

Fractal Structure of the Universe

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Abstract

Hierarchic fractal structure of the Universe enabling to redefine its observed characteristics is considered. According to the hypothesis the Universe consists of an infinite number of spatial and hierarchic fractal levels of matter that are nested within each other (fractals mean self-similar events, processes and spatial forms) and represented as moving spaces, presumably of a spherical shape. Distinguished in ascending order are the following basic fractals of the Universe that are conventionally connected with the kinds of matter interaction: nuclear, atomic, electromagnetic and gravitational. It can also be assumed that there exist fractals which are older than the gravitational ones. Each fractal is characterized by finite geometrical dimensions and finite value of its own energy, consequently, by the finite value of the spatial density of energy. Whenever the lower hierarchic level fractals (nuclear) transit to the higher levels (gravitational), the space and spatial density of energy inflate, and their information variety increases (as a sum of informational variety of spatial and energy forms and their levels). At transit from the lower level fractals to the higher level fractals the energy density inflates which leads to that (i) each fractal type is characterized by the finite maximum transfer velocity of internal physical interaction, and (ii) this velocity increases. It means that the maximum transit physical interaction velocity within the gravitational fractal exceeds the velocity of light which is the maximum for the electromagnetic fractal while the maximum transit physical interaction velocity of the atomic fractal is lower than the velocity of light (it is reduced by the fine structure constant). The fractal structure of the Universe hypothesis makes it possible for the authors to put forward several other assumptions: dark energy does not exist and the apparent effect of its presence in the electromagnetic fractal as well as appearance of asymmetry between the matter and antimatter are explained by its finite geometrical dimensions, spherical shape and rotational motion of this sphere around at least one of the axes.

Keywords: fractal, structure, Universe, expansion, space.

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1 Introduction

The Universe is an infinite aggregate of spatial hierarchic fractals of a spherical shape. Spatial hierarchy of fractals means that the smaller by size (and by hierarchy) fractals lie within the greater fractals, i.e., fractals are nested within each other. A certain linear dimension of the space length makes the similarity basis of the Universe fractals. This dimension tends to zero,

however our knowledge about Nature does not still allow us of making analysis with the use of the linear dimensions which are smaller than the Planck dimension: $l_p = 1,616199 \bullet 10^{-35} \text{m}$ [1]. Let us consider that the Planck dimension is the universal constant for the all level fractals of the Universe. Therefore, the basis of the spatial fractal structure of the Universe is selected as follows: - for vacuum - the Planck cube. Its volume equals: $Q_{cp} = 4,2216721272 \bullet 10^{-105} \text{m}^3$; - for the space where a mass is - the Planck sphere. Its volume equals: $Q_{sp} = 1,768369885 \bullet 10^{-104} \text{m}^3$. Let us consider the most accessible for observation electromagnetic fractal of the Universe. We assume that it is shaped as a limited-size sphere. The sphere rotates in a single plane, as a minimum. Electromagnetic fractal of the Universe is located within the gravitational fractal of the Universe. In its turn electromagnetic fractal is senior in relation to the atomic and nuclear fractals. In accordance with the assumed hypothesis, on the opposite poles of the rotating sphere of the electromagnetic fractal of the Universe singularity points are formed from time to time. Conversely, the formation of the opposite singularity points leads to a series of Big Bangs. These result in a pulsation of the "matter - antimatter" link. In other words, in a direct cycle after the Big Bang due, for instance, to the counter-clockwise rotation of the fractal sphere, a matter is formed, and, during the next cycle, as the matter accumulates in the singularity point at the opposite pole and following the new Big Bang and clockwise rotation of the fractal sphere, the antimatter is formed. The assumption that the sphere of the electromagnetic fractal of the Universe rotates makes useless the hypotheses about the expanding and accelerating Universe and dark energy. As the fractal hierarchy grows, the Universe does expand but that expansion is fractal and stationary.

2 Assessment of geometrical dimensions, period of rotation and fundamental frequency of electromagnetic fractal of the Universe

As a result of the last Big Bang the matter flew omnidirectionally within the sphere of the electromagnetic fractal. Possibly its small part got in the gravitational fractal of the Universe and then, due to gravity force, was returned to the electromagnetic fractal space. It is also possible that the black hole of the Universe is located in the centre of the electromagnetic fractal of the Universe and that this black hole is a source of the dark matter. We cannot rule out an influence of the senior gravitational fractal upon the nature and presence of dark matter in the electromagnetic fractal. It can be assumed, as well, that the dark matter characteristics are influenced by rotation of the sphere of the electromagnetic fractal of the Universe. Let us assume that the electromagnetic fractal space in the form of the rotating sphere exists endlessly and does not vary with time and its geometrical dimensions are determined by a ratio of the levels of its own internal energy and the energy of the senior gravitational fractal. We shall show that the apparent expansion of the Universe recorded by means of the Doppler effect can be interchanged with a model of the rotating sphere having fixed dimensions. Linear velocity V of any point of the rotating sphere is equal to the product of the circular frequency of the sphere rotation ω by the distance R from this point to the rotation axis:

$$V = \omega R, \quad (1)$$

At that:

$$\omega = \frac{2\pi}{T}, \quad (2)$$

where T_e is a period rotation of the sphere. An increment of the linear velocity ΔV for one of two points in the electromagnetic fractal (let the points lie in one plane which is perpendicular to the rotation axis of the electromagnetic fractal sphere, and let one of the points being linked to the observer), while the other point velocity equals V , the points being located at various distances from the rotation axis and at a radial distance ΔR from each other, and moving, as a result of the Big Bang, in various directions, can be found from the ratios:

$$V + \Delta V = \frac{2\pi(R + \Delta R)}{T_e}, \quad (3)$$

$$\Delta V = \frac{2\pi(\Delta R)}{T_e}, \quad (4)$$

where T_e is a period of the sphere and the index e indicates the electromagnetic fractal. The velocity increment value ΔV should equal the Hubble constant H_0 , i.e., the apparent velocity of expansion of the Universe. According to [2], the H_0 numerical value equals $H_0 = 70, 4_{-1,4}^{+1,3}$ (km/s)/mpc. $\Delta R=1$ mpc, i.e.,

$$\Delta R = 3, 08568025 \bullet 10^{22}\text{m}.$$

Then T_e - a period of the sphere of the electromagnetic fractal of the Universe - equals: $T_e = 2, 753963183 \bullet 10^{18}\text{s}$. If 1 year is $3, 1556926 \bullet 10^7\text{s}$, then a period of the sphere of the electromagnetic fractal of the Universe equals $T_e = 87, 26969107$ bln of years. The fundamental frequency of the electromagnetic fractal of the Universe F_e equals: $F_e = 3, 631130605 \bullet 10^{-19}\text{Hz}$. The fundamental circular frequency of the electromagnetic fractal of the Universe ω_e equals: $\omega_e = 2, 281506647 \bullet 10^{-18}\text{Hz}$. The maximum linear velocity will be at the equator of the rotating sphere. The light velocity for the electromagnetic fractal of the Universe equals $c = 2, 99792458 \bullet 10^8\text{km/s}$ [1]. Wherefrom the radius R_e of the sphere of the electromagnetic fractal of the Universe can be evaluated: $R_e = \frac{cT_e}{2\pi} = 1, 31401089 \bullet 10^{26}\text{m}$. If the light-year equals $9, 46073047 \bullet 10^{15}\text{m}$, then the radius of the electromagnetic fractal of the Universe can be evaluated as 13, 8891060731 bln light-years which correlates with the contemporary evaluations of the visible Universe size. The volume of the sphere of the electromagnetic fractal of the Universe equals: $Q_{Ue} = \frac{4\pi R_e^3}{3} = 9, 5035421 \bullet 10^{78}\text{m}^3$. Let us compute the characteristics of the electromagnetic fractal of the Universe for the upper and lower estimates of the Hubble constant. In doing so, the signs (-) and (+) in the below formulae indicate the lower and upper limits of the computed characteristics. If it is assumed that the upper estimate of the Hubble constant $H_0 = 71, 7$ (km/s)/mpc, the values of the characteristics of the electromagnetic fractal of the Universe will be as follows:

$$T_e^- = 2, 704 \bullet 10^{18}\text{s}; \text{ or: } T_e^- = 85, 687 \text{ bln years};$$

$$F_e^- = 3, 6981827328 \bullet 10^{-19} \text{ Hz}; \omega_e^- = 2, 323636741 \bullet 10^{-18} \text{ Hz};$$

$$R_e^- = 1, 29 \bullet 10^{26}\text{m}; \text{ or: } R_e^- = 13, 637 \text{ bln light-years};$$

$$Q_{Ue}^- = 8, 9959 \bullet 10^{78}\text{m}^3$$

For the lower estimate H_0 , which equals 69 (km/s)/mpc, the values of the characteristics of the electromagnetic fractal of the Universe will be: $T_e^+ = 2, 80984 \bullet 10^{18}$ s; or: $T_e^+ = 89, 04$ bln years;

$$F_e^+ = 3, 55892 \bullet 10^{-19} \text{ Hz}; \omega_e^+ = 2, 236135776 \bullet 10^{-18}\text{Hz};$$

$$R_e^+ = 1, 34067 \bullet 10^{26} \text{ m}; \text{ or: } R_e^+ = 14, 17 \text{ bln light-years};$$

$$Q_{Ue}^+ = 1, 009383516 \bullet 10^{79}\text{m}^3.$$

The finite dimensions of the electromagnetic fractal of the Universe enable the authors to put forward a hypothesis about a fractal link, e.g., its radius and the wavelength of the

relic emission. We denote the similarity coefficient base of the golden fractal by f_g , i.e., $f_g = 0,6180339887498948482$, Any fractal is formed by composition and multiple duplication of its basic element. Mantissa of the golden fractal is the basic element for the algebraic golden fractal. The golden fractal mantissa f_{mg} of any positive algebraic number lies within the range: $1 \leq f_{mg} \leq 1,618$, The maximum of the relic emission spectrum fall on the frequency 160.4 GHz which corresponds to the wavelength $\lambda_r = 0,0018690302\text{m}(1,8690302\text{mm})$ [2,3]. If we assume that the assigned frequency in the relic emission spectrum was formed due to a resonance of relic emission because of the finite dimension of the electromagnetic fractal of the Universe and that the radius of the sphere of this fractal R_e and the wavelength λ_r are golden fractals of various levels with the same mantissa, then $f_{mg} = 1,57559$, the wavelength λ_r being the golden fractal of the +14 hierarchical level, i.e., $\lambda_r = f_{mg} \cdot f_g^{14}$, and that the radius of the sphere of the electromagnetic fractal of the Universe is a golden fractal of the (-124) hierarchic level, i.e., $R_e = f_{mg} \cdot f_g^{-124}$, then the specified values of the radius of the sphere of the electromagnetic fractal of the Universe, its period and the Hubble constant are as follows:

$$R_e = 1,293929736 \cdot 10^{26}\text{m}; \text{ or: } R_e = 13,676848 \text{ bln light-years};$$

$$T_e = 2,71 \cdot 10^{18}\text{s}; \text{ or: } T_e = 85,936 \text{ bin years};$$

$$H_0 = 71,493 \text{ (km/s)/mpc}.$$

The above computations are based on the Hubble constant value for 2010y. which was obtained on the basis of seven years measurements made by NASA (Wilkinson Microwave Anisotropy Probe -WMAP) in combination with other methods of measurement. As WMAP reported, the Hubble constant value for 2012 equals $69,32 \pm 0,80 \text{ (km/s)/mpc}$ [4]. According to the observation data published by the Planck Mission of the European Space Agency in 2013, the Hubble constant value for 4 years (from 2009 to 2013) comprise $67,80 \pm 0,77 \text{ (km/s)/mpc}$ [5]. Based on this data it can be supposed that the Hubble constant scattering for various methods of measurement and by years can also be caused by precession of the rotating sphere of the electromagnetic fractal of the Universe in the plane being at a small angle to the major rotation axis. The main kinds of matter motion within the electromagnetic fractal of the Universe are:

1. Motion of matter along the rotation axis of the electromagnetic fractal of the Universe caused by the Big Bang. This motion is similar to the existing vision about motion of the matter after the Big Bang, however without space expansion.
2. Rotational motion of matter around one of the axis of the sphere of the electromagnetic fractal of the Universe.
3. Motion of matter caused by precession of the sphere of the electromagnetic fractal of the Universe.
4. Motion of matter caused by centrifugal forces in the rotating and precessing sphere of the electromagnetic fractal of the Universe (effect of a centrifuge with precession).
5. Motion of matter caused by the own gravitational interaction forces.
6. Motion of matter caused by dark matter.

All above motions are independent. After superposition of all kinds of motion the resultant vectors of total velocity of matter in each point of space in the sphere of the electromagnetic fractal of the Universe within the near field of view zone will have a chaotic distribution of directions and meanings of the absolute values. As the distance from the observation point (Earth) increases, the component of the total velocity vector conditioned by the rotating motion of the sphere of the electromagnetic fractal of the Universe will grow proportionate to the Hubble constant and the distance; from the distance of 5 bln light-years and more the contribution of this component will become prevailing, which is confirmed by the experimental Hubble law.

3 Evaluation of mass and its volumetric density for the electromagnetic fractal of the Universe

Based on the mathematical pendulum formula we can assess the gravity factor g_e of the electromagnetic fractal of the Universe:

$$T_e = 2\pi\sqrt{\frac{R_e}{g_e}}, \quad (5)$$

$$g_e = \frac{4\pi^2 R_e}{T_e^2}, \quad (6)$$

Based on the formulas (5) and (6) we find g_e : $g_e = 2,1771711389 \bullet 10^{-10} \text{m}^1 \cdot \text{s}^{-2}$. In order to evaluate the mass M_{Ue} of the electromagnetic fractal of the Universe its simplified model is applied: let all mass of the fractal be in the centre of its sphere, then:

$$M_{Ue} = \frac{g_e R_e^2}{G}, \quad (7)$$

where G is the gravitational constant. $G = 6,67384 \bullet 10^{-11} \text{m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$ [1]. According to the formula (7) we find M_{Ue} : $M_{Ue} = 5,632675176 \bullet 10^{52} \text{kg}$. It was shown earlier that the volume of the sphere of electromagnetic fractal of the Universe equals: $Q_{Ue} = 9,5035421025 \bullet 10^{78} \text{m}^3$. The spatial (volumetric) density of the mass of the electromagnetic fractal of the Universe equals: $\rho_{Ue} = \frac{M_{Ue}}{Q_{Ue}} = 5,926921894 \bullet 10^{-27} \text{kg}^1 \cdot \text{m}^{-3}$.

4 Evaluation of mass and its volumetric density for the nuclear and atomic fractals of the Universe

As hydrogen comprises more than 75 percent of the baryon mass of the electromagnetic fractal of the Universe [6,7], the hydrogen nucleus and atom were selected as the model. Correspondingly, the proton mass and radius are: $m_{pr} = 1,672621777 \bullet 10^{-27} \text{kg}$ [1]. $r_{pr} = 8,768 \bullet 10^{-16} \text{m}$ [1]. Then the volume of the sphere of the nuclear fractal of the Universe equals: $Q_{Un} = 2,82351586756 \bullet 10^{-45} \text{m}^3$. The mass of the nuclear fractal of the Universe equals: $M_{Un} = m_{pr} = 1,672621777 \bullet 10^{-27} \text{kg}$. The volumetric density of the nuclear fractal of the Universe equals: $\rho_{Un} = 5,92389721 \bullet 10^{17} \text{kg}^1 \cdot \text{m}^3$. The mass of the nuclear fractal can be determined at a first approximation as the sum of masses of the proton m_{pr} [1] and of the electron m_e [1]: $m_{pr} = 1,672621777 \bullet 10^{-27} \text{kg}$, $m_e = 9,10938291 \bullet 10^{-31} \text{kg}$; $M_{Ua} = m_{pr} + m_e$; $M_{Ua} = 1,673532715291 \bullet 10^{-27} \text{kg}$. The radius of the sphere of the atomic fractal of the Universe R_a is the Bohr radius, [1] i.e.: $R_a = r_b = 5,2917721092 \bullet 10^{-11} \text{m}$. The volume of the sphere of the atomic fractal of the Universe equals: $Q_{Ua} = 6,2071466797 \bullet 10^{-31} \text{m}^3$. The volumetric density of the atomic fractal of the Universe equals: $\rho_{Ua} = 2,6961385 \bullet 10^3 \text{kg}^1 \cdot \text{m}^{-3}$.

5 Evaluation of geometrical dimensions, mass and its volumetric density of the gravitational fractal of the Universe. Assessment of the spatial and energy parameters more older fractals of the Universe

As fractals are self-similar events, processes and spatial forms, then the geometrical dimensions of the gravitational fractal of the Universe can be evaluated after we find the spatial analogue coefficient which correlates the electromagnetic and gravitational fractals of the Universe. The spatial analogue coefficient linking the gravitational fractal of the Universe and its electromagnetic fractal is determined similar to Coulomb laws and the universal law of gravitation:

$$F_e = \frac{kq_1q_2}{r_{e12}^2}, \quad (8)$$

$$F_g = \frac{Gm_1m_2}{r_{g12}^2}, \quad (9)$$

where k is the electrical constant, $k = 8,854187817 \bullet 10^{-12} \text{F}^1 \cdot \text{m}^{-1}$ [1]; G is the gravitational constant. Let $m_1 = m_2 = 1 \text{kg}$, for the gravitational force $r_{g12} = 1 \text{m}$. Based on the formula (9): $F_g = G$. As it is known the elementary charge value q_e equals $q_e = 1,602176565 \bullet 10^{-19} \text{C}$. [1]. Let us find a distance at which the force created by two elementary charges equals the force created by two bodies of 1 kg mass each that are located at 1 m distance from each other. Based on the formulas (8,9): $r_{e12}^2 = \frac{kq_1q_2}{G} = 3,4056 \bullet 10^{-39} \text{m}^2$. Hence: $r_{e12} = 5,835752 \bullet 10^{-20} \text{m}$. The ratio $\frac{1}{r_{e12}}$ is assumed at a first approximation as similarity coefficient k_f between the gravitational and electromagnetic fractals of the Universe. $k_f = \frac{1}{r_{e12}} = 1,713575149 \bullet 10^{19}$. Subsequently, the radius of the gravitational fractal of the Universe R_g equals: $R_g = R_e \bullet k_f = 2,251656407 \bullet 10^{45} \text{m}$. The volume of the gravitational fractal of the Universe Q_{Ug} equals: $Q_{Ug} = 4,7818392 \bullet 10^{136} \text{m}^3$. Before analyzing obtained results let us consider the formulae of fractal link (through f_g - the golden fractal characteristic) of some fundamental constants: number π , number e , velocity of light $c = 2,99792458 \bullet 10^8 \text{km/c}$ [1], fine structure constant $\alpha = 7,2973525698 \bullet 10^{-3}$ [1]. Any natural process, including the fundamental constants, can be represented as the idea of the aggregate of fractals. In case the fractal mantissas, e.g., of the fundamental constants, happen to be equal, it means that these constants refer to one and the same (or naturally alike) fractal process. The golden fractal mantissa of 2π number equals: $f_{2\pi mg} = 1,4833$, number 2π is the golden fractal of the -3 level of number $f_{2\pi mg}$, i.e., $2\pi = f_{2\pi mg} \bullet f_g^3$,

the $(-2nd)$ level of the golden fractal of number $f_{2\pi mg}$ equals: $f_{2\pi mg} \bullet f_g^{-2} = 3,8832$, The fine structure constant cube equals: $\alpha^3 = 3,8859399 \bullet 10^{-7}$, The ratio of the fine structure constant cube mantissa to the $(-2nd)$ level of the golden fractal number $f_{2\pi mg}$ equals: 1.0006997; In other words, the relative incongruence of values is about 0,07 percent. The light velocity squared equals: $c^2 = 8,9875517873681764 \bullet 10^{16} \text{km}^2 \text{s}^{-2}$, Raising the mantissa of the light velocity squared to the f_g power: $(8,9875517873681764)^{f_g} = 3,88493$. The ratio of mantissa of the light velocity squared to the f_g power and the $-2nd$ level of the golden fractal of number $f_{2\pi mg}$ equals: 1.0004389, i.e., the relative incongruence of values is about 0.044 percent. The ratio of the fine structure constant cube mantissa to the mantissa of the light velocity squared mantissa raised to f_g power equals: 1.00026, i.e., the relative incongruence of values equals 0.026 percent. Let us raise number e to the power e , then raise the obtained value one more

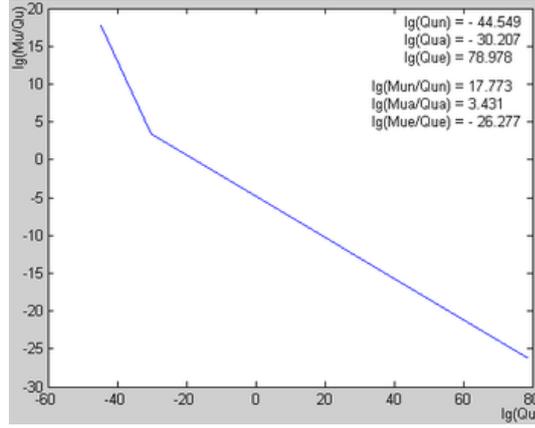


Figure 1: Volumetric density of mass of the Universe fractal versus its volume for the nuclear, atomic and electromagnetic fractals of the Universe.

time to the power e and divide the result by 1,000: $\frac{(e^e)^e}{1000} = 1,6182$, The ratio of the obtained number 1.618178 and number f_g^{-1} equals: 1.000088999, i.e., the relative incongruence of values is about 0.009 percent. These formulae prove that there is a fractal link between the fundamental constants, i.e., they refer to very close fractals, and as far as the formulae are not identities then this link is indeterminate, kind of blurry. This conclusion is also confirmed by the analysis of fractal links of other fundamental constants. Let us construct a graph (log-log plot) which reflects dependence between the volumetric (spatial) density of the mass of nuclear, atomic and electromagnetic fractals of the Universe and their volumes (Fig.1). The analysis of the graph and numeric characteristics of the atomic fractal of the Universe leads to a conclusion that this fractal is transitional, boundary between two basic fractals of the Universe -electromagnetic and nuclear. It can also be assumed that there exists a transitional fractal between the electromagnetic and gravitational fractals of the Universe. Based on the formulae describing the fractal link of fundamental constants and on the analysis of the atomic fractal characteristics it can be presumed that the fractal structure of the Universe may not have clearly defined transitions between basic fractals, i.e., such transitions, while being fractals as well, are sort of blurry and "hazy" (sfumato) and the very fractal structure of the Universe is, actually, of sfumato and fractal type. Let us construct a graph (log-log plot), which reflects dependence between the volumetric (spatial) density of the mass of nuclear and electromagnetic fractals of the Universe and their volumes (Fig.2), and extrapolate this graph to the common logarithm value of the volume of the gravitational fractal of the Universe.

It follows from the graph Fig. 2 that the value $\lg(Q_{Ug}) = 136,68$ of the common logarithm of the volume of the gravitational fractal of the Universe corresponds to the volumetric density of the fractal mass in the log scale which equals $\lg(\rho_{Ug}) = -46,78$. Assuming this density, the mass of the gravitational fractal of the Universe M_{Ug} is: $M_{Ug} = 7,943 \bullet 10^{89}\text{kg}$. To evaluate the gravity factor of the gravitational fractal of the Universe g_g , we apply its simplified model: let all mass of the fractal lies in the centre of its sphere and let the gravitational constant value is the same as for the electromagnetic fractal of the Universe, then:

$$g_g = \frac{GM_{Ug}}{R_g^2}, \quad (10)$$

Based on the formula (10) g_g equals: $g_g = 1,0446 \bullet 10^{-11}\text{m}\cdot\text{s}^{-2}$. Should the gravitational fractal of the Universe rotate, its period T_g can be determined by the formula of mathematical

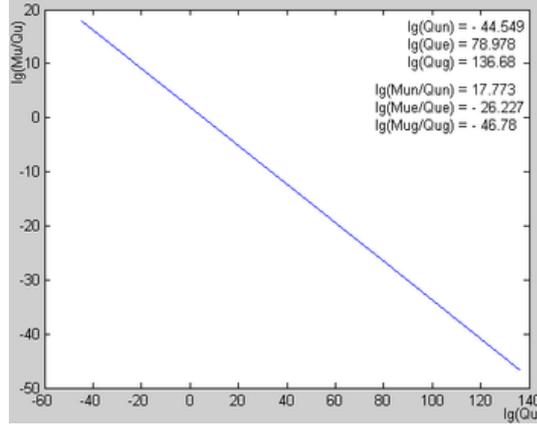


Figure 2: Volumetric density of mass of the Universe fractal versus its volume for the nuclear, electromagnetic and gravitational fractals of the Universe

pendulum:

$$T_g = 2\pi \sqrt{\frac{R_g}{g_g}}, \quad (11)$$

Based on the formula (11) T_g equals: $T_g = 9,2246 \bullet 10^{28}$ s. Assuming such values of the radius and the period, the maximum velocity V_g at the equator of the gravitational fractal sphere equals: $V_g = \omega_g R_g$, $V_g = 1,53 \bullet 10^{17}$ m·s⁻¹. Or else: $V_g = 1,7 \bullet K_s$ m·s⁻¹, Here K_s is a factor which is numerically equal to the light velocity squared: $8,9875517873681764 \bullet 10^{16}$. It follows from the obtained estimates that the maximum velocity of the physical interaction transfer within the gravitational fractal of the Universe is greater than the light velocity squared. Supposing that the fractal structure of the Universe is based upon the golden multiplicative fractal (characteristics of its elements are obtained by multiplying the characteristics of two preceding elements), then the estimates of the spatial volumes and masses of the Universe fractals equal a product of the corresponding characteristics of two preceding fractals of the Universe. Or, in terms of log scale, the golden fractal will be an additive one and in this instance the estimates of the logarithms of spatial volumes and masses of the Universe fractals, following the gravitational fractal, will equal a sum of logarithms of the corresponding characteristics of two preceding fractals of the Universe. In other words, if we assign sequence number 4 to the fractal which follows the gravitational fractal in the hierarchy, then: $Q_{Ut} = k_1 \bullet Q_{Ut-1} \bullet Q_{Ut-2}$, $t = 4 \dots \infty$, Q_{Ui} is the volume of the t -th order fractal of the Universe, $M_{Ut} = k_2 \bullet M_{Ut-1} \bullet M_{Ut-2}$, $t = 4 \dots \infty$, M_{Ui} is the mass of the t -th order fractal of the Universe, where k_1 and k_2 are the coefficients that account for an indeterminate boundaries between adjacent fractals. Alternately, in the log scale:

$$\begin{aligned} \lg(Q_{Ut}) &= \lg(Q_{Ut-1}) + \lg(Q_{Ut-2}) \pm \lg(k_1), \\ \lg(M_{Ut}) &= \lg(M_{Ut-1}) + \lg(M_{Ut-2}) \pm \lg(k_2). \end{aligned}$$

In particular, having made appropriate computations, we obtain for the fractal of order number 4 (provided that $k_1 = k_2 = 1$):

$$\begin{aligned} \lg(Q_{Ui}) &= \lg(Q_{Ue}) + \lg(Q_{Ug}) = 78,98 + 136,68 = 215,66, \\ \lg(M_{Ui}) &= \lg(M_{Ue}) + \lg(M_{Ug}) = 52,75 + 89,9 = 142,65. \end{aligned}$$

In doing so, the ratios

$$\frac{\lg(M_{Ut})}{\lg(Q_{Ut})}, \frac{\lg(Q_{Ut-1})}{\lg(Q_{Ut})}, \frac{\lg(M_{Ut-1})}{\lg(M_{Ut})},$$

fluctuate around the number which makes the golden fractal base.

6 Discussion

In each fractal of the Universe there is a dominant kind of energy (force interaction) while the "traces" of any and all kinds of energy of other fractals are also present. The energy value of these "traces" decreases with the increase of the difference of fractal numbers and is inversely proportionate to the product of similarity coefficients by energy between the intermediate fractals. Taking into consideration the similar structure of the Coulomb law and the law of universal gravitation, it can be supposed that the force interaction of fractals that are older than the gravitational one is based on various aggregative states of mass in these fractals. That is, the law of universal gravitation for the fractals that are older than the gravitational one (in relation to the gravitational fractal) is given by:

$$F = \prod_{d=4}^{\infty} k_{fd} \frac{GA_d(m_1, l_1)A_d(m_2, l_2)}{r_{12}^2}, \quad (12)$$

where k_{fd} mean the similarity coefficients by mass between the adjacent fractals. $A_d(m_1, l_1)$, $A_d(m_2, l_2)$ are, respectively, the aggregative state of mass m_1 , as well as the radius of curvature of space l_1 , which is created by mass m_1 , and aggregative state of mass m_2 , as well as the radius of curvature of space l_2 , which is created by mass m_2 , the fractal of the Universe under number d ; G is the gravitational constant; r_{12} is a distance between aggregative states of masses $A_d(m_1, l_1)$? $A_d(m_2, l_2)$. As the limit velocity of physical interaction transfer increases with the increase of the order number of the Universe fractal, the Einstein's formula of the total energy of body of mass m in number d fractal increases by the value of a product of similarity coefficients k_{ef} of adjacent fractals by velocity:

$$E = \prod_{d=4}^{\infty} k_{ed} mc^2, \quad (13)$$

From (12) and (13) follows that the fractal structure of the Universe implies a presence therein of a single discrete-continuous scale for measuring physical values, and a multitude of local discrete-continuous scales for measuring physical values associated with particular fractals. Non-homogeneity of mass (energy) distribution in the space of the Universe is a source of motion and physical interaction of forces in the Universe. Consequently, mass and length are the basic physical characteristics of the Universe. As a result, the main fundamental constants are l_p number, length and Planck mass. Velocity of light can be represented as a ratio of Planck length l_p to Planck time t_p . Hence, Planck time t_{pd} for the number d fractal of the Universe is equal to:

$$t_{pd} = \prod_{d=4}^{\infty} k_{ed} \sqrt{\frac{m}{E}} l_p, \quad (14)$$

From (14) follows that each fractal of the Universe has its own discrete-continuous scale for measuring time and possesses a peculiar time potential. This potential is the maximum for the Universe fractals having the maximum density of mass (nuclear), and it decreases (correspondingly, the march of time accelerates) as the fractal number increases. On a formal level time changes on its global scale discretely and runs from the past to the future: from nuclear fractals through the present in the electromagnetic fractal and to the future in the gravitational and more senior fractals of the Universe. Local time of each fractal of the Universe is calibrated by a value of the Planck time constant for the given fractal. It changes in a discrete-continuous mode. In doing so, the march of time (within the limits of its scale) is minimum near great masses and maximum in the spaces where there is no mass at all.

7 Conclusions

According to the adopted hypothesis the Universe has a sfumato-fractal structure with spatial and energy characteristics which is based on multiplicative golden fractal. It enables to reinterpret certain peculiarities of the observed Universe. Reduction of the spatial density of energy coming in parallel with the increase of the order (seniority) of a fractal leads to a higher limit velocity of the physical interaction transfer: for example, the limit velocity of an atomic fractal (velocity of light reduced by the fine structure constant value) is less than the velocity of light, which is maximum for the electromagnetic fractal, which, in its turn is smaller than the maximum velocity for the gravitational fractal. Inflation of space of the Universe is a stationary sfumato-fractal process that does not require an assumption concerning expansion of the Universe due to dark energy. There exists no dark energy. The effect interpreted as a presence of dark energy is created by a rotary motion of the electromagnetic fractal spherical space. It can also be presumed that because the electromagnetic fractal space of the Universe existed before the Big Bang and as it was rotating, then this rotation during the period of about 10^{-6} s after the Big Bang caused appearance of a left-handed (right-handed) angle between the direction of matter escape from the singularity point and the direction towards a point in space where, finally, this matter emerges at a time point 10^{-6} s. Nonzero angle of matter escape leads to asymmetry and prevalence of matter over antimatter. At some time point all matter will accumulate in the other pole of the sphere of the electromagnetic fractal of the Universe where, upon accumulation of the critical mass, the next Big Bang will occur but the clocking angle with respect of the flying apart matter will be right-handed (left-handed), therefore antimatter will prevail in the electromagnetic fractal. Despite the limit velocity of the physical interaction transfer within the electromagnetic fractal of the Universe may not, due to its spatial and energy parameters, exceed the velocity of light, within this fractal there should be sfumato-fractal "traces" of the maximum velocity which is characteristic of the gravitational fractal, e.g., of the velocity of gravitational waves. Still, instead of the term "gravitational waves" the authors prefer to use the term "space warp" of a radius which equals the gravitational wave length.

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