New Cosmology – Third Revolution in Physics

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Abstract

Dirac's themes were the unity and beauty of Nature. He identified three revolutions in modern physics – Relativity, Quantum Mechanics and Cosmology. In his opinion: *The new cosmology will probably turn out to be philosophically even more revolutionary than relativity or the quantum theory, perhaps looking forward to the current bonanza in cosmology, where precise observations on some of the most distant objects in the universe are shedding light on the nature of reality, on the nature of matter and on the most advanced quantum theories* [Farmelo, G. (2009) The Strangest Man. The Hidden Life of Paul Dirac, Mystic of the Atom. Basic Books, Britain, 661p].

In 1937, Paul Dirac proposed: the Large Number Hypothesis and the Hypothesis of the variable gravitational "constant"; and later added the notion of continuous creation of Matter in the World. The developed Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing a different mechanism of matter creation. In this paper, we show that WUM is a natural continuation of Classical Physics and it can already serve as a basis for a New Cosmology proposed by Paul Dirac.

1. Introduction

In our view, we should make use of a number of hypotheses unknown and forgotten by mainstream scientific community in order to elaborate a New Cosmology. Below we will describe the Hypotheses belonging to classical physicists such as Newton, Le Sage, McCullagh, Riemann, Heaviside, Tesla, Dirac, and Sakharov and develop them in frames of WUM. Please pay tribute to these great physicists!

The presented Hypotheses are not new, and we don't claim credit for them. In fact, we are developing the existent Hypothesis and proposing new Hypothesis in frames of WUM. The main objective of the Model is to unify and simplify existing results in Classical Physics into a single coherent picture of New Cosmology.

Cosmology is a branch of Classical Physics. It should then be described by classical notions, which define emergent phenomena. By definition, an emergent phenomenon is a property that is a result of simple interactions that work cooperatively to create a more complex interaction. Physically, simple interactions occur at a microscopic level, and the collective result can be observed at a macroscopic level.

2. Classical Physics

In this Section we describe principal milestones in Classical Physics. Based on the analysis of measured physical constants we conclude that the most important Fundamental constants could be calculated before Quantum Mechanics [1].

Maxwell's equations were published by J. C. Maxwell in 1861 [2]. He calculated the velocity of electromagnetic waves from the value of the **electrodynamic constant** c measured by Weber and Kohlrausch in 1857 [3] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [4]. This observation made him suggest that light is an electromagnetic phenomenon [5].

Rydberg constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series [6].

Electron Charge-to-Mass Ratio e/m_e is a Quantity in experimental physics. It bears significance because the electron mass m_e cannot be measured directly. The e/m_e ratio of an electron was successfully calculated by J. J. Thomson in 1897 [7]. We name it after Thomson: $R_T \equiv e/m_e$.

Planck Constant h was suggested by Max Planck in 1901 as the result of investigating the problem of black-body radiation. He used Boltzmann's equation from **Statistical Thermodynamics**: $S = k_B \ln W$ that shows the relationship between entropy S and the number of ways the atoms or molecules of a thermodynamic system can be arranged (k_B is the Boltzmann constant) [8].

Based on the experimentally measured values of the constants R_∞, R_T, c, h we calculate **the most important Fundamental constants in WUM** as follows [1]:

- Basic unit of size a :

$$a = 0.5\,[8(\mu_0 h/c)^3 R_\infty R_T^6]^{1/5}$$

- Dimensionless Rydberg constant α :

$$\alpha = (2aR_\infty)^{1/3}$$

where μ_0 is the magnetic constant (or vacuum permeability): $\mu_0 = 4\pi \times 10^{-7}\ H/m$. It is worth noting that the constant α was later named "Sommerfeld's constant" and subsequently "Fine-structure constant".

WUM is based on two parameters only: **dimensionless Rydberg constant** α and **time-varying Quantity** Q that is a measure of the Size R and Age A_τ of the World and is, in fact, the **Dirac Large Number** (t_0 is the basic unit of time: $t_0 = a/c$):

$$Q = \frac{R}{a} = \frac{A_\tau}{t_0}$$

3. Hypotheses Revisited by WUM

3.1. Aether

Physical Aether was suggested as early as 17th century, by Isaac Newton. Following the work of Thomas Young (1804) and Augustin-Jean Fresnel (1816), it was believed that light propagates as a transverse wave within an elastic medium called Luminiferous Aether. At that time, it was realized that Aether could not be an elastic matter of an ordinary type that can only transmit longitudinal waves. Unique properties of Aether were discussed by James McCullagh in 1846 who proposed a theory of a rotationally elastic medium, i.e. a medium in which every particle resists absolute rotation. This theory produces equations analogous to Maxwell's electromagnetic equations [9].

Aether with these properties can transmit transverse waves. Luminiferous Aether was abandoned in 1905.

In later years there have been classical physicists who advocated the existence of Aether:

- Nikola Tesla declared in 1937 in "Prepared Statement on the 81st birthday observance": *All attempts to explain the workings of the universe without recognizing the existence of the aether and the indispensable function it plays in the phenomena are futile and destined to oblivion* [10];
- Paul Dirac stated in 1951 in an article in Nature, titled "Is there an Aether?" that *we are rather forced to have an aether* [11].

WUM introduces the Medium of the World, which is composed of stable elementary particles: protons, electrons, photons, neutrinos, and Dark Matter Particles (DMPs). **The existence of the Medium is a principal point of WUM**. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation; Far-Infrared Background Radiation. According to WUM, inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. The Medium is the absolute frame of reference [1].

3.2. Le Sage's Theory of Gravitation

Wikipedia summarizes this theory as *a mechanical explanation for Newton's gravitational force in terms of streams of tiny unseen particles (which Le Sage called ultra-mundane corpuscles) impacting all material objects from all directions. According to this model, any two material bodies partially shield each other from the impinging corpuscles, resulting in a net imbalance in the pressure exerted by the impact of corpuscles on the bodies, tending to drive the bodies together.*

According to **WUM**, the energy density of the Medium ρ_M is 2/3 of the total energy density of the World ρ_W in all cosmological times. The energy density of all Macroobjects adds up to 1/3 of ρ_W throughout the World's evolution. The relative energy density of DMPs is about 92.8% and Ordinary Particles (protons, electrons, photons and neutrinos) – about 7.2% . A **time-varying gravitational parameter** G is proportional to the **time-varying** ρ_M [12]. In frames of WUM:

- DMPs are "*Le Sage's ultra-mundane corpuscles*";
- Le Sage's theory of gravitation defines Gravity as an emergent phenomenon;
- **Gravity is not an interaction but a manifestation of the Medium**.

3.3. Hypersphere Universe

In 1854, Georg Riemann proposed a hypersphere as a model of a finite universe [13].

WUM: Before the Beginning of the World there was nothing but an Eternal Universe. About 14.22 billion years ago the World was started by a fluctuation in the Eternal Universe, and the Nucleus of the World, a 4-dimensional ball, was born. An extrapolated Nucleus radius at the Beginning was equal to a . The 3D World is a hypersphere that is the surface of the 4-ball Nucleus. All points of the hypersphere are equivalent; there are no preferred centers or boundary of the World [14]. The extrapolated energy density of the World at the Beginning was four orders of magnitude smaller than the nuclear energy density [15].

3.4. Gravitoelectromagnetism

Gravitoelectromagnetism (GEM) refers to a set of formal analogies between the equations for Electromagnetism (EM) and relativistic gravitation. GEM is an approximation to Einstein's field equations for General Relativity in the weak field limit. H. Thirring pointed out this analogy in his "On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation" paper published in 1918 [16]. The equations for GEM were first published in 1893 by O. Heaviside as a separate theory expanding Newton's law [17].

WUM follows this theory. In most cases of the weak gravitational fields, we can neglect the influence of General Relativity effects. For example, the surface gravity of the Earth equals : $g = 9.80665\ m\ s^{-2}$ and a general relativity acceleration is $\sim 3 \times 10^{-10}\ m\ s^{-2}$ [18].

3.5. Dirac Large Number Hypothesis

Dirac Large Number Hypothesis is an observation made by Paul Dirac in 1937 relating ratios of size scales in the Universe to that of force scales. The ratios constitute very large, dimensionless numbers, **some 40 orders of magnitude** in the present cosmological epoch. According to Dirac's hypothesis, the apparent equivalence of these ratios might not to be a mere coincidence but instead could imply a New Cosmology where the strength of gravity, as represented by the gravitational "constant" G, is inversely proportional to the cosmological time τ : $G \propto \tau^{-1}$ [19].

WUM follows the idea of time-varying G and introduces a dimensionless time-varying quantity Q, that is, in fact, the **Dirac Large Number**, which in present epoch equals to: $Q = 0.759972 \times 10^{40}$. G can be calculated from the value of the parameter Q [14]:

$$G = \frac{a^2 c^4}{8\pi hc} \times Q^{-1} = \frac{a^3 c^3}{8\pi hc} \times \tau^{-1}$$

3.6. Creation of Matter

In 1964, F. Hoyle and J. V. Narlikar offered an explanation for the appearance of new matter by postulating the existence of what they dubbed the "Creation field", or just the "C-field"[20].

In 1974, Paul Dirac discussed continuous creation of matter by additive mechanism (uniformly throughout space) and multiplicative mechanism (proportional to the amount of existing matter) [21].

WUM: 3D World is a hypersphere of 4D Nucleus of the World, which is expanding in the Eternal Universe with speed c (gravitodynamic constant) for the absolute cosmological time τ from the Beginning and equals to $R = c\tau$. By definition, the **gravitodynamic constant** c is the ratio of the absolute gravitomagnetic unit of charge E_0 to the absolute gravitostatic unit of charge E_0/c , where E_0 is the basic unit of energy: $E_0 = hc/a$. The distance between any two points on the surface is increasing on the same value anywhere in the Hypersphere. There is no preferred center of the expansion. It follows that the **value of Hubble's parameter can be measured anywhere in the World**, for example on the Earth [15].

The surface of the Nucleus is created in a process **analogous to sublimation**. Continuous creation of matter is the result of this process. Sublimation is a well-known endothermic process that happens

when surfaces are intrinsically more energetically favorable than the bulk of a material, and hence there is a driving force for surfaces to be created.

Matter comes from the Universe to the Nucleus along the fourth spatial dimension of the Nucleus, passing through the Hypersphere, which is our World. DMPs carry new Dark Matter (DM) into the Nucleus. By analogy with three-dimensional ball, which has two-dimensional sphere surface (that has **surface energy**), we can imagine that our three-dimensional World (Hypersphere) has a "**Surface Energy**" of the four-dimensional Nucleus [1]. It is important to emphasize that

- Creation of Matter is a direct consequence of expansion;
- Creation of DM occurs homogeneously in all points of the hypersphere World;
- Ordinary Matter is a by-product of DM self-annihilation. Consequently, the **matter-antimatter asymmetry problem** discussed in literature does not arise (since antimatter does not get created by DM self-annihilation).

3.7. Multi-Component Dark Matter

Two-component DM system consisting of bosonic and fermionic components is proposed for the explanation of emission lines from the bulge of Milky Way galaxy. C. Boehm, P. Fayet, and J. Silk propose a way *to reconcile the low and high energy signatures in gamma-ray spectra, even if both of them turn out to be due to Dark Matter annihilations. One would be a heavy fermion for example, like the lightest neutralino (> 100 GeV), and the other one a possibly light spin-0 particle (~ 100 MeV). Both of them would be neutral and also stable* [22].

WUM proposes multicomponent DM system consisting of two couples of coannihilating DMPs: a heavy Dark Matter Fermion (DMF) – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV) that is a dipole of Dirac's monopoles with charge $\mu = e/2\alpha$; a heavy fermion – DMF2 (9.6 GeV) and a light spin-0 boson – ELOP (340 keV) that is a dipole of preons with electrical charge e/3; a self-annihilating fermion – DMF3 (3.7 keV) and a fermion DMF4 named DION (0.2 eV).

WUM postulates that rest energies of DMFs and bosons are proportional to a Rydberg unit of energy $Ry = hcR_\infty = 13.605693\ eV$ multiplied by different exponents of α and can be expressed with the following formulae:

DMF1 (fermion): $E_{DMF1} = 2\alpha^{-5}Ry = 1.3149950\ TeV$

DMF2 (fermion): $E_{DMF2} = 2\alpha^{-4}Ry = 9.5959823\ GeV$

DIRAC (boson): $E_{DIRAC} = 2\alpha^{-3}Ry = 70.025267\ MeV$

ELOP (boson): $E_{ELOP} = 4/3\alpha^{-2}Ry = 340.66606\ keV$

DMF3 (fermion): $E_{DMF3} = 2\alpha^{-1}Ry = 3.7289402\ keV$

DION (fermion): $E_{DION} = 2\alpha Ry = 0.19857111\ eV$

We still don't have a direct confirmation of DMPs' rest energies, but we do have a number of indirect observations. The signatures of DMPs self-annihilation with expected rest energies of 1.3 TeV; 9.6 GeV; 70 MeV; 340 keV; 3.7 keV are found in spectra of the diffuse gamma-ray background and the emission of various Macroobjects in the World. We connect the observed gamma-ray spectra with the structure of Macroobjects (nuclei and shells composition). Self-annihilation of those DMPs can

give rise to any combination of gamma-ray lines. Thus, the **diversity of Very High Energy gamma-ray sources in the World has a clear explanation** in frames of WUM [15].

In this regard, it is worth recalling a story about neutrinos: *The neutrino was postulated first by W. Pauli in 1930 to explain how beta decay could conserve energy, momentum, and angular momentum (spin). But we still don't know the values of neutrino masses*. Although we still can't measure neutrinos' masses directly, no one doubts their existence.

3.8. Macroobjects

The existence of supermassive objects in galactic centers is now commonly accepted. Many non-traditional models explaining the supermassive dark objects observed in galaxies and galaxy clusters are widely discussed in literature ([23] - [29]). The first phase of stellar evolution in the history of the World may be Dark Stars, powered by DM heating rather than fusion [30]. E. Ripamonti and T. Abel discuss the role of DM in the formation of Primordial Luminous Objects [31]. The prospect that DMPs might be observed in Centers of Macroobjects (MOs) has drawn many new researchers to the field. Indirect effects in cosmic rays and gamma-ray background from the annihilation of DM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [32] - [37].

According to **WUM**, Macrostructures of the World (Superclusters, Galaxies, Extrasolar systems) have Nuclei made up of DMFs, which are surrounded by Shells composed of DM and baryonic matter. The shells envelope one another, like a Russian doll. The lighter a particle, the greater the radius and the mass of its shell. Innermost shells are the smallest and are made up of heaviest particles; outer shells are larger and consist of lighter particles. The calculated parameters of the shells show that [38]:

- Nuclei made of DMF1 and/or DMF2 compose Cores of stars in extrasolar systems;
- Shells of DMF3 around Nuclei made of DMF1 and/or DMF2 make up Cores of galaxies;
- Nuclei made of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of superclusters.

3.9. Emergent Gravity, Space and Time

C. Barcelo, *et al.* have this to say about emergent gravity: *One of the more fascinating approaches to "quantum gravity" is the suggestion, typically attributed to Sakharov [39], [40] that* ***gravity itself may not be "fundamental physics"****. Indeed, it is now a relatively common opinion, that gravity (and in particular the* ***whole notion of spacetime and spacetime geometry****) might be no more "fundamental" than is fluid dynamics. The word "fundamental" is here used in a rather technical sense – fluid mechanics is not fundamental because there is a known underlying microphysics that of molecular dynamics, of which fluid mechanics is only the low-energy low-momentum limit* [41].

WUM: Time and Space are closely connected with Mediums' impedance and gravitomagnetic parameter. It follows that neither Time nor Space could be discussed in absence of the Medium. The gravitational parameter G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. **Gravity, Space and Time are all emergent phenomena** [1]. WUM confirms the **Supremacy of Matter** postulated by Albert Einstein: *When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter.*

4. Hypothesis of Hypersphere World-Universe Model

4.1. Inter-Connectivity of Primary Cosmological Parameters

The constancy of the universe fundamental constants, including Newtonian constant of gravitation, is now commonly accepted, although has never been firmly established as a fact. All conclusions on the (almost) constancy of G are model-dependent. A commonly held opinion states that gravity has no established relation to other fundamental forces, so it does not appear possible to calculate it from other constants that can be measured more accurately, as is done in some other areas of physics.

WUM holds that there indeed exist relations between all Primary Cosmological Parameters (PCPs) that depend on dimensionless time-varying quantity Q. The Model develops a mathematical framework that allows for direct calculation of the following PCPs through Q [14]:

- Newtonian parameter of gravitation G;
- Age of the World A_τ;
- The Worlds' radius of curvature in the fourth spatial dimension R;
- Hubble's parameter H;
- Critical energy density ρ_{cr};
- Concentration of Intergalactic Plasma n_{IGP};
- Minimum Energy of Photons E_{ph};
- Temperature of the Microwave Background Radiation T_{MBR};
- Temperature of the Far-Infrared Background Radiation peak T_{FIRB};
- Fermi coupling parameter G_F;
- Electronic neutrino rest energy E_{ν_e};
- Muonic neutrino rest energy E_{ν_μ};
- Tauonic neutrino rest energy E_{ν_τ}.

In frames of WUM, we calculate the values of these PCPs, which are in good agreement with the latest results of their measurements. For example:

- The calculated value of $T_{MBR} = 2.72518\,K$ is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\,K$ [42].
- The calculated value of $H_0 = 68.7457\,km/s\,Mpc$ is in good agreement with $H_0 = 69.32 \pm 0.8\,km/s\,Mpc$ obtained using WMAP data [43] and with the newest value of

$$H_0 = 69.6 \pm 0.8\,(\pm 1.1\%\,stat) \pm 1.7\,(\pm 2.4\%\,sys)\,km/s\,Mpc$$

found by W. L. Freedman, *et al.* using *the revised (and direct) measurement of the LMC (Large Magellanic Cloud) TRGB (Tip of the Red Giant Branch) extinction* [44].

E. Conover outlined the following situation with the measurements of an expansion rate of the universe in "Debate over the universe's expansion rate may unravel physics. Is it a crisis?" [45]:

- *Scientists with the Planck experiment have estimated that the universe is expanding at a rate of 67.4 km/s Mpc with an experimental error of 0.5 km/s Mpc;*
- *But supernova measurements have settled on a larger expansion rate of 74.0 km/s Mpc, with an error of 1.4 km/s Mpc. That leaves an inexplicable gap between the two estimates.*

L. Verde, T. Treu, and A. G. Riess gave a brief summary of the "Workshop at Kavli Institute for Theoretical Physics, July 2019" [46]. It is not yet clear whether the discrepancy in the observations is due to systematics, or indeed constitutes a major problem for the Standard Cosmology (SC).

The results of measurements of the Hubble's constant H_0, which characterizes the expansion rate of the universe, shows that the values of H_0 vary significantly depending on Methodology. The disagreement in the values of H_0 obtained by the various teams far exceeds the standard uncertainties provided with the values. This discrepancy is called the **Hubble tension.**

In our view, it is a major problem for SC that is connected to the principal difference between **Cosmological Time along with Time-varying PCPs** in WUM and **Solar Time along with Constant PCPs** in SC. According to WUM, the Hubble's parameter depends on the cosmological time only: $H = \tau^{-1}$. It means that the value of H should be measured for each Galaxy separately depending on its distance to Earth and corresponding cosmological time. We must not calculate average values of H depending on Methodology as it is done in experiments [47].

4.2. Cosmological Time vs. Solar Time

In our real life we use time that is defined by parameters of the Solar system: the rotation of the Earth around its own axis (day) and the Sun (year); we'll refer to this definition as **Solar Time**. The "Second" of mean solar time as the unit of time was used since 1862. MKS was adopted internationally during the 1940s, defining the "Second" as 1/86400 of a mean solar day. This method was based upon the interaction between two objects, the Sun and the Earth.

The Solar system exists for 4.57 Billion years and the World exists for 14.22 Billion years. How do we know that we can use Solar Time for the whole life of the World?

In WUM, we introduce a **Cosmological Time** that is defined by the **Impedance of the Medium** of the World that is equal to the **Hubble's parameter** [47]. It is not based upon an interaction between any Macroobjects in the World. Cosmological time defines the Age of the World $A_\tau = \tau$ and the Radius of the 4D Nucleus of the World $R = c\tau$. It marches on at a constant pace from the Beginning of the World up to the present Epoch. The absolute Age of the World equals to: $A_\tau = t_0 \times Q$ and is measured in seconds due to t_0 being measured in seconds [47].

4.3. Atomic Time vs. Solar Time. Variations of Earth's Rotational Speed

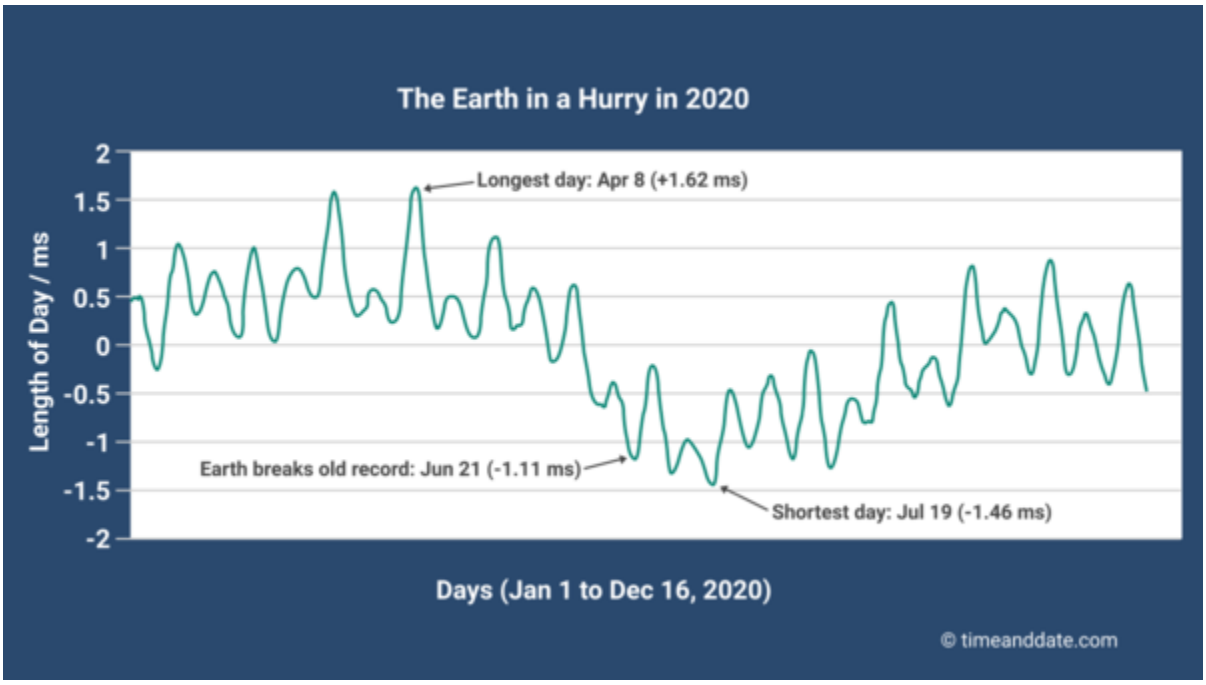
Since 1967, the "Second" has been defined as "*the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom*". Atomic Time is therefore also defined through Solar Time but with much better accuracy.

G. Jones and K. Bikos in the paper "Earth Is in a Hurry in 2020" wrote [48]:

The Earth is an excellent timekeeper: on average, with respect to the Sun, it rotates once every 86,400 seconds, which equals 24 hours, or one mean solar day. But it is not perfect. When highly accurate atomic clocks were developed, they showed that the length of a mean solar day can vary by milliseconds. These differences are obtained by measuring the Earth's rotation with respect to distant astronomical objects.

Before this year began, the shortest day since 1973 was July 5, 2005, when the Earth's rotation took 1.0516 milliseconds less than 86,400 seconds. But in the middle of 2020, the Earth beat that record no less than 28 times. The shortest day of all came on July 19, when the Earth completed its rotation in 1.4602 milliseconds less than 86,400 seconds. Scientists monitoring the Earth's rotational speed expect the trend of having shorter days to follow us into 2021 as well.

The speed of the Earth's rotation varies constantly because of the complex motion of its molten core, oceans and atmosphere, plus other effects.



Variation of daylength throughout 2020. The length of day is shown as the difference in milliseconds (ms) between the Earth's rotation and 86,400 seconds.

In our opinion, there is the only one mechanism that can provide **random variations of the Earth's rotational speed on a daily basis** – variations in an activity of the Earth's core which is a "Dark Matter Reactor" (DMR) fueled by DMPs [15]. The following experimental results speak in favor of this mechanism:

- By analyzing the earthquake doublets, Zhang, *et al.* concluded that the Earth's inner core is **rotating faster than its surface by about 0.3 – 0.5 degrees per year** [49]. The fact that Macroobject Cores rotate faster than surrounding envelopes, despite high viscosity of the internal medium, is intriguing. WUM explains this phenomenon through absorption of DMPs by Cores. Dark Matter particles supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^{2}$). Cores irradiate products of annihilation, which carry away excessive angular momentum;
- The analysis of Sun's heat for planets in Solar system yields the effective temperature of Earth of 255 K [50]. The actual mean surface temperature of Earth is 288 K [51]. The higher actual

temperature of Earth is due to energy generated internally by the planet itself. According to the standard model, the Earth's **internal heat** is produced mostly through radioactive decay. The major heat-producing isotopes within Earth are K-40, U-238, and Th-232. Radiogenic decay can be estimated from the flux of geoneutrinos that are emitted during radioactive decay. Based on the observations the KamLAND Collaboration made a conclusion that ***heat from radioactive decay contributes about half of Earth's total heat flux*** [52];

- **Pu-244 has a half-life of 80 million years**. Unlike other plutonium isotopes, Pu-244 is not produced in quantity by the nuclear fuel cycle, because it needs very high neutron flux environments. A nuclear weapon explosion can produce some Pu-244 by **rapid successive neutron capture.** Nevertheless, D. C. Hoffman *et al.* in 1971 obtained the first indication of **Pu-244 present existence in Nature** [53];
- In a study published in Science [54], W. Wu, S, Ni, and J. Irving investigated scattered seismic waves traveling inside the Earth to constrain the roughness of the Earth's 660-km boundary. The researchers were surprised by just how rough that boundary is—**rougher than the surface layer that we all live on**. The roughness wasn't equally distributed, either; just as the crust's surface has smooth ocean floors and massive mountains, the 660-km boundary has rough areas and smooth patches [55].

In our opinion, all chemical elements, compositions, substances, etc. of the Earth including isotopes K-40, U-238, Th-232, Pu-244, are produced within the DMR inside of the Earth as the result of DMPs self-annihilation. They arrive in the Crust of the Earth due to convection currents in the mantle carrying heat and all chemical products from the interior to the planet's surface [56]. According to WUM, the 660-km boundary is a boundary between DMR and Upper mantle with Crust [57].

In frames of WUM, variations of the Earth's rotational speed can be explained by variations in an activity of the Earth's DMR. As the result of DMPs self-annihilation, **random mass ejections** are happening. During a time of high DMR activity, the Earth's rotational speed is lower (long days) due to increase of the Earth's moment of inertia. When **random mass ejections** are less frequent, the Earth's moment of inertia is decreasing, we observe short days.

4.4. Angular Momentum Problem

Angular Momentum Problem is one of the most critical problem in SC that must be solved. SC cannot explain how Galaxies and Extra Solar systems obtained their enormous orbital and rotational angular momenta. Any theory of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out. To the best of our knowledge, WUM is the only cosmological model in existence that is consistent with this Fundamental Law.

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – **Rotational Fission** of overspinning (surface speed at equator exceeding escape velocity that is the second cosmic velocity) Prime Objects. From the point of view of Fission model, the prime object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite**. In frames of WUM, Prime Objects are DM Cores of Superclusters, which must accumulate tremendous angular momenta before the Birth of the Luminous World. It means that it must be some

long enough time in the history of the World, which we named "Dark Epoch" [57]. **To be consistent with the Law of Conservation of Angular Momentum** we developed a New Cosmology of the World:

- The Model introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter Macroobjects existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous Macroobjects (MOs) emerged;
- The main players of the World are overspinning DM Cores of Superclusters, which accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their Rotational Fission;
- Big Bang discussed in SC is a transition from Dark Epoch to Luminous Epoch due to Rotational Fission of Overspinning DM Supercluster's Cores. In our opinion, all Supercluster Cores had undergone Rotational Fission at approximately the same cosmological time;
- Dark Matter Core of Milky Way galaxy was born 13.77 billion years ago as the result of the Rotational Fission of the Local Supercluster DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the Rotational Fissions of the Milky Way DM Core in different times (4.57 billion years ago for the Solar system);
- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons;
- Gravitational waves can be a product of Rotational Fission of overspinning Macroobject Cores.

4.5. Dark Matter Fermi Bubbles

In 2010, the discovery of two Fermi Bubbles (FBs) emitting gamma- and X-rays was announced. FBs extend for about 25 kly above and below the center of the galaxy [58]. The outlines of the bubbles are quite sharp, and the bubbles themselves glow in nearly uniform gamma rays over their colossal surfaces. Gamma-ray spectrum at Galactic latitude $\leq 10^\circ$, without showing any sign of cutoff up to around 1 TeV, remains unconstrained [59]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

WUM explains FBs the following way [38]:

- Core of the Milky Way is made up of DMPs: DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV). The second component (DMF2) explains the excess GeV emission reported by Dan Hooper from the Galactic Center [60]. Core rotates with surface speed at equator close to the escape velocity between Gravitational Bursts (GBs), and over the escape velocity at the moments of GBs;
- Bipolar astrophysical jets (which are astronomical phenomena where outflows of matter are emitted as an extended beams along the axis of rotation [61]) of DMPs are ejected from the rotating Core into the Galactic halo along the rotation axis of the Core;
- Due to self-annihilation of DMF1 and DMF2, these beams are gamma-ray jets [62]. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre 'chimneys' [63]) are the result of the self-annihilation of DMF3;
- FBs are bubbles whose boundary with the Intergalactic Medium has a basic surface energy density σ_0 equals to: $\sigma_0 = hc/a^3$. These bubbles are filled with DMPs: DMF1, DMF2, and DMF3. The calculated diameter D_{FB} of FBs: $D_{FB} = 28.6\, kly$ is in good agreement with the measured

size of the FBs 25 kly [58] and 32.6 kly [63]. **FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2.**

- With Nikola Tesla's principle at heart – *There is no energy in matter other than that received from the environment* – we calculate mass M_{FB} of FBs: $M_{FB} = 3.6 \times 10^{41} kg$. Recall that the mass of Milky Way galaxy M_{MW} is about: $M_{MW} = (1.6 - 3.2) \times 10^{42} kg$;
- FBs radiate X-rays due to the self-annihilation of DMF3 (3.7 keV). Gamma rays up to 1 TeV [64], [65] are the result of self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) in Dark Matter Objects (DMOs) whose density is sufficient for the self-annihilation of DMPs to occur. On the other hand, DMOs are much smaller than stars in the World, and have a high concentration in FBs to provide nearly uniform gamma ray glow over their colossal surfaces [38];
- The total flux of the gamma radiation from FBs is the sum of the contributions of all individual DMOs, which irradiate gamma quants with different energies and attract new DMF1 and DMF2 from FBs. The Core of the Milky Way supplies FBs with new DMPs through the galactic wind, explaining the brightness of FBs remaining fairly constant during the time of observations. In our opinion, FBs are built continuously throughout the lifetime of the Milky Way galaxy.

In our view, **FBs are DMPs' clouds containing uniformly distributed clumps of Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays.** Dark Matter Fermi Bubbles constitute a principal proof of the WUM.

5. Hypersphere World-Universe Model

5.1. Assumptions

WUM is based on three primary assumptions:

- The World is a finite 3D Hypersphere of a 4D Nucleus of the World and is expanding inside the Universe along the fourth spatial dimension of the Nucleus with speed equal to the **gravitodynamic constant** c . The Universe serves as an unlimited source of DMPs, which continuously enters into the World. Ordinary Matter is a by-product of DMPs self-annihilation;
- Medium of the World, consisting of protons, electrons, photons, neutrinos, and DMPs, is an active agent in all physical phenomena in the World;
- Two fundamental parameters in various rational exponents define all macro and micro features of the World: dimensionless Rydberg constant α and dimensionless quantity Q that is a measure of the Size R and Age A_τ of the World and is, in fact, the **Dirac Large Number.**

5.2. Evidence of Hypersphere World

The physical laws we observe appear to be independent of the Worlds' curvature in the fourth spatial dimension due to the very small value of the dimension-transposing gravitomagnetic parameter of the Medium [66]. Consequently, direct observation of the Worlds' curvature would appear to be a hopeless goal.

One way to prove the existence of the Worlds' curvature is direct measurement of truly large-scale parameters of the World: Gravitational, Hubble's, Temperature of the Microwave Background Radiation. Conducted at various points of time, these measurements would give us varying results,

providing insight into the curved nature of the World. Unfortunately, the accuracy of the measurements is quite poor. Measurement errors far outweigh any possible "curvature effects", rendering this technique useless in practice. To be conclusive, the measurements would have to be conducted billions of years apart [15].

Let's consider so-called **Faint young Sun problem**, an effect that has indeed been observed for billions of years, albeit indirectly [15]. 4.57 billion years ago the Sun's output has been only 70% as intense as it is today [67]. One of the consequences of WUM holds that all stars were fainter in the past. As their cores absorb new DM, size of macroobjects cores R_{MO} and their luminosity L_{MO} are increasing in time $R_{MO} \propto Q^{1/2} \propto \tau^{1/2}$ and $L_{MO} \propto Q \propto \tau$ respectively. Taking the Age of the World $\cong 14.22\ Byr$ and the age of the Solar system $\cong 4.57\ Byr$, it is easy to find that the young Suns' output was 67% of what it is in the present epoch.

In WUM, Local Physics is linked with the large-scale structure of the Hypersphere World through the dimensionless quantity Q . The proposed approach to the fourth spatial dimension agrees with Mach's principle: "*Local physical laws are determined by the large-scale structure of the universe*". Applied to WUM, it follows that all parameters of the World depending on Q are a manifestation of the Worlds' curvature in the fourth spatial dimension [15].

5.3. Principal Points

WUM is based on the following Principal Points [68]:

The Beginning. The World was started by a fluctuation in the Eternal Universe, and the Nucleus of the World, which is a four dimensional 4-ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a . The World is a finite three-dimensional Hypersphere that is the surface of the 4-ball Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World. The extrapolated energy density of the World at the Beginning was four orders of magnitude smaller than the nuclear energy density.

Expansion. The 4D Nucleus is expanding inside the Universe along the fourth spatial dimension and its surface, the 3D Hypersphere, is likewise expanding so that the radius of the Nucleus is increasing with speed c that is the gravitodynamic constant.

Creation of Matter. The surface of the Nucleus is created in a process analogous to sublimation. Matter arises from the fourth spatial dimension of the Nucleus. The Universe is responsible for the creation of Matter. DMPs carry new Matter into the World. Ordinary Matter is a by-product of DMPs self-annihilation. Consequently, the matter-antimatter asymmetry problem discussed in literature does not arise. Creation of Matter is a direct consequence of expansion.

Content of the World. The World consists of the Medium and Macroobjects (MOs). Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium is 2/3 of the total energy density and MOs (Galaxy clusters, Galaxies, Extrasolar systems, Planets, Moons, *etc.*) – 1/3 in all cosmological times. The relative energy density of DMPs DIONs is about 68.8%, self-annihilating DMPs (DMF1, DMF2, DMF3, DIRACs, and ELOPs) – about 24%, and Ordinary Particles (protons, electrons, photons and neutrinos) – about 7.2% .

Two Fundamental Parameters in various rational exponents define all micro- and macro-features of the World: dimensionless Rydberg constant α and Quantity Q . The World's energy density is

proportional to Q^{-1} in all cosmological times. The particles relative energy densities are proportional to α. Q in present epoch equals to: $Q = 0.759972 \times 10^{40}$.

Supremacy of Matter. Time, Space and Gravitation have no separate existence from Matter. They are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium respectively.

Inter-Connectivity of Primary Cosmological Parameters. WUM reveals the Inter-Connectivity of PCPs and calculates their values, which are in good agreement with the latest results of their measurements.

WUM introduces **Dark Epoch** (spanning from the Beginning of the World for 0.45 billion years) and **Luminous Epoch** (ever since, 13.77 billion years). Big Bang discussed in SC is a transition from Dark Epoch to Luminous Epoch due to Rotational Fission of Overspinning DM Supercluster's Cores and self-annihilation of DMPs.

Macroobjects Shell Model. Macroobjects of the World possess the following properties: their Cores are made up of DMPs; they contain other particles, including DMPs and Ordinary Particles, in shells surrounding the Cores. **Weak Interaction** between DMPs provides integrity of all shells. Self-annihilation of DMPs can give rise to any combination of gamma- and X-ray lines.

Macroobjects Formation and Evolution. Macroobjects form from galaxy clusters down to galaxies and extrasolar systems in parallel around different Cores made of different DMPs. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing. Assuming an Eternal Universe, the numbers of cosmological structures on all levels will increase: new galaxy clusters will form; existing clusters will obtain new galaxies; new stars will be born inside existing galaxies; sizes of individual stars will increase, etc. The temperature of the Medium will asymptotically approach absolute zero.

Nucleosynthesis of all elements occurs inside of Macroobjects during their evolution. Stellar nucleosynthesis theory should be enhanced to account for self-annihilation of DMPs inside of Stars.

Black-body spectrum of the Cosmic Microwave Background Radiation is due to thermodynamic equilibrium of photons with Intergalactic Plasma.

Milky Way Galaxy is a Disk Bubble whose boundary with Intergalactic Medium has a surface energy density σ_0. The Disk Bubble contains Intragalactic Medium and 100 – 400 billion Stars.

Dark Matter Fermi Bubbles are stable clouds of DMPs containing uniformly distributed Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays. Proposed **Weak interaction** between particles DMF3 (3.7 keV) provides integrity of Fermi Bubbles.

Extrasolar systems. The boundary between Extrasolar systems and Intragalactic Medium has a surface energy density σ_0. This bubble-like region of space, which surrounds the Sun, is named Heliosphere that is continuously inflated by Solar jets, known as the Solar wind.

Solar System. A detailed analysis of the Solar system shows that the overspinning DM Core of the Sun can give birth to DM planetary cores, and they can generate DM cores of moons through the Rotational Fission mechanism.

Solar Corona, Geocorona and Planetary Coronas made up of DMPs resemble honeycombs filled with plasma particles (electrons, protons, multicharged ions) which are the result of DMPs self-annihilation.

Lightning initiation problem and **Terrestrial Gamma-Ray Flashes** are explained by self-annihilation of DMPs in Geocorona.

Dark Matter Reactors. Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, substances, rocks, etc. are produced by MOs themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded objects of the Solar system is explained by the differences in their DM cores (mass, size, composition). The DM Reactors at their cores (including Earth) are very efficient and provide enough energy for the internal heating of all gravitationally-rounded objects and all their geological processes like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc.

5.4. Predictions

It doesn't make any difference how beautiful your guess is, it doesn't make any difference how smart you are, who made the guess, or what his name is. If it disagrees with experiment, it's wrong. That's all there is to it.

Richard Feynman

Newtonian Constant of Gravitation. The very first manuscript "World-Universe Model" was published on viXra in March 2013 [69]. At that time, the most important for the Cosmology, Newtonian constant of gravitation G, proved too difficult to measure [70]. Its measurement precision was the worst among all Fundamental physical constants. In 2010, CODATA stated the following value of G:

$$G(2010) = 6.67384 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (120\ ppm)$$

with Relative Standard Uncertainty $RSU = 1.2 \times 10^{-4} = 120\ ppm$.

In 2013, WUM proposed a principally different way to solve the problem of G measurement precision [71]. WUM revealed a self-consistent set of time-varying values of PCPs. Based on the value of Fermi Coupling constant in 2010:

$$G_F(2010)) = 1.166364 \times 10^{-5}\ GeV^{-2}\ (4.3\ ppm)$$

WUM predicted a value of the gravitational constant G^*_{2014} equals to [69]:

$$G^*_{2014} = 6.67420 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

To the best of our knowledge, no breakthrough in G measurement methodology has been since achieved. Nevertheless, in 2015 CODATA recommended a more precise value of G(2014):

$$G(2014) = 6.67408 \times 10^{-11} m^3 kg^{-1} s^{-2}\ \ (47\ ppm)$$

In 2018, the recommendation improved further:

$$G(2018) = 6.67430 \times 10^{-11} m^3 kg^{-1} s^{-2}\ \ (22\ ppm)$$

Since 2013, the RSU of G measurements reduced from 120 ppm to 22 ppm! It seems that CODATA considered the WUM's recommendation of the predicted value of G and used it for G(2014) and G(2018) without any reference or explanation of their methodology.

Considering a more precise value of Fermi Coupling constant in 2014:

$$G_F(2014) = 1.1663787 \times 10^{-5} GeV^{-2} \ (0.51\ ppm)$$

WUM calculated a predicted value of gravitational constant G^*_{2018} [15]:

$$G^*_{2018} = \ 6.674536 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

which is x8 more accurate than G^*_{2014}. The predicted value of G^*_{2018} is in excellent agreement with experimentally measured by Q. Li, *et al.* in 2018 values of G using two independent methods [72]:

$$G(1) = 6.674184 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.64\ ppm)$$

$$G(2) = 6.67484 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.61\ ppm)$$

WUM recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of the Newtonian Constant of Gravitation G^*_{2018}.

Missing Baryon Problem related to the fact that the observed amount of baryonic matter did not match theoretical predictions. Observations by the Planck spacecraft in 2015 yielded a theoretical value for baryonic matter of 4.85% of the contents of the Universe [73]. However, directly adding up all the known baryonic matter produces a baryonic density less than half of this [74].

In 2013, WUM calculated **a** relative energy density of protons in the Medium Ω_p [69]:

$$\Omega_p = 2\pi^2\, \alpha/3 = 0.048014655$$

that is in good agreement with the experimentally measured value of density of ionized baryons in the intergalactic medium Ω_{IGM} obtained by E. F. Keane, *et al.* in 2016 [75]:

$$\Omega_{IGM} = 4.9 \pm 1.3\%$$

Minimum Energy of Photons. Analysis of Intergalactic plasma shows that the value of the lowest plasma frequency ν_{pl} is [69]: $\nu_{pl} = 4.5322\ Hz$. Photons with energy smaller than $E_{ph} = h\nu_{pl}$ cannot propagate in plasma, thus $h\nu_{pl}$ is the smallest amount of energy a photon may possess. Following L. Bonetti, *et al.* [76] we can call this amount of energy the rest energy of photons that equals to: $E_{ph} = 1.8743 \times 10^{-14}\ eV$. This value, predicted by WUM in 2013, is in good agreement with the value $E_{ph} \lesssim 2.2 \times 10^{-14}\ eV$ obtained by L. Bonetti, *et al.* in 2017 [76]. It is more relevant to call E_{ph} the minimum energy of photons which can pass through the Intergalactic plasma.

Dark Matter Compact Objects. "The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy" (Nobel Prize in Physics 2020) made by Prof. R. Genzel and A. Ghez is a confirmation of one of the most important predictions of WUM in 2013: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [69].

6. Conclusion

The Hypersphere World-Universe Model successfully describes primary cosmological parameters and their relationships, ranging in scale from cosmological structures to elementary particles. WUM allows for precise calculation of values that were only measured experimentally earlier and makes verifiable predictions. WUM does not attempt to explain all available cosmological data, as that is an impossible feat for any one manuscript. Nor does WUM pretend to have built an all-encompassing theory that can be accepted as is. The Model needs significant further elaboration, but in its present shape, it can already serve as a basis for the New Cosmology proposed by Paul Dirac in 1937. The Model should be developed into a well-elaborated theory by entire physical community.

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