Nondecelerative Cosmology: Background and Outcomes.

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ABSTRACT

This survey consists of six parts and appendices. Following the introduction, the nondecelerative model of the Universe is analyzed. Its parameters, characteristic features, thermodynamics, and metrics are presented. To localize gravitational energy, the Vaidya metric is applied. It is demonstrated that this metric can help in describing gravitational field near the black holes horizon. The questions of dark energy are disputed.

In the third part of this paper, the issue of quantum cosmology is reviewed and stemming from the Vaidya metric, a true energy-momentum tensor complying with the nondecelerative model is derived.

The forth part of our paper is devoted to elementary particles; in particular, the mass of Higgs boson is calculated. It is supposed that the masses of elementary particles are determined by random Hermitean matrix and cannot, in principle, be obtained by theoretical independent calculation.

The fifth part deals with physical constants and eventual consequences of their time evolution. While the main conclusions and suggestions provided by the ENU model are summarized in the sixth part. In the paper's Appendix, the mode of quantification of gravitational field by means of the ENU model is given.

(Keywords: nondecelerative Universe, Vaidya metric, black holes, dark energy, quantum gravity, Higgs boson, ENU)

INTRODUCTION

In present times we act as witnesses to unbelievable progress in science and technology. Scientific knowledge penetrates into practice at an unprecedented rate. The volume of information is increasing and science is characterized by still narrower specialization. There is no doubt that mathematics and physics represent the alpha and omega of scientific research.

The interest of the lay public in the latest scientific knowledge is growing. Of course, the more scientific knowledge we have, the more unresolved and unknown problems emerge. Also at present, along with facing the everlasting topics, a huge amount of new questions appear and science is trying to unveil answers. The open questions may be exemplified by the following themes:

- How and why the Universe originated;
- What is the essence of dark matter and dark energy;
- What will be the fate of the Universe in the future, and less philosophically and more specifically, is it possible to unify the theory of relativity and quantum theory;
- Would it be possible to develop a theory providing the mass of each elementary particle;
- Are there any extra-dimensions;
- Could it be possible to control antigravity, etc.

These are only a few questions both experts and laymen are currently interesting in. In spite of indisputable achievements having been reached by cosmology within the last decade, our image of the Universe has become notably more complicated. Besides the known and visible baryonic matter accounting only for 4%, there is 23% of invisible dark matter and unknown dark energy forming about 73% of the total mass of our Universe. Efforts to understand and explain the dark energy have failed up to now. If the Einstein cosmological constant Λ is responsible for the Universe acceleration, the acceleration should be more pronounced and the ratio of pressure to energy density should be equal to –1 (currently accepted estimations vary about –0.7).

At the same time, theoretical estimations of the cosmological constant lead to values higher by several orders when compared to the observed values. The situation concerning the quintessential model is even worse. It is not clear what is the gist of dark energy; why it comes to effect so late; whether it will act also in the future; and if so, in what extent and intensity? There are several question surfacing and there is not a flicker of scientific theory able to offer sound and logical answers.

Dark energy has introduced a high level of complexity if not a chaos into our conception of the Universe. Such a complex picture is in contradiction with the principle called Occam's Razor ("Invent no unnecessary hypotheses") or with the sense of Beysian analysis - models with fewer free parameters are preferred. It is evident that something important is outside of our knowledge. Something, we are not able to clearly formulate. Taking this aspect into account, any prediction on the future fate of our Universe seems to be just a spine-chiller.

In case of continuation of the acceleration the Universe expansion, cosmic objects will gradually disappear from our range of vision. At first those outermost located and subsequently those located nearer. It is a paradox, the older our Universe becomes, the smaller (relatively) will become our horizon.

If, in the future, an intelligent life originates in such a Universe, it could not imagine any idea on the structure of its Universe, on its dynamics, future, and even on its past. It becomes obvious that such a scenario must be unacceptable for scientific thinking. Moreover, there is a further unbelievable coincidence. Currently we are living in a privileged era when a past deceleration of the Universe is exactly compensated by just occurring acceleration of this expansion. Strangely, if we live in the past or in the future, such coincidence would not exist.

The existence of a privileged space or time contradicts to the Copernicus principle. Such a unique coincidence is not just probable. There is no adequate and justifiable theory of dark energy phenomenon and explanation of the phenomenon is still missing. An acceleration of the expansion will to have lead in the future to an absurd relative diminution of the horizon, the basic scientific principles will be breached and this represents only a tip of iceberg of the problems in current cosmology.

Another problem is even more fundamental. Any acceleration of the Universe expansion casts doubts on the inflationary model. The matter emerging from beyond the horizon at a deceleration of the Universe expansion would become back hidden beyond the horizon at the expansion acceleration. The situation is “saved” only by our “privileged” era.

If the idea of the Universe which decelerated and subsequently accelerated its expansion is substituted for the idea of a nondecelerative expansion (by the constant velocity of the expansion equal to the speed of light) of the Universe, among other issues, the question of dark energy may be elegantly solved. This contribution is devoted to such a solution and to other consequences of nondecelerative expansion of the Universe.

NONDECELERATIVE UNIVERSE

Characteristics of Nondecelerative Model

Based on a generally accepted premise that the Universe is a dynamic and expanding system, its expansion may be, in principle, decelerated, accelerated, steady-state with an expansion rate lower that the speed of light, constant with an expansion rate equal to the speed of light, or with an expansion rate changing over the Universe evolution. Any of the modes of the Universe expansion has been evaluated theoretically and some actual or illusive experimental evidence found. Our model of the Universe expansion (Expansive Nondecelerative Universe, hereinafter ENU) and its consequences are 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:

$$\Lambda = 0 \qquad \textbf{(1)}$$

where Λ is the cosmological constant,

$$k = 0 \qquad \textbf{(2)}$$

where k is the curvature, and

$$a = c \cdot t_U \quad \textbf{(3)}$$

where a is the scale factor, c is the speed of light in vacuum, t_U is the cosmological time (their present ENU-based values are following: $a \cong 1.229 \times 10^{26}$ m; $t_U \cong 1.373 \times 10^{10}$ 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 [1-8]. Introducing a dimensionless conform time the equations can be expressed as follows [9]:

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

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

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

$$a = \frac{da}{d\eta} \quad \textbf{(6)}$$

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

$$\varepsilon = \frac{3c^4}{8\pi G a^2} \quad \textbf{(7)}$$

$$p = -\frac{\varepsilon}{3} \quad \textbf{(8)}$$

The energy density can be expressed also in the form:

$$\varepsilon = \frac{3m_U c^2}{4\pi a^3} \quad \textbf{(9)}$$

where m_U is the mass of the Universe ($m_U \cong 8.673x10^{52}$ kg).

Combining Equations (7) and (9), one obtains:

$$a = \frac{2G\, m_U}{c^2} \quad \textbf{(10)}$$

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:

$$\delta = \frac{dm_U}{dt} = \frac{m_U}{t_U} = \frac{c^3}{2G} \quad \textbf{(11)}$$

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 account. 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 thus in compliance with a Hawking's statement that the total mass-energy of our Universe must equal precisely to 0 [10]. 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 as an absolute system, no measurable quantity (mass, energy, charge, momentum, etc.) may be added to it. 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 contradiction with the reasoning on the Universe as an absolute system.

At the time being, the majority of cosmologists are convinced about a zero curvature of our Universe and a number of those believing in the finity of such a Universe, is gradually increasing. The same conclusion can be applied to the ENU, too. Explanation of it may be provided using topology.

Thermodynamics of Nondecelerative Universe

The thermodynamics of the Universe is, in general, dictated by which form of energy dominates it - relativistic particles which are referred to as radiation with the rest mass equal to zero or negligible compared to their energy and moving at the speed of light or very close to it; or non-relativistic particles which are referred to as matter with kinetic energy much lower than their rest mass and moving thus much slower than the speed of light.

The Universe is a dynamic system described by Friedmann equations. It has a certain energy density, entropy, pressure, and temperature. Within the Universe expansion, the values of these parameters have changed. The mode of their predicted change depends on the model of the Universe dynamics. In this part, we will compare the inflationary and ENU models, limiting discussion to the issues of the time evolution of energy density, temperature and entropy.

Until the end of radiation-dominated era it was not possible to differ these two models, however, the 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 3,000 K to the present 2.74 K, and the value of specific entropy (10^9) has kept constant. In the inflationary model it holds for the temperature T and energy density ε_{rad} of radiation:

$$T \sim \frac{1}{a} \qquad (12)$$

$$\varepsilon_{rad} = \frac{4\,\sigma\,T^4}{c} \qquad (13)$$

$$\varepsilon_{rad} \sim \frac{1}{a^4} \qquad (14)$$

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

$$T \sim \left(\frac{1}{a}\right)^{\frac{3}{4}} \qquad (15)$$

$$\varepsilon_{rad} \sim \left(\frac{1}{a}\right)^{3} \qquad (16)$$

The ENU model leads to the current temperature and radiation energy density values. Based on relations (15) and (16), specific entropy value S_{sp} depends on the Universe scale factor a as follows:

$$S_{sp} \sim \left(\frac{1}{a}\right)^{\frac{1}{4}} \qquad (17)$$

Its value had to decrease from 10^9 at the end of the radiation-dominated era to the present value 10^8. Relations (15) to (17) differ due to the Universe mass creation and additional heating of Nondecelerative 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 fails 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. The situation is saved by a strange coincidence that we are living in a privileged time when the consequences of the previous deceleration of expansion are just balanced by its present acceleration.

The situation concerning the inflationary model is even worse when analyzing the specific entropy value. The majority of cosmologists suppose 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.

Metric

When dealing with cosmological issues, a choice of the metric is of a crucial importance. Properties and application fields of individual metrics are thoroughly reviewed in [11, 12].

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 [10] 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, the Einstein equation:

$$R_{ik} - \frac{1}{2} g_{ik} R = \frac{8\pi G}{c^4} T_{ik} \qquad \textbf{(18)}$$

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

$$\varepsilon_g = -\frac{c^4}{8\pi G} R \qquad \textbf{(19)}$$

When applying Schwarzschild metric for vacuum, (19) becomes equal to zero. In the ENU model, matter is created and thus Vaidya metric [13, 14] should be used. In this metric the line element is expressed as:

$$ds^2 = \left(\frac{d\Psi}{c\,dt}\right)^2 \frac{1}{f^2{}_m} \left(1 - \frac{2\Psi}{r}\right) c^2 dt^2 - \left(1 - \frac{2\Psi}{r}\right)^{-1} dr^2 - r^2 \left(d\theta^2 + \sin^2\theta\, d\varphi^2\right) \qquad \textbf{(20)}$$

where f_m is an arbitrary function and Ψ is:

$$\Psi = \frac{G\,m}{c^2} \qquad \textbf{(21)}$$

At the same time, in the ENU model must be:

$$\frac{d\Psi}{c \cdot dt} = \frac{\Psi}{a} \qquad \textbf{(22)}$$

Using relations (20) to (22), scalar curvature R is obtained as:

$$R = \frac{6G}{c^3 r^2} . \frac{dm}{dt} = \frac{3 r_g}{a r^2} \qquad \textbf{(23)}$$

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 (19) and (23) one can obtain:

$$\varepsilon_g = -\frac{3 m c^2}{4\pi a r^2} \qquad \textbf{(24)}$$

The relation (24) 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 (24):

$$r_{ef} = \left(r_g a\right)^{\frac{1}{2}} \qquad \textbf{(25)}$$

Non-relativistic gravitation potential can be thus express as:

$$\Phi = \Phi_0 \exp\left(\frac{-r}{r_{ef}}\right) \qquad \textbf{(26)}$$

where,

$$\Phi_0 = -G\int \frac{\rho}{r} dV = -\frac{G\,m}{r} \qquad \textbf{(27)}$$

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

The hierarchical structure of astronomical objects is well known beginning with star systems as the smallest objects, passing through galaxies, galaxy cluster up to super-clusters 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 super-clusters 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.

At the end, we would like to attract attention to one interesting fact. The surface temperature of our Sun is about 5,500 K and that of its corona is 10^6 K. The mechanism of the corona heating is not still fully understood. We are able to propose an explanation. An average value of the magnetic field of our Sun is of the order of 10^{-4} T. In the areas of solar spots, this value can increase by some orders reaching 10^{-1}T.

Applying the Vaidya metric we can determine the absolute value of the gravitational energy density on the Sun surface. When we know the magnitude of the Sun magnetic field, the magnetic energy density can be determined. Both the values are identical at 0.05 T. It is in the region of solar spots and thus interference of the both fields may occur. The role of mediator can be played by electrons near the Sun surface, where the gas is completely ionized.

The whole problem is then reduced to a simple task of finding such a concentration of electrons in the vicinity of the Sun at which the electrons have (at 0.05 T) identical value of plasma and precession frequency. A very simple calculation led to a condition 10^{16} electrons in a m^3. This is exactly their concentration in the solar chromosphere which is the area between the photosphere and the corona. We think that vibrating electrons in the chromosphere at 0.05 T form interference pulse propagating into the corona. Thus, the corona particles play the role analogous to that of the weight at Podkletnov's experiments [15]. The corona particles gain kinetic energy in this way resulting in the corona heating. This is a possible mode of increase of the corona temperature by the Sun gravitational field through magnetic field.

Black Holes

The issue of black holes may be considered and understood from various viewpoints [16]. 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, and as 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_{ar} can approach but cannot exceed the absolute value of the gravitational energy density of the black hole, (i.e. as a maximum):

$$\left|\varepsilon_{\text{g}}\right| \sim \varepsilon_{\text{ar}} \qquad \textbf{(28)}$$

The relations (13) and (24) lead to the maximum temperature of the accretion disc and 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:

$$\left|P_g\right| = \frac{d}{dt}\int \frac{c^4}{8\pi G} R.dV = \frac{m_{BH} c^2}{t_U} \qquad \textbf{(29)}$$

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:

$$P_{evap} = \frac{h c^2}{2\pi r_{BH}^2} \qquad \textbf{(30)}$$

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. Making (29) and (30) equal, one obtains:

$$m_{BH(min)} = \left(\frac{h c^4 t_U}{8\pi G^2}\right)^{\frac{1}{3}} = 10^{12}\,\mathrm{kg} \qquad \textbf{(31)}$$

The term $m_{BH(min)}$ is the mass of a primordial black hole, in the conception of the ENU model it represents, however, the lightest 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.

At the end of this section we will show how could the dimension of the Einstein-Rosen (ER) bridge be simply derived using the ENU model and the Vaidya metric. The ratio of the absolute value of gravitational energy under the black hole horizon to the black hole rest mass, and that of radius of the ER bridge to its gravitational radius are identical. It holds:

$$\frac{r_{ER}}{r_{BH}} = \left|\int \frac{c^4}{8\pi G} R\, dV\right| \left(m_{BH}\, c^2\right)^{-1} \qquad \textbf{(32)}$$

where r_{ER} is the radius of ER bridge. If follows from the relation (32) that:

$$r_{ER} = \frac{r_{BH}^2}{a} \qquad \textbf{(33)}$$

This simple relation makes it possible to calculate (e.g. that a black hole with the mass of our Sun will have the radius of ER bridge of about 10^{-19} m and for the largest currently known black hole with the mass about 3 billion Suns it is about 1 m).

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 [17]. Dark energy is the most popular way to explain recent observations that the universe appears to be expanding at an accelerating rate. 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. Several issues of dark matter and dark energy are reviewed in [18].

Based on the information provided on the ENU model, the issue of dark energy can be solved. Provided that we accept the constant velocity (the speed of light) of the Universe expansion, the explanation of the dark energy issue is a simple task. The background of this explanation is shown in Figure 1.

Figure 1 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.

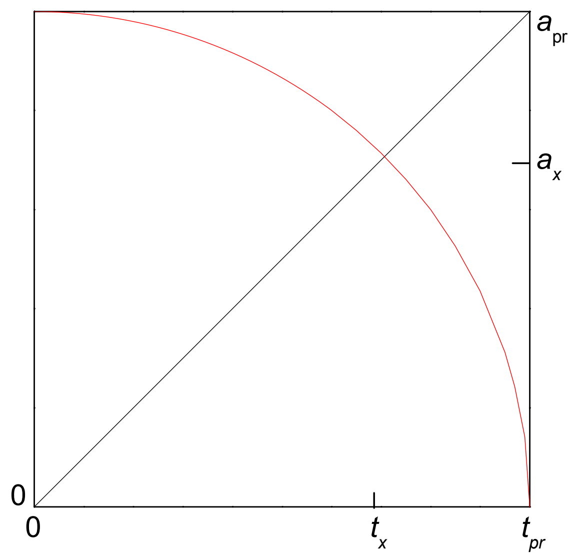

Figure 1: A Plot of the Universe Scale Factor (*y* axis) and Cosmological Time (*x* axis) - straight lines - and the Line of Observation (curved). The Crossing Point (t_x , a_x) Represents the State at the Red Shift Value *Z* = 1.4 (for details, see text).

The farther the distance viewed by an observer is, the farther objects he can see. The farther 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 $c = 1$):

$$x = y \qquad \textbf{(34)}$$

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

$$y = k \cdot a_{pr} \qquad \textbf{(35)}$$

where,

$$k = \frac{v}{c} \qquad \textbf{(36)}$$

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

$$x = (1 - k^2)^{1/2} \cdot t_{pr} \qquad \textbf{(37)}$$

In the cross-section point it holds:

$$k \cdot a_{pr} = (1 - k^2)^{1/2} \cdot t_{pr} \qquad \textbf{(38)}$$

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

$$k = (0.5)^{1/2} = 0.7071067 \qquad \textbf{(39)}$$

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

$$z = \frac{(1+k)^{\frac{1}{2}}}{(1-k)^{\frac{1}{2}}} - 1 = 1.4 \qquad \textbf{(40)}$$

Inspecting Figure 1, now it is clear that any interval from the region ($0 - t_x$) will display itself in the region ($a_x - a_{pr}$) as a 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 bright). The inversion point of such relative luminosities is at the red shift $z = 1.4$. This fact was proved in 2004 [19]. In the ENU model it corresponds to three quarters of cosmological time. Based on the ENU model, dark energy is only an unnecessarily illusion.

QUANTUM GRAVITY

Quantum Cosmology

In 1968, the Wheeler–de Witt equation of the Universe was proposed [20]. 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. Another unpleasant 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; this means a solution corresponding to our observed Universe and providing exact and scientifically verifiable predictions. This was the essence of Hartle's and Hawking's approach [10] 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.

The 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 [10], 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 are 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:

$$\Psi_{\mathrm{U}} = \sum e^{-\left(\frac{2\pi}{h}\right)\int_0^t E_{\mathrm{U}} dt} \qquad \textbf{(41)}$$

Figure 2 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.

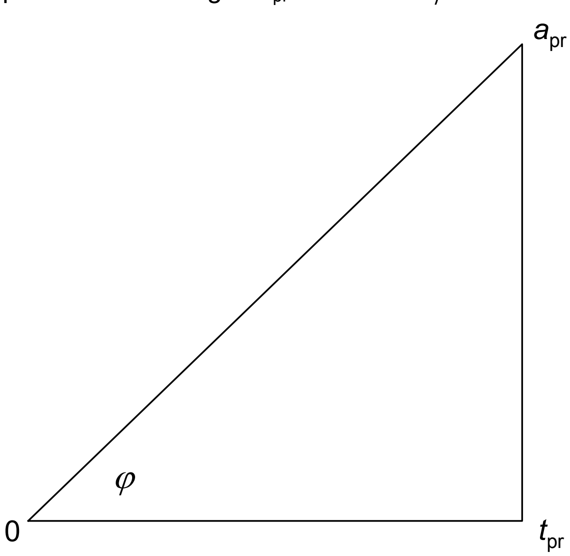

Figure 2: Dependence of the Universe Dimension (*y* axis) on Cosmological Time (*x* axis).

It is obvious that the sum of histories is equal to the sum of all configurations 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:

$$\Psi_{\mathrm{U}} = \sum e^{-S} \qquad \textbf{(42)}$$

The area S can be expressed as:

$$S = \cot g\varphi \left(\frac{a_{\mathrm{pr}}^2}{2 l_{\mathrm{Pc}}^2} \right) \qquad \textbf{(43)}$$

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

$$\cot g\varphi = \frac{c\, t_{\mathrm{pr}}}{a_{\mathrm{pr}}} \qquad \textbf{(44)}$$

The relations (42) to (44) are normalized so as the area S is a dimensionless quantity. All improbable histories mutually cancelled in the relations (41) and (42) remaining thus only actual possibilities. We get the following relation:

$$\cot g\varphi = \frac{r_{g(\mathrm{U})}}{a_{\mathrm{pr}}} \qquad \textbf{(45)}$$

in which $r_{\mathrm{g(U)}}$ 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 $\varphi = 45°$, cotg$\varphi = 1$.

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 $\varphi < 45°$, cotg$\varphi > 1$.

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 Friedmann 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 Friedmann cosmic deceleration parameter *q*, this is the case of q < 0.5.

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

Dimensions of the Universe approach zero value, cosmological time dilates, this scenario represents gravitational collapse 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.

One can devise a question; what information can be extracted from the Universe wave function concerning its initial phase? At the beginning of its expansion, the Universe was characterized by Planck dimensions. The wave function is consequently simplified to the expression:

$$\Psi_U = \exp(-\frac{\cot g\varphi}{2}) \qquad \textbf{(46)}$$

The probability *P* of the Universe origination is then:

$$P = \exp(-\cot g\varphi) \qquad \textbf{(47)}$$

It means, however, that at the beginning of the Universe expansion, there had to be an inflationary phase. Later on, subsequent to the inflationary phase, the Universe can expand by the classic Friedman way.

Provided that the curvature *k* = 1, the Universe will decelerate its expansion and new matter will surface from behind its horizon.

In case, *k* = 0, the expansion will preserve its constant velocity (speed of light in the ENU).

If *k* = –1, the expansion will accelerate and the Universe matter will gradually escape behind the horizon. At first sight it seems that the existence of the inflationary phase is not compatible with the ENU model. Our Universe has critical density and expands by the speed of light. It means, nothing can escape beyond the horizon and nothing can emerge from the horizon. We thus cannot know what is located behind the horizon. This is why the existence of inflation has only platonic or academic meaning for us. It rather means that in the case of our model, the inflation represent an origin of infinite number of such Universes types.

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 (24). This equation can be derived also applying Feynmann approach. Putting the exponents of Equations (41) and (42) divided by the volume *V* equal, integrating over time *t* = *r*/*c* and multiplying the exponent in (42) by the number –1 (which is the component g_{00} of the metric tensor in case of weak fields), it results:

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

Substituting,

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

(where $r_{g(m)}$ is the gravitational radius of a body with the mass m), then combining (49) and (48) we obtain relation (24).

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

$$S_{ik} = \frac{(g_{ik})^{/} m^{/} c^2}{4\pi r^2} \quad \textbf{(50)}$$

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 Cartesian coordinates as follows:

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

The components $(g_{ik})^{/}$ are obtained squaring the expression 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:

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

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

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

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

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

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

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

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

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

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

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

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 pseudo-tensor (providing that we work with the Vaidya metric). These components, which are imaginary in the ENU, are anti-symmetric in Einstein or Tolman pseudo-tensor.

Now, the behavior 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:

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

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

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

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 us 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 evidence on the existence of an extra-dimension.

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 decrease, 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).

ELEMENTARY PARTICLES

Weak Interactions and Axions

The cross-section of weak interactions σ can be expressed in a simple mode as [21-23]:

$$\sigma \cong \frac{g_F^2 E_w^2}{\left(\frac{h\,c}{2\pi} \right)^4} \quad \textbf{(64)}$$

where g_F is the Fermi constant and E_w is the energy of weak interaction.

The relation (64) leads to:

$$E_w \cong \frac{r\, h^2 c^2}{4\pi^2 g_F} \quad \textbf{(65)}$$

In limiting case, the Comptom length (λ = *r*) of vector bosons Z and W can be expressed as:

$$\lambda = \frac{h}{2\pi\, m_w\, c} \quad \textbf{(66)}$$

where m_w is the bosons mass.

The maximum energy of weak interactions E_w could reach:

$$E_w \leq m_w c^2 \quad \textbf{(67)}$$

The bosons mass can be expressed stemming from (65) to (67) as follows:

$$m_w^2 \cong \frac{h^3}{8\pi^3 g_F c} \cong (100 \text{ GeV})^2 \quad \textbf{(68)}$$

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.,

$$\left| \int \varepsilon_g dV \right| = E_w \quad \textbf{(69)}$$

Based on (65) and (69), the limiting mass is as follows:

$$m_{lim} \cong \frac{a_{pr} h^2}{4\pi^2 g_F} \quad \textbf{(70)}$$

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

$$a_X \cong \frac{4\pi^2 g_F m_{Pc}}{h^2} \cong 10^{-2} \text{ m} \quad \textbf{(71)}$$

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 (70), we obtain the minimum possible rest mass of an elementary particle as 10^{-5} eV. We suppose the particle is the axion. These particles could form a significant of dark matter. It should be mentioned that a particle with no charge, no spin, a very low mass and a lifetime of picosecond order, known as the axion, has actually been detected [24].

Mass Spectrum of the Particles - Higgs Boson

Stemming from the previous discussion, an interesting opportunity to at more generalized conclusions concerning the mass of particles is offered. Of the whole mass spectrum we know limiting masses, (i.e., the lightest 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:

$$m_{(N)} = m_{Pc} e^{K X_{(N)}} \quad \textbf{(72)}$$

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 (72) we can determine the value of K. 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. Taking h into account, for $h/2\pi$ it is $K = -78.23475$.

Further suitable step would lie in determination of the variable X for individual particles. Increasing the particle mass, the value of X decreases, and for the heaviest up-to-now registered particles, bosons W and Z, the value of K is slightly higher than 0.5. An idea enters the mind. Theoretical physics is expecting appearance or theoretical evidence of a new particle called Higgs boson.

This boson must have a mass of some hundreds GeV, (i.e., it should be heavier than bosons Z and W). The 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 will 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 (72). Provided that it is a case, the relation (72) leads to its mass. Using the value of K, the mass of the Higgs boson will be 125 GeV. This is in accord with expectations and calculations concerning the Higgs boson mass [25].

Let us investigate the mass of all known particles. Very light particles are located, of course, far from the mass spectrum center. Increasing the particle mass, still more and more approaching the limiting value X = 0.5. For the majority of the known mesons, baryons and hyperons, their X value slightly exceeds 0.5. 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 Higgs boson).

The essence of the issue lies in the fact that the distribution of the mass spectrum, expressed by means of the variables $X_{(N)}$ is very similar to the eigen values of random Hermitean matrix. If the exact mass of Higgs boson will be known (making the constant *K* more precise) it will be necessary to write the mass of all known particles as precisely as possible from a reliable source (Particle Data Group). Next, using (72), the value *X* will be attributed to all the particles and all these values will be normalized (taking the currently known amount of particles into account, it will be sufficient to multiply all *X* value by 100. We are still aware of working only with a half of the matrix). All true Hermitean matrices have exactly attributed properties of gaps between their eigen values. These properties are expressed mathematically by means of so called form factor of pair correlation function. In case of Hermitean matrices it can be written as follows:

$$\int_0^x \left(1-\left(\frac{\sin \pi u}{\pi u}\right)^2\right) du \qquad \textbf{(73)}$$

We could calculate the form factor for our set of particles. In case of its identity with (73), it would be a proof that the mass of the elementary particles are determined by a random Hermitean matrix and cannot be in no case exactly calculated in advance. A number of random matrices and that of Calabi-Yao spaces is infinitive All of them are equivalent and this is why there is no meaning in trying to search for a random matrix or Calabi-Yao space which are more fundamental than the others. In other Universes, the mass of particles might differ.

One important conclusion is to be pointed out. On the other side of our Gaussian curve there might be expected super-symmetrical heavier particles. Most of them will have a mass close to that of Higgs boson and with increasing their mass, their density will decrease. At the ends of both sides of Gaussian distribution there will be the axion (the lightest particle) and Planck (the heaviest) particle existing at the beginning of the Universe. In our model, similarly to many other theories, the existence of super-symmetrical particles is unavoidable.

CONSTANTS

The Future of the Universe

The Universe development is illustrates in Figure 3. 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.

The Universe expansion will continue which is expressed by dashed lines. We show also a future causal horizon as a cone with its apex in the point M on the time axis. It can be understood as follows: at the time being, we are able to influence our nearest future. We may make a decision on what to do tomorrow and fulfill the decision. The further it is to the scheduled future, the less possibility it 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 in evaluating the future beyond this limit. At this moment we do not know the maximum cosmological time (the frontiers of the future causal horizon are shown only for illustration in Figure 3), we can, however, easily come to the result. The angle of a future causal horizon and the time axis is β. It must hold that:

$$\beta = \frac{a_{pr}}{ct_{max}} \qquad \textbf{(74)}$$

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.

In our discussion of energy-momentum tensor we documented that 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 guaranteed minimum gravitational influence on the Universe as a whole.

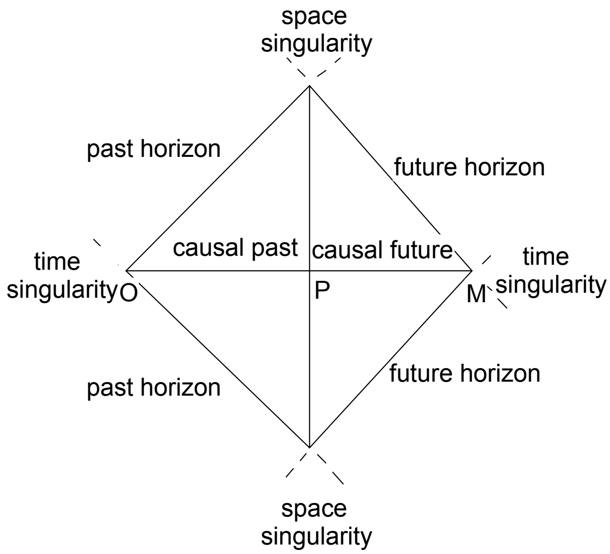

Figure 3: The Universe Development (see text).

This minimum effect may curve the world line 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:

$$\beta = \frac{l_{Pc}}{a_{pr}} \qquad \textbf{(75)}$$

Equations (74) and (75) lead to maximum cosmological time of the value about 10^{71} years.

Let us look to another direction. The lightest particle is probably an axion which will produce gravitons with the longest wavelength. There are certain reasons to suppose that just such a wavelength determines the size of the currently largest black hole. This present value is determined by (63) and by the axion mass (10^{-5} eV) and approaches 10^{13} m. Based on the mentioned value, the largest black holes should have their mass approaching the mass of 3 billion Suns.

Just when the cosmological time reaches 10^{71} years, the axion gravitons wavelength and the maximum dimensions of black holes will be 10^{43} m and, at the same time, it will be the wavelength of relic photons having the temperature about 10^{-45} K (see Equation (15)). New black holes will not be formed since the mass of "primordial" black hole will be, based on Equation (31), higher than a hundred of the Sun mass. Reaching 10^{71} years, something similar to a thermal death of the Universe will happen and there is no sense to think about its further fate.

The most interesting idea is that at the time being, 13.7 billion 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 privileged time. We are, however, in a strong opposition to such privilege and in no case we believe in such an unbelievable coincidence. Once we overcome such a coincidence when we have explained an ostensible privilege time when it seems that the Universe deceleration is exactly compensated by its current acceleration.

What is the solution? Are we living in a privilege period? The answer is both yes and no. 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.

Change of Physical Constants

Taking into account the result derived in the previous section, we can come to an interesting conclusion. Each observer will have a different time limit in the future and will perceive himself/herself as being in the geometric centre of the time axis. The physical laws do not involve the time direction and thus, what is valid for the Universe end must be valid also for its beginning. 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's 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.

In case of the constants changing, a change must progress simultaneously for many of them, and the validity of physical laws must be preserved. It is worth mentioning that there have been previously rationalized opinions on the change of certain constants [26, 27].

Any of the fundamental interactions may be expressed by means of its dimensionless constant. As for the strong interaction constant α_s,

$$\alpha_s = 1 \quad \textbf{(76)}$$

Dimensionless constant of electromagnetic interaction α_{em} is:

$$\alpha_{em} = \frac{e^2}{2\varepsilon_0 hc} = \frac{1}{137} \quad \textbf{(77)}$$

For the constant of the weak interaction α_w it holds:

$$\alpha_w = \frac{8\pi^3 g_F m_p^2 c}{h^3} = 10^{-6} \quad \textbf{(78)}$$

Constant of the gravitational interaction α_g is:

$$\alpha_g = \frac{2\pi G m_p^2}{hc} = 10^{-38} \quad \textbf{(79)}$$

In Equations (78) and (79), m_p is the proton mass.

There are a huge amount of possibilities of changing certain constants while preserving the physical laws validity. 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.

The changes may be in practice extremely slow. It would be enough to change the constants depending on natural logarithm of the cosmological time. It seems that similarly to quantum mechanics, also in this case the interpretation of the reality will rest with its observer.

Observing the Universe just in this time, all physical constants may be taken as unchangable and such a Universe can be described using any of the cosmological models. If we, however, put questions on the exact cause of the Universe creation, mechanism and initial conditions, we are not able to submit rationalized answers, since such answers cannot exist. Each right question must be put in the right context to be meaningful. We can just state that the reality is much more complex and complicated than we have thought before. It is not probable that the reality and its time development could be squeezed into a definite final theory concluding with a one-page result. It is much more probable that the process of knowledge unveiling is, similarly as the whole Universe, infinite in the time and space.

CONCLUSIONS

At the time being, thank to accelerators we have at our disposal a huge amount of facts on the elementary particles. Various calibration theories and superstring mathematics are used. All known fundamental laws can be written by a relatively simple form and the mathematician or physicist is able to appraise the logical and aesthetical side of such a form at first sight. A uniform expression of force acting of all fundamental physical interactions should lead, along with aesthetical experience, also to a deeper understanding of the reality.

Reductionists anticipate an origination of the ultimate theory, we are, however, afraid that it is impossible. Increasing a number of elements of a system and overcoming a certain threshold, the growing quantity creates a new quality which is not a simple sum of its elements. We are convinced that no ultimate theory can exist because the Universe development and cognitive development have no time or space limits.

A further reason not to accept reductionism lies in the limits of the initial conditions of the Universe origin (let us forget for a while that the Universe has no initial point of its origin). It is not absolutely clear whether the initial conditions should be involved in the ultimate theory or whether they were of random nature. In case of their random nature, the value of the ultimate theory will be significantly restricted. The state of physical vacuum before the inflationary phase had to be known, fundamental constant values and the mass of the elementary particles could be chosen by randomly.

There is also a third reason against the ultimate theory. The Universe might pass several periods of different phase transitions during its existence and its original properties might significantly change. Likewise, nonlinear processes might have occurred in the past and their effect is unpredictable.

At the end 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 explains 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 [7];
- To describe the Universe, the Vaidya metric is applied, and Newton potential is replaced by Yukawa potential in case of weak fields [28];
- The ENU model allows to estimate a mass of current lightest black hole, which is equal to the mass of primordial black hole [8, 29];
- A mass of the current heaviest black hole is estimated as equivalent to 3 billions of our Sun mass;
- Based on the ENU model, a temperature of the accretion disc of a black hole is estimated;
- A simple mode can be applied to determine the dimension of Einstein-Rosen bridge of black holes;
- 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;
- This model does not exclude the existence of extra-dimensions, it does not, however, require such a extra-dimensions;
- The ENU model predict the mass of the Higgs boson and that of the axion;
- The ENU model rationalizes the necessity of the existence of super-symmetric particles;
- Based on the ENU model, the mass spectrum of the particles is determined by a random Hermitean matrix, (i.e., there is no chance to calculate it theoretically);
- 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;
- Based on the above conclusions, this model casts doubts on the existence of the ultimate theory.
- Applying the ENU model it has been possible to predict several limiting parameters of neutron stars [8, 27], to rationalize mutually related characteristics of the hydrogen atom [30,31], to explain the mechanism of Podkletnov's phenomena [5], to predict bands in low-temperature far-infrared spectra [32], etc.;
- Observation of Hubble deep field indicates a possibility that an increase in galaxies matter and dimensions, as well as an increase in central black holes mass, can be elegantly explained by the ENU model, incorporating the matter creation.

There are still some issues to be solved. These concern such things as the mechanism of matter creation preserving the ratio of hydrogen, helium, and other light elements. As documented in our exploration of the thermodynamics of nondecelerative Universe, this proportionality works within creation of baryons and photons of relict radiation and it thus should not represent a serious problem.

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, launching 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 engaged in the field, a long time expected ultimate theory, is under way.

APPENDICES

Appendix 1 - Quantification of Gravitational Field

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 momentum in a dimensionless form using the Vaidya metric and the postulates of the ENU model.

$$|S| = \frac{c^3}{8\pi G}\int R(-g)^{\frac{1}{2}} d^4x = \frac{r^2}{\lambda_G^2} \qquad \textbf{(A1)}$$

where λ_g is:

$$\lambda_\mathrm{g} = \left(\frac{ha}{2\pi mc}\right)^{\frac{1}{2}} \qquad \textbf{(A2)}$$

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

$$\Psi = \exp\left(\frac{ir^2}{2\lambda_\mathrm{g}^2}\right) = \exp\left(\frac{ic^2t^2}{2\lambda_\mathrm{g}^2}\right) \qquad \textbf{(A3)}$$

From time-depended Schrödinger equation, the total energy of retarded waves E_ret emerges as:

$$E_\mathrm{ret} = \frac{mc^2r}{a} = E_\mathrm{g}N \qquad \textbf{(A4)}$$

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:

$$E_\mathrm{g} = \frac{hc}{2\pi\lambda_\mathrm{g}} \qquad \textbf{(A5)}$$

$$N = \frac{r}{\lambda_\mathrm{g}} \qquad \textbf{(A6)}$$

For advanced waves it holds:

$$\Psi^* = \exp\left(-\frac{ir^2}{2\lambda_\mathrm{g}^2}\right) = \exp\left(-\frac{ic^2t^2}{2\lambda_\mathrm{g}^2}\right) \qquad \textbf{(A7)}$$

The total energy of advanced waves E_adv is obtained from time-dependent Schrödinger equation:

$$E_\mathrm{adv} = -\frac{mc^2r}{a} = -E_\mathrm{g}N \qquad \textbf{(A8)}$$

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 transferring the momentum and energy, and thus also gravitational influence. In addition, it holds:

$$P = \int \Psi^*\Psi dV = 1 \qquad \textbf{(A9)}$$

For the potential energy between the both bodies U_g we obtain based on Equation (8):

$$U_\mathrm{g} = -\frac{E_\mathrm{g}N r_{\mathrm{ef(B2)}}^2}{4r^2} = -\frac{Gm_1m_2}{2r} \qquad \textbf{(A10)}$$

where $r_{ef(B2)}$ is the effective gravitational cross-section of the body B2, being proportional to the square of its effective range (see Equation (25)).

The body B2 exerts the same impact to the body B1 and thus the total potential gravitational energy between these two bodies is $2U_g$.

Stemming from (A6) it follows that $r \geq \lambda_g$, and at the same time it must hold $r \leq r_{ef}$. Both the conditions are satisfied for the mass $m \geq m_{Pc}$, where m_{Pc} is Planck mass. For black holes $r_{BH} \geq \lambda_g$. 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:

$$E_{adv} = \int S_{00} dV \qquad \textbf{(A11)}$$

$$E_{ret} = \int S_{\alpha\alpha} dV \qquad \textbf{(A12)}$$

where α = 1, 2, 3.

Based on (A4), (A8), (A11) and (A12) it follows:

$$\Psi^* = \exp(-\frac{2\pi}{ih}\int dt \int S_{00} dV) \qquad \textbf{(A13)}$$

$$\Psi = \exp(-\frac{2\pi}{ih}\int dt \int S_{\alpha\alpha} dV) \qquad \textbf{(A14)}$$

Both relations (A13) and (A14) can be expressed uniformly through a metric:

$$\Psi = \exp(-\frac{2\pi}{ih}\int dt \int g'_{ik} m' c^2 \chi \, dV) \qquad \textbf{(A15)}$$

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 (A15), $m' = m/a$, $\chi = 1/4\,\pi\, r^2$ 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 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.

It may happen that the concept of the advanced waves would be possible to apply not only to electromagnetic interactions (Wheeler–Feynman, Cramer), but also to short-range interactions. This conception even does not exclude the existence of parallel worlds, it rather support such the existence. Putting identity of the advanced waves and space-time, the Universe expansion can be understood as a reception of the advanced waves from parallel future Universes.

Relation (A6) documents that gravity cannot act in arbitrarily small dimensions and singularities thus cannot actually exist (gravitation cannot function in sub-Planck 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 collapse followed by standing waves origination.

Appendix 2 – Matter Creation Issue

This issue may be solved in the following mode. At kaon decay, T-symmetry is violated. Taking uncertainty relations into account, the T-symmetry violation is associated either by the matter conservation law violation or by a change in the Planck constant *h* value. The occurrence of both the effects is improbable. If the physical laws should be kept, changes in the elementary particle mass must be admitted preserving the *h* constant value. At the same time, the gravitational constant, Fermi constant and Boltzmann constant must undergo changes.

The conservation law as a whole would not be violated due to an increase in a number of elementary particles accompanying a reduction of their mass. Given the constant value of the speed of light c, there is no alternative to the inflationary model (Maquieio a spol.) and our ENU model envisages non-existence of B-mode polarization of photons of the relict radiation. In addition, we postulate the existence of neutron dipol moment, which is a T-symmetry violation and represents a possibility to rationalize the creation of baryonic matter.

At the wavelength λ_X:

$$\lambda_X = \frac{l_{Pc}}{\sqrt{\alpha_e}} \qquad \textbf{(A16)}$$

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 probability P of the creation of a new neutron is:

$$P = e^{-\frac{d\sqrt{\alpha_e}}{l_{Pc}}} \qquad \textbf{(A17)}$$

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

$$P = \frac{\lambda_n}{a} \qquad \textbf{(A18)}$$

where λ_n is the Compton length of the neutron, a is the Universe gauge factor.

Putting (A17) and (A18) equal, the distance d and subsequently the value of neutron dipol moment p(n) is obtained:

$$p(\mathrm{n}) = 1.8 \times 10^{-30}\ \mathrm{e{\cdot}cm} \qquad \textbf{(A19)}$$

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

Appendix 3 – Matter, Spacetime, and Gravitation

The ENU model is based on a presumption stating the matter is 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 1: Spacetime and matter are formed by advanced and retarded waves with a phase shift equal π.

Definition 2: Gravity 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 be valid:

$$\sin\frac{\alpha}{2} = 1 - \frac{2Gm}{rc^2} = 1 \qquad \textbf{(A20)}$$

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. The matter, space and time do not interact with the surrounding which represents a black hole formation.

Using α and relation (A20) it is possible to derive the metric tensor g_{ik}. It holds:

$$g_{00} = -\sin\frac{\alpha}{2} \qquad \textbf{(A21)}$$

$$g_{11} = g_{22} = g_{33} = \sin\frac{\alpha}{2} \qquad \textbf{(A22)}$$

Schwarzschild metric can be expressed in the form:

$$ds^2 = -\left(\sin\frac{\alpha}{2}\right)c^2dt^2 + \left(\sin\frac{\alpha}{2}\right)^{-1}dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right) \qquad \textbf{(A23)}$$

Conclusions: Spacetime and matter may be considered advanced and retarded waves propagating with a phase shift π. Gravitation is just a tendency to bring advanced and retarded waves into identical phase. Using sinα, the metric tensor and corresponding metric can be smartly expressed.

Hypothesis of Inertion: It can be supposed that at any force impact there is an absolute motion between advanced and retarded waves. This motion exhibits a tendency to reduce the phase extent between the both kinds of waves. A material body resists a phase change, which can be understood as inertia. A tested body located on a surface of a large body with large mass is thus in absolute motion in relation to advanced waves (it should be taken into account that advanced waves propagate always to bodies). This is why there is a resistance to a phase change which is rationalized as gravitational force. Contrary, at a free fall, a tested body moves together with advanced waves, a phase may be gradually changed and no force impact is seen.

Hypothesis of Total Field: 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 super-symmetric 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 a consequence of a phase shift between time-space and matter caused by their absolute motion. It has nothing to do with the "ether theory".

Time-space is not something fixed, contrary, it is a dynamic quantity dependent on the matter density and distribution. 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).

Note: the gravitational potential can be expressed in our ENU model as follows:

$$\varphi = -\frac{G\,m}{r} e^{-\frac{r}{r_{ef}}} \qquad \textbf{(A24)}$$

where $r_{ef} = \left(r_{grav} a\right)^{0,5}$

For the vacuum scalar curvature then it holds:

$$R = -\frac{2\Delta\varphi}{c^2}\left(1 - \sin\frac{\alpha}{2}\right) = = -\frac{2\Delta\varphi}{c^2}\left(1 - g_{\alpha\alpha}\right) = \frac{3r_{grav}}{ar^2} \qquad \textbf{(A25)}$$

with α = 1, 2 or 3.

At black hole horizon:

$$r = r_{grav} = a \qquad \textbf{(A26)}$$

and at the same time:

$$R = \frac{3}{r^2{}_{grav}} \qquad \textbf{(A27)}$$

It is a good approximation given the non-relativistic nature of relation (A24). Exact calculation leads to a value higher by 1.15. In our model, relation for the scale factor is the same as that for black hole gravitational radius. It thus seems that based on relation (A27), the Universe scalar curvature is $3/a^2$. It would valid in case of equaling the Universe mass and matter mass, and such relation emerges also from equations of the GRT when using classic metric. However, using Vaidya metric, the Universe scalar curvature must equal zero (see A25). In flat space, sin(α/2) = $g_{\alpha\alpha}$ = 1. The Universe zero scalar curvature is obtained also when using classical metric and relations (A24) and (A25). We would like to stress that our theory is not an alternative to the General Relativity Theory and that the tensor S_{ik} is not a tensor of gravitational field energy density, but a density of the total field. All postulates of the GRT are respected, to describe the total field, however, modified relations for gravitational potential and scalar curvature are applied. All conservation laws are fully observed as well.

Appendix 4 – Changes in Constants

A gradual linear increase of gravitational and Fermi constants in time accompanied by a simultaneous decrease of Boltzmann constant and the mass of all elementary particles (proportional to the square root of cosmological time) are postulated. Dimensionless quantities and physical laws are preserved. In spite of that, changes in the micro-world occurs, namely an increase in the Compton wavelength, atomic orbitals radius, and a decrease in binding energies. In addition, space and time intervals would undergo changes. However, the changes would not be registered by any observer. In the macro-world – the world of gravitation, the changes in $G_{(t)}$, $m_{(t)}$ and in space interval $R_{(t)}$ would occur in such a way that no deviation from the relativity theory would be observed.

Suppose, there will be a possibility to exchange of information between the intelligent beings in a far future and ourselves. It would be an agreement that physical laws are preserved, the Universe history is consistent, radiation era terminated at a temperature about 4,000 K, the ionization energy of the hydrogen atom is still 13.6 eV and the radius of its *s*-orbital is 52.8 pm (given the exact definition of the meter), boiling temperature of water is 100°C (given the exact definition of Celsius degree), etc. Essential, however, is that neither observers in far future nor we ourselves would become aware of the difference in units such kg, m, s, J, K.

Since the physical laws and matter properties seem to be constant, the postulate on a change of some constants in time cannot be verified by observation. Acceptation of the postulate, however, leads directly to conclusions concerning the Universe properties. The Universe is everlasting, has no beginning or end, no frontiers. Its expansion and increase of cosmologic time may be explained through an increase of the gravitational constant.

Appendix 5 – The Universe Wave Equation

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

$$\Psi_U = \exp\left(-\frac{a^2}{2\, l_{Pc}^2}\right) = \exp\left(-\frac{a^2\omega^2}{2}\right) \qquad \textbf{(A28)}$$

Since the total energy of the Universe must be zero [10], it follows from Schrödinger equation that:

$$\left(\frac{d^2}{da^2} + X\right)\Psi_U = 0 \qquad \textbf{(A29)}$$

Ψ_U depends on gauge factor *a*. It follows from (A28) and (A29) that:

$$X = \omega^2 - \omega^4 a^2 \qquad \textbf{(A30)}$$

and substituting this relation into (A29) the Universe wave equation is obtained in the form:

$$\left(\frac{d^2}{da^2} - \omega^4 a^2 + \omega^2\right)\Psi_U = 0 \qquad \textbf{(A31)}$$

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

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