor is related to 10 times increase of distance unit (m) and time (s), and 10 times decrease of mass unit (kg). These changes are unobservable. The mass of any elementary particles 10 times decreases too, the fact which is also unobservable. The number of elementary particles 10 times increases, which is, however, observable (in the ENU model it is matter creation, in the inflationary model it represents the matter appearing from the horizon). The amount of matter is not, in fact, changed. In reality, the gravitational constant 100 times increases (see equation 10). Due to changes in timespace and mass units, we are not aware of this consequence and the given increase is related to 100 times increase in the Universe matter. Through creation, the number of particles increases only 10 times. This discrepancy in the matter can be a basis for explanation of the dark matter. Owing to unobservable increase of the gravitational constant, we attributed to the Universe more matter as it in reality contains. This missing matter cannot be seen. It is just a phantom matter, or in the other words, the dark matter. This is a reason of our observing stronger gravitational forces without finding corresponding amount of matter. Such a redundant gravitation can be observed predominantly for smaller galaxies with a high mass density. Dimensions of greater systems approach their gravitational radius and their density is close to the critical density. Beyond the effective radius the gravitational impact is minimal and there is no space for a supplementary phantom gravitational influence.

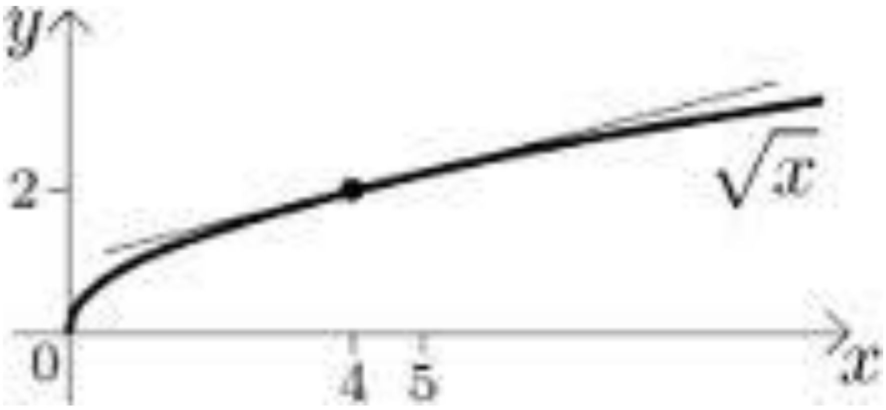

Fig. 9 *Dependence of actual creation of the cosmological time*.

In the ENU model there is a dependence of the amount of created matter (*y*-axis) on the cosmological time (*x*-axis) in the form *y* = *x*. (Following normalization and putting $\delta = 1$, it follows that $m_U = \delta . t_U$). However, reducing *y*-axis (decreasing the mass unit) and prolongating *x*-axis (increasing the time unit), the dependence exhibited in Fig 9 is obtained (a parabola describing by $y = \sqrt{x}$).

The actual creation is thus smaller then it seems to be based on the gauge factor. This difference might explain the phenomenon of dark matter. Moreover, increasing the cosmological time also the amount of "dark matter" will increase.

Based on current accepted estimations (cosmological time 1.37×10^{10} years, 4% of baryonic matter in the Universe) it can be calculated that the phantom matter (dark matter and dark energy) appeared in the cosmological time 2.19×10^7 years as dark matter. Passing the time, the share of dark matter will increase approaching 100%. It does not represent, however, the end due to a simultaneous formation of new universes (black holes). At present we do not have any definite candidate for dark matter (it might be axions).

The idea of phantom matter is supported by an important fact. Based on current models, simulations and analyses, dark matter began to aggregate about 20 millions year after the big bang [13, 14]. This is in good accord with our value 2.19×10^7 years (at the value *x* = 1 in Fig. 9).

Fig. 8 enable to explain also the matter creation before the time 2.19×10^7 years. There is sharp decline of the Planck particle energy at the beginning of the time axis. It is thus evident that there was a more intensive creation of particles then given by the product of $\delta . t_U$. This oversized creation is present exactly to the cosmological time 21.9 million of years. It is obvious also from the shape of parabola (Fig. 9), the y-axis of the parabola is higher that corresponds to the value of *y* = *x* at the beginning. Just in the time 21.9 million of years both parameters adopt the same value. After that, the real creation is lower than corresponds to $\delta . t_U$. This is the moment of appearance of illusive dark matter.

The ENU dynamics is constant in practice. The initial overproduction of matter is compensated by a mild increase in pressure and temperature, accompanied by the equivalent of gravitational constant decrease. The current deficiency of matter is compensated by a relative increase of its *G* value. To preserve the ENU dynamics, relation (10) must be valid. This is why the formation of first matter structure held by gravitation began at the initial deficiency of matter creation and is attributed to hypothetical dark matter.

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