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ANALYTICAL EVALUATION OF THE NUMERICAL VALUES OF THE HUBBLE CONSTANT AND MAIN SPATIAL-ENERGY CHARACTERISTICS OF THE OBSERVABLE UNIVERSE

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АНАЛІТИЧНА ОЦІНКА ЧИСЛОВИХ ЗНАЧЕНЬ КОНСТАНТИ ХАББЛА ТА ОСНОВНИХ ПРОСТОРОВО-ЕНЕРГЕТИЧНИХ ХАРАКТЕРИСТИК СПОСТЕРЕЖУВАНОГО ВСЕСВІТУ

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Abstract. *Since the baryonic matter of the observable Universe consists mainly of protons and neutrons, then the numerical value of its mass can be represented and calculated on the basis of an additive-multiplicative golden algebraic fractal, based on golden algebraic fractals of the masse of proton, neutron, and muon. Based on an analytical estimate of the mass of the observable Universe, using the law "Planck's Universal Proportions", an analytical estimate of the Hubble constant and the main spatial-energy characteristics of the observed Universe is obtained. An analytical estimate of the Hubble constant is consistent with the experimental data of Planck's mission, SDSS-III Baryon Oscillation Spectroscopic Survey, DES Collaboration. The objectivity of the experimental estimation of the Hubble constant from the H0LiCOW, Riess et al, Hubble Space Telescope collaborations does not raise any doubts. This means that the Hubble constant describes two similar, but different physical processes and has at least two values. The value of the Hubble constant from the collaborations Planck's mission, SDSS-III Baryon Oscillation Spectroscopic Survey, DES Collaboration describes the process of rotation of the space of the observed Universe, and the value of the Hubble constant from the collaborations H0LiCOW, Riess et al, Hubble Space Telescope describes the process of rotation of substance in the space of the observed Universe. It is shown that after the Big Bang, the space of the observable Universe made one incomplete revolution of at 345 degrees, and the substance in it made one complete revolution of approximately 379 degrees. New estimates are given: of the gravitational constant, of the Planck energy, of the Planck acceleration, of the Planck force, of the gravity factor of the observable Universe, of the Planck temperature, of the angular velocity of rotation of the space of the observable Universe. Estimates of temperature and wavelength of thermal radiation of the observable Universe, as the Hubble sphere, are given.*

Keywords: *Hubble constant, universe, fractal, proportions and constants of Planck, black hole, the Hubble sphere.*

Анотація. *Оскільки баріонна речовина спостережуваного Всесвіту складається в основному з протонів і нейтронів, то числове значення його маси можна представити і розрахувати на основі адитивно-мультиплікативного золотого алгебраїчного фрактала, заснованого на золотих алгебраїчних фракталах маси протона, нейтрона і мюона. Виходячи з аналітичної оцінки маси спостережуваного Всесвіту, використовуючи закон «Універсальні пропорції Планка», отримано аналітичну оцінку постійної Хаббла і основних просторово-енергетичних характеристик спостережуваного Всесвіту. Аналітична оцінка константи Хаббла узгоджується з експериментальними даними місії Планка, дослідження SDSS-III Baryon Oscillation Spectroscopic Survey, DES Collaboration. Об'єктивність експериментальної оцінки постійної Хаббла від колаборацій: H0LiCOW, Riess et al, Hubble Space Telescope не викликає сумнівів. Це означає, що постійна Хаббла описує два однакових, але різних фізичних процесу і має як мінімум два значення. Значення постійної Хаббла від колаборацій: Місія Планка, SDSS-III Baryon Oscillation Spectroscopic Survey, DES Collaboration описує процес обертання простору спостережуваного Всесвіту, а значення постійної Хаббла від колаборацій: H0LiCOW, Riess et al, Hubble Space Telescope описує процес обертання речовини в просторі спостережуваного Всесвіту. Показано, що після*

Великого вибуху простір спостережуваного Всесвіту вчинив один не повний оборот на 345 градусів, а речовина в ньому вчинила один повний оборот приблизно на 379 градусів. Наведені нові оцінки: гравітаційної постійної, енергії Планка, прискорення Планка, сили Планка, гравіті фактора спостережуваного Всесвіту, температури Планка, кутової швидкості обертання простору спостережуваного Всесвіту. Наведено оцінки температури і довжини хвилі теплового випромінювання спостережуваного Всесвіту, як сфери Хаббла.

Ключові слова: *константа Хаббла, всесвіт, фрактал; пропорції і константи Планка,чорна діра; сфера Хаббла.*

1 INTRODUCTION. FORMULATION OF THE PROBLEM

It is known that fractals are self-similar algebraic and geometric constructions, in which each part of them is similar to the whole structure, and the entire structure is similar to each its part. In [1,2,3] it was shown that physical constants can be represented in the form of gold algebraic fractals (GAF). The basis of these fractals is the number f_g, which is the coefficient of similarity of fractals:

$$f_g = \sqrt{5}/2 - 0.5 = 2\sin(18°) = 2\cos(72°) = 0.6180339887498948482045868343656... \quad (1)$$

Then any physical constant ϕ in the form of a golden algebraic fractal has the form:

$$\phi = M_g \cdot f_g^y, \quad (2)$$

where M_g is the mantissa of the GAF constant ϕ, y is the structural level of the GAF. The number M_g and integer y satisfy the conditions:

$$1 \le M_g \le 1/f_g = 1.6180339887498948482045868343656...; \quad -\infty < y < \infty. \quad (3)$$

Mantissas M_g and M_{gi} physical constants ϕ and $1/\phi$ satisfy the condition:

$$1/f_g = M_g \cdot M_{gi}. \quad (4)$$

The mantissa M_{gi} will be called the inversion of the mantissa M_g.

The numerical value of the mass [4] of some elementary particles: electron, muon, tau, proton, neutron and Planck's hypothetical particle will be presented in the form of GAF (2), and the data will be entered in Table 1. We take into the account that the muon and the hypothetical Planck particle are the same GAF [1], so the characteristics of a hypothetical Planck particle are determined on the basis of the characteristics of the muon:

Table 1 – The mantissa, the inversion of mantissa, the structural level of the GAF: electron, muon, tau, proton, neutron, hypothetical Planck particle.

Particle name	Particle mass, kg	Mantissa M_g	Inverse mantissa M_{gi}	Level GAF y
electron	$9.10938356 \cdot 10^{-31}$	1.13164233169	1.42981041221	144
muon	$1.883531594 \cdot 10^{-28}$	1.17578810591	1.37612719555	133
tau	$3.16747 \cdot 10^{-27}$	1.10190162111	1.46840149588	127
proton	$1.672621898 \cdot 10^{-27}$	1.52336288580	1.06214612672	129
neutron	$1.674927471 \cdot 10^{-27}$	1.52546271742	1.06068406017	129
hypot. Planck	$2.17663883450 \cdot 10^{-8}$	1.17578810591	1.37612719555	37

Based on experimental data estimates of the Hubble constant, which were obtained from various sources: the Planck Mission [5,6,7,8], the Wilkinson Microwave Anisotropy Probe (WMAP 9 years, combined with other measurements) [9], SDSS-III Baryon Oscillation Spectroscopic Survey [10], DES Collaboration [11], using the law "Planck's Universal Proportions" [12], calculate the estimate of the mass of the observable Universe. The obtained data, including the value of the estimated mass of the observable Universe in the form of a GAF, are presented in Table 2.

Table 2 – The estimation of the mass of the observable Universe based on the Hubble constant, which is obtained from the various experimental sources of the information

Name of the data source	Citation	Hubble const., (km/s)/Mpc	Mass of the Universe, kg	GAF form of a mass of the Universe, kg
Planck Mission	[5]	67.66 ± 0.42	$1.8414357 \cdot 10^{53}$	$1.52158398 \cdot f_g^{-254}$
Planck Mission	[6,7]	67.74 ± 0.46	$1.839260 \cdot 10^{53}$	$1.51978700 \cdot f_g^{-254}$
Planck Mission	[8]	67.80 ± 0.77	$1.837633 \cdot 10^{53}$	$1.5184420 \cdot f_g^{-254}$
WMAP	[9]	69.32 ± 0.80	$1.797339 \cdot 10^{53}$	$1.485146740 \cdot f_g^{-254}$
SDSS-III BOSS	[10]	67.6(+0.7)(-0.6)	$1.8430700 \cdot 10^{53}$	$1.522934498 \cdot f_g^{-254}$
DES Collaborat.	[11]	67.77 ± 1.30	$1.838447 \cdot 10^{53}$	$1.51911424 \cdot f_g^{-254}$

The GAF can be divided into: the simple fractals (e.g., such as in Table 1); multiplicative - those in which the mantissa is formed by multiplying the mantissas of the simple fractals with their subsequent normalization to the form (3); additive ones are those whose mantissa can be represented as a sum of an infinite series of power functions f_g^n [2]; mixed type - additive-multiplicative or multiplicative-additive. Obviously, two or more algebraic fractals are the same fractal if their mantissas are equal.

The Hubble constant has a dual nature. It describes with the same success two different physical processes in the observable Universe: expansion and rotation of its space. That is, the redshift from distant objects of the observable Universe can be described with equal success on the one hand by the removal (scattering) of these objects under the action of the force of so-called dark energy, and on the other hand by the rotation of the space of the observed Universe. Both hypotheses have flaws. In the first case, a scientifically based source of dark energy is required, and in the second case, under certain conditions, the basic principle of cosmology, the principle of isotropy of space, is violated. Currently, of the many hypotheses about the nature of the source of dark energy, the most widely used hypothesis is the cosmological constant or, as say, the lambda constant. According to this hypothesis, the lambda constant in Einstein's equations gets a physical meaning - the pressure of the vacuum. The expansion of the space of the observable Universe occurs under the action of the pressure of the vacuum. However, space can expand only from the area of high pressure to the area of low pressure, that is, only under the action of pressure drop. The lambda calibration coefficient is constant for all points of the Universe, that is, the vacuum pressure at all points of the Universe is the same and there is no pressure differential in it. This means that the hypothesis of the cosmological constant, as a source of dark energy, is not consistent. The solution of the Einstein equations for the rotating space of the Universe was proposed by Gödel in 1949 [13]. Further development of the hypothesis of the rotation of the space of the observable Universe was obtained in [14,15,16,17,18]. Professor Michael Longo (University of Michigan in Ann Arbor), having studied [14,15] in the framework of Sloan Digital Sky Survey (SDSS) database project SDSS DR5, which contains about 40,000 galaxies (of them - more than 15,000 spiral galaxies), for where the value of redshift $z < 0.04$, came to the conclusion that left twisted spiral galaxies is much larger than spiral galaxies swirling right. Conclusions of professor Michael Longo confirmed a group of scientists led by Professor Lior Shamir (Lawrence Technological University) [16]. Was investigated about 250 thousand spiral galaxies, for which the value of redshift $z < 0.3$. Professor Lior Shamir also found that galaxies left more than right. Symmetry breaking between the right- and left - twisted spiral galaxies are about seven percent, but the probability that is a cosmic accident is very low - claims Professor Michael Longo. The results of research professors Michael Longo and Lior Shamir contradict the notion that the Universe is homogeneous and symmetric. Scientists believe that the asymmetry of the Universe emerged in the Big Bang at the expense of the initial rotation of the Universe space counterclockwise.

This means, firstly, that the space of the Universe could have existed before the Big Bang, and secondly, as claims, Professor Michael Longo universe revolves now. In [17] it is shown that the rotation of the space of the observable Universe can be a source of dark energy and dark matter. The rotation of the space of the Universe is also supported by research Professors S.-C. Su and M.-C. Chu

(Department of Physics and Institute of Theoretical Physics, The Chinese University of Hong Kong, Shatin, Hong Kong, China) [18].

2 ANALYTICAL ESTIMATE OF HUBBLE CONSTANT NUMERICAL VALUE

It is known [19, 20] that the mass of the baryonic matter of the observable Universe consists of more than 75 % protons. Then, taking into account that the electron mass is much less than the proton and neutron masses, and also that the neutron and proton masses are close in value, we can conditionally assume that the mass of the observable Universe is 75 % composed of protons and 25 % of neutrons.

Analysis of the data in Tables 1 and 2 shows that the mantissas of the masse of the observable Universe are very close to the mantissas of the masses of the proton and neutron, in all cases, except for the data from WMAP.

Let the mass of the observable universe is formed only from protons. Then, assuming that the mass of the observable Universe and the mass of the proton are one and the same golden algebraic fractal, but on different structural levels of matter, we choose the proton mantissa as the standard, and on its basis, we estimate the mass of the observed Universe $M_U^{p^+}$:

$$M_U^{p^+} = 1.52336288580... \cdot f_g^{-254} = 1.8435885153510... \cdot 10^{53} \text{ kg.} \tag{5}$$

Let the mass of the observable Universe and the mass of the neutron - is one and the same golden algebraic fractal, but on different structural levels of matter, then choose of the mantissa of the neutron as standard, and on its basis to estimate of the mass of the observable Universe $M_U^{n^0}$:

$$M_U^{n^0} = 1.5254627174172... \cdot f_g^{-254} = 1.84612975190... \cdot 10^{53} \text{ kg.} \tag{6}$$

Let us estimate the mass of the observable Universe $M_U^{p^+ + n^0}$, provided that it consists of 75 % protons and 25 % neutrons:

$$M_U^{p^+ + n^0} = 0.75 \cdot M_U^{p^+} + 0.25 \cdot M_U^{n^0} = 1.84422382448890... \cdot 10^{53} \text{ kg.} \tag{7}$$

Since the hypothetical Planck particle and the muon are the same golden algebraic fractal, then the Planck constants: of the mass $m_p^{\mu^-}$, of length $l_p^{\mu^-}$ and of time $t_p^{\mu^-}$, which determined through the characteristics of the muon have the following meanings [1]:

$$m_p^{\mu^-} = 2.17663883450... \cdot 10^{-8} \text{ kg; } l_p^{\mu^-} = 1.61610315323... \cdot 10^{-35} \text{ m; } t_p^{\mu^-} = 5.3907398606... \cdot 10^{-44} \text{ s.} \tag{8}$$

To estimate the Hubble constant taking into account formulas (5–7), we use the law "Planck's Universal Proportions". To do this, based on the values of the constants (8), we calculate the proportionality coefficient estimate ρ_{pt}^{-1} for this law:

$$\rho_{pt}^{-1} = \frac{t_p^{\mu^-}}{m_p^{\mu^-}} = 2.4766349727317... \cdot 10^{-36} \text{ s} \cdot \text{kg}^{-1}. \tag{9}$$

Then the Hubble constant estimate H^{p^+} for the observable Universe, which consists only of protons, is equal to:

$$T_U^{p^+} = \rho_{pt}^{-1} \cdot M_U^{p^+} = 4.56589579244490... \cdot 10^{17} \text{ s; } H^{p^+} = \frac{1}{T_U^{p^+}} = 2.19015072935891... \cdot 10^{-18} \text{ s}^{-1}, \tag{10}$$

where $T_U^{p^+}$ is the Hubble time, or the delay in the propagation of the light signal at a distance that is equal to the radius of the observed Universe. The value of the evaluation of the Hubble constant in the traditional form:

$$H^{p^+} = 67.5809900 \ (\text{km/s})/\text{Mpc}. \tag{11}$$

The Hubble constant estimate H^{n^0} for the observable Universe, which consists only of neutrons, is equal to:

$$T_U^{n^0} = \rho_{pt}^{-1} \cdot M_U^{n^0} = 4.572189507762430... \cdot 10^{17} \text{s}; \; H^{n^0} = \frac{1}{T_U^{n^0}} = 2.1871359406740... \cdot 10^{-18} \text{s}^{-1}. \quad (12)$$

The value of the evaluation of the Hubble constant in the traditional form:

$$H^{n^0} = 67.4879634 (\text{km/s}) \text{Mpc}. \quad (13)$$

The Hubble constant estimate $H^{p^+ + n^0}$ for the observable Universe, which consists of protons and neutrons, is equal to:

$$T_U^{p^+ + n^0} = \rho_{pt}^{-1} \cdot M_U^{p^+ + n^0} = 4.56746922127... \cdot 10^{17} \text{ s}; \; H^{p^+ + n^0} = \frac{1}{T_U^{p^+ + n^0}} = 2.18939625327... \cdot 10^{-18} \text{ s}^{-1}. \quad (14)$$

The value of the evaluation of the Hubble constant in the traditional form:

$$H^{p^+ + n^0} = 67.55770 \; (\text{km/s}) / \text{Mpc}. \quad (15)$$

Then the analytical evaluation of the Hubble constant can be represented as:

$$H = 67.55770^{+\,0.02329}_{-\,0.06974} \; (\text{km/s}) / \text{Mpc}. \quad (16)$$

Or taking into account the percentage ratio of protons and neutrons:

$$H = 67.55770^{+\,0.02329} \; (km / s) / Mpc. \quad (17)$$

The analytical estimate of the Hubble constant is within the tolerances of the experimental Hubble constant values, which are obtained by Planck Mission, DES Collaboration, SDSS-III BOSS.

There are two main ways to experimentally determine the Hubble constant: by studying the relict radiation and by measuring the distances to distant objects of the Universe, for example, quasars, Cepheids and red giant stars. Relic radiation is distributed throughout the space of the observable Universe, therefore, an experimental estimate of the Hubble constant based on it reflects the physical process that is inherent in the entire space of the observable Universe. An experimental estimate of the Hubble constant based on measuring changes in the distances to quasars, Cepheids, and red giant stars reflects the physical process associated with the movement of substance in the observable Universe. This means that the Hubble constant objectively has at least two values. In this case, the value of the Hubble constant about the value: 1) $H = 67.55770^{+\,0.02329} \, (\text{km/s})/\text{Mpc}$, displays the process of rotation of the space of the observed Universe, and the value of the Hubble constant, for example, about the value: 2) $H = 74.03 \; \pm 1.42 (\text{km/s})/\text{Mpc}$ [21], displays the process of rotation of the substance in the space of the observed Universe. It is possible that an estimate of the Hubble constant based on the motion of a substance whose mass density is significantly lower than the mass density of quasars, Cepheids, and red giant stars will differ from the known values 1) and 2).

3 EVALUATION OF THE MAIN SPATIAL AND ENERGETIC CHARACTERISTICS OF THE OBSERVABLE UNIVERSE

Based on the values of Planck's constants - of the mass, of length and of time, which are represented in formula (8), we calculate the coefficients of proportionality for the law "Planck's Universal Proportions". To do this, we first introduce an auxiliary coefficient: the unit rarefaction of Planck's mass ρ_p^{-1}:

$$\rho_p^{-1} = \frac{1}{m_p^{\mu^-}} = 4.594239449... \cdot 10^7 \text{ kg}^{-1}. \quad (18)$$

The impulse of a unit rarefaction of the mass of Planck ρ_{pt}^{-1} is represented by formula (9), that is:

$$\rho_{pt}^{-1} = t_p^{\mu^-} \cdot \rho_p^{-1} = \frac{t_p^{\mu^-}}{m_p^{\mu^-}} = 2.4766349727317... \cdot 10^{-36} \text{ kg}^{-1}\text{s} \quad (19)$$

The quantum of Planck's mass h_{pm}:

$$h_{pm} = \frac{m_p^{\mu^-}}{t_p^{\mu^-}} = 4.0377367315... \cdot 10^{35} \text{ kg} \cdot \text{s}^{-1}. \quad (20)$$

The linear density of Planck's mass ρ_{pl}:

$$\rho_{pl} = \frac{m_p^{\mu^-}}{l_p^{\mu^-}} = 1.34684399950... \cdot 10^{27} \text{ kg} \cdot \text{m}^{-1}. \quad (21)$$

The linear rarefaction of Planck's mass ρ_{pl}^{-1}:

$$\rho_{pl}^{-1} = \frac{l_p^{\mu^-}}{m_p^{\mu^-}} = 7.424764860... \cdot 10^{-28} \text{ kg}^{-1}\text{m}. \quad (22)$$

The quantum of Planck's length, or the speed of light in vacuum c:

$$c = \frac{l_p^{\mu^-}}{t_p^{\mu^-}} = 299792458 \text{ m} \cdot \text{s}^{-1}. \quad (23)$$

In electromagnetism [21], electrical resistance has the dimension of velocity, then by analogy, we call the quantity, which is inverse to velocity, the conductivity of light in a vacuum c^{-1}:

$$c^{-1} = \frac{t_p^{\mu^-}}{l_p^{\mu^-}} = 3.33564095198... \cdot 10^{-9} \text{ m}^{-1}\text{s}. \quad (24)$$

In addition to the coefficients that are presented in formulas (19–24), we calculate the coefficients that characterize the density of mass (and its rarefaction) of Planck and the product of the Planck constants: of mass, of length and of time. The surface density of Planck's mass ρ_{ps}:

$$\rho_{ps} = \frac{m_p^{\mu^-}}{(l_p^{\mu^-})^2} = 8.33389871685... \cdot 10^{61} \text{ kg}^1\text{m}^{-2}. \quad (25)$$

The surface rarefaction of Planck's mass ρ_{ps}^{-1}:

$$\rho_{ps}^{-1} = \frac{(l_p^{\mu^-})^2}{m_p^{\mu^-}} = 1.199918590... \cdot 10^{-62} \text{ kg}^{-1}\text{m}^2. \quad (26)$$

The density of Planck's mass ρ_{pv}:

$$\rho_{pv} = \frac{m_p^{\mu^-}}{(l_p^{\mu^-})^3} = 5.156786372... \cdot 10^{96} \text{ kg} \cdot \text{m}^{-3}. \quad (27)$$

The rarefaction of Planck's mass ρ_{pv}^{-1}:

$$\rho_{pv}^{-1} = \frac{(l_p^{\mu^-})^3}{m_p^{\mu^-}} = 1.9391922174000... \cdot 10^{-97} \text{ kg}^{-1}\text{m}^3. \quad (28)$$

The moment of Planck's mass j_{pm}:

$$j_{pm} = m_p^{\mu^-} \cdot l_p^{\mu^-} = 3.51767288389...\cdot 10^{-43} \text{ kg}\cdot\text{m}. \quad (29)$$

The impulse of Planck's mass δ_{pm}:

$$\delta_{pm} = m_p^{\mu^-} \cdot t_p^{\mu^-} = 1.17336937272...\cdot 10^{-51} \text{ kg}\cdot\text{s.}\cdot \quad (30)$$

The impulse of Planck's length δ_{pl}:

$$\delta_{pl} = l_p^{\mu^-} \cdot t_p^{\mu^-} = 8.7119916869...\cdot 10^{-79} \text{ m}\cdot\text{s.} \quad (31)$$

Formulas (7) and (14) represent the mass $M_U = M_U^{p^+ + n^0}$ of the observable Universe as well as the Hubble time $T_U = T_U^{p^+ + n^0}$. Based on the law "Planck's Universal Proportions" and formulas (19–24), using one of the three characteristics of the observed Universe: mass M_U, Hubble time T_U, or Hubble radius R_U, we can estimate two other characteristics. A similar statement is true for any, having a mass, body of the observable Universe. Let us estimate the radius of the observable Universe R_U, or Hubble radius:

$$R_U = \rho_{pl}^{-1} \cdot M_U = 1.36929282469...\cdot 10^{26} \text{ m}, \quad (32)$$

$$R_U = c \cdot T_U = 1.36929282469...\cdot 10^{26} \text{ m}. \quad (33)$$

Also true:

$$M_U = \rho_{pl} \cdot R_U = 1.84422382448890...\cdot 10^{53} \text{ kg}, \quad (34)$$

$$M_U = h_{pm} \cdot T_U = 1.84422382448890...\cdot 10^{53} \text{ kg}, \quad (35)$$

$$T_U = \rho_{pt}^{-1} \cdot M_U = 4.56746922127...\cdot 10^{17} \text{ s}, \quad (36)$$

$$T_U = c^{-1} \cdot R_U = 4.56746922127...\cdot 10^{17} \text{ s}. \quad (37)$$

It follows from the law of "Planck's Universal Proportions" that formulas (19–24) are also valid when instead of the Planck constants: of mass, of length and of time are substituted for the corresponding characteristics of the observed Universe. Then:

$$\rho_{Ut}^{-1} = \rho_{pt}^{-1} = \frac{T_U}{M_U} = 2.4766349727317...\cdot 10^{-36} \text{ kg}^{-1}\text{s}, \quad (38)$$

$$h_{Um} = h_{pm} = \frac{M_U}{T_U} = 4.0377367315...\cdot 10^{35} \text{ kg}\cdot\text{s}^{-1}, \quad (39)$$

$$\rho_{Ul} = \rho_{pl} = \frac{M_U}{R_U} = 1.34684399950...\cdot 10^{27} \text{ kg}\cdot\text{m}^{-1}, \quad (40)$$

$$\rho_{Ul}^{-1} = \rho_{pl}^{-1} = \frac{R_U}{M_U} = 7.424764860...\cdot 10^{-28} \text{ kg}^{-1}\text{m}, \quad (41)$$

$$c = \frac{R_U}{T_U} = 299792458 \text{ m}\cdot\text{s}^{-1}, \quad (42)$$

$$c^{-1} = \frac{T_U}{R_U} = 3.33564095198...\cdot 10^{-9}\text{m}^{-1}\text{s}. \quad (43)$$

The estimate of the surface density of the mass of the observable Universe ρ_{Us}:

$$\rho_{Us} = \frac{M_U}{R_U^2} = 9.836055336170...\ \mathrm{kg}\cdot\mathrm{m}^{-2}. \quad (44)$$

Note. With accuracy 10^{-2}, formula (44) can be represented as:

$$\rho_{Us} \approx \pi^2\ kg^1 m^{-2}. \quad (45)$$

The estimate of the surface rarefaction of the mass of the observable Universe ρ_{Us}^{-1} :

$$\rho_{Us}^{-1} = \frac{R_U^2}{M_U} = 0.101666772484...\ \mathrm{kg}^{-1}\mathrm{m}^2. \quad (46)$$

The estimate of the density of the mass of the observable Universe ρ_U :

$$\rho_U = \frac{M_U}{R_U^3} = 7.183310361998...\cdot 10^{-26}\ \mathrm{kg}\cdot\mathrm{m}^{-3}. \quad (47)$$

The estimate of the rarefaction of the mass of the observable Universe ρ_U^{-1}:

$$\rho_U^{-1} = \frac{R_U^3}{M_U} = 1.39211582070...\cdot 10^{25}\ \mathrm{kg}^{-1}\mathrm{m}^3. \quad (48)$$

Clarify the value of the estimates [1, 3]: of the energy of the observable Universe E_U, (without taking into account the rotation of its space), of the Planck energy E_p, of the Planck acceleration a_p, of the Planck force F_p, of the gravitational constant G :

$$E_U = M_U \cdot c^2 = 1.65750571300...\cdot 10^{70}\ J, \quad (49)$$

$$E_p = m_p^{\mu^-} \cdot c^2 = 1.95626542475...\cdot 10^9\ J, \quad (50)$$

$$a_p = \frac{l_p^{\mu^-}}{(t_p^{\mu^-})^2} = 5.56124884070...\cdot 10^{51}\ \mathrm{m}\cdot\mathrm{s}^{-2}, \quad (51)$$

$$F_p = m_p^{\mu^-} \cdot a_p = h_{Um} \cdot c = h_{pm} \cdot \mathrm{c} = 1.21048301950...\cdot 10^{44}\ \mathrm{kg}\cdot\mathrm{m}\cdot\mathrm{s}^{-2}, \quad (52)$$

$$G = \frac{(l_p^{\mu^-})^3}{m_p^{\mu^-} \cdot (t_p^{\mu^-})^2} = \frac{(R_U)^3}{M_U \cdot (T_U)^2} = \rho_{pl}^{-1} \cdot c^2 = \rho_{Ul}^{-1} \cdot c^2 = \rho_U^{-1} \cdot H^2 = \frac{c^4}{F_p} = 6.6730459...\cdot 10^{-11}\ \mathrm{m}^3\mathrm{kg}^{-1}\mathrm{s}^{-2}. \quad (53)$$

Clarify the value of the estimates of the total energy of the observable Universe $E_{U\Sigma}$, taking into account the rotation of its space [3,17]:

$$E_{U\Sigma} = E_U + 0.268 \cdot E_U = 2.1017172440...\cdot 10^{70}\ \mathrm{J}. \quad (54)$$

The estimate of the energy of dark matter, as the kinetic energy of rotation of the space of the observable Universe E_{Udm} :

$$E_{Udm} = 0.268 \cdot E_U = 4.442115310...\cdot 10^{69}\ \mathrm{J}. \quad (55)$$

The estimate of the equivalent of the mass of dark matter M_{Udm}:

$$M_{Udm} = \frac{E_{Udm}}{c^2} = 4.94251984960...\cdot 10^{52}\ \mathrm{kg}. \quad (56)$$

The estimation of the Planck power P_p:

$$P_p = \frac{E_p}{t_p^{\mu^-}} = 3.62893679784...\cdot 10^{52} W\ \left[\mathrm{kg}\cdot\mathrm{m}^2\mathrm{s}^{-3}\right]. \quad (57)$$

Estimation of the power of the observable Universe P_U without taking into account the rotation of its space, and also taking into account the rotation of its space $P_{U\Sigma}$:

$$P_U = \frac{E_U}{T_U} = 3.62893679784...\cdot 10^{52} W, \ \left[\text{kg}\cdot\text{m}^2\text{s}^{-3}\right], \tag{58}$$

$$P_{U\Sigma} = \frac{E_{U\Sigma}}{T_U} = 4.60149185966...\cdot 10^{52} W, \ \left[\text{kg}\cdot\text{m}^2\text{s}^{-3}\right]. \tag{59}$$

As can be seen from the formulas (57) and (58), the Planck power and the power of the observable Universe, without taking into account the rotation, are equal to each other.

Let us specify the value of the Planck temperature estimate T_p:

$$T_p = \frac{E_p}{k} = 1.41691777191...\cdot 10^{32} \text{ K}, \tag{60}$$

where k is the Boltzmann constant [4]:

$$k = 1.38064852\cdot 10^{-23} J^1 \text{ K}^{-1}. \tag{61}$$

The estimation of the total of energy luminosity of a hypothetical Planck particle S_p:

$$S_p = \delta\cdot T_p^4 = 2.285544905450...\cdot 10^{121} \text{ W}\cdot\text{m}^{-2}, \tag{62}$$

where δ is the constant of Stephen - Boltzmann [4]:

$$\delta = \frac{\pi^2}{60}\cdot\frac{k^4}{c^2\cdot\hbar^3} = 5.670367\cdot 10^{-8} \text{ W}\cdot\text{m}^{-2}\text{K}^{-4}, \tag{63}$$

where $\hbar$ is Planck's constant over 2pi.

Obviously (62) can also be represented as:

$$S_p = \frac{\pi^2}{60}\cdot\frac{P_p}{(l_p^{\mu^-})^2} = 2.285544905450...\cdot 10^{121} \text{ W}\cdot\text{m}^{-2}. \tag{64}$$

By analogy with (64), the estimation of the total of energy luminosity S_U of the observable Universe, as a Hubble sphere, without taking into account the rotation of its space:

$$S_U = \frac{\pi^2}{60}\cdot\frac{P_U}{(R_U)^2} = 0.318372270570... \text{ W}\cdot\text{m}^{-2}. \tag{65}$$

Note. With accuracy 10^{-4}, formula (65) can be represented as:

$$S_U \approx \frac{1}{\pi} \text{ W}\cdot\text{m}^{-2}. \tag{66}$$

The estimation of the total of energy luminosity of the observable Universe, as the Hubble sphere, taking into account the rotation its space:

$$S_{U\Sigma} = \frac{\pi^2}{60}\cdot\frac{P_{U\Sigma}}{(R_U)^2} = 0.4036960390... \text{ W}\cdot\text{m}^{-2}. \tag{67}$$

The estimation of the temperature of the observable Universe, as the Hubble sphere, without taking into account the rotation of its space T_U°, and also taking into account the rotation of its space $T_{U\Sigma}^{\circ}$:

$$T_U^{\circ} = \sqrt[4]{\frac{S_U}{\delta}} = 48.67780... \text{ K}, \tag{68}$$

$$T^{\circ}_{U\Sigma} = \sqrt[4]{\frac{S_{U\Sigma}}{\delta}} = 51.65482...\ \text{K}. \quad (69)$$

We will determine, according to Wien's law, the estimation of the maximum wavelengths $\lambda_{U\max}$ and $\lambda_{U\Sigma\max}$, which correspond temperature by formulas (68) and (69):

$$\lambda_{U\max} = \frac{0.0028999\ [\text{m}\cdot\text{K}]}{T^{\circ}_{U}} = 5.95733476...\cdot 10^{-5}\ \text{m}, \quad (70)$$

$$\lambda_{U\Sigma\max} = \frac{0.0028999\ [\text{m}\cdot\text{K}]}{T^{\circ}_{U\Sigma}} = 5.61399720...\cdot 10^{-5}\ \text{m}. \quad (71)$$

The wavelength range (56–60) mkm is a far infrared region that is far beyond the range of visible light. Taking into account the new value of the Hubble constant according to the formula (17), let us specify the values of estimations of large energy numbers of Dirac [1] N_{De} and N^2_{De}:

$$N_{De} = \frac{E_U}{E_p} = \frac{M_U\cdot c^2}{m_p^{\mu^-}\cdot c^2} = \frac{F_p\cdot R_U}{F_p\cdot l_p^{\mu^-}} = \frac{M_U}{m_p^{\mu^-}} = \frac{R_U}{l_p^{\mu^-}} = \frac{T_U}{t_p^{\mu^-}} = 8.472805847494600...\cdot 10^{60}, \quad (72)$$

$$N^2_{De} = \frac{M_U}{m_p^{\mu^-}}\cdot\frac{R_U}{l_p^{\mu^-}} = \frac{M_U}{m_p^{\mu^-}}\cdot\frac{T_U}{t_p^{\mu^-}} = \frac{R_U}{l_p^{\mu^-}}\cdot\frac{T_U}{t_p^{\mu^-}} = \frac{S_p}{S_U} = 7.178843892933870...\cdot 10^{121}. \quad (73)$$

Estimation of the angular velocity ω_U of rotation of the space of the observable Universe:

$$\omega_U = \frac{2\pi}{T_U} = 1.3756382370...\cdot 10^{-17}\ \text{rad}\cdot\text{s}^{-1}, \quad (74)$$

or:

$$\omega_U = 4.3382127443...\cdot 10^{-10}\ \text{rad}\cdot\text{year}^{-1}. \quad (75)$$

In [18] it was shown that if the angular velocity of rotation of the space of the observable Universe is less than $10^{-9} rad\cdot year^{-1}$, then the principle of isotropy of its space is not violated. The value of the angular velocity (75)confirms the principle of isotropy of the space of the observable Universe.

Since the Big Bang (for the age of the observable Universe - 13.88 billion years [25]), the observable Universe, as the Hubble sphere, has made one incomplete turn of 345 degrees, and the substance in it made one complete revolution of approximately 379 degrees [21]. The difference between the rotation angles of the space of the observable Universe and the substance in it is a value that is close to the angle value: 1) $Q_{12} = 33.69^{\circ}$ the neutrino mixing matrix [2], then, if we take the analytical estimate of the Hubble constant as a basis: 2) $H = 67.55770^{+\ 0.02329}\ (\text{km/s})/\text{Mpc}$, and take the difference in rotation angles to 1), then the analytical estimate of its second value is: 3) $H = 74.15^{+\ 0.02329}\ (\text{km/s})/\text{Mpc}$.

Forecast: experimental estimates of the Hubble constant based on CMB will be grouped around the value of: $H = 67.55770^{+\ 0.02329}\ (\text{km/s})/\text{Mpc}$, and experimental estimates of the Hubble constant based on measurement of changes in the distance to distant objects of the Universe will be grouped around the value of: $H = 74.15^{+\ 0.02329}\ (\text{km/s})/\text{Mpc}$.

Since, according to the basic principle of cosmology, the space of the observable Universe is isotropic, then we can assume that the Hubble sphere is an axisymmetric sphere. Then we clarify the value of the estimation of the Schwarzschild radius R_{US} for the observable Universe:

$$R_{US} = \frac{2G \cdot M_U}{c^2} = 2.73858564937... \cdot 10^{26} \text{ m.} \tag{76}$$

From formulas (69) and (32,33) it follows that:

$$R_{US} = 2R_U. \tag{77}$$

Since the radius of the observed Universe is two times smaller than the Schwarzschild radius, that is, two times smaller than the gravitational radius or the radius of the event horizon, the observed Universe, as the Hubble sphere, is a black hole. Additional indirect signs that the observable Universe is a black hole are: 1) the wavelength range of its thermal radiation is in the far infrared region radiation; 2) the presence of gravitational-electromagnetic resonance, which is confirmed experimentally [12,23,24]. At present, there are no cases of expansion with the acceleration of the black hole space, but at the same time, there is a red shift from distant objects of the observable Universe, which means that the black hole, like the Hubble sphere, rotates. The rotation of the space of the observable Universe is also confirmed by the fact that the acceleration of the force of imaginary dark energy is equal in absolute value to the gravity factor of the observable Universe [17].

Let us calculate the estimate of the magnitude of the modulus of the force of imaginary dark energy F_{ide}:

$$|F_{ide}| = M_U \cdot c \cdot H = 1.21048301950... \cdot 10^{44} \text{ kg} \cdot \text{m} \cdot \text{s}^{-2}. \tag{78}$$

This force is applied to each point of the boundary of the Hubble sphere and it is directed outward from the Hubble sphere. Let us calculate the estimate of the magnitude of the force of gravitational compression of the observable Universe F_g. This force acts on every point of the boundary of the Hubble sphere and it is directed into the interior of the Hubble sphere:

$$|F_g| = M_U \cdot c \cdot H = 1.21048301950... \cdot 10^{44} \text{ kg} \cdot \text{m} \cdot \text{s}^{-2}. \tag{79}$$

Obviously, that the force F_{ide}, the force F_g and the Planck force F_p are equal to each other:

$$|F_{ide}| = |F_g| = F_p. \tag{80}$$

Obviously, that:

$$G = \rho_{Us}^{-1} \cdot \frac{R_U}{T_U^2} = \rho_{Us}^{-1} \cdot g = \rho_{Us}^{-1} \cdot c \cdot H = 6.673045869... \cdot 10^{-11} m^3 kg^{-1} s^{-2}. \tag{81}$$

Based on the formula (80), it can be argued that at present, there is no expansion of the space of the observed Universe after the Big Bang.

4 RESULTS

Estimates of the main spatial and energy characteristics of the observable Universe are presented in Table 3.

Abbreviations in the table:(s.) – static; (d.) – dynamic.

Table 3 – Estimates of the main spatial and energy characteristics of the observable Universe

Characteristic	Characteristic value	Dimension
Hubble constant	$2.1893962533\ldots\cdot 10^{-18}$	s^{-1}
Hubble constant (traditional form)	$67.55770^{+0.02329}$	(km/s)/Mpc
the Hubble constant (for the substance)	$74.15^{+0.02329}$	(km/s)/Mpc
Hubble time	$4.5674692213\ldots\cdot 10^{17}$	s
Mass of the observable Universe	$1.8442238245\ldots\cdot 10^{53}$	kg
Radius of the observable Universe	$1.3692928247\ldots\cdot 10^{26}$	m
Quantum of the mass of the observable Universe	$4.0377367315\ldots\cdot 10^{35}$	$kg\cdot s^{-1}$
Linear density of the mass of the observable Universe	$1.3468439995\ldots\cdot 10^{27}$	$kg\cdot m^{-1}$
Linear rarefaction of the mass of the observable Universe	$7.424764860\ldots\cdot 10^{-28}$	$kg^{-1}m^{1}$
Surface density of the mass of the observable Universe	9.8360553362…	$kg\cdot m^{-2}$
Surface rarefaction of the mass of the observable Universe	0.1016667725…	$kg^{-1}m^{2}$
Density of the mass of the observable Universe	$7.183310362\ldots\cdot 10^{-26}$	$kg\cdot m^{-3}$
Rarefaction of the mass of the observable Universe	$1.392115820\ldots\cdot 10^{25}$	$kg^{-1}m^{3}$
Energy of the observable Universe (s.)	$1.6575057130\ldots\cdot 10^{70}$	J
Total energy of the observable Universe (d.)	$2.1017172440\ldots\cdot 10^{70}$	J
Energy of dark matter	$4.442115310\ldots\cdot 10^{69}$	J
Equivalent of the mass of dark matter	$4.9425198496\ldots\cdot 10^{52}$	kg
Gravity factor of the observable Universe	$6.5636448430\ldots\cdot 10^{-10}$	$m\cdot s^{-2}$
Acceleration of imaginary dark energy	$6.5636448430\ldots\cdot 10^{-10}$	$m\cdot s^{-2}$
Power of the observable Universe (s.)	$3.6289367978\ldots\cdot 10^{52}$	W
Total power of the observable Universe (d.)	$4.6014918597\ldots\cdot 10^{52}$	W
Total energy luminosity of the observable Universe (s.)	0.318372270570…	$W\cdot m^{-2}$
Total energy luminosity of the observable Universe (d.)	0.4036960390…	$W\cdot m^{-2}$
Temperature of the observable Universe (s.)	48.67780…	K
Temperature of the observable Universe (d.)	51.65482…	K
Max radiation wavelengths of the observable Universe (s.)	$5.95733476\ldots\cdot 10^{-5}$	m
Max radiation wavelengths of the observable Universe (d.)	$5.61399720\ldots\cdot 10^{-5}$	m
Large energy number of Dirac	$8.4728058475\ldots\cdot 10^{60}$	
Angular rotation velocity of the space of the observable Universe	$4.3382127443\ldots\cdot 10^{-10}$	$rad\cdot year^{-1}$
Number of revolutions of the space of the observable Universe	one not full at 345°	
Linear velocity at the Hubble sphere boundary	light speed in a vacuum	$m\cdot s^{-1}$
Integral an angle between the direction Coriolis force and the axis of rotation [17]	9.79°	
Planck force	$1.21048301950\ldots\cdot 10^{44}$	$kg\cdot m\cdot s^{-2}$
The force of gravitational compression of the observable Universe	$1.21048301950\ldots\cdot 10^{44}$	$kg\cdot m\cdot s^{-2}$
The force of imaginary dark energy	$1.21048301950\ldots\cdot 10^{44}$	$kg\cdot m\cdot s^{-2}$

Analytical estimation of the Hubble constant made it possible to clarify the main spatial and energy characteristics of the observable Universe.

5 CONCLUSION

The mass of the observable Universe is an additive golden algebraic fractal of a proton and of a neutron. The Hubble constant is an inverse additive-multiplicative fractal of the temporal characteristics of the proton, of neutron and of the muon. The analytical estimate of the Hubble constant is within the tolerances of the experimental Hubble constant values, which are obtained by Planck Mission, DES Collaboration, SDSS-III BOSS. Based on the proposed method, it is possible to clarify the mass of distant objects of the observable Universe. Analytical evaluation of the Hubble constant only on the basis of the characteristics of elementary particles suggests that the Hubble constant is an internal immanent characteristic of the observed Universe, which excludes the presence of dark energy in it. The presence of a red shift from distant objects of the observable Universe and the absence of dark energy can only be explained by the rotation of the space of the observable Universe [17]. Improving the accuracy of the analytical evaluation of the Hubble constant will be possible when the percentage composition of protons and neutrons in the mass of the observable Universe is more accurately estimated. More accurate than in formula (17), the experimental definition of the Hubble constant will make it possible to specify the percentage ratio of protons and neutrons in the mass of the observed Universe. Analytical estimations: of the Hubble constant, of the gravity factor of the observable Universe and of the acceleration of the force of imaginary dark energy, of the force of imaginary dark energy, of the Schwarzschild radius of the observable Universe, allow us to state that of dark energy not exist. The observable Universe, as of electromagnetic fractal of the Universe [25], is a slowly rotating black hole in the space of a gravitational fractal of the Universe. The magnitude of the angular velocity of rotation of the space of the observable Universe is such that the cosmological principle of isotropy is not violated.

The dark energy hypothesis allows only an unambiguous value of the Hubble constant. The hypothesis of the rotation of the space of the observed Universe admits a multi-valued value of the Hubble constant.

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REFERENCES

1 Timkov V. F., S. V. Timkov, V. A. Zhukov, K. E. Afanasiev. “Fractal structure of the fundamental constants. Numerical evaluation of the values of some of the fundamental constants with the use of the major characteristics of a muon.” International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, 3 (59), p.p. 188–194, 2017, https://hal.archives-ouvertes.fr/hal-01581300v1.

2 Timkov V. F., S. V. Timkov, V. A. Zhukov, and K.E. Afanasiev. “Fractal genesis of the angles of the neutrino mixing matrix.” Herald of Khmelnitsky National University, Khmelnitsky National University, 263(4), p.p. 263-272, 2018. https://hal.archives-ouvertes.fr/hal-01782443v1.

3 Timkov V. F., S. V.Timkov, and V. A. Zhukov. “Evaluation of the main spatial characteristics of the observable Universe based on the law “Planck Universal Proportions”.International scientific-technical magazine: Measuring and computing devices in technological processes,ISSN 2219-9365, № 1 (54), p.p. 144–147, 2016, https://hal.archives-ouvertes.fr/hal-01330333v3.

4 Fundamental Physical Constants, https://physics.nist.gov/cuu/Constants/Table/allascii.txt.

5 Planck Collaboration, et al. (2018). “Planck 2018 results. VI. Cosmological parameters.”*Cosmos*, www.*cosmos*.esa.int. arXiv:1807.06209. Bibcode:2018arXiv180706209P. Accessed 18 July 2018.

6 European Space Agency. "Planck Publications: Planck 2015 Results". European Space Agency. February 2015, https://www.cosmos.esa.int/web/planck/publications. Accessed 9 February 2015.

7 Cowen Ron, Davide Castelvecchi. "European probe shoots down dark-matter claims", *nature*, Dec., 2014, doi:10.1038/nature.2014.16462. Accessed 6 December 2014.

8 Bucher P. A. R.; et al. (Planck Collaboration).: "Planck 2013 results. I. Overview of products and scientific Results". Astronomy & Astrophysics. 571: A1. 2013. arXiv:1303.5062v2. Bibcode:2014A&A...571A...1P. doi:10.1051/0004-6361/201321529.

9 Bennett C. L., et al. "Nine-year Wilkinson Microwave Anisotropy Probe (WMAP) observations: Final maps and results". The Astrophysical Journal Supplement Series. Vol. 208, № 2, 20 Sep. 2013. arXiv:1212.5225. Bibcode:2013ApJS..208...20B. doi:10.1088/0067-0049/208/2/20.

10 Grieb Jan N., Ariel G. Sánchez, Salvador Salazar-Albornoz. "The clustering of galaxies in the completed SDSS-III Baryon Oscillation Spectroscopic Survey: Cosmological implications of the Fourier space wedges of the final sample". Monthly Notices of the Royal Astronomical Society. Vol. 467, Is. 2 May 2017, doi:10.1093/mnras/stw3384.: stw3384. arXiv:1607.03143. Bibcode:2017MNRAS.467.2085G.

11 Macaulay E, et al. (DES collaboration). "First Cosmological Results using Type Ia Supernovae from the Dark Energy Survey: Measurement of the Hubble Constant". May 2019, doi:10.1093/mnras/stz978 arXiv:1811.02376 astro-ph.CO.

12 Timkov V. F., S. V. Timkov, V. A. Zhukov. "Planck universal proportions. Gravitational-electromagnetic resonance." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, № 3 (52), p.p. 7–11, 2015, https://hal.archives-ouvertes.fr/hal-01329094v1.

13 Gödel K.: "An example of a new type of cosmological solution of Einstein's field equations of gravitation". Rev. Mod. Phys. 21: 447–450., 1949. DOI:10.1103/RevModPhys.21.447.

14 Michael J., Longo: "Detection of a dipole in the handedness of spiral galaxies with redshiftsz~0.04". Physics Letters B, Vol. 699, Is. 4, 16 May 2011, pp 224-229. https://doi.org/10.1016/j.physletb.2011.04.008 15 https://lsa.umich.edu/physics/people/emeritus/mlongo.html.

15 Lior Shamir. "Handedness asymmetry of spiral galaxies with z<0.3 shows cosmic parity violation and a dipole axis", Physics Letters B, Volume 715, Is. 1–3, Pages 25–29, 29 August 2012.

16 Timkov V. F., S. V. Timkov. "Rotating space of the Universe, as the source of dark energy and dark matter." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, № 3 (52), 2015, p.p. 200–204, https://hal.archives-ouvertes.fr/hal-01329145v1.

17 Su S.-C., and M.-C. Chu: "Is the Universe rotating?", The Astrophysical Journal, № 703, Sep. 2009 pp. 354–361, doi:10.1088/0004-637X/703/1/354.

18 Palmer D. "Hydrogen in the Universe", NASA, 13 September 1997. Retrieved 2008. 02.05.

19 http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/971113i.html.

20 Riess Adam G., et al. "Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant and Stronger Evidence for Physics Beyond ΛCDM". arXiv:1903.07603 [astro-ph.CO].

21 Timkov S. V.Timkov, V. A.Zhukov. "Electric charge as a function of the moment of mass. The gravitational form of Coulomb`s law." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, – № 3 (56), – 2016, – pp.27–32, https://hal.archives-ouvertes.fr/hal-01374611v1.

22 Timkov S. V.Timkov, V. A.Zhukov. "Gravitational-electromagnetic resonance of the Sun as one of the possible sources of auroral radio emission of the planets in the kilometer range." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, – № 4 (53), – 2015, p.p. 23–32, https://hal.archives-ouvertes.fr/hal-01232287v1.

23 Timkov V. F., Timkov, S. V., Zhukov, V. A.: "Gravitational-electromagnetic resonance of the Sun in the low-frequency of the radio spectrum of the Jupiter." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, – № 2 (55), – 2016, p.p. 198–203, https://hal.archives-ouvertes.fr/hal-01326265v1.

24 Planck Collaboration. "Planck 2015 results. XIII. Cosmological parameters". Astronomy & Astrophysics. Vol. 594, Table 4, oct. 2016, arXiv:1502.01589. Bibcode:2016A&A...594A..13P. doi:10.1051/0004-6361/201525830.

25 Timkov V. F., S. V. Timkov, V. A. Zhukov. "Fractal structure of the Universe." International scientific-technical magazine: Measuring and computing devices in technological processes, ISSN 2219-9365, № 2 (55), p.p. 190–197, 2016, https://hal.archives-ouvertes.fr/hal-01330337v1.

REFERENCES

1 Timkov, V. F., S.V. Timkov, V. A. Zhukov, K. E. Afanasiev. "Fractal structure of the fundamental constants. Numerical evaluation of the values of some of the fundamental constants with the use of the major characteristics of a muon." *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365,No 3 (59), 2017, p.p. 188–194, https://hal.archives-ouvertes.fr/hal-01581300v1.

2 Timkov, V. FS. V. Timkov, V. A. Zhukov, and K.E. Afanasiev. "Fractal genesis of the angles of the neutrino mixing matrix." *Herald of Khmelnitsky National Universit*y, Khmelnitsky National University, 263(4), 2018, p.p. 263-272, https://hal.archives-ouvertes.fr/hal-01782443v1/

3 Timkov, V. F., S. V.Timkov, and V. A. Zhukov. "Evaluation of the main spatial characteristics of the observable Universe based on the law "Planck Universal Proportions". *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365, No 1(54), 2016, p.p. 144–147, https://hal.archives-ouvertes.fr/hal-01330333v3.

4 *Fundamental Physical Constants*, https://physics.nist.gov/cuu/Constants/Table/allascii.txt

5 Planck Collaboration, et al. (2018). “Planck 2018 results. VI. Cosmological parameters.” *Cosmos*, www.*cosmos*.esa.int. arXiv:1807.06209. Bibcode:2018arXiv180706209P. Accessed 18 July 2018.

6 European Space Agency. “Planck Publications: Planck 2015 Results.”*Cosmos*,Feb., 2015. https://www.cosmos.esa.int/web/planck/publications. Accessed 9 Feb. 2015.

7 Cowen, Ron, and Davide Castelvecchi. “European probe shoots down dark-matter claims.” *nature*, Dec., 2014, doi:10.1038/nature.2014.16462.

8 Bucher, P. A. R.; et al. (Planck Collaboration). “Planck 2013 results. I. Overview of products and scientific Results.” *Astronomy & Astrophysics*, arXiv:1303.5062v2, doi:10.1051/0004-6361/201321529. 571: A1. 2013.arXiv:1303.5062. Bibcode:2014A&A...571A...1P.

9 Bennett, C. L., et al. “Nine-year Wilkinson Microwave Anisotropy Probe (WMAP) observations: Final maps and results.” *The Astrophysical Journal Supplement Series*, Vol. 208, no 2, 20 Sep. 2013, doi:10.1088/0067-0049/208/2/20. 2013. arXiv:1212.5225. Bibcode:2013ApJS..208...20B.

10 Grieb, Jan N., Ariel G.Sánchez, and Salvador Salazar-Albornoz. “The clustering of galaxies in the completed SDSS-III Baryon Oscillation Spectroscopic Survey: Cosmological implications of the Fourier space wedges of the final sample.” *Monthly Notices of the Royal Astronomical Society*, Vol. 467, Is. 2 May 2017, doi:10.1093/mnras/stw3384. stw3384. arXiv:1607.03143. Bibcode:2017MNRAS.467.2085G. ., (2016-07-13).

11 Macaulay, E, et al. (DES collaboration). “First Cosmological Results using Type Ia Supernovae from the Dark Energy Survey: Measurement of the Hubble Constant.” May 2019, doi:10.1093/mnras/stz978, arXiv:1811.02376 astro-ph.CO.

12 Timkov, V.F., S.V. Timkov, and V.A. Zhukov. “Planck universal proportions. Gravitational-electromagnetic resonance.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, no. 3 (52), 2015, p.p. 7–11, ISSN 2219-9365,https://hal.archives-ouvertes.fr/hal-01329094v1.

13 Gödel, K. “An example of a new type of cosmological solution of Einstein's field equations of gravitation”. *Rev. Mod. Phys*. 21: 447–450., 1949, doi:10.1103/RevModPhys.21.447.

14 Michael, J., Longo: “Detection of a dipole in the handedness of spiral galaxies with redshiftsz~0.04”. *Physics Letters B*, Vol. 699, Issue 4, pp 224-229, 16 May 2011. https://doi.org/10.1016/j.physletb.2011.04.008 15https://lsa.umich.edu/physics/people/emeritus/mlongo.html.

16 Lior, Shamir. “Handedness asymmetry of spiral galaxies with z<0.3 shows cosmic parity violation and a dipole axis”, *Physics Letters B*, Vol. 715, Is. 1–3, pp 25–29, 29 Aug. 2012.

17 Timkov, V. F., and S. V. Timkov. “Rotating space of the Universe, as the source of dark energy and dark matter.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365, no. 3 (52), 2015, p.p. 200–204, https://hal.archives-ouvertes.fr/hal-01329145v1.

18 Su,S.-C., and M.-C. Chu. “Is the Universe rotating?”,*The Astrophysical Journal*, no.703, Sep. 2009, pp. 354–361, doi:10.1088/0004-637X/703/1/354.

19 Palmer, D. “Hydrogen in the Universe.” *NASA*, 13 Sep. 1997. Accessed 2008. 02.05.

20 http://*imagine*.gsfc.nasa.gov/docs/ask_astro/answers/971113i.html.

21 Riess, Adam G., et al. “Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant and Stronger Evidence for Physics Beyond ΛCDM.” *astroph-ph*, *astroph*.CO, *arXiv:1903.07603*.

22 Timkov, V. F., S. V.Timkov, and V. A.Zhukov. “Electric charge as a function of the moment of mass. The gravitational form of Coulomb`s law.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365, no. 3 (56), 2016, pp.27–32, https://hal.archives-ouvertes.fr/hal-01374611v1.

23 Timkov, V. F., S. V.Timkov, and V. A.Zhukov. “Gravitational-electromagnetic resonance of the Sun as one of the possible sources of auroral radio emission of the planets in the kilometer range.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365,no. 4 (53), 2015, p.p. 23–32, https://hal.archives-ouvertes.fr/hal-01232287v1.

24 Timkov, V. F., S. V. Timkov, and V. A. Zhukov. “Gravitational-electromagnetic resonance of the Sun in the low-frequency of the radio spectrum of the Jupiter.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365, no. 2 (55), 2016, p.p. 198–203, https://hal.archives-ouvertes.fr/hal-01326265v1.

25 Planck Collaboration. "Planck 2015 results. XIII. Cosmological parameters". *Astronomy & Astrophysics*. Vol. 594, Table 4. 2016, *arXiv*:*1502.01589*. *Bibcode*:*2016A&A...594A..13P*, *doi*:*10.1051/0004-6361/201525830*.

26 Timkov, V. F., S. V.Timkov, and V. A.Zhukov. “Fractal structure of the Universe.” *International scientific-technical magazine: Measuring and computing devices in technological processes*, ISSN 2219-9365, no. 2 (55), 2016, p.p. 190–197, https://hal.archives-ouvertes.fr/hal-01330337v1.