Development of Hypersphere World-Universe Model. Narrative. Part V. Paradigm Shift in Cosmology

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Abstract

The main objective of a paper is to discuss the most important Concepts for any Cosmological model: universality of physical laws; cosmological principle (homogeneous and isotropic universe); Space, Time, and Gravitation; speed of light in vacuum; structure and content of the World; dark matter and ordinary matter; origin of matter (singularity or continuous creation); Law of Conservation of Angular Momentum; Primary Cosmological Parameters; Four Pillars of Standard Cosmology (SC) – expansion of Universe, nucleosynthesis of light elements, formation of large-scale structures, origin of cosmic background radiation. The performed analysis shows that SC fails to account for most of these concepts. The most intriguing result is that there was no **Initial Singularity**: all galaxies are gravitationally bound with their Superclusters. Proposed Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology. According to WUM, Superclusters are, in fact, the principal objects of the World. Macroobjects form from the top (Superclusters) down to galaxies and extrasolar systems in parallel around different Cores made up of different Dark Matter Particles. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

Hypersphere World-Universe Model: Basic Ideas

Abstract

Hypersphere World-Universe Model (WUM) envisions Matter carried from the Universe into the World from the fourth spatial dimension by Dark Matter Particles (DMPs). Luminous Matter is a byproduct of Dark Matter (DM) self-annihilation. WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) and Luminous Epoch (ever since for 13.77 billion years). Big Bang discussed in Standard Cosmology (SC) is, in our view, transition from Dark Epoch to Luminous Epoch due to Rotational Fission of Overspinning DM Supercluster's Cores and self-annihilation of DMPs. WUM solves a number of physical problems in SC and Astrophysics through DMPs and their interactions: **Angular Momentum problem** in birth and subsequent evolution of Galaxies and Extrasolar systems; **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center; **Coronal Heating problem** in solar physics – temperature of Sun's corona exceeding that of photosphere by millions of degrees; **Cores of Sun and Earth** rotating faster than their surfaces; Diversity of **Gravitationally-Rounded Objects** in Solar system and their **Internal Heating**. Model makes predictions pertaining to **Rest Energies of DMPs**, proposes **New Type of their Interactions**. WUM reveals **Inter-Connectivity of Primary Cosmological Parameters** and calculates their values, which are in good agreement with the latest results of their measurements.

Keywords: "Hypersphere World-Universe Model"; "Law of Conservation of Angular Momentum"; "Dark Epoch"; "Rotational Fission"; "Luminous Epoch"; "Dark Matter Particles Self-annihilation"; "Macroobject Shell Model"; "Dark Matter Core"; "Medium of the World"; "Dark Matter Fermi Bubbles"; "Solar Corona"; "Geocorona"; "Planetary Corona"; "Galactic Wind"; "Solar Wind"; "Gamma-Ray Bursts"; "Gravitational Bursts"; "Fast Radio Bursts"; "Dark Matter Reactor"; "Lightning Initiation Problem"; "Terrestrial Gamma-Ray Flashes"; "Missing Baryon Problem"; "Energy-Varying Photons"

1. Introduction

We can't solve problems by using the same kind of thinking we used when we created them.
Albert Einstein

Today, a growing feeling of Physics' stagnation is shared by a large number of researchers. In some respects, the situation today is similar to that at the end of the19th century, when the common consensus held that the body of physics is nearly complete. The time may be ripe to propose new Physical models that will be both simpler than the current state of the art, as well as open up new areas of research.

Hypersphere WUM is proposed as an alternative to the prevailing Big Bang Model (BBM) of Standard Cosmology. WUM is a natural continuation of Classical Physics. The Model makes use of a number of Hypotheses proposed by classical physicists from the 17th until the beginning of the 21st century. The presented Hypotheses are not new, and we don't claim credit for them. In fact, we are developing the existent Hypotheses and proposing new Hypotheses 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.

In our view, there is a principal difference between Physics and Mathematics. I am convinced that Physics cannot exist without Mathematics, but Mathematics must not replace Physics. I absolutely agree with John von Neumann who said: "*The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct, which, with addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work".*

WUM is a classical model. It should then be described by classical notions, which define emergent phenomena. By definition, **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.

Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases [1] – [15].

2. Big Bang Model

The framework for BBM relies on General Relativity, which is based on the gravitational constant G and the **speed of light in vacuum** c. The Lambda Cold Dark Matter (ΛCDM) model is a parametrization of BBM, in which the universe contains three major components: a Cosmological constant Λ associated with dark energy; the postulated **Cold Dark Matter**; and Ordinary Matter. The ΛCDM model is based on **six parameters**, which are mostly not predicted by current theory; it had to be extended by adding cosmological inflation. It is frequently referred to as the Standard Cosmology (SC).

One of the most critical shortcomings of SC is the **Angular Momentum problem**. 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 [14].

The Four Pillars of the SC are as follows [16]:

- Expansion of the Universe;
- Nucleosynthesis of the light elements;
- Formation of galaxies and large-scale structures;
- Origin of the cosmic background radiation.

2.1. Expansion of Universe

The fact that galaxies are receding from us in all directions was first discovered by Hubble. Projecting galaxy trajectories backwards in time means that they converge to the **initial singularity** at $t = 0$ that is an infinite energy density state. This uncovers one of the shortcomings of the SC – the Horizon problem: *Why does the universe look the same in all directions when it arises out of causally disconnected regions? This problem is most acute for the very smooth cosmic microwave background radiation* [17].

This problem was resolved by the **cosmological inflation**, which is a theory of an extremely rapid exponential expansion of space. This rapid expansion increased the linear dimension of an early universe by a factor of at least 10^{26}. The inflationary epoch lasted from 10^{-36} s after the conjectured initial singularity to some time between 10^{-33} and 10^{-32} s after the singularity. Following the inflationary period, the universe continued to expand, but at a slower rate.

"*It's a beautiful theory*, said J. Peebles. *Many people think it's so beautiful that it's surely right. But the evidence of it is very sparse*" [18].

According to J. Silk, *our best theory of the beginning of the universe, inflation, awaits a definitive and falsifiable probe, in order to satisfy most physicists that it is a trustworthy theory. Our basic problem is that we cannot prove the theory of inflation is correct, but we urgently need to understand whether it actually occurred* [19].

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?*" [20]:

- *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*" [21]. It is not yet clear whether the discrepancy in the observations is due to systematics, or indeed constitutes a major problem for the SC.

2.2. Nucleosynthesis of Light Elements

Big Bang Nucleosynthesis (BBN) refers to the production of nuclei other than those of hydrogen during the early phases of the Universe. BBN is believed to have taken place in the interval from roughly 10 seconds to 20 minutes after the Big Bang (BB) and is calculated to be responsible for the formation of most of the universe's helium as the isotope helium-4, along with small amounts of

deuterium, helium-3, and a very small amount of lithium-7. All of the elements that are heavier than lithium were created much later, by stellar nucleosynthesis in evolving and exploding stars [14].

The history of BBN began with the calculations of R. Alpher in the 1940s. During the 1970s, there were major efforts to find processes that could produce deuterium. While the concentration of deuterium in the universe is consistent with BBM as a whole, it is too high to be consistent with a model that presumes that most of the universe is composed of protons and neutrons. The standard explanation now used for the abundance of deuterium is that the universe does not consist mostly of baryons, but that **non-baryonic dark matter** makes up most of the mass of the universe [22].

According to SC, lithium was one of the three elements synthesized in BB. But in case of lithium, we observe a **cosmological lithium discrepancy** in the universe: older stars seem to have less lithium than they should, and some younger stars have much more. M. Anders, *et al.* report on the results of the first measurement of the $^{2}H(\alpha,\gamma)^{6}Li$ cross section at BB energies. The results they obtained have firmly **ruled out BBN lithium production** as a possible explanation for the reported ^{6}Li detections[23].

2.3. Formation of Galaxies and Large-Scale Structures

The formation and evolution of galaxies can be explained only in terms of gravitation within an inflation + dark matter + dark energy scenario [24]. At about 10,000 years after BB, the temperature had fallen to such an extent that the energy density of the Universe began to be dominated by massive particles, rather than the light and other radiation that had predominated earlier. This change in the form of the main matter density meant that the gravitational forces between the massive particles could now begin to take effect, so that any small perturbations in their density would grow.

This brings into focus one of the shortcomings of the SC – the **density fluctuation problem**: *The perturbations which gravitationally collapsed to form galaxies must have been primordial in origin; from whence did they arise?* [17].

2.4. Origin of Cosmic Background Radiation

According to BBM, about 380,000 years after BB the temperature of the universe fell to the point where nuclei could combine with electrons to create neutral atoms. As a result, photons no longer interacted frequently with matter, the universe became transparent, and the Cosmic Microwave Background (CMB) radiation was created. This cosmic event is usually referred to as Decoupling. The photons present at the time of decoupling have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time. They are the same photons that we see in the CMB now [14]. But then, why is the **CMB a perfect blackbody**?

3. Analysis of Big Bang Model

3.1. Expansion of Universe

The initial singularity is a gravitational singularity predicted by General Relativity to have existed before BB and thought to have contained all the energy and spacetime of the Universe.

WUM: From a physical point of view, existence of a mathematical singularity is a drawback of any theory. It means that the theoretical model did not consider some significant physical phenomenon, which prevents an occurrence of the singularity. In our view, there is no way to prevent an occurrence of the initial singularity in BBM. It must be a principally different Beginning of the World – a Fluctuation in the Eternal Universe with a finite size and energy. The size of this fluctuation can

increase with a finite speed. Then, there is no need for cosmological inflation. But in this case, an issue with a creation of Matter in the World arises (see Section 6.2).

3.2. Nucleosynthesis of Light Elements

Primordial nucleosynthesis of the Light Elements is believed to have taken place in the interval from roughly 10 seconds to 20 minutes after BB.

WUM: Nucleosynthesis of all elements (including light elements) occurs inside of Dark Matter (DM) Cores of all Macroobjects during their evolution. The theory of Stellar Nucleosynthesis is well developed, starting with the publication of a celebrated B^2FH review paper [25]. With respect to WUM, this theory should be expanded to include self-annihilation of heavy DM fermions in Macroobjects' Cores (see Section 7.2).

3.3. Formation of Galaxies and Large-Scale Structures

At about 10,000 years after BB, the gravitational forces between the massive particles could begin to take effects, so that any small perturbations in their density would grow.

WUM: 14.22 billion years ago, the 3D World, which is a Hypersphere of 4-Ball **Nucleus of the World**, started by a fluctuation in the Eternal Universe. 4-Ball is expanding in the Eternal Universe. Density fluctuations could happen in the Medium of the World filled with multicomponent Dark Matter Particles (DMPs) and Ordinary particles. Heavy DMPs could collect into clumps with distances between them smaller than the range of the **Weak Interaction** (see Section 6.7). Larger clumps attract smaller clumps of DMPs and initiate a process of expanding the DM clumps followed by growth of surrounding shells made up of other DMPs up to the maximum mass of DM Cores of Superclusters at the end of Dark Epoch. Large-scale structures (Superclusters, Galaxies, Extrasolar systems) arise as the result of Rotational Fission of Superclusters' Cores (see Section 6.9).

3.4. Origin of Cosmic Background Radiation

The photons that existed at the time of photon decoupling have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time.

WUM: Wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They do not have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*". The black-body spectrum of CMB is due to thermodynamic equilibrium of photons with the Intergalactic plasma, the existence of which is experimentally proved. It explains why the CMB is a perfect blackbody [14].

3.5. Nebular Hypothesis

Nebular hypothesis maintains that 4.57 billion years ago, the Solar system formed from the gravitational collapse of a giant molecular cloud, which was light years across. Most of the mass collected in the Centre, forming the Sun; the rest of the mass flattened into a protoplanetary disc, out of which the planets and other bodies in the Solar system formed [11]. The Nebular hypothesis is not without its critics. In his "*The Wonders of Nature*", Vance Ferrell outlined the following counter-arguments [26]:

- *It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;*

- *Each planet and moon in solar system has unique structures and properties. How could each one be different if all of them came from the same nebula;*
- *A full 98 percent of all the angular momentum in the solar system is concentrated in the planets, yet a staggering 99.8 percent of all the mass in our Solar system is in our Sun;*
- *Jupiter itself has 60 percent of the planetary angular motion. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;*
- *There is no possible means by which the angular momentum from the Sun could be transferred to the planets. Yet this is what would have to be done if any of the evolutionary theories of Solar system origin are to be accepted.*

WUM: 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 (see Section 6.9).

3.6. Angular Momentum Problem

There is another principal problem in the SC – **Angular Momentum problem**. BBM cannot answer the following question: how did the Milky Way and Solar system obtain their substantial orbital angular momenta?

WUM proposes a Rotational Fission mechanism of creation and evolution of Macrostructures of the World (Superclusters, Galaxies, Extrasolar systems), based on Overspinning DM Cores of the World's Macroobjects, and the Law of Conservation of Angular Momentum [1]. From the point of view of the Fission model, the Prime object is transferring some of its rotational momentum to orbital and rotational momenta of Satellites. It follows that at the moment of creation **the rotational momentum of the prime object should exceed the orbital momentum of its satellite** (see Section 6.9).

3.7. Black Holes

In 1916, the first **mathematical solution** of Einstein's field equations that would characterize a Black Hole (BH) was published by Karl Schwarzschild in the paper "On the Gravitational Field of a **Mass Point** according to Einstein's Theory" [27]. The simplest BH solution is the Schwarzschild solution, which describes the gravitational field in the spherically symmetric, **static, vacuum** case. The **BH singularity** is a gravitational singularity predicted by General Relativity.

The existence of supermassive objects in galactic centers is now commonly accepted. It is commonly believed that the central mass is a supermassive BH. There exists, however, evidence to the contrary [14]. In 2013, N. Hurley-Walker spotted a previously unknown radio galaxy NGC1534 that is quite close to Earth but is much fainter than it should be if the central BH was accelerating the electrons in the jets: *"The discovery is also intriguing because at some point in its history the central black hole switched off but the radio jets have persisted"*. It's also possible there was never a BH there at all [28].

In 2014, L. Mersini-Houghton claimed to demonstrate mathematically that, given certain assumptions about BH firewalls, current theories of BH formation are flawed. She claimed that Hawking radiation causes the star to shed mass at a rate such that it no longer has the density sufficient to create a BH [29].

Julie Hlavacek-Larrondo, *et al.* present the first observational evidence for massive, runaway cooling occurring in the absence of supermassive BH feedback in the high-redshift galaxy cluster

SpARCS104922.6+564032.5. Their observations show the dramatic impact when supermassive BH feedback fails to operate in clusters [30]. Black Hole fails to do its job [31].

R. K. Leane and T. R. Slatyer in the paper "*Revival of the Dark Matter Hypothesis for the Galactic Center Gamma-Ray Excess*" examine the impact of unmodeled source populations on identifying the true origin of the galactic center GeV excess. They conclude that *dark matter may provide a dominant contribution to the galactic center GeV excess after all* [32].

WUM: All Macroobjects of the World have Cores at their centers, which are made from fermionic DMPs with shells composed of different DMPs and Ordinary particles (see Section 6.8).

As a conclusion:

- Four Pillars of the SC are model-dependent and not strong enough to support BBM;
- The existence of Dark Matter is a principal point of BBM;
- SC doesn't answer the question about orbital angular momenta of Milky Way and Solar system;
- There exists observational evidence for the existence of **non-luminous objects** in centers of galaxies.

4. Classical Physics

WUM is a natural continuation of Classical Physics. In this Section we describe principal milestones in Classical Physics. Based on the analysis of experimentally measured values of physical constants we make a conclusion that the most important Fundamental constants could be calculated before Quantum Physics [10].

Kinetic Theory of Gases explains macroscopic properties of gases, such as pressure, temperature, viscosity, thermal conductivity, and volume, by considering their molecular composition and motion. In 1859, James Clerk Maxwell formulated the Maxwell distribution of molecular velocities, which gave the proportion of molecules having a certain velocity in a specific range [33]. This was the first-ever statistical law in Physics that defines macroscopic properties of gases as **emergent phenomena**.

Maxwell's equations were published by J. C. Maxwell in 1861 [34]. He calculated the velocity of electromagnetic waves from the value of the electrodynamic constant c measured by Weber and Kohlrausch in 1857 [35] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [36]. This observation made him suggest that light is an electromagnetic phenomenon [37].

We emphasize that c in Maxwell's equations is the **electrodynamic constant** but not the **speed of light in vacuum**. By definition, the electrodynamic constant c is the ratio of the absolute electromagnetic unit of charge e to the absolute electrostatic unit of charge e/c, where e is the elementary charge.

Most articles on electromagnetic theory follow the classical approach of steady state solutions of Maxwell's equations. H. Harmuth and K. Lukin in "*Interstellar Propagation of Electromagnetic Signals*" point out the deficiencies in Maxwell's theory and present a new way of obtaining transient or signals solutions. A new approach based on microscopic description of the medium and analytical solution of Maxwell's equations in time domain has been used to solve the problem [38].

WUM: The existence of the Medium is a principal point of WUM. Hence, WUM follows the H. Harmuth and K. Lukin approach.

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 [39]. As of 2018, R_∞ is the most accurately measured Fundamental physical constant. The Rydberg constant can be expressed as in the following equation:

$$R_\infty = \alpha^3/2a$$

where α is a dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ that was later named "Sommerfeld's constant," and subsequently "Fine-structure constant". In WUM, a is the basic unit of size.

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 [40]. We define it after Thomson: $R_T \equiv e/m_e$.

Planck Constant was suggested by Max Planck as the result of his investigation of the problem of black-body radiation. He used Boltzmann's famous 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). Planck was able to calculate the values of constants h and k_B from experimental data on black-body radiation in 1901 [41].

We emphasize that Planck constant h , which is generally associated with the behavior of microscopically small systems, was introduced by Max Planck based on **Statistical Thermodynamics** before Quantum Physics.

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

$$\alpha = [2(\mu_0 h/c)R_\infty^2 R_T^2]^{1/5}$$

$$a = [\frac{(\mu_0 h/c)^3 R_\infty R_T^6}{4}]^{1/5}$$

$$m_e = \frac{h}{c}[\frac{8R_\infty}{(\mu_0 h/c)^2 R_T^4}]^{1/5}$$

$$e = (\frac{2\alpha h/c}{\mu_0})^{1/2}$$

where μ_0 is the magnetic constant: $\mu_0 = 4\pi \times 10^{-7}\ H/m$. All these Fundamental constants, including classical electron radius $a_o = a/2\pi$, were measured and could be calculated before Quantum Physics.

Below we will refer to the following Basic Units:

- energy $E_0 = \frac{hc}{a}$;
- energy density $\rho_0 = \frac{hc}{a^4}$;
- surface energy density $\sigma_0 = \frac{hc}{a^3}$;
- time $t_0 = \frac{a}{c}$.

5. Hypotheses Revisited by WUM

Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand. Albert Einstein

WUM is a natural continuation of classical physics and makes use of several hypotheses unknown and forgotten by mainstream scientific community. Below we will describe the Hypotheses belonging to classical physicists such as Newton, Riemann, Heaviside, Tesla, and Dirac, and develop them in frames of WUM. Please pay tribute to these great physicists!

5.1. Aether

Physical Aether was suggested as early as the 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, which was abandoned in 1905. In later years there have been classical physicists who advocated the existence of Aether [10]:

- Nikola Tesla declared in 1937: *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* [42];
- Paul Dirac stated in 1951 in an article in Nature, titled "Is there an Aether?" that *we are rather forced to have an Aether* [43].

WUM introduces the Medium of the World, which consists of stable elementary particles: protons, electrons, photons, neutrinos, and DMPs. The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation (FIRB). Cosmic MBR is part of the Medium; it then follows that the Medium is an absolute frame of reference. Relative to the MBR rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 km/s respectively [13].

5.2. Hypersphere Universe

In 1854, Georg Riemann proposed a Hypersphere as a model of a finite Universe [44]. A Hypersphere is a 3-dimensional Surface of a 4-dimensional Ball.

WUM follows the idea of a 3D Hypersphere World, albeit proposing that the World is expanding and filled with the Medium and Macroobjects consisting of stable elementary particles (see Section 6.3).

5.3. 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 [9]. 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 [45]. The equations for GEM were first published in 1893 by O. Heaviside as a separate theory expanding Newton's law [46].

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 general relativity acceleration is $\sim 3 \times 10^{-10}\ m\ s^{-2}$ [47].

We emphasize that c in GEM Maxwell's equations is the **gravitodynamic constant** but not the **speed**

of gravitational waves in vacuum. 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 (see Section 4).

WUM is based on Maxwell's equations for the EM and GEM, which contain a single constant: the electrodynamic and gravitodynamic constant c; two parameters of the Medium: the magnetic constant μ_0 and the gravitomagnetic parameter μ_g; and two measurable characteristics: an energy density and energy flux density. All other notions are used for calculations of these two measurable characteristics [3].

5.4. 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 [5]. According to Dirac's hypothesis, the apparent equivalence of these ratios might not to be a mere coincidence but instead could imply a cosmology where:

- The strength of gravity, as represented by the gravitational constant G, is inversely proportional to the cosmological time τ: $G \propto 1/\tau$;
- The mass of the universe is proportional to the square of the universe's age A_τ: $M \propto A_\tau^2$ [48].

WUM follows the idea of time-varying G and introduces a dimensionless time-varying quantity Q, that is a measure of the Age of the World. Q can be calculated from the value of the parameter G:

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

Q in present epoch equals to: $Q = 0.759972 \times 10^{40}$ [4].

5.5. Creation of Matter

In 1964, F. Hoyle and J. V. Narlikar explained the appearance of new matter by postulating the existence of what they dubbed the "Creation field", or just the "C-field"[49]. 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) [50].

WUM follows the idea of the continuous creation of matter, albeit introducing a different mechanism of matter creation (see Section 6.2).

5.6. Rotational Fission

Lunar origin fission hypothesis was proposed by George Darwin in 1879 to explain the origin of the Moon by rapidly spinning Earth, on which equatorial gravitative attraction was nearly overcome by centrifugal force [51].

Solar fission theory was proposed by Louis Jacot in 1951 who stated that [52]:

- *The planets were expelled from the Sun one by one from the equatorial bulge caused by rotation;*
- *The moons and rings of planets were formed from the similar expulsion of material from their parent planets.*

Tom Van Flandern further extended this theory in 1993 [53]. Flandern proposed that planets were expelled from the Sun in pairs at different times. Six original planets exploded to form the rest of the modern planets. It solves several problems the SC does not:

- *If planets fission from the Sun due to overspin while the proto-Sun is still accreting, this more easily explains how 98% of the solar system's angular momentum ended up in the planets;*
- *It solves the mystery of the dominance of prograde rotation for these original planets since they would have shared in the Sun's prograde rotation at the outset;*
- *It also explains coplanar and circular orbits;*
- *It is the only model that explains the twinning of planets (and moons) and difference of planet pairs because after each planet pair is formed in this way, it will be some time before the Sun and extended cloud reach another overspin condition.*

The outstanding issues of the Solar fission:

- Tidal friction between a proto-planet and a gaseous parent, such as the proto-Sun, ought to be negligible because the gaseous parent can reshape itself so that any tidal bulge has no lag or lead, and therefore transfers no angular momentum to the proto-planet;
- Neither L. Jacot nor T. Van Flandern proposed an origin for the Sun itself. It seems that they followed the standard Nebular hypothesis of formation of the Sun [11].

WUM concentrates on furthering the Solar Fission theory (see Section 6.9).

6. Hypersphere World-Universe Model

In science one tries to tell people, in such a way as to be understood by everyone, something that no one ever knew before. But in poetry, it's the exact opposite. Paul Dirac

It is the main goal of WUM to develop a Model based on **two dimensionless parameters** only: the constant α and the time-varying parameter Q, which is a measure of the Size and Age of the World. In WUM, we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units (see Section 4). Taking the relative values of physical parameters in terms of the Basic Units we can express all dimensionless parameters of the World through two parameters α and Q in various rational exponents, as well as small integer numbers and π [13].

As we mentioned in Introduction, the Angular Momentum problem is one of the most critical problems in any Cosmological model that must be solved. To be consistent with the Law of Conservation of Angular Momentum a Model must answer the following questions:

- How did Galaxies and Extrasolar systems obtain their substantial orbital and rotational angular momenta;
- How did Milky Way (MW) galaxy give birth to different Extrasolar systems at different times;
- The age of MW nearly equals the Age of the World. What is the origin of MW huge angular momentum? We must discuss the Beginning of MW;
- The beginning of the Solar System (SS) was 4.57 billion years ago. What is the origin of SS angular momentum? We must discuss the Beginning of SS;
- In the theory of planetary formation, all planets, being made of the same ingredients, should have the same composition, yet they do not.

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects of the World – the Rotational Fission of overspinning Prime Objects: they are transferring some of

rotational angular momenta to orbital and rotational momenta of Satellites. In frames of WUM, Prime Objects are DM Cores of Superclusters, which should accumulate huge angular momenta before the Birth of the Luminous World [14]. It means that the "Dark Epoch" must have lasted for at least 400 million years (see Section 6.8).

6.1. The Beginning of the World

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**, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a. The 3D World is a Hypersphere that is the surface of a 4-ball Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World [5].

6.2. Expansion and Creation of Matter

The 4-ball is expanding in the Eternal Universe, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for the absolute cosmological time τ from the Beginning and equals to $R = c\tau$. The expansion of the Hypersphere World can be understood through the analogy with an expanding 3D balloon: imagine an ant residing on a seemingly two-dimensional surface of a balloon. As the balloon is blown up, its radius increases, and its surface grows. The distance between any two points on the surface increases. The ant sees her world expand but does not observe a preferred center [13].

According to WUM, the surface of the 4-ball is created in a process analogous to sublimation. Continuous creation of matter is the result of such 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 arises from the fourth spatial dimension. The Universe is responsible for the creation of Matter. Dark Matter Particles (DMPs) carry new Matter into the World (see Section 6.4).

It is important to emphasize that

- Creation of Matter is a direct consequence of expansion;
- Creation of Dark Matter (DM) occurs homogeneously in all points of the Hypersphere World;
- Luminous Matter is a byproduct 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).

6.3. Content of the World

The Medium consists of stable elementary particles with lifetimes longer than the Age of the World: protons, electrons, photons, neutrinos, and DM particles (DMPs). For all particles under consideration we use the following characteristics:

- Type of particle (fermion or boson);
- Rest energy;
- Electrical charge.

The total energy density of the Medium is 2/3 of the overall energy density of the World. Superclusters, Galaxies, Extrasolar systems, planets, moons, etc. are made of the same particles. The energy density of Macroobjects adds up to 1/3 of the total energy density of the World throughout the World's evolution (see Section 6.4).

6.4. Critical Energy Density

The principal idea of WUM is that the energy density of the World ρ_W equals to the critical energy density ρ_{cr}, which can be found by considering a sphere of radius R_M and enclosed mass M that can be calculated by multiplication of critical density by the volume of the sphere. When the World has the critical density, the Hubble velocity $H \times R_M$ is equal to the escape velocity, which gives an equation for the mass M leading to the equation for ρ_{cr} [54]:

$$\rho_{cr} = 3H^2c^2/8\pi G$$

This equation can be rewritten as [1]:

$$\frac{4\pi G}{c^2} \times \frac{2}{3}\rho_{cr} = \mu_g \times \rho_M = H^2 = \frac{c^2}{R^2}$$

where $\mu_g = \frac{4\pi G}{c^2}$ is a gravitomagnetic parameter and $\rho_M = \frac{2}{3}\rho_{cr}$ is the energy density of the Medium.

The physical conditions at the expanding 4-ball Nucleus and Universe boundary remain constant in all times. If we assume that the content of Matter in 4-ball Nucleus is proportional to the surface of the 4-ball (hypersphere) and basic unit of surface energy density σ_0, then an energy density of the Nucleus ρ_N [5]:

$$\rho_N = \frac{2\pi^2R^3\sigma_0}{0.5\pi^2R^4} = \frac{4hc}{a^3R} = 4\rho_0 \times Q^{-1}$$

is higher than the critical energy density of the World (see Section 7.1):

$$\rho_{cr} = 3\rho_0 \times Q^{-1}$$

It means that the surface of the 4-ball Nucleus is intrinsically more energetically favorable than the bulk, and hence there is a driving force for the surface to be created. It is worth to note that energy density of the Nucleus $\rho_N \propto R^{-1}$, and hence the surface energy density of the Hypersphere $\rho_{cr} \propto R^{-1}$. Considering that $H \propto R^{-1}$, it is easy to see that the gravitational parameter $G \propto R^{-1}$ [1].

6.5. Gravity, Space and Time

In frames of WUM, the parameter G can be calculated based on the value of the energy density of the Medium ρ_M of the World [7]:

$$G = \frac{\rho_M}{4\pi} \times P^2$$

where a dimension-transposing parameter P equals to:

$$P = a^3c^2/2hc$$

Then the Newton's law of universal gravitation can be rewritten in the following way:

$$F = G\frac{m \times M}{r^2} = \frac{\rho_M}{4\pi}\frac{\frac{a^3}{2L_{Cm}} \times \frac{a^3}{2L_{CM}}}{r^2}$$

where we introduced the measurable parameter of the Medium ρ_M instead of the phenomenological coefficient G; and gravitomagnetic charges $\frac{a^3}{2L_{Cm}}$ and $\frac{a^3}{2L_{CM}}$ instead of macroobjects masses m and M (L_{Cm} and L_{CM} are Compton length of mass m and M respectively). The gravitomagnetic charges have a dimension of "Area", which is equivalent to "Energy", with the constant that equals to the basic unit of surface energy density σ_0.

Following WUM approach, we can find a gravitomagnetic parameter of the Medium μ_g: $\mu_g = R^{-1}$ and the impedance of the Medium Z_g: $Z_g = \mu_g c = H = \tau^{-1}$ [1]. These parameters are analogous to the magnetic constant μ_0 and impedance of electromagnetic field $Z_0 = \mu_0 c$.

It follows that measuring the value of Hubble's parameter **anywhere** in the World and taking its inverse value allows us to calculate the absolute Age of the World. The Hubble's parameter is then the most important characteristic of the World, as it defines the Worlds' Age. While in our Model Hubble's parameter H has a clear physical meaning, the gravitational parameter $G = \frac{a^3c^3}{8\pi hc}H$ is a phenomenological coefficient in Newton's law of universal gravitation.

The second important characteristic of the World is the gravitomagnetic parameter μ_g. Taking its inverse value, we can find the absolute radius of curvature of the World in the fourth spatial dimension. We emphasize that the above two parameters (Z_g and μ_g) are principally different physical characteristics of the Medium that are connected through the gravitodynamic constant c. It means that "Time" is not a physical dimension and is an absolutely different entity than "Space". Time is a factor of the World [13].

In WUM, Time, Space and Gravity are closely connected with Mediums' parameters. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. Gravity, Space and Time are all emergent phenomena [5]. In this regard, it is worth recalling Albert Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

6.6. Multicomponent Dark Matter

DMPs might be observed in Centers of Macroobjects has drawn many new researchers to the field in the last forty years [8]. Indirect effects in cosmic rays and gamma-ray background from the annihilation of cold DM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [55]-[60]. A mechanism whereby DM in protostellar halos plays the role in the formation of the first stars is discussed by D. Spolyar, *et al.* [61]. Heat from neutralino DM annihilation is shown to overwhelm any cooling mechanism, consequently impeding the star formation process. A "dark star'' powered by DM annihilation instead of nuclear fusion may result [62]. Important cosmological problems like Dark Matter and Dark Energy could be, in principle, solved through extended gravity. This is stressed, for example, in the famous paper of Prof. C. Corda [63].

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, *et al.* analyze the possibility of two coannihilating neutral and stable DMPs: a heavy fermion for example, like the lightest neutralino (> 100 GeV), and the other possibly a light spin-0 particle (~ 100 MeV) [64].

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 E_0 multiplied by different exponents of α and can be expressed with the following formulae [2]:

DMF1 (fermion): $E_{DMF1} = \alpha^{-2}m_0 = 1.3149950\ TeV$

DMF2 (fermion): $E_{DMF2} = \alpha^{-1}m_0 = 9.5959823\ GeV$

DIRAC (boson): $E_{DIRAC} = \alpha^{0}m_0 = 70.025267\ MeV$

ELOP (boson): $E_{ELOP} = 2/3\alpha^{1}m_0 = 340.66606\ keV$

DMF3 (fermion): $E_{DMF3} = \alpha^{2}m_0 = 3.7289402\ keV$

DION (fermion): $E_{DION} = \alpha^4 m_0 = 0.19857111\ eV$

The values of rest energies of DMF1, DMF2, DMF3 fall into the ranges estimated in literature for neutralinos, WIMPs, and sterile neutrinos respectively [1]. DMF1, DMF2 and DMF3 partake in the self-annihilation interaction with strength equals to α^{-2}, α^{-1} and α^2 respectively.

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 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). 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 [8].

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.

6.7. Weak Interaction

The widely discussed models for nonbaryonic DM are based on the Cold DM hypothesis, and corresponding particles are commonly assumed to be WIMPs, *which interact via gravity and any other force (or forces), potentially not part of the standard model itself, which is as weak as or weaker than the weak nuclear force, but also non-vanishing in its strength* [65]. It follows that a new weak force needs to exist, providing interaction between DMPs. The strength of this force exceeds that of gravity, and its range is considerably greater than that of the weak nuclear force [15].

According to WUM, strength of gravity is characterized by gravitational parameter [1]:

$$G = G_0 \times Q^{-1}$$

where $G_0 = a^2c^4/8\pi hc$ is an extrapolated value of G at the Beginning of the World ($Q=1$). Q in the present Epoch equals to: $Q = 0.759972 \times 10^{40}$.

The range of the gravity equals to the size of the World R:

$$R = a \times Q = 1.34558 \times 10^{26}\ m$$

In WUM, weak interaction is characterized by the parameter G_W:

$$G_W = G_0 \times Q^{-1/4}$$

which is about 30 orders of magnitude greater than G. The range of the weak interaction R_W in the present Epoch equals to:

$$R_W = a \times Q^{1/4} = 1.65314 \times 10^{-4}\ m$$

that is much greater than the range of the weak nuclear force. Calculated concentration of DIONs n_D in the largest shell of Superclusters: $n_D \cong 4.2 \times 10^{15}\ m^{-3}$ shows that a distance between particles is around $\sim 10^{-5}\ m$, which is much smaller than R_W. Thus, the introduced weak interaction between DMPs will provide integrity of all DM shells. In our view, weak interaction between particles DMF3 provides integrity of Fermi Bubbles (see Section 7.2).

6.8. Dark Epoch

Dark Epoch started at the Beginning of the World and lasted for about 0.45 billion years. The 3D World, which is a Hypersphere of 4-Ball, started by a fluctuation in the Eternal Universe. 4-Ball is

expanding in the fourth spatial dimension with speed c. Density fluctuations could happen in the Medium of the World filled with DMPs (DMF1, DMF2, DIRACs, ELOPs, DMF3, DIONs) and Ordinary particles (protons, electrons, photons, neutrinos) arising as a byproduct of DMPs self-annihilation.

Heavy DMPs could collect into clumps with distances between particles smaller than R_W. Larger clumps will attract smaller clumps and DMPs and initiate a process of expanding the DM clumps followed by growth of surrounding shells made up of other DMPs, up to the maximum mass of the shells made up of DIONs at the end of Dark Epoch (0.45 billion years) [13].

The process described above is the formation of a DM Supercluster Core (SC). We estimate a number of SCs at present Epoch to be around $\sim 10^3$. DMPs supply not only additional mass ($\propto \tau^{3/2}$) to Cores, but also additional angular momentum ($\propto \tau^2$) fueling the overspinning of SCs (see Section 6.9). In our opinion, all SCs had undergone rotational fission at approximately the same cosmological time.

6.9. Rotational Fission

According to WUM, the rotational angular momentum of overspinning objects before rotational fission equals to [13]:

$$L_{rot} = \frac{4\sqrt{2}}{15}\frac{1+5\delta}{1+3\delta} G^{0.5} M^{1.5} R^{0.5} \theta_F^2$$

where M is a mass of overspinning object, R is its radius, δ is the density ratio inside of the object: $\delta = \rho_{min}/\rho_{max}$, and an Age parameter θ_F is a ratio of cosmological time of Core fission τ_F to the Age of the World in present Epoch A_W: $\theta_F = \tau_F/A_W$. Then, for parameters G, M, R we use their values in the present Epoch. Parameters G, M, R for Macroobjects' Cores are time-varying: $G \propto \tau^{-1}$, $M \propto \tau^{3/2}$ and $R \propto \tau^{1/2}$. It follows that the rotational angular momentum of Cores L_{rot} is proportional to τ^2.

Local Supercluster (LS) is a mass concentration of galaxies containing the Local Group, which in turn contains the Milky Way galaxy. At least 100 galaxy groups and clusters are located within its diameter of 110 million light-years. Considering parameters of DIONs' shell (see **Table 2**), we calculate the rotational angular momentum L_{rot}^{LSC} of LS Core before rotational fission:

$$L_{rot}^{LSC} = 3.7 \times 10^{77} J\ s$$

Milky Way (MW) is gravitationally bound with LS [66]. Let's compare L_{rot}^{LSC} with an orbital momentum of Milky Way L_{orb}^{MW} calculated based on the distance of 65 million light years from LS Core and orbital speed of about 400 km/s [66]:

$$L_{orb}^{MW} = 2.5 \times 10^{71}\ J\ s$$

It means that as the result of rotational fission of LS Core, approximately $\sim 10^6$ galaxies like the Milky Way could be generated at the same time. Considering that density of galaxies in the LS falls off with the square of the distance from its center near the Virgo Cluster, and the location of MW on the outskirts of the LS [67], the actual number of created galaxies could be much larger.

The mass-to-light ratio of the LS is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [68]. These facts support the rotational fission mechanism proposed above.

In 1933, F. Zwicky investigated the velocity dispersion of the Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: *if this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter* [69]. These ratios are one of the main arguments in favor of presence of large amounts of DM in the World.

Analogous calculations for MW Core based on parameters of DMF3 shell (see **Table 2**) produce the

following value of rotational angular momentum L_{rot}^{MWC} [13]:

$$L_{rot}^{MWC} = 2.4 \times 10^{60}\ J\ s$$

which far exceeds the orbital momentum of the Solar system L_{orb}^{SS} calculated based on the distance from the galactic center of 26.4 kly and orbital speed of about 220 km/s :

$$L_{orb}^{SS} = 1.1 \times 10^{56}\ J\ s$$

As the result of rotational fission of MW Core 13.77 billion years ago, approximately $\sim 10^4$ Extrasolar systems like the Solar system could be created at the same time. Considering that MW has grown inside out (in the present Epoch, most old stars are found near the center of the Milky Way, while the ones formed more recently are on the outskirts [70]), the number of generated Extrasolar systems could be much larger. Extrasolar system Cores can give birth to planetary cores, which in turn can generate cores of moons by the same Rotational Fission mechanism [11].

The oldest known star HD 140283 (Methuselah star) is a subgiant star about 190 light years away from Earth for which a reliable age has been determined [71]. H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8\ Byr$ that does not conflict with the Age of the Universe, $13.77 \pm 0.06\ Byr$, based on the microwave background and Hubble constant [72]. It means that this star must have formed between 13.66 and 13.83 Byr, amount of time that is too short for formation of second generation of stars according to prevailing theories. In our Model, this discovery can be explained by generation of HD 140283 by overspinning Core of the MW 13.77 billion years ago.

In frames of the developed Rotational Fission model, it is easy to explain hyper-runaway stars unbound from the Milky Way with speeds of up to $\sim 700\ km/s$ [73]: they were launched by overspinning Core of the Large Magellan Cloud with the speed higher than the escape velocity [12].

6.10. Luminous Epoch

Luminous Epoch spans from 0.45 billion years up to the present Epoch (during 13.77 billion years). According to WUM, Cores of all Macroobjects (MOs) of the World (Superclusters, Galaxies, Extrasolar systems) possess the following properties [11]:

- Their Nuclei are made up of DMFs and contain other particles, including DM and baryonic matter, in shells surrounding the Nuclei;
- DMPs are continuously absorbed by Cores of all MOs. Luminous Matter (about 7.2% of the total Matter in the World) is a byproduct of DMPs self-annihilation. Luminous Matter is re-emitted by Cores of MOs continuously;
- Nuclei and shells are growing in time: size $\propto \tau^{1/2}$; mass $\propto \tau^{3/2}$; and rotational angular momentum $\propto \tau^2$, until they reach the critical point of their stability, at which they detonate. Satellite cores and their orbital L_{orb} and rotational L_{rot} angular momenta released during detonation are produced by Overspinning Core (OC). The detonation process does not destroy OC; it is rather gravitational hyper-flares;
- Size, mass, composition, L_{orb} and L_{rot} of satellite cores depend on local density fluctuations at the edge of OC and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation.

WUM refers to the OC detonation process as Gravitational Burst (GB), analogous to Gamma Ray Burst [6]. In frames of WUM, the repeating GBs can be explained the following way:

- As the result of GB, the OC loses a small fraction of its mass and a large part of its rotational angular momentum;
- After GB, the Core absorbs new DMPs. Its mass increases $\propto \tau^{3/2}$, and its angular momentum L_{rot}

increases much faster $\propto \tau^2$, until it detonates again at the next critical point of its stability;
- Afterglow of GBs is a result of processes developing in the Nuclei and shells after detonation;
- In case of Extrasolar systems, a star wind is the afterglow of star detonation: star Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 billion years ago. It creates the bubble of the Heliosphere continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic Core detonations. In the Milky Way, it continuously creates two Dark Matter Fermi Bubbles (see Section 7.3).

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass of about 2.3 solar masses that is located at a distance of $\sim$ 9 kpc from the Sun. When integrated backwards in time, the orbit of the star points unambiguously to the Galactic Centre, implying that S5-HVS1 was kicked away from Sgr A* with a velocity of $\sim$ 1800 km/s , and travelled for 4.8 Myr to its current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [74]. In frames of the developed Model, this discovery can be explained by Gravitational Burst of the overspinning Core of the Milky Way 4.8 million years ago, which gave birth to S5-HVS1 with the speed higher than the escape velocity of the Core.

C. J. Clarke, *et al.* observed CI Tau, a young 2-million-year-old star. CI Tau is located about 500 light years away in a highly-productive stellar 'nursery' region of the galaxy. They discovered that the Extrasolar system contains four gas giant planets that are only 2 million years old [75], an amount of time that is too short for formation of gas giants according to the prevailing theories. In frames of the developed Rotational Fission model, this discovery can be explained by a Gravitational Burst of the overspinning Core of the Milky Way two million years ago, which gave birth to CI Tau system with all the planets generated at the same time [11].

To summarize:

- The rotational fission of Macroobjects Cores is the most probable process that can generate satellite cores with large orbital and rotational momenta in a very short time;
- 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's Cores;
- WUM can serve as a basis for Transient Gravitational Astrophysics.

7. Physics of Luminous Epoch

7.1. 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 that depend on dimensionless time-varying quantity Q .

The Model develops a mathematical framework that allows for direct calculation of the following primary cosmological parameters through Q [7]:

- Newtonian parameter of gravitation G ;
- Age of the World A_τ ;
- The Worlds' radius of curvature in the fourth spatial dimension R ;

- Concentration of Intergalactic Plasma n_{IGP} ;
- Minimum Energy of Photons E_{ph} ;
- Temperature of the Far-Infrared Background Radiation peak T_{FIRB} ;
- Electronic neutrino rest energy E_{ν_e} ;
- Muonic neutrino rest energy E_{ν_μ} ;
- Tauonic neutrino rest energy E_{ν_τ} ;
- Fermi coupling parameter G_F ;
- Hubble's parameter H: $H = (t_0 \times Q)^{-1}$
- Critical energy density ρ_{cr} : $\rho_{cr} = 3\rho_0 \times Q^{-1}$
- Temperature of the Microwave Background Radiation T_{MBR} :

$$T_{MBR} = \frac{E_0}{k_B}\left(\frac{15\alpha}{2\pi^3}\frac{m_e}{m_p}\right)^{1/4} \times Q^{-1/4}$$

At the Beginning of the World ($Q=1$), the extrapolated values of ρ_{cr0} and T_{MBR0} were:

$$\rho_{cr0} \cong 6.064 \times 10^{30} J\, m^{-3}$$

that is four orders of magnitude smaller than the nuclear density [1], and

$$T_{MBR0} \cong 2.5446 \times 10^{10}\ \mathrm{K}$$

which is considerably smaller than values commonly discussed in literature. Let us proceed to calculate the value of T_{MBR} at different Ages of the World A_τ .

Table 1. Values of Temperature of Microwave Background Radiation at different Ages of the World.

Age of the World, A_τ	T_{MBR} , K	H, $km/s\,Mpc$
1 s	7.0538×10^4	
0.45 Byr (Luminous Epoch)	6.4775	2172
9.65 Byr (Birth of the Solar system)	3.0141	101.3
14.22 Byr (Present)	2.72518	68.7457

The calculated value of T_{MBR} in present time is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [76].

Observe that practically all Macroobjects – galaxies, stars, planets, etc. – have arisen in a cold World. Our Solar system, for instance, was created when the temperature of MBR was about $3\ K$. Therefore, any Model describing creation of Macroobjects must hold true in cold World conditions.

In frames of WUM, we calculate the values of these primary cosmological parameters, which are in good agreement with the latest results of their measurements. For example, calculating the value of Hubble's parameter H_0 based on the average value of the gravitational parameter G we find $H_0 = 68.7457\ km/s\ Mpc$, which is in good agreement with $H_0 = 69.32 \pm 0.8\ km/s\ Mpc$ obtained using WMAP data [72] 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* [77].

Note that the precision of H_0 value has increased by three orders of magnitude. Similar precision enhancement holds for other parameters' values as well.

7.2. Macroobject Shell Model

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 [8].

Table 2 describes the parameters of Macroobjects Cores (which are Fermionic Compact Stars in WUM) in the present Epoch made up of different DM fermions: self-annihilating DMF1, DMF2, DMF3 and DIONs. The calculated parameters of the shells show that [13]:

- 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.

Table 2. Parameters of Macroobjects Cores made up of different DMFs in the present Epoch.

Fermion	Fermion Rest Energy E_f, MeV	Macroobject Mass M_{max}, kg	Macroobject Radius R_{min}, m	Macroobject Density $\rho_{max}, kg/m^3$
DMF1	1.3×10^6	1.9×10^{30}	8.6×10^3	7.2×10^{17}
DMF2	9.6×10^3	1.9×10^{30}	8.6×10^3	7.2×10^{17}
DMF3	3.7×10^{-3}	1.2×10^{41}	5.4×10^{14}	1.8×10^{-4}
DION	2×10^{-7}	4.2×10^{49}	1.9×10^{23}	1.5×10^{-21}

The following facts support the existence of Cores in Macroobjects:

- Fossat, *et al.* obtained that solar core rotates 3.8 ± 0.1 faster than the radiative envelope [78];
- By analyzing the minute changes for 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 [79];
- T. Guillot, *et al.* found that the deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to atmosphere [80].

K. Mehrgan, *et al.* observed a supergiant elliptical galaxy Holmberg 15A about 700 million light-years from Earth. They found an extreme core with a mass of 4×10^{10} solar masses at the center of Holm 15A [81]. The calculated maximum mass of galaxy Core of 6×10^{10} solar masses (see **Table 2**) is in good agreement with the experimentally found value [81].

The analysis of the Sun's heat for planets in the Solar system yields the effective temperature of all planets that is much lower than their actual temperatures. According to WUM, the internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate through the entire objects' envelope, get

absorbed into the cores, and continuously support DMF1 self-annihilation. Objects' cores are essentially Dark Matter Reactors fueled by DMF1 [11].

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 cores (mass, size, composition). The DM Reactors inside of them (including Earth) are very efficient to provide enough energy for all geological processes on planets and moons like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc. All gravitationally-rounded objects in hydrostatic equilibrium, down to Mimas in the Solar system, prove the validity of WUM [11].

7.3. 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 [82]. 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 [83]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

M. Su, *et al.* identify a gamma-ray cocoon feature in the southern and north Fermi bubble, a jet-like feature along the cocoon's axis of symmetry. Both the cocoon and jet-like feature have a hard spectrum from 1 to 100 GeV. If confirmed, these jets are the first resolved gamma-ray jets ever seen [84].

G. Ponti, *et al.* report prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane, which appear to connect the Galactic Centre region to the FBs. These structures, which they term the Galactic Centre 'chimneys', constitute exhaust channels through which energy and mass, injected by a quasi-continuous train of episodic events at the Galactic Centre, are transported from the central few parsecs to the base of the FBs [85].

D. Hooper and T. R. Slatyer discuss two emission mechanisms in the FBs: inverse Compton scattering and annihilating DM [86]. In their opinion, the second emission mechanism must be responsible for the bulk of the low-energy, low-latitude emission. The spectrum and angular distribution of the signal is consistent with that predicted from ~10 GeV DMPs annihilating to leptons. This component is similar to the excess GeV emission previously reported by D. Hooper from the Galactic Center [87].

It is worth noting that a similar excess of gamma-rays was observed in the central region of the Andromeda galaxy (M31). A. McDaniel, *et al.* calculated the expected emission across the electromagnetic spectrum in comparison with available observational data from M31 and found that the best fitting models are with the DMP mass 11 GeV [88].

WUM explains FBs the following way [13]:

- Core of the Milky Way galaxy 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 [100]. 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 [89]) of DMPs are ejected from the rotating Core into the Galactic halo along the rotation axis of the Galaxy;

- Due to self-annihilation of DMF1 and DMF2, these beams are gamma-ray jets [84]. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre 'chimneys' [85]) are the result of the self-annihilation of DMF3;
- FBs are bubbles whose boundary with the Intergalactic Medium has a surface energy density σ_0. These bubbles are filled with DM particles: DMF1, DMF2, and DMF3. In our Model, FBs are Macroobjects with a mass M_{FB} and diameter D_{FB}, which are proportional to: $M_{FB} \propto Q^{3/2}$ and $D_{FB} \propto Q^{3/4}$ respectively. According to WUM, diameter of FBs equals to:

$$D_{FB} = L_{DMF3} \times Q^{3/4} = \frac{a}{\alpha^2} \times Q^{3/4} = 28.6\ kly$$

  where L_{DMF3} is Compton length of particles DMF3. The calculated diameter is in good agreement with the measured size of the FBs 25 kly [82] and 32.6 kly [85]. Weak interaction between DMF3 particles provides integrity of Fermi Bubbles. 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}:

$$M_{FB} = \frac{\pi D_{FB}^2 \sigma_0}{c^2} = \frac{\pi m_0}{\alpha^4} \times Q^{3/2} \cong 3.6 \times 10^{41} kg$$

  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 particles with concentration $n_{DMF3} \geq R_W^{-3}$. Concentrations of DMF1 and DMF2 in FBs are very small: about α^3 and α^4 smaller than n_{DMF3}, respectively. In our view, gamma rays up to 1 TeV [90] are the result of self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) in Dark Matter Objects (DMOs). DMOs are macroobjects whose density is sufficient for the 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 [13];
- 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 annihilate and radiate X-rays and gamma rays. Dark Matter Fermi Bubbles constitute a principal proof of the World-Universe Model.

7.4. Milky Way Galaxy. Extrasolar Systems

The Milky Way (MW) is a spiral galaxy with an estimated visible stellar disk diameter $D_{MW} = (170 - 200)\ kly$, thickness of thin stellar disk about $2\ kly$ and mass $M_{MW} = (1.6 - 3.2) \times 10^{42} kg$. In our view, MW is a Disk Bubble (DB) whose boundary with the Intergalactic Medium has a surface energy density σ_0 (see Section 7.3). This Disk Bubble contains an Intragalactic Medium and $(100 - 400)\ bln$ Extrasolar systems.

According to WUM, mass of MW equals to:

$$M_{MW} = \frac{\pi D_{MW}^2 \sigma_0}{2c^2}$$

We calculate D_{MW} by the following equation:

$$D_{MW} = (\frac{2M_{MW}c^2}{\pi\sigma_0})^{1/2} = (170 - 240)\ kly$$

The calculated value of the visible stellar disk diameter is in good agreement with its estimated value obtained by astronomers.

Average energy density of MW is: $\rho_{MW} \cong 9 \times 10^{-4}\ J\ m^{-3}$ that is about six orders of magnitude larger than the critical energy density of the World: $\rho_{cr} \cong 8 \times 10^{-10}\ J\ m^{-3}$. The Intragalactic Medium consists of protons, electrons, photons, neutrinos, DIONs and DMPs (24%) with energy density 2/3 of ρ_{MW} . Extrasolar systems consist of the same particles. The energy density of Macroobjects (stars, planets, moons) adds up to 1/3 of ρ_{MW} . In our view, DMPs play the main role in the Cores of Macroobjects (see Section 7.2) and in their Coronas (see Section 7.5).

According to WUM, Extrasolar Systems (ESS) are Bubbles with a boundary between ESS and Intragalactic Medium that has a surface energy density σ_0 . This vast, bubble-like region of space, which surrounds the Sun, is named Heliosphere. The bubble of the heliosphere is continuously inflated by solar jets, known as the solar wind [91]. The outside radius of the solar heliosphere R_{HS} equals to:

$$R_{HS} = (\frac{3M_{\odot}c^2}{4\pi\sigma_0})^{1/2} \cong 1.1 \times 10^{15} m \cong 0.12\ ly$$

where $M_{\odot}$ is the mass of the Sun. The value of 3 above follows from the ratio for all Macroobjects of the World: 1/3 of the total mass is in the central macroobject and 2/3 of the total mass is in the structure around it (see Section 7.5).

7.5. Solar Corona. Geocorona. Planetary Corona

Solar Corona is an aura of plasma that surrounds the Sun and other stars. The Sun's corona extends at least 8 million kilometers into outer space [92] and is most easily seen during a total solar eclipse. Spectroscopy measurements indicate strong ionization and plasma temperature in excess of $10^6 K$ [93]. The corona emits radiation mainly in the X-rays, observable only from space. The plasma is transparent to its own radiation and to solar radiation passing through it, therefore we say that it is optically-thin. The gas, in fact, is very rarefied, and the photon mean free-path by far overcomes all other length-scales, including the typical sizes of the coronal features.

Coronal heating problem in solar physics relates to the question of the temperature of the Solar corona being millions of degrees higher than that of the photosphere. The high temperatures require energy to be carried from the solar interior to the corona by non-thermal processes.

WUM: the origin of the Solar corona plasma is not the coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. The plasma is the result of annihilation of DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV) particles. The Solar corona made up of DMPs resembles a honeycomb filled with plasma [12].

The **Geocorona** is the luminous part of the outermost region of the Earth's atmosphere that extends to at least 640,000 km from the Earth [94]. It is seen primarily via far-ultraviolet light (Lyman-alpha) from the Sun that is scattered by exospheric neutral hydrogen.

X-rays from Earth's Geocorona were first detected by Chandra X-ray Observatory in 1999 [95]. The main mechanism explaining the geocoronal X-rays is that they are caused by collisions between neutral atoms in the geocorona with carbon, oxygen and nitrogen ions that are streaming away from the Sun in the solar wind [96], [97], [98]. This process is called "charge exchange", since an electron

is exchanged between neutral atoms in geocorona and ions in the solar wind.

X-rays from Planets were also observed by Chandra [96]. According to NASA:

- The X-rays from Venus and, to some extent, the Earth, are due to the fluorescence of solar X-rays striking the atmosphere;
- Fluorescent X-rays from oxygen atoms in the Martian atmosphere probe heights similar to those on Venus. The intensity of the X-rays did not change during the dust storm;
- Jupiter has an environment capable of producing X-rays in a different manner because of its substantial magnetic field. X-rays are produced when high-energy particles from the Sun get trapped in its magnetic field and accelerated toward the polar regions where they collide with atoms in Jupiter's atmosphere;
- Like Jupiter, Saturn has a strong magnetic field, so it was expected that Saturn would also show a concentration of X-rays toward the poles. However, Chandra's observation revealed instead an increased X-ray brightness in the equatorial region. Furthermore, Saturn's X-ray spectrum was found to be similar to that of X-rays from the Sun.
- V. I. Shematovich and D. V. Bisikalo gave the following explanation of the planetary coronas [99]: *The measurements reveal that planetary coronas contain both a fraction of thermal neutral particles with a mean kinetic energy corresponding to the exospheric temperature and a fraction of hot neutral particles with mean kinetic energy much higher than the exospheric temperature. These suprathermal (hot) atoms and molecules are a direct manifestation of the non-thermal processes taking place in the atmospheres.*

WUM: The Planetary Coronas are similar to the Solar Corona [12]:

- At the distance of 640,000 km from the Earth [94], atoms and molecules are so far apart that they can travel hundreds of kilometers without colliding with one another. Thus, the exosphere no longer behaves like a gas, and the particles constantly escape into space. In our view, FUV radiation and X-rays are the consequence of DMF3 self-annihilation;
- All planets and some observed moons (Europa, Io, Io Plasma Torus, Titan) have X-rays in upper atmosphere of the planets, similar to the Solar Corona;
- The Geocorona is a stable Shell around the Earth with inner radius $R_{in} \cong 6.5 \times 10^6\ m$ and observed outer radius $R_{out} \cong 6.4 \times 10^8\ m$. The total mass of this Shell is $\cong 4.1 \times 10^{18}\ kg$;
- Suprathermal atoms and molecules are the result of DMPs self-annihilation in Geocorona.

7.6. High-Energy Atmospheric Physics

Lightning initiation problem. Years of balloon, aircraft, and rocket observations have never found large enough electric fields inside thunderstorms to make a spark. Yet, lightnings strike the Earth about 4 million times per day. This has led to the cosmic-ray model of lightning initiation [100], [101]. **Terrestrial Gamma-Ray Flashes** (TGFs) were first detected by chance by NASA's Earth-orbiting Compton gamma ray telescope. Compton was searching for Gamma Ray Bursts (GRBs) from exploding stars, when it unexpectedly began detecting very strong bursts of high energy x-rays and gamma rays, coming from the Earth [102]. There are two leading models of TGF formation: Lightning leader emission and Dark Lightning [100], but they still don't account for:

- A bright TGF observed by a spacecraft in the middle of the Sahara Desert on a nice day. The nearest thunderstorms were ~ 1000 miles away [103];
- Unusual surges of radiation at 511 keV when there were no thunderstorms;
- Beams of antimatter (positrons) produced above thunderstorms on the Earth;
- A gamma-ray flash coming down from the overhead thundercloud;

- The spectra of TGFs at very high energies (40–100 MeV).

WUM: The characteristics of Geocorona are similar to the characteristics of the Solar Corona. As the result of a large fluctuation of DMPs in Geocorona and their self-annihilation, X-rays and gamma-rays are going not only up and out of the Earth, but also down to the Earth's surface. TGFs are, in fact, well-known GRBs [6]. The spectra of TGFs at very high energies can be explained by DMF1 and DMF2 self-annihilation. Lightning initiation problem can be solved by X-rays and gamma-rays, which slam into the thunderclouds and carve a conductive path through a thunderstorm. From this point of view, it is easy to explain all experimental results summarized above [12].

7.7. Formation and Evolution of Macroobjects. Ultimate Fate

All Macroobjects of the World have Cores made up of different DMPs. The matter creation is occurring homogeneously in all points of the World. It follows those new stars can be created inside of galaxies, new galaxies can be created inside of superclusters, which can arise in the World. Structures form 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 [5]. The Universe is continuously creating Matter in the World. Assuming an Eternal Universe, the numbers of cosmological structures and their size on all levels will increase. The temperature of the Medium will asymptotically reach zero [1].

7.8. 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 exceedingly small value of the dimension-transposing gravitomagnetic parameter of the Medium [1]. 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 [5].

Let's consider an effect that has indeed been observed for billions of years, albeit indirectly [5]. 4.57 billion years ago the Sun's output has been only 70% as intense as it is today [104]. 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 [2].

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 [5].

8. WUM 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 is wrong. That is all there is to it. Richard Feynman

8.1. Newtonian Constant of Gravitation

The very first manuscript "World-Universe Model" (WUM) was published on viXra in March 2013 [105]. At that time great results in Cosmology were achieved:

- The cosmic Far-Infrared Background was announced in 1999 [106];
- Microwave Background Radiation temperature was measured in 2009 [107];
- Nine-Year Wilkinson Microwave Anisotropy Probe Observations were published in 2012 [72].

At the same time, the most important for the Cosmology, Newtonian constant of gravitation G, proved too difficult to measure [108]. 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): $RSU = 1.2 \times 10^{-4} = 120\ ppm$.

In 2013, WUM proposed a principally different way to solve the problem of G measurement precision. WUM revealed a self-consistent set of time-varying values of Primary Cosmological Parameters (see Section 7.1). 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 the value of the gravitational constant G^*_{2014} equals to [109]:

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

To the best of our knowledge, no breakthrough in G measurement methodology has been achieved since. 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 relative standard uncertainty 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) 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 the 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 the experimentally measured by Q. Li, *et al.* in 2018 values of G using two independent methods [110]:

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

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

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}.

8.2. Missing Baryon Problem

The 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 [111]. However, directly adding up all the known baryonic matter produces a baryonic density less than half of this [112]. The missing baryons are believed to be located in the warm–hot intergalactic medium.

The existence of the Medium of the World is a principal point of WUM. It follows from the observations of Intergalactic Plasma (IGP). Detailed analysis of IGP carried out in 2013 [109] showed that the relative energy density of protons in the Medium Ω_p is [105]:

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

In our opinion, direct measurements of the IGP parameters can be done by investigations of Fast Radio Bursts, which are millisecond duration radio signals originating from distant galaxies. These signals are dispersed according to a precise physical law and this dispersion is a key observable quantity which, in tandem with a redshift measurement, can be used for fundamental physical investigations [113]. The dispersion measure and redshift, carried out in 2016 by E. F. Keane, *et al.*, provide a direct measurement of density of ionized baryons in the intergalactic medium Ω_{IGM} [113]:

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

that is in excellent agreement with the predicted by WUM value of Ω_p.

To summarize:

The values of the Intergalactic Plasma parameters predicted by WUM in 2013 are confirmed by experiments conducted in 2016.

8.3. Minimum Energy of Photons

Analysis of Intergalactic plasma shows that the value of the lowest plasma frequency ν_{pl} is [105]:

$$\nu_{pl} = t_0^{-1}(\frac{m_e}{m_p})^{1/2} \times Q^{-1/2} = 4.5322\ Hz$$

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.* [114] we can call this amount of energy the rest energy of photons that equals to

$$E_{ph} = (\frac{m_e}{m_p})^{1/2} E_0 \times Q^{-1/2} = 1.8743 \times 10^{-14}\ eV$$

The above 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 [114]. It is more relevant to call E_{ph} the minimum energy of photons which can pass through the Intergalactic plasma.

8.4. Distribution of the World's Energy Density

According to WUM, the predicted distribution of the World's energy density in terms of proton energy density in the Medium of the World $\rho_p = \frac{2\pi^2\alpha}{3}\rho_{cr}$, is as follows [7]:

DIONs	$\rho_{DION} = \frac{45}{\pi}\rho_p = 0.68775927\rho_{cr}$
DMPs	$\rho_{DM} = 5\rho_p = 0.24007327\rho_{cr}$
Baryons	$\rho_B = 1.5\rho_p = 0.072021982\rho_{cr}$
Electrons	$\rho_e = 1.5\frac{m_e}{m_p}\rho_p$
MBR	$\rho_{MBR} = 2\frac{m_e}{m_p}\rho_p$
Neutrinos	$\rho_\nu = \rho_{MBR}$
FIRB	$\rho_{FIRB} = \frac{1}{5\pi}\frac{m_e}{m_p}\rho_p$

Then the energy density of the World ρ_W equals to the theoretical critical energy density ρ_{cr}

$$\rho_W = \left[\frac{45}{\pi} + 6.5 + \left(5.5 + \frac{1}{5\pi}\right)\frac{m_e}{m_p}\right]\rho_p = \rho_{cr}$$

From this equation we can calculate the value of $1/\alpha$ using electron-to-proton mass ratio m_e/m_p

$$\frac{1}{\alpha} = \frac{\pi}{15}\left[450 + 65\pi + (55\pi + 2)\frac{m_e}{m_p}\right] = 137.03600$$

which is in excellent agreement with the commonly adopted value of 137.035999. It follows that there is a direct correlation between constants α and m_e/m_p expressed by the obtained equation. As shown, m_e/m_p is not an independent constant but is instead derived from α [7].

As the conclusion:

- The World's energy density is $\rho_W \propto Q^{-1} \propto \tau^{-1}$ in all cosmological times;
- The particles relative energy densities are proportional to α in Luminous Epoch.

9. Hypotheses Proposed by WUM

WUM proposed the following Hypotheses:

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 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. The Universe is responsible for the creation of Matter. Dark Matter Particles (DMPs) carry new Matter into the World. Luminous Matter is a byproduct 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% . The Medium is an absolute frame of reference.

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.

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 Standard Cosmology is a transition from Dark Epoch to Luminous Epoch due to **Rotational Fission of Overspinning Dark Matter Supercluster's Cores** and self-annihilation of DMPs.

Solar System. A detailed analysis of the Solar system shows that the overspinning Dark Matter (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.

Two Fundamental Parameters in various rational exponents define all macro-features of the World: dimensionless Rydberg constant α and Quantity Q. While α is constant, $Q \propto R \propto \tau$ and is, in fact, a measure of the Worlds' curvature in the fourth spatial dimension and the Age of the World. 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: $Q = 0.759972 \times 10^{40}$.

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

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

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.

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

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.

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. **Weak interaction** between particles DMF3 (3.7 keV) provides integrity of Fermi Bubbles.

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

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. The bubble of the Heliosphere is continuously inflated by Solar jets, known as the Solar wind.

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 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 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.

Predictions. WUM predicts rest energies of neutrinos and DMPs and their distribution in the World.

10. Conclusion

Dark Matter is abundant:

- 2.4 % of Luminous Matter is in Superclusters, Galaxies, Stars, Planets, etc.
- 4.8 % of Luminous Matter is in the Medium of the World;
- The remaining 92.8 % is Dark Matter.

Dark Matter is omnipresent:

- Cores of all Macroobjects;
- Coronas of all Macroobjects of the World;
- The Medium of the World;
- Fermi Bubbles.

WUM makes reasonable assumptions in the main areas of Cosmology. The remarkable agreement of the calculated values of the primary cosmological parameters with the observational data gives us considerable confidence in the Model.

WUM is based on two dimensionless parameters only: Rydberg constant α and time-varying quantity Q. In WUM we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units of time t_0, size a, and energy E_0. For example, $c = a/t_0$ and $h = E_0 \times t_0$. Taking the relative values of physical parameters in terms of the Basic Units we can express all dimensionless parameters of the World through two parameters α and Q in various rational exponents, as well as small integer numbers and π.

There are no Fundamental Physical Constants in WUM. In our opinion, constant α and quantity Q should be named "Universe Constant" and "World Parameter" respectively.

The Hypersphere World–Universe Model successfully describes primary cosmological parameters and their relationships, ranging in scale from cosmological structures to elementary particles.

In 2013, WUM predicted the values of several cosmological parameters: Gravitational; Concentration of Intergalactic Plasma; Relative energy density of baryons in the Medium of the World; Minimum energy of photons. The predictions were subsequently confirmed through experiments in 2015–

2018. The Model allows for precise calculation of values of Hubble's Parameter, Temperature of Microwave Background Radiation, and Temperature of Far-Infrared Background Radiation Peak, that were experimentally measured earlier, and makes verifiable predictions.

Based on the totality of the results obtained by WUM, we suggest adopting the existence of Dark Matter in the World from the Classical Physics point of view. While WUM needs significant further elaboration, it can already serve as a basis for a New Physics proposed by Paul Dirac in 1937.

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Hypersphere World-Universe Model. Cosmological Time

Abstract

The main objective of this paper is to discuss the most important notions for any Cosmological model – Space, Time and Gravitation. According to Hypersphere World-Universe Model (WUM), the World is a 3D Hypersphere of the 4D Nucleus of the World, which is a 4D ball expanding in the fourth spatial dimension. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World. The World is Finite and has a **Spatial Measure** – Radius of the curvature in the fourth spatial dimension R and volume $V = 2\pi^2 R^3$. Any cosmological model of the infinite Universe has no Spatial Measure and should come up with it.

WUM introduces a Cosmological Time that is principally different from Solar Time. Cosmological Time is a **Timing Measure** that defines the Age of the World. WUM makes a conclusion that any theory of evolution of the Universe, including the Big Bang Model, should be consistent with the Cosmological Time.

WUM states a 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 of the World, respectively. Gravitation, Space and Time are all emergent phenomena. In this regard, it is worth recalling Albert Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

Keywords

"Hypersphere World-Universe Model"; "Spatial Measure"; "Timing Measure"; "Cosmological Time"; "Solar Time"; "Medium of the World"; "Macroobjects"; "Supremacy of Matter"; "The World"; "Gravitomagnetic parameter"; "Impedance"; "Energy Density"; "Gravitational Constant"; "Hubble's Parameter"; "Temperature of Microwave Background Radiation"; "Inter-Connectivity of Primary Cosmological Parameters"; "Variable Speed of Time".

1. Introduction

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?*" [1]:

- *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*" [2]. 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).

In our view, it is a major problem for SC that connected with the principal difference between Cosmological Time in WUM and Solar Time in SC.

Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases [3]-[21].

2. The World

2.1. Beginning, Expansion, Creation of Matter, Content

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, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a, where $a = 2\pi a_0$, a_0 being the classical electron radius [3], [4], [14]. The 3D World is a Hypersphere that is the surface of a 4-ball Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World [17], [18], [19], [21].

The 4-ball is expanding in the Eternal Universe, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for the Cosmological Time τ from the Beginning and equals to $R = c\tau$. The expansion of the Hypersphere World can be understood through the analogy with an expanding 3D balloon: imagine an ant residing on a seemingly two-dimensional surface of a balloon. As the balloon is blown up, its radius increases, and its surface grows. The distance between any two points on the surface increases. The ant sees her world expand but does not observe a preferred center [17].

According to WUM, the World is 3D space filled out with the Medium and Macroobjects. We don't know that our 3D space is curved. We know that it is expanding without center of expansion. By the analogy with the expanding 3D balloon, we introduced the radius of the curvature in the fourth spatial dimension $R = a \times Q$ to give an explanation providing insight into the curved nature of the World.

According to WUM, the surface of the 4-ball is created in a process analogous to sublimation. Continuous creation of matter is the result of such 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 [9]. Matter arises from the fourth spatial dimension. The Universe is responsible for the creation of Matter. Dark Matter Particles carry new Matter into the World. Luminous Matter is a byproduct of Dark Matter Particles annihilation. Consequently, the matter-antimatter asymmetry problem discussed in literature does not arise (since antimatter does not get created by Dark Matter Particles annihilation) [6], [7], [10].

The principal idea of WUM is that the energy density of the World ρ_W equals to the critical energy density ρ_{cr} necessary for 3-Manifold at any cosmological time. A 3-Manifold is a space that locally looks like Euclidean 3-dimensional space: just as a sphere looks like a plane to small enough observers. In WUM the World is a Hypersphere that is an example of a 3-Manifold [9].

The World consists of the Medium and Macroobjects (Superclusters, Galaxies, Extrasolar systems, planets, moons, etc.). Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium ρ_M is $2/3$ of the total energy density ρ_W and Macroobjects —$1/3$ in all cosmological times [9], [12], [15], [16].

2.2. The Medium of the World

WUM introduces the Medium of the World, which consists of stable elementary particles: protons, electrons, photons, neutrinos, and Dark Matter Particles. The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation. Cosmic MBR is part of the Medium; it then follows that the Medium is an absolute frame of reference. Relative to the MBR rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 km/s respectively [9].

WUM is based on Maxwell's equations for the Electromagnetism and Gravitoelectromagnetism, which contain [13]:

- a single constant: the electrodynamic and gravitodynamic constant c ;
- two parameters of the Medium: the magnetic constant (or vacuum permeability) μ_0 and the gravitomagnetic parameter μ_g ; impedance of free space (or wave resistance of free space) Z_0 that is a physical constant relating the magnitudes of the electric and magnetic fields of electromagnetic radiation travelling through free space. That is, $Z_0 = \frac{|\mathbf{E}|}{|\mathbf{H}|} = \mu_0 c$, where $|\mathbf{E}|$ is the electric field strength and $|\mathbf{H}|$ the magnetic field strength. By analogy with the Electromagnetism, we introduced an impedance of the Medium $Z_g = \mu_g c$;
- two measurable characteristics: an energy density and energy flux density.

In frames of WUM, a gravitational parameter G can be calculated based on the value of the energy density of the Medium of the World ρ_M [5]:

$$G = \frac{\rho_M}{4\pi} \times P^2$$

where a dimension-transposing parameter P equals to:

$$P = a^3 c^2 / 2hc$$

Then the Newton's law of universal gravitation can be rewritten in the following way:

$$F = G\frac{m \times M}{r^2} = \frac{\rho_M}{4\pi}\frac{\frac{a^3}{2L_{Cm}} \times \frac{a^3}{2L_{CM}}}{r^2}$$

where we introduced the measurable parameter of the Medium ρ_M instead of the phenomenological coefficient G; and gravitomagnetic charges $m \times P = \frac{a^3}{2L_{Cm}}$ and $M \times P = \frac{a^3}{2L_{CM}}$ instead of macroobject masses m and M (L_{Cm} and L_{CM} are Compton length of mass m and M respectively). The gravitomagnetic charges have a dimension of "Area", which is equivalent to "Energy", with the constant that equals to the basic unit of surface energy density $\sigma_0 = \frac{hc}{a^3}$ [3], [9].

Following this approach, we can find the gravitomagnetic parameter of the Medium μ_g :

$$\mu_g = \frac{4\pi G}{c^2} = \frac{1}{R} \times P$$

and the impedance of the Medium Z_g :

$$Z_g = \mu_g c = H \times P$$

where H is a Hubble's parameter. We apply the following transformation to Maxwell's equations for the Gravitoelectromagnetism: multiply mass by the parameter P and divide the impedance and gravitomagnetic parameter of the Medium by the same parameter P. As a result of this transformation:

- All parameters of the gravitoelectromagnetic field have dimensions of "Length" and "Time"; "Mass" dimension has disappeared;
- All physical parameters of the World measured in terms of the basic unit of size a and the basic unit of time $t_0 = \frac{a}{c}$ become scalars;
- Absolute Size and Age of the World equal to a dimensionless time-varying quantity $Q = \frac{R}{a} = \frac{\tau}{t_0}$;
- The gravitoelectromagnetic charge has a dimension of "Area";
- The impedance of the Medium Z_M equals to the Hubble's parameter $Z_M = H$.

It follows that measuring the value of Hubble's parameter **anywhere** in the World and taking its inverse value allows us to calculate the absolute Age of the World. The Hubble's parameter is then the most important characteristic of the World, as it defines the Worlds' Age. While in our Model Hubble's parameter H has a clear physical meaning, the gravitational parameter $G = \frac{a^3c^3}{8\pi hc}H$ is a phenomenological coefficient in Newton's law of universal gravitation (h is Planck constant).

The second important characteristic of the Medium of the World is the gravitomagnetic parameter $\mu_M = R^{-1}$. Taking its inverse value, we can find the absolute Size of the World. We emphasize that the above two parameters (Z_M and μ_M) are principally different physical characteristics of the Medium that are connected through the gravitoelectrodynamic constant c.

It means that "Time" is not a physical dimension and is an absolutely different entity than "Space". Time is a factor of the World. It means that Time is the parameter of the Medium, which equals to: $\tau = H^{-1}$ [5].

In WUM, Time, Space and Gravitation are closely connected with the Mediums' parameters. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. Gravitation, Space and Time are all emergent phenomena [8]. In this regard, it is worth recalling Albert Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

2.3. 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), which depend on dimensionless time-varying quantity Q that increases with cosmological time τ, and is, in fact, a measure of the Size and the Age of the World.

The Model develops a mathematical framework that allows for direct calculation of the following PCPs through Q [3], [11]:

- Age of the World: $A_\tau \sim Q \sim \tau$;
- The Worlds' radius of curvature in the fourth spatial dimension: $R \sim Q \sim \tau$;
- Newtonian parameter of gravitation: $G \sim Q^{-1} \sim \tau^{-1}$;
- Hubble's parameter: $H \sim Q^{-1} \sim \tau^{-1}$;
- Critical energy density: $\rho_{cr} = 3\rho_{cr0} \times Q^{-1} \sim \tau^{-1}$ ($\rho_{cr0} = \frac{hc}{a^4}$):
- Concentration of Intergalactic Plasma: $n_{IGP} \sim Q^{-1} \sim \tau^{-1}$;
- Minimum Energy of Photons: $E_{ph} \sim Q^{-1/2} \sim \tau^{-1/2}$;
- Temperature of the Far-Infrared Background Radiation peak: $T_{FIRB} \sim Q^{-1/4} \sim \tau^{-1/4}$;
- Temperature of the Microwave Background Radiation: $T_{MBR} = T_{MBR0} \times Q^{-1/4} \sim \tau^{-1/4}$.

In frames of WUM, we calculate the values of these PCPs, which are in good agreement with the latest results of their measurements [9], [17], [20].

At the Beginning of the World ($Q=1$), the extrapolated values of ρ_{cr0} and T_{MBR0} were:

$$\rho_{cr0} \cong 6.064 \times 10^{30} J\ m^{-3}$$

that is four orders of magnitude smaller than the nuclear density [3], and

$$T_{MBR0} \cong 2.5446 \times 10^{10}\ \mathrm{K}$$

which is considerably smaller than values commonly discussed in literature. Let's proceed to calculate the value of T_{MBR} and H at different Ages of the World A_τ .

The calculated value of T_{MBR} in present epoch is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [22].

Observe that practically all Macroobjects – galaxies, stars, planets, etc. – have arisen in a cold World when temperature of MBR was about $6\ K$. Our Solar system, for instance, was created when the temperature of MBR was about $3\ K$. Therefore, any Model describing creation of Macroobjects must hold true in cold World conditions.

Table 1. Values of Temperature of Microwave Background Radiation and Hubble's parameter at different Ages of the World.

Age of the World, A_τ	T_{MBR} , K	H, $km/s\ Mpc$
1 s	7.0538×10^4	
0.45 Byr (Luminous Epoch)	6.4775	2172
9.65 Byr (Birth of the Solar system)	3.0141	101.3
14.22 Byr (Present)	2.72518	68.7457

Calculating the value of Hubble's parameter in the present epoch H_0 based on the average value of the gravitational parameter G we find $H_0 = 68.7457\ km/s\ Mpc$, which is in good agreement with $H_0 = 69.32 \pm 0.8\ km/s\ Mpc$ obtained using WMAP data [23] 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* [24].

Note that the precision of H_0 value has increased by three orders of magnitude. Similar precision enhancement holds for other PCPs' values as well.

E. Siegel in the paper "*Surprise! The Hubble Constant Changes Over Time*" [25] said that

The expansion rate, and therefore the value of the Hubble constant, changes with time. The Hubble constant was higher in the distant past, when much of the light was emitted, but it's taken billions of years for that light to arrive at our eyes. If we went back to a time when the Universe was half its present age, the expansion rate was 80% greater than it is today. When the Universe was just 10% of its current age, the expansion rate was 17 times greater than its present value.

These values of the Hubble's parameter are in good agreement with the calculated values in frames of WUM (see **Table 1**).

Sir Roger Penrose has got Nobel Prize in Physics for "The discovery that black hole formation is a robust prediction of the general theory of relativity." At the same time, Prof. Genzel, R. and Ghez, A. have got their Nobel Prize for "The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy". According to the Nobel Prize, there are the astronomical observations of a **Supermassive Compact Object** and mathematical theory of **Black Hole formation** that is **a robust prediction.** There are no Black Holes!

The astronomical observation of a **Supermassive Compact Object** is a confirmation of one of the most important predictions of WUM: "*Macroobjects of the World have cores made up of the DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [3].

3. Cosmological Time and 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 can name our time 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 1/86,400 of a mean solar day. Since 1967, the second has been defined as exactly "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". 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 introduced a Cosmological Time and defined the Age of the World A_τ equals to $A_\tau = \tau$ and the Worlds' radius of curvature in the fourth spatial dimension $R = c\tau$. **Cosmological Time marches on at the constant pace** from the Beginning of the World up to the present Epoch and is, in fact, a **Timing Measure**. The absolute Age of the World equals to: $A_\tau = \tau = t_0 \times Q$ and measured in seconds due to $t_0 = a/c$ measured in seconds.

WUM revealed the Inter-Connectivity of PCPs and found them to be inversely proportional to different exponents of τ (see Section 2.3.). It means that at cosmological times close to the Beginning, PCPs changed considerably faster than in the present Epoch. For example, the temperature of Microwave Background Radiation dropped down from the extrapolated value of 2.5446×10^{10} K to the value of 6.4775 K during Dark Epoch (0.45 Byr) and to the value of 2.72518 K during Luminous Epoch (13.77 Byr).

R. M. L. Baker Jr. in the paper "*A Theory of Our Universe*" proposed a revolutionary "*idea of a variable speed of time that has never before been put into the context of cosmology and a theory of our*

Universe". According to Baker, "*the speed of time variation is much faster in the past than at the more recent time*" [26]. It is interesting that "*Notional graph of the change-of-speed-of-time variation with today's time dimension*" in [26] looks like a graph of a function $y = \frac{1}{x}$ (compare with the dependence of PCPs values $\sim \frac{1}{\tau}$ in WUM).

4. Conclusions

In our view, the outlined in the Introduction situation with the measurements of an expansion rate of the universe is the **crisis** for the "Big Bang" Cosmology based on Solar Time. This major problem for the "Big Bang" Cosmology can be explained by

- "Big Rollout" Cosmology based on a variable speed of the Solar Time [26];
- WUM based on Cosmological Time that marches on at the constant pace from the Beginning of the World up to the present Epoch and time-variable PCPs.

In our opinion, WUM gives the most probable way to solve the crisis with the measurements of the expansion rate of the World.

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 a new Physics proposed by Paul Dirac in 1937. The Model should be developed into the well-elaborated theory by all physical community.

Acknowledgements

I am a Doctor of Sciences in Physics. I belong to the school of physicists established by Alexander Prokhorov–Nobel Prize Laureate in Physics. I am Laser Physicist by education, having published over 150 papers in the field of "Interaction of Laser Radiation with Matter". I'm eternally grateful to Prof. A. M. Prokhorov and Prof. A. A. Manenkov, whose influence on my scientific life has been decisive.

18 years ago, I have developed an interest in Cosmology. I have been elaborating a model I dubbed the World-Universe Model, and published a series of papers in the Journal of High Energy Physics, Gravitation and Cosmology (JHEPGC). I am much obliged to Prof. C. Corda for publishing my manuscripts in JHEPGC.

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Hypersphere World-Universe Model. The World

Abstract

The main objective of this paper is to discuss the Evolution of a 3D Finite World (that is a Hypersphere of a 4D Nucleus of the World) from the Beginning up to the present Epoch in frames of World-Universe Model (WUM). WUM is the only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum. To be consistent with this Fundamental Law, WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter (DM) Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to Rotational Fission of Overspinning DM Superclusters' Cores and self-annihilation of Dark Matter Particles (DMPs). WUM envisions that DM is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Luminous Matter is a byproduct of DMPs self-annihilation. By analogy with 3D ball, which has two-dimensional sphere surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus. Luminous Matter is a byproduct of DMPs self-annihilation.

WUM solves a number of physical problems in contemporary Cosmology and Astrophysics through DMPs and their interactions: **Angular Momentum problem** in birth and subsequent evolution of Galaxies and Extrasolar systems – how do they obtain it; **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center; **Missing Baryon problem** related to the fact that the observed amount of baryonic matter did not match theoretical predictions. WUM reveals **Inter-Connectivity of Primary Cosmological Parameters** and calculates their values, which are in good agreement with the latest results of their measurements.

In 2013, WUM predicted the values of the following Cosmological parameters: gravitational, concentration of intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015 – 2018. *"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*".

Keywords

"Hypersphere World-Universe Model"; "Law of Conservation of Angular Momentum"; "Dark Epoch"; "Rotational Fission"; "Luminous Epoch"; "Dark Matter Particles"; "Macroobject Shell Model"; "Dark Matter Core"; "Medium of the World"; "Dark Matter Fermi Bubbles"; "Galactic Wind"; "Solar Wind"; "Gamma-Ray Bursts"; "Gravitational Bursts"; "Intergalactic Plasma"; "Cosmological Time"; "Solar Time"; "Macroobjects"; "Supremacy of Matter"; "Gravitomagnetic parameter"; "Impedance"; "Energy Density"; "Gravitational Parameter"; "Hubble's Parameter"; "Temperature of Microwave Background Radiation"; "Inter-Connectivity of Primary Cosmological Parameters"; "Dark Matter Reactor"

1. Introduction

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?*" [1]:

- *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*" [2]. 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).

Table 1, borrowed from Wikipedia [Hubble's law] summarizes the results of measurements of the Hubble's constant H_0 in 2019-2020 [3]. Observe 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. The average values of H_0 vary from 67.6 to 76.8 $km\ s^{-1}Mpc^{-1}$. This discrepancy is called the **Hubble tension** [4]. A. Mann gave a summary of the situation with the measurements of H_0 in "*One Number Shows Something Is Fundamentally Wrong with Our Conception of the Universe*" [5].

In 1937, Paul Dirac in the paper "*A new basis for cosmology*" said [6]:

Since general relativity explains so well local gravitational phenomena, we should expect it to have some applicability to the universe as a whole. We cannot, however, expect it to apply with respect to the metric provided by the atomic constants, since with this metric the " gravitational constant " is not constant but varies with the epoch. We have, in fact, the ratio of the gravitational force to the electric force between electron and proton varying in inverse proportion to the epoch, and since, with our atomic units of time, distance and mass, the electric force between electron and proton at a constant distance apart is constant, the gravitational force between them must be inversely proportional to the epoch. Thus, the ***gravitational constant will be inversely proportional to the epoch.***

In Summary, he concluded:

It is proposed that all the ***very large dimensionless numbers*** *which can be constructed from the important natural constants of cosmology and atomic theory are connected by simple mathematical relations involving coefficients of the order of magnitude unity. The main consequences of this assumption are investigated, and it is found that a* ***satisfactory theory of cosmology can be built up from it.***

In 1974, P. Dirac discussed the mechanisms of the additive and multiplicative **Creation of Matter** [7]. The developed 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.

Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases [8]-[28].

Table 1. Measurements of the Hubble constant H_0 .

Date Published	H_0 $km\ s^{-1}Mpc^{-1}$	Observer	Remarks/Methodology
2020-09	$67.6^{+4.3}_{-4.2}$	S. Mukherjee, *et al.*	Gravitational waves, assuming that the transient ZTF19abanrh found by the Zwicky Transient Facility is the optical counterpart to GW190521. Independent of distance ladders and the cosmic microwave background.
2020-02	$73.9^{+3.0}_{-3.0}$	Megamaser Cosmology Project	Geometric distance measurements to Megamaser-hosting galaxies. Independent of distance ladders and the cosmic microwave background.
2019-10	$74.2^{+2.7}_{-3.0}$	STRIDES	Modelling the mass distribution & time delay of the lensed quasar DES J0408-5354.
2019-09	$76.8^{+2.6}_{-2.6}$	SHARP H0LiCOW	Modelling three galactically lensed objects and their lenses using ground-based adaptive optics and the Hubble Space Telescope
2019-08	$70.3^{+1.36}_{-1.35}$	K. Dutta, *et al.*	This is obtained analyzing low-redshift cosmological data within ΛCDM model. The datasets used are Type-Ia Supernova, Baryon Acoustic Oscillations, Time-Delay measurements using Strong-Lensing, measurements using Cosmic Chronometers and growth measurements from large scale structure observations.
2019-08	$73.5^{+1.4}_{-1.4}$	M. J. Reid, D. W. Pesce, A. G. Riess	Measuring the distance to Messier 106 using its supermassive black hole, combined with measurements of eclipsing binaries in the Large Magellanic Cloud.
2019-07	$69.8^{+1.9}_{-1.9}$	Hubble Space Telescope	Distances to red giant stars are calculated using the tip of the red-giant branch (TRGB) distance indicator.
2019-07	$73.3^{+1.7}_{-1.7}$	H0LiCOW collaboration	Updated observations of multiply imaged quasars, now using six quasars, independent of the cosmic distance ladder and independent of the cosmic microwave background measurements.
2019-07	$70.3^{+5.3}_{-5.0}$	LIGO and Virgo detectors	Uses radio counterpart of GW170817, combined with earlier gravitational wave and electromagnetic data.
2019-03	$68.0^{+4.2}_{-4.1}$	Fermi-LAT	Gamma ray attenuation due to extragalactic light. Independent of the cosmic distance ladder and the cosmic microwave background.
2019-03	$74.03^{+1.42}_{-1.42}$	Hubble Space Telescope	Precision HST photometry of Cepheids in the Large Magellanic Cloud (LMC) reduce the uncertainty in the distance to the LMC from 2.5% to 1.3%. The revision increases the tension with CMB measurements to the 4.4σ level (P=99.999% for Gaussian errors), raising the discrepancy beyond a plausible level of chance. Continuation of a collaboration known as Supernovae, for the Equation of State of Dark Energy (SHoES).
2019-02	$67.78^{+0.91}_{-0.87}$	Joseph Ryan, *et al.*	Quasar angular size and baryon acoustic oscillations, assuming a flat LambdaCDM model. Alternative models result in different (generally lower) values for the Hubble constant.

2. Hypersphere World-Universe Model

We cannot solve problems by using the same kind of thinking we used when we created them.

Albert Einstein

WUM is proposed as an alternative to the prevailing Big Bang Model of SC. The main objective of WUM is to unify and simplify existing results in Classical Physics into a single coherent picture. In our view, there is a principal difference between Physics and Mathematics. I am convinced that Physics cannot exist without Mathematics, but Mathematics must not replace Physics. I absolutely agree with John von Neumann who said: "*The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct, which, with addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work".*

WUM is a classical model, and is 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. WUM introduces classical notions once the very first ensemble of particles has been created at the cosmological time $\cong 10^{-18}\ s$.

2.1. Beginning, Expansion, Creation of Matter, Content

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, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a [8], [9], [19]. The 3D Finite World is a Hypersphere that is the surface of the 4D Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World [22], [23], [24], [26].

In WUM, the basic unit of size a is calculated from the dimensionless Rydberg constant α [19]:

$$a = \frac{\alpha^3}{2R_\infty}$$

where R_∞ is the Rydberg constant. It is worth noting that the constant α was later named "Sommerfeld's constant," and subsequently "Fine-structure constant".

The 4D ball is expanding in the Eternal Universe, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for a Cosmological time τ from the Beginning and equals to $R = c\tau$. 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 [22].

The principal idea of WUM is that the energy density of the World ρ_W equals to the critical energy density ρ_{cr} necessary for 3-Manifold at any cosmological time. A 3-Manifold is a space that locally

looks like Euclidean 3-dimensional space: just as a sphere looks like a plane to small enough observers. In WUM, the World is a Hypersphere that is an example of the 3-Manifold [14].

According to WUM, the surface of the 4D Nucleus is created in a process **analogous to sublimation**. Continuous creation of matter is the result of such a 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 [14]. Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Luminous Matter is a byproduct of DMPs self-annihilation. Consequently, the matter-antimatter asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has two-dimensional sphere surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus. [11], [12], [15].

The proposed process is a 4D process responsible for the expansion, creation of Matter and arrow of time. It is a hypothesis of WUM. In our view, the arrow of the cosmological time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created.

The World consists of the Medium and Macroobjects (Superclusters, Galaxies, Extrasolar systems, planets, moons, etc.). Total energy density of the World equals to the critical energy density throughout the Worlds' evolution. The energy density of the Medium ρ_M is 2/3 of the total energy density and Macroobjects —1/3 in all cosmological times [14], [17], [20], [21].

2.2. The Medium of the World

WUM introduces the Medium of the World, which consists of stable elementary particles: protons, electrons, photons, neutrinos, and DMPs. The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation. Cosmic MBR is a part of the Medium; it then follows that the Medium is an absolute frame of reference. Relative to the MBR rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 km/s respectively [14].

WUM is based on Maxwell's equations for the Electromagnetism and Gravitoelectromagnetism, which contain [18]:

- a single constant: the electrodynamic and gravitodynamic constant c ;
- two parameters of the Medium: the magnetic constant (or vacuum permeability) μ_0 and the gravitomagnetic parameter μ_g ; impedance of free space (or wave resistance of free space) Z_0 that is a physical constant relating the magnitudes of the electric and magnetic fields of electromagnetic radiation travelling through free space. That is, $Z_0 = \frac{|\mathbf{E}|}{|\mathbf{H}|} = \mu_0 c$, where $|\mathbf{E}|$ is the electric field strength and $|\mathbf{H}|$ is the magnetic field strength. By analogy with the Electromagnetism, we introduced an impedance of the Medium $Z_g = \mu_g c$ in the Gravitoelectromagnetism.
- two measurable characteristics: an energy density and energy flux density.

Maxwell's equations were published by J. C. Maxwell in 1861 [29]. He calculated the velocity of electromagnetic waves from the value of the electrodynamic constant c measured by Weber and Kohlrausch in 1857 [30] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [31]. This observation made him suggest that **light is an electromagnetic phenomenon** [32].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** but **not the speed of light in vacuum.** By definition, the electrodynamic constant c is the ratio of the absolute electromagnetic unit of charge e to the absolute electrostatic unit of charge e/c, where e is the elementary charge. It is worth noting that the speed of light in vacuum, commonly denoted as c, is not related to the World in our Model, because there is no vacuum in it. Instead, there is the Medium of the World consisting of elementary particles.

In frames of WUM, a gravitational parameter G can be calculated based on the value of the energy density of the Medium of the World ρ_M [10], [13]:

$$G = \frac{\rho_M}{4\pi} \times P^2$$

where a dimension-transposing parameter P equals to:

$$P = a^3 c^2 / 2hc$$

Then the Newton's law of universal gravitation can be rewritten in the following way:

$$F = G\frac{m \times M}{r^2} = \frac{\rho_M}{4\pi}\frac{\frac{a^3}{2L_{Cm}} \times \frac{a^3}{2L_{CM}}}{r^2}$$

where we introduced the measurable parameter of the Medium ρ_M instead of the phenomenological coefficient G; and gravitomagnetic charges $m \times P = \frac{a^3}{2L_{Cm}}$ and $M \times P = \frac{a^3}{2L_{CM}}$ instead of macroobject masses m and M (L_{Cm} and L_{CM} are Compton length of mass m and M respectively). The gravitomagnetic charges have a dimension of "Area", which is equivalent to "Energy", with the constant that equals to the basic unit of surface energy density $\sigma_0 = \frac{hc}{a^3}$ [8], [14].

Following this approach, we can find the gravitomagnetic parameter of the Medium μ_g:

$$\mu_g = \frac{4\pi G}{c^2} = \frac{1}{R} \times P$$

and the impedance of the Medium Z_g:

$$Z_g = \mu_g c = H \times P$$

where H is the Hubble's parameter: $H = \frac{c}{R} = \frac{1}{\tau}$. We apply the following transformation to Maxwell's equations for the Gravitoelectromagnetism: multiply mass by the parameter P and divide the impedance and gravitomagnetic parameter of the Medium by the same parameter P. As a result of this transformation:

- All parameters of the gravitoelectromagnetic field have dimensions of "Length" and "Time"; "Mass" dimension has disappeared;

- All physical parameters of the World measured in terms of the basic unit of size a and the basic unit of time $t_0 = a/c$ become scalars;
- Absolute Size and Age of the World equal to a dimensionless time-varying quantity $Q = \frac{R}{a} = \frac{\tau}{t_0}$;
- The gravitoelectromagnetic charge has a dimension of "Area";
- The impedance of the Medium Z_M equals to the Hubble's parameter $Z_M = H$.

It follows that measuring the value of Hubble's parameter **anywhere** in the World and taking its inverse value allows us to calculate the absolute Age of the World. The Hubble's parameter is then the most important characteristic of the World, as it defines the Worlds' Age. While in our Model Hubble's parameter H has a clear physical meaning, the gravitational parameter $G = \frac{a^3c^3}{8\pi hc}H$ is a phenomenological coefficient in Newton's law of universal gravitation (h is Planck constant).

The second important characteristic of the Medium of the World is the gravitomagnetic parameter $\mu_M = R^{-1}$. Taking its inverse value, we can find the absolute Size of the World and the radius of the 4D Nucleus characterizing the curved nature of the World. We emphasize that the above two parameters (Z_M and μ_M) are principally different physical characteristics of the Medium that are connected through the gravitodynamic constant c.

It means that "Time" is not a physical dimension and is an absolutely different entity than "Space". Time is a factor of the World. It is the most important characteristic of the Medium of the World [10].

In WUM, Time, Space and Gravitation are closely connected with the Mediums' parameters. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. Gravitation, Space and Time are all emergent phenomena [8]. 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*".

2.3. 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), which depend on dimensionless time-varying quantity Q that increases with cosmological time τ, and is, in fact, a measure of the Size R and the Age of the World A_τ.

The Model develops a mathematical framework that allows for direct calculation of the following PCPs through Q [8], [16]:

- Age of the World: $A_\tau = \tau \sim Q$;
- The Radius of 4D Nucleus of the World: $R \sim Q \sim \tau$;
- Newtonian parameter of gravitation: $G \sim Q^{-1} \sim \tau^{-1}$;
- Hubble's parameter: $H = \tau^{-1} \sim Q^{-1}$;
- Critical energy density: $\rho_{cr} = 3\rho_{cr0} \times Q^{-1} \sim \tau^{-1}$ ($\rho_{cr0} = \frac{hc}{a^4}$):

- Concentration of Intergalactic Plasma: $n_{IGP} \sim Q^{-1} \sim \tau^{-1}$;
- Minimum Energy of Photons: $E_{ph} \sim Q^{-1/2} \sim \tau^{-1/2}$;
- Temperature of the Far-Infrared Background Radiation peak: $T_{FIRB} \sim Q^{-1/4} \sim \tau^{-1/4}$;
- Temperature of the Microwave Background Radiation: $T_{MBR} = T_{MBR0} \times Q^{-1/4} \sim \tau^{-1/4}$.

In frames of WUM, we calculate the values of these PCPs, which are in good agreement with the latest results of their measurements [11], [19], [22].

At the Beginning of the World ($Q=1$), the extrapolated value of ρ_{cr0} was:

$$\rho_{cr0} \cong 6.0640 \times 10^{30} J\, m^{-3}$$

that is four orders of magnitude smaller than the nuclear density, and

$$\rho_{cr}(10^{-18} s) \cong 3.5814 \times 10^{26} J\, m^{-3}$$

that is eight orders of magnitude smaller than the nuclear density [8]. The extrapolated value of T_{MBR0} was:

$$T_{MBR0} \cong 2.5446 \times 10^{10} \text{ K}$$

which is considerably smaller than values commonly discussed in literature. Let's proceed to calculate the values of T_{MBR} and H at different Ages of the World A_τ .

Table 2. Values of Temperature of MBR and Hubble's parameter at different Ages of the World.

Age of the World, A_τ	**T_{MBR} , K**	**$H, km\, s^{-1} Mpc^{-1}$**
$10^{-18} s$	2.2306×10^9	
0.45 Byr (Luminous Epoch)	6.4775	2172
9.65 Byr (Birth of the Solar system)	3.0141	101.3
14.22 Byr (Present)	2.72518	68.7457

The calculated value of T_{MBR} in present epoch is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [33].

Observe that practically all Macroobjects – galaxies, stars, planets, etc. – have arisen in a cold World when temperature of MBR was about $6\ K$. Our Solar system, for instance, was created when the temperature of MBR was about $3\ K$. Therefore, any Model describing creation of Macroobjects must hold true in cold World conditions.

Calculating the value of Hubble's parameter in the present epoch H_0 based on the average value of the gravitational parameter G we find $H_0 = 68.7457\ km\, s^{-1} Mpc^{-1}$, which is in good agreement with $H_0 = 69.32 \pm 0.8\ km\, s^{-1} Mpc^{-1}$ obtained using WMAP data [34] and with the newest value of

$$H_0 = 69.6 \pm 0.8\ (\pm 1.1\%\ stat) \pm 1.7\ (\pm 2.4\%\ sys)\ km\, s^{-1} Mpc^{-1}$$

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* [35]. Note that the precision of H_0 value has increased by three orders of magnitude. Similar precision enhancement holds for other PCPs' values as well.

E. Siegel in the paper "*Surprise! The Hubble Constant Changes Over Time*" [36] said that

The expansion rate, and therefore the value of the Hubble constant, changes with time. The Hubble constant was higher in the distant past, when much of the light was emitted, but it's taken billions of years for that light to arrive at our eyes. If we went back to a time when the Universe was half its present age, the expansion rate was 80% greater than it is today. When the Universe was just 10% of its current age, the expansion rate was 17 times greater than its present value.

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 a distance to it and corresponding cosmological time. We must not calculate average values of H depending on Methodology as it is done in **Table 1**.

3. Time

3.1. 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 will 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?

3.2. Atomic Time

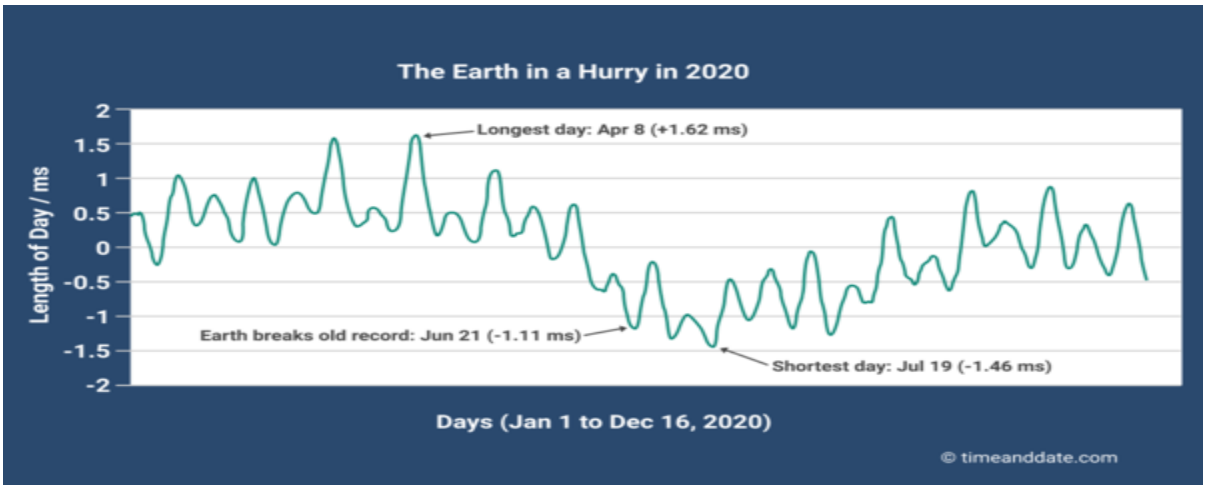
Since 1967, the "Second" has been defined as "*the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom*". Atomic Time is therefore also defined through Solar Time but with much better accuracy.

3.3. Variations of Earth's Rotational Speed

G. Jones and K. Bikos in the paper "Earth Is in a Hurry in 2020" wrote [37]:

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 [17]. 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** [38]. 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 self-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 [39]. The actual mean surface temperature of Earth is 288 K [40]. 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*** [41];
- **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** [42];
- In a study published in[43], 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 was not 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 [44].

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 [45]. According to WUM, the 660-km boundary is a boundary between DMR and Upper mantle with Crust, which were produced by DMR during 4.57 billion years [20].

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.

3.4. Cosmic Time

It is well known that **the time coordinate commonly used in the Big Bang Cosmology** is the so-called **cosmic time,** which is defined for a homogeneous, expanding universe so that the universe has the same density everywhere at each moment in time (the fact that this is possible means that the universe is, by definition, homogeneous).

The clocks measuring cosmic time should move along the Hubble flow. In other words, cosmic time is a measure of time by a physical clock with zero peculiar velocity in the absence of matter over-/under-densities (to prevent time dilation due to relativistic effects or confusions caused by expansion of the universe).

R. M. L. Baker Jr. in the paper "*A Theory of Our Universe*" proposed a revolutionary "*idea of a variable speed of time that has never before been put into the context of cosmology and a theory of our Universe*". According to Baker, "*the speed of time variation is much faster in the past than at the more recent time*" [46]. It is interesting that "*Notional graph of the change-of-speed-of-time variation with today's time dimension*" in [46] looks like a graph of a function $y = x^{-1}$ (compare with the dependence of Primary Cosmological Parameters values $\sim \tau^{-1}$ in WUM).

Assuming a linear decrease of a gravitational potential V in the universe, K. Trencevski *explained both the Hubble red shift and the anomalous acceleration from the spacecraft Pioneer 10 and 11. The change of the potential V causes an accelerated time which is easily seen by the Hubble red shift* [47].

3.5. Cosmological Time

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** [28]. 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 [28].

WUM revealed the Inter-Connectivity of PCPs and found them to be inversely proportional to different exponents of τ (see Section 2.3.). It means that at cosmological times close to the Beginning, PCPs changed considerably faster than in the present Epoch. For example, the temperature of MBR dropped down from the extrapolated value of 2.5446×10^{10} K to the value of 6.4775 K during Dark Epoch (0.45 Byr) and to the value of 2.72518 K during Luminous Epoch (13.77 Byr).

4. Evolution of the World

4.1. Angular Momentum Problem

Angular momentum problem is one of the most critical problems in any Cosmological model, including the SC, that must be solved. 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 it [23].

To be consistent with this Law a Model must answer the following questions:

- How did Galaxies and Extrasolar systems obtain their substantial orbital and rotational angular momenta;
- Why are all Macroobjects rotating;
- How did Milky Way (MW) galaxy give birth to different Extrasolar systems in different times;
- The age of MW is about equal to the Age of the World (13.77 billion years). What is the origin of MW huge angular momenta? We must discuss the Beginning of MW;
- The beginning of the Solar System (SS) was 4.57 billion years ago. What is the origin of SS angular momenta? We must discuss the Beginning of SS;
- Why is the orbital momentum of Jupiter much larger than the rotational momentum of the Sun? There is no possible means by which the angular momentum from the Sun could be transferred to the planets;
- In the theory of planetary formation, all planets, being made of the same ingredients, should have the same composition, yet they don't.

In our opinion, there is 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 the 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 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"[22].

4.2. Dark Epoch

Dark Epoch started at the Beginning of the World and lasted for about 0.45 billion years. The 3D World, which is a Hypersphere of 4D Nucleus, started by a fluctuation in the Eternal Universe. 4-Ball is expanding in the fourth spatial dimension with speed c. Density fluctuations could happen in the Medium of the World filled with DMPs and Ordinary particles arising as a byproduct of DMPs self-

annihilation. Heavy DMPs could collect into clumps with distances between particles smaller than the range of the weak interaction R_W introduced in WUM. In the present Epoch R_W equals to:

$$R_W = a \times Q^{1/4} = 1.65314 \times 10^{-4}\ m$$

that is much greater than the range of the weak nuclear force. Larger clumps will attract smaller clumps and DMPs and initiate a process of expanding the DM clumps followed by growth of surrounding shells made up of other DMPs, up to the maximum mass of the shells made up of DIONs at the end of Dark Epoch [22].

The process described above is the formation of a DM Supercluster Core. DMPs supply not only additional mass ($\propto \tau^{3/2}$) to Cores, but also additional angular momentum ($\propto \tau^2$) fueling the overspinning of DM Supercluster Cores (see Section 4.3).

4.3. Rotational Fission

MW is **gravitationally bound** with Local Supercluster (LS) [48]. In WUM, we calculated an orbital angular momentum of MW based on the distance of 65 million light-years from LS Core and orbital speed of about 400 km/s [48] and found that as the result of rotational fission of LS Core, approximately $\sim 10^6$ galaxies like MW could be generated at the same time. Considering that the density of galaxies in the LS falls off with the square of the distance from its center near the Virgo Cluster, and the location of MW on the outskirts of the LS [49], the actual number of created galaxies could be much larger [20].

The mass-to-light ratio of the LS is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [50]. These facts support the rotational fission mechanism proposed above. In 1933, F. Zwicky investigated the velocity dispersion of the Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: "*if this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter*" [51].

Dark Matter (DM) is among the most important open problems in both cosmology and particle physics. Dark Matter Particles (DMPs) might be observed in Centers of Macroobjects has drawn many new researchers to the field in the last forty years [22]. Important cosmological problems like Dark Matter and Dark Energy could be, in principle, solved through extended gravity. This is stressed, for example, in the famous paper of Prof. C. Corda [52].

As the result of rotational fission of MW Core 13.77 billion years ago, approximately $\sim 10^4$ Extrasolar systems like the Solar system could be created at the same time. Considering that MW has grown inside out (in the present Epoch, most old stars are found near the center of the Milky Way, while the ones formed more recently are on the outskirts [52]), the number of generated Extrasolar systems could be much larger. Extrasolar system DM Cores can give birth to planetary cores, which in turn can generate cores of moons by the same Rotational Fission mechanism [22].

The oldest known star HD 140283 (Methuselah star) is a subgiant star about 190 light years away from Earth for which a reliable age has been determined [53]. H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8\ Byr$ that does not conflict with the Age of the Universe, $13.77 \pm 0.06\ Byr$, based on the microwave background radiation and Hubble constant [34]. It means that this star must have formed

between 13.66 and 13.83 Byr, an amount of time that is too short for formation of the second generation of stars according to prevailing theories. In our Model, this discovery can be explained by generation of HD 140283 by overspinning Core of MW 13.77 billion years ago.

In frames of the developed Rotational Fission model, it is easy to explain hyper-runaway stars unbound from the Milky Way with speeds of up to $\sim 700\, km/s$ [54]: they were launched by overspinning Core of the Large Magellanic Cloud with the speed higher than the escape velocity [22].

4.4. Luminous Epoch

Luminous Epoch spans from 0.45 billion years up to the present Epoch (during 13.77 billion years). According to WUM, Cores of all Macroobjects (MOs) of the World (Superclusters, Galaxies, Extrasolar systems) possess the following properties [17]:

- Their Nuclei are made up of DM Fermions and contain other particles, including DM and baryonic matter, in shells surrounding the Nuclei;
- DMPs are continuously absorbed by Cores of all MOs. Luminous Matter (about 7.2% of the total Matter in the World) is a byproduct of DMPs self-annihilation. Luminous Matter is re-emitted by Cores of MOs continuously, which are, in fact, Dark Matter Reactors;
- Nuclei and shells are growing in time: size $\propto \tau^{1/2}$; mass $\propto \tau^{3/2}$; and rotational angular momentum $\propto \tau^2$, until they reach the critical point of their stability, at which they detonate. Satellite cores and their orbital L_{orb} and rotational L_{rot} angular momenta released during detonation are produced by Overspinning Core (OC). The detonation process does not destroy OC; it's rather gravitational hyper-flares;
- Size, mass, composition, L_{orb} and L_{rot} of satellite cores depend on local density fluctuations at the edge of OC and cohesion of the outer shell. Consequently, the diversity of satellite DM cores has a clear explanation.

WUM refers to the OC detonation process as Gravitational Burst (GB), analogous to Gamma Ray Burst [15]. In frames of WUM, the repeating GBs can be explained the following way:

- As the result of GB, the OC loses a small fraction of its mass and a large part of its rotational angular momentum;
- After GB, the Core absorbs new DMPs. Its mass increases $\propto \tau^{3/2}$, and its angular momentum L_{rot} increases much faster $\propto \tau^2$, until it detonates again at the next critical point of its stability;
- Afterglow of GBs is a result of processes developing in the Nuclei and shells after detonation;
- In case of Extrasolar systems, a star wind is the afterglow of star detonation: star Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 billion years ago. It creates the bubble of the Heliosphere continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic Core detonations. In the Milky Way, it continuously creates two Dark Matter Fermi Bubbles [22].

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass of about 2.3 solar mass that is located at a distance of $\sim$ 9 kpc from the Sun. When integrated backwards in time, the orbit of the star points unambiguously to the Galactic Centre, implying that S5-HVS1 was kicked away from Sgr A* with a velocity of $\sim$ 1800 km/s , and travelled

for 4.8 Myr to its current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [55]. In frames of the developed Model, this discovery can be explained by Gravitational Burst of the overspinning Core of the Milky Way 4.8 million years ago, which gave birth to S5-HVS1 with the speed higher than the escape velocity of the Core.

C. J. Clarke, *et al.* observed CI Tau, a young 2 million years old star. CI Tau is located about 500 light years away in a highly-productive stellar "nursery" region of the galaxy. They discovered that the Extrasolar system contains four gas giant planets that are only 2 million years old [56], an amount of time that is too short for formation of gas giants according to the prevailing theories. In frames of the developed Rotational Fission model, this discovery can be explained by GB of the MW OC two million years ago, which gave birth to the CI Tau system with all the planets generated at the same time [26].

To summarize:

- The rotational fission of Macroobjects DM Cores is the most probable process that can generate satellite cores with large orbital and rotational momenta in a very short time;
- 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 Macroobjects' Cores.

5. Evidence of the Hypersphere World

The physical laws we observe appear to be independent of the Worlds' curvature in the fourth spatial dimension of the Nucleus due to the very small value of the dimension-transposing gravitomagnetic parameter of the Medium [10]. 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 a direct measurement of truly large-scale parameters of the World: Gravitational, Hubble's, Temperature of MBR. 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 [14].

Let us consider an effect that has indeed been observed for billions of years, albeit indirectly [14]. 4.57 billion years ago the Sun's output was only 70 percent as intense as it is today [56]. 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 $R_{MO} \propto \tau^{1/2}$ and $L_{MO} \propto \tau$ 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 today [11].

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 curved nature of the World 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 of the Nucleus of the World [14].

6. World-Universe Model Predictions

In 2013, WUM proposed a principally different way to solve the problem of Newtonian Constant of Gravitation measurement precision. WUM revealed a self-consistent set of time-varying values of PCPs of the World: Gravitation parameter, Hubble's parameter, Age of the World, Fermi coupling parameter, Temperature of MBR, and the concentration of Intergalactic plasma. Based on the inter-connectivity of these parameters, WUM solved the Missing Baryon problem and predicted the values of the following Cosmological parameters: gravitation G, concentration of Intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015 – 2018. Between 2013 and 2018, the relative standard uncertainty of G measurements decreased x6. It seems that CODATA considered the WUM recommendation of the predicted value of G and used it for G(2014) and G(2018) without any reference or explanation of their methodology [25].

K. Mehrgan, *et al.* observed a supergiant elliptical galaxy Holmberg 15A about 700 million light-years from Earth. They found an extreme core with a mass of 4×10^{10} solar mass at the center of Holm 15A [57].

WUM: The calculated maximum mass of galaxy DM Core of 6×10^{10} solar mass [28] is in good agreement with the experimentally found value [57].

B. Carr, F. Kühnel, and L. Visinelli *consider the observational constraints on stupendously large black holes (SLABs) in the mass range* $M > 10^{11} M_{\odot}$ *. These have attracted little attention hitherto, and we are aware of no published constraints on a SLAB population in the range (*$10^{12} - 10^{18}) M_{\odot}$ *. However, there is already evidence for black holes of up to nearly* $10^{11} M_{\odot}$ *in galactic nuclei* [57], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes* [58].

WUM: The calculated maximum mass of supercluster DM Core of 2×10^{19} solar mass [28] is in good agreement with the discussed values [78]. In a future, these stupendously large compact objects can give rise new luminous superclusters as the result of their DM Cores' rotational fission.

R. Genzel and A. Ghez were awarded the 2020 Nobel Prize in Physics "For the Discovery of a Supermassive Compact Object at the Centre of Our Galaxy" [59].

WUM: The results obtained by K. Mehrgan, *et al.* [57], B. Carr, F. Kühnel, and L. Visinelli [58], and R. Genzel and A. Ghez [59] confirm 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*" [8].

7. Conclusions

In our view, the situation with the measurements of an expansion rate of the universe outlined in the Introduction can be explained by

- WUM based on Cosmological Time that marches on at the constant pace from the Beginning of the World up to the present Epoch along with time-varying PCPs;
- "Big Rollout" Cosmology based on a variable speed of Cosmic Time along with constant PCPs [46].

In our opinion, WUM gives the most probable way to explain the situation with the measurements of the expansion rate of the World.

The Essence of WUM is:

- The Finite World is a 3D Hypersphere of the 4D Nucleus of the World, which is 4D ball expanding in the fourth spatial dimension. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World;
- DM is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new Matter into the World. Luminous Matter is a byproduct of DMPs self-annihilation. Dark Matter plays a central role in creation and evolution of all Macroobjects;
- The Medium of the World, consisting of protons, electrons, photons, neutrinos, and DMPs, is an active agent in all physical phenomena in the World. Time, Space and Gravitation are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium respectively. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. Gravitation, Space and Time are all emergent phenomena;
- WUM is the only cosmological model in existence that is consistent with the Fundamental Law of Conservation of Angular Momentum;
- WUM is based on two parameters only: dimensionless Rydberg constant α and time-varying Quantity Q that is, in fact, a measure of the Worlds' curvature in the fourth spatial dimension of the Nucleus and the Age of the World. In our opinion, constant α and quantity Q should be named "Universe Constant" and "World Parameter" respectively.

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 a 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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New Cosmology – Third Revolution in Physics

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, and Dirac and develop them in frames of WUM. Please pay tribute to these great physicists!

The presented Hypotheses are not new, and we do not 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 a New Cosmology. Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases.

Cosmology is a branch of Classical Physics. It should then be described by classical notions, which define emergent phenomena. 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].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** but **not the speed of light in vacuum.** By definition, the electrodynamic constant c is the ratio of the absolute electromagnetic unit of charge e to the absolute electrostatic unit of charge e/c, where e is the elementary charge. It is worth noting that the speed of light in vacuum, commonly denoted as c, is not related to the World in our Model, because there is no Vacuum in it. Instead, there is the Medium of the World consisting of elementary particles.

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 measured 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 constants in WUM** as follows [1]:

- Basic unit of size a :

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

- Dimensionless Rydberg constant α :

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

where μ_0 is a 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 a 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 the article in Nature, titled "Is there an Aether?" that "*we are rather forced to have an aether"* [11].

There are no Luminiferous Aether and Vacuum in **WUM**. The Model 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 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 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to a. The Finite World is a 3D Hypersphere that is the surface of the 4D 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 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 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]. In case of strong gravitational fields, we should use the Einstein's field equations for General Relativity.

3.5. Dirac Large Number Hypothesis

In 1937, Paul Dirac in the paper "*A new basis for cosmology*" said [19]:

"Since general relativity explains so well local gravitational phenomena, we should expect it to have some applicability to the universe as a whole. We cannot, however, expect it to apply with respect to the metric provided by the atomic constants, since with this metric the "gravitational constant" is not constant but varies with the epoch. We have, in fact, the ratio of the gravitational force to the electric force between electron and proton varying in inverse proportion to the epoch, and since, with our atomic units of time, distance and mass, the electric force between electron and proton at a constant distance apart is constant, the gravitational force between them must be inversely proportional to the epoch. Thus, the ***gravitational constant will be inversely proportional to the epoch****".*
In Summary, he concluded:
"It is proposed that all the ***very large dimensionless numbers*** *which can be constructed from the important natural constants of cosmology and atomic theory* ***are connected by simple mathematical relations*** *involving coefficients of the order of magnitude unity. The main consequences of this assumption are investigated, and it is found that a* ***satisfactory theory of cosmology can be built up from it****".*

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]:

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

WUM holds that there indeed exist **simple mathematical relations** between all Primary Cosmological Parameters (PCPs) that depend on Q (see Section 4.1.):

- 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}.

These PCPs belong to the Medium of the World. There are no Aether and Vacuum in WUM.

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" [20].

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

WUM: The 3D World, which is a Hypersphere of 4D Nucleus, was started by a fluctuation in the Eternal Universe. 4D Nucleus is expanding in the fourth spatial dimension, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing 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 a basic unit of energy: $E_0 = hc/a$.

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.

Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a matter-antimatter asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has two-dimensional sphere surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus.

The proposed process is a 4D process responsible for the expansion, creation of Matter and arrow of Time. It is a Hypothesis of WUM. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created.

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.

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 (0.2 eV).

WUM postulates that rest energies of DMFs and bosons are proportional to the basic unit of energy E_0 multiplied by different exponents of α and can be expressed with the following formulae:

DMF1 (fermion): $E_{DMF1} = \alpha^{-2}E_0 = 1.3149950\ TeV$

DMF2 (fermion): $E_{DMF2} = \alpha^{-1}E_0 = 9.5959823\ GeV$

DIRAC (boson): $E_{DIRAC} = \alpha^0 E_0 = 70.025267\ MeV$

ELOP (boson): $E_{ELOP} = 2/3\alpha^1 E_0 = 340.66606\ keV$

DMF3 (fermion): $E_{DMF3} = \alpha^2 E_0 = 3.7289402\ keV$

DMF4 (fermion): $E_{DMF4} = \alpha^4 E_0 = 0.19857111\ eV$

It is worth noting that the rest energy of electron E_e equals to: $E_e = \alpha E_0$ and the Rydberg unit of energy is: $Ry = hcR_\infty = 0.5\alpha^3 E_0 = 13.605693\ eV$.

We still do not 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 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 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 cannot 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 supermassive dark objects observed in galaxies and galaxy clusters are widely discussed in literature [23]-[29]. The prospect that DMPs might be observed in Centers of Macroobjects 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].

Observational data like dynamics of galaxies and star formation disfavor exotic cold and warm DM proposed in the Standard Cosmology. In his famous paper [38], Prof. P. Kroupa stated that "*all observational quantities that are derived at present, such as star-formation rate densities, distances and ages from redshifts, and galaxy masses, are likely to require possibly major revision*".

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 [39].

Table 1 describes the parameters of **Macroobjects Cores** (which are Fermionic Compact Stars in WUM) in the present Epoch made up of different DM fermions: self-annihilating DMF1, DMF2, DMF3 and fermion DMF4.

The calculated parameters of the shells show that [39]:

- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in extrasolar systems;
- Shells of DMF3 around Nuclei made up of DMF1 and/or DMF2 make up Cores of galaxies;

- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of superclusters.

Table 1. Parameters of Macroobjects Cores made up of different DMFs.

Fermion	Fermion Mass m_f, MeV	Macroobject Core Mass M_{max}, kg	Macroobject Core Radius R_{min}, m	Macroobject Core Density $\rho_{max}, kg/m^3$
DMF1	1.3×10^6	1.9×10^{30}	8.6×10^3	7.2×10^{17}
DMF2	9.6×10^3	1.9×10^{30}	8.6×10^3	7.2×10^{17}
DMF3	3.7×10^{-3}	1.2×10^{41}	5.4×10^{14}	1.8×10^{-4}
DMF4	2×10^{-7}	4.2×10^{49}	1.9×10^{23}	1.5×10^{-21}

Macroobjects' Cores have the following properties:

- The minimum radius of Core R_{min} made up of any fermion equals to three Schwarzschild radii;
- Core density does not depend on M_{max} and R_{min} and does not change in time while $M_{max} \propto \tau^{3/2}$ and $R_{min} \propto \tau^{1/2}$;
- DM cores of superclusters and galaxies are responsible for the gravitational lensing effect.

In WUM, the calculated maximum stellar mass is: $M_S \cong 174\ M_\odot$ [40] . It is in good agreement with the mass of one of the most massive known stars **R136a1**: $M_S = 215^{+45}_{-31}\ M_\odot$ [41].

K. Mehrgan, *et al.* observed a supergiant elliptical galaxy **Holmberg 15A**. It has been alleged that the primary component of the galactic core is a supermassive black hole with a mass of $4 \times 10^{10} M_\odot$ [42].

TON 618 is a very distant and extremely luminous quasar. It possesses one of the most massive black holes ever found, with a mass of $6.6 \times 10^{10}\ M_\odot$ at the center of TON 618 [43].

How supermassive black holes initially formed is one of the biggest problems in the study of galaxy evolution today. Supermassive black holes have been observed as early as 800 million years after the Big Bang, and how they could grow so quickly remains unexplained.

C. R. Argüelles, *et al.* propose a novel mechanism for the creation of supermassive black holes from dark matter without requiring prior star formation or needing to invoke seed black holes with unrealistic accretion rates. The authors investigate the potential existence of stable galactic cores made of fermionic dark matter, and surrounded by a diluted dark matter halo, finding that the centers of these structures could become so concentrated that they could also collapse into supermassive black holes once a critical threshold is reached. They analyzed this mechanism with DM haloes mass up to $5.9 \times 10^{10}\ M_\odot$ [44].

According to **WUM**, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with shell of DMF3 with the calculated maximum mass of $6 \times 10^{10}\ M_\odot$ (see **Table 1**). This value is in good agreement with the experimentally found values in [42], [43] and with the analyzed values in [44].

Laniakea Supercluster (LS) is a galaxy supercluster that is home to the Milky Way and approximately 100,000 other nearby galaxies. It is known as the largest supercluster with estimated binding mass $10^{17}\ M_\odot$ [45]. The mass-to-light ratio of the LS is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [46]. In 1933, Fritz Zwicky investigated the velocity dispersion of Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: "*if this would be confirmed, we would get the surprising result that dark matter is present*

in much greater amount than luminous matter" [47]. These ratios are one of the main arguments in favor of presence of large amounts of Dark Matter in the World.

In frames of **WUM**, Laniakea Supercluster emerged 13.77 billion years ago due to Rotational Fission of Overspinning DM Supercluster Core and self-annihilation of DMPs. The Core was created during Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter Macroobjects existed [39].

B. Carr, F. Kühnel, and L. Visinelli "*consider the observational constraints on stupendously large black holes (SLABs) in the mass range* $M > 10^{11} M_{\odot}$ *. These have attracted little attention hitherto, and we are aware of no published constraints on a SLAB population in the range (*$10^{12} - 10^{18}) M_{\odot}$ *. However, there is already evidence for black holes of up to nearly* $10^{11} M_{\odot}$ *in galactic nuclei* [42], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes"* [48].

According to **WUM**, the calculated maximum mass of supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the estimated value in [45] and discussed values in [48].

4. Hypothesis of Hypersphere World-Universe Model

Imagination is more important than knowledge. Knowledge is limited.
Imagination encircles the world.
Albert Einstein

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 $2.72548 \pm 0.00057\,K$ [49].
- 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 [50] 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"* [51].

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 [52]. 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.**

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 [52].

4.2. Angular Momentum Problem

Angular Momentum Problem is one of the most critical problem in Standard Cosmology (SC) that must be solved. SC does not explain how Galaxies and Extra Solar systems obtained their enormous orbital 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) 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" [53]. To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter (DM) Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Overspinning DM Superclusters' Cores and self-annihilation of Dark Matter Particles (DMPs).
- 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. The experimental observations of galaxies in the universe showed that most of them are **disk galaxies**: about 60% are ellipticals and about 20% are spirals [54]. These results speak in favor of the developed Rotational Fission mechanism;

- Dark Matter Core of Milky Way galaxy was born 13.77 billion years ago as the result of the Rotational Fission of the Laniakea 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.

4.3. 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 [55]. 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 [56]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

WUM explains FBs the following way [39]:

- 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 [57]. 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 [58]) 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 [59]. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre 'chimneys' [60]) 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 [55] and 32.6 kly [60]. **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 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 [61] 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 [39];
- 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, **Fermi Bubbles are DMPs' clouds containing uniformly distributed Dark Matter Objects,** in which DMPs self-annihilate and radiate X-rays and gamma rays. Dark Matter Fermi Bubbles constitute a principal proof of WUM.

4.4. Dark Matter Reactors

The following facts support the existence of **Dark Matter Cores** in Macroobjects:

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [62];
- By analyzing the earthquake doublets, J. 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 [63];
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [64].

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 Solar wind is the result of this mechanism [39].

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 [65]. The researchers were surprised by just how rough that boundary is – rougher than the surface layer that we all live on. The roughness was not 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 [66].

According to **WUM**, the 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [53].

Gravitationally-Rounded Objects Internal Heat. The analysis of Sun's heat for planets in Solar system yields the effective temperature of **Earth** of 255 K [67]. The actual mean surface temperature of Earth is 288 K [68]. 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"* [69];

Jupiter radiates more heat than it receives from the Sun [70]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 degrees C [71]) have been difficult to explain, due to lack of a known heat source [12]. **Saturn** radiates 2.5 times more energy than it receives from the Sun [72]; **Uranus** – 1.1 times [73]; **Neptune** – 2.6 times [74]. Many Icy Solar system bodies including **Pluto** possess subsurface oceans [75].

According to **WUM**, the internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate through the entire objects' envelope, get absorbed into the cores, and continuously support DMF1 self-annihilation.

Plutonium-244 with half-life of 80 million years is not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Plutonium-244 present in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [76].

In frames of **WUM**, all chemical products of the Earth including isotopes K-40, U-238, Th-232, and Pu-244, are produced within the Earth as the result of DMF1 self-annihilation. They arrive in the Crust of the Earth due to convection currents in the mantle carrying heat and isotopes from the interior to the planet's surface [77].

Random Variations of Earth's Rotational Speed. G. Jones and K. Bikos in the paper "Earth Is in a Hurry in 2020" wrote [78]: "*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*".

In frames of **WUM**, Random variations of the Earth's rotational speed on a daily basis can be explained by variations in an activity of the Earth's Dark Matter Reactor (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.

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

Scientists from the Tibet ASγ experiment observed gamma rays with energies between 0.1 and 1 PeV, coming from the galactic disk regions. Specifically, they found 23 ultra-high-energy cosmic gamma rays with energies above 398 TeV along the Milky Way [79]. In frames of WUM, the gamma rays with energies between 1 TeV and 1 PeV can be explained by nuclear fission of DMSPs, consisting of many fused DMF1 (1.4 TeV), produced in the cores of Milky Way and stars.

4.5. Solar Corona. Geocorona. Planetary Coronas

Structure of Solar Atmosphere. According to the standard model, the visible surface of the Sun, the photosphere, is the layer below which the Sun becomes opaque to visible light [80]. Above the photosphere visible sunlight is free to propagate into space, and almost all of its energy escapes the Sun entirely. The sunlight has the spectrum of a black-body radiating at about 5,800 K.

Above the photosphere lies the chromosphere that is about 2,500 km thick, dominated by a spectrum of emission and absorption lines. The temperature of the chromosphere increases gradually with altitude, ranging up to $\sim 2 \times 10^4\ K$ near the top. The particle density decreases rapidly from 10^{22} to $10^{17} m^{-3}$ [81], [82].

Above the chromosphere, in a thin (about 200 km) transition region, the temperature rises rapidly to coronal temperatures closer to $10^6\ K$. The particle density decreases from 10^{17} up to $10^{16}-10^{15}\ m^{-3}$ in the low corona [81].

Solar Corona is an aura of plasma that surrounds the Sun and extends at least $8 \times 10^6\ km$ into outer space [83] (compare with the Sun's radius $7 \times 10^5\ km$). Spectroscopy measurements indicate strong ionization and **plasma temperature** in excess of $10^6\ K$ [84]. The corona emits radiation mainly in the X-rays, observable only from space. The plasma is transparent to its own radiation and to solar radiation passing through it, therefore we say that it is optically-thin. The gas, in fact, is very rarefied, and the photon mean free-path by far overcomes all other length-scales, including the typical sizes of the coronal features.

J. Schmelz made the following comment on the composition of Solar corona: "*Along with temperature and density, the elemental abundance is a basic parameter required by astronomers to understand and model any physical system. The abundances of the solar corona are known to differ from those of the solar photosphere"* [85].

Coronal Heating Problem in solar physics relates to the question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. The high temperatures require energy to be carried from the solar interior to the corona by non-thermal processes.

According to **WUM**, the origin of the Solar corona plasma is not the coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. The plasma is the result of a self-annihilation of DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV) particles. The Solar corona made up of DMPs resembles a honeycomb filled with plasma.

The following experimental results speak in favor of this model [39]:

- The corona emits radiation mainly in X-rays due to the annihilation of DMF3;
- The plasma is transparent to its own radiation and to the radiation coming from below;
- The elemental composition of the Solar corona and the Solar photosphere are known to differ;
- During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted [86] (one photon had an energy as high as 467.7 GeV [53]). In our view, it is the result of enormous density fluctuations of DMPs in the Solar corona and their self-annihilation;
- Assuming the particle density in the low corona $10^{15}\ m^{-3}$ and mass of DMF1: $m_{DMF1} = 2.3 \times 10^{-24}\ kg$ we can find mass density $\rho^{in}_{DMF1} = 2.3 \times 10^{-9}\ kg/m^3$ that is equal to the density of the fractal structure [53];
- A distance between DMF1 is about $10^{-5}\ m$ that is much smaller than the range of the introduced weak interaction of DMPs: $R_W = 1.65314 \times 10^{-4}\ m$ [39]. Weak Interaction between DMPs provides integrity of the Solar corona;
- At the same density of the fractal structure, a distance between DMF3 with mass $m_{DMF3} = 6.7 \times 10^{-33}\ kg$ is about $10^{-8}\ m$. The smallest distance between DMF3 explains the fact that corona emits radiation mainly in the X-rays;
- The Solar corona is a stable Shell around the Sun with an inner radius $R_{in} \cong 7 \times 10^8\ m$ and an outer radius $R_{out} \cong 3 \times 10^{12}\ m$. The total mass of the Corona is: $M_{SC} \cong 9 \times 10^{25}\ kg$ [53];
- Observable outer radius of the Solar corona $8 \times 10^6\ km$ [83] depends on the concentration of DMPs, the strength of their annihilation interaction, and a sensitivity of the measuring instrument.

Geocorona is a luminous part of an outermost region of the Earth's atmosphere that extends to at least 640,000 km from the Earth [87]. It is seen primarily via Far-Ultra- Violet (FUV) light from the

Sun that is scattered by neutral hydrogen [88]. The first high-quality and wide-field-of-view image of Earth's corona of 243,000 km was obtained by Hisaki, the first interplanetary microspacecraft. It acquires spectral images (52-148 nm) of the atmospheres of planets from Earth orbit and has provided quasi-continuous remote sensing observations of the geocorona since 2013 [89]. The most popular explanation of this geocoronal emission is the scattering of Solar FUV photons by exospheric hydrogen [90].

X-rays from Earth's Geocorona were first detected by Chandra X-ray Observatory in 1999 [91]. X-rays were observed in the range of energies $0.08 - 10\ keV$. The main mechanism explaining the geocoronal X-rays is that they are caused by collisions between neutral atoms in the geocorona with carbon, oxygen and nitrogen ions that are streaming away from the Sun in the solar wind [91], [92], [93]. This process is called "charge exchange" since an electron is exchanged between neutral atoms in geocorona and ions in the solar wind.

X-rays from Planets were also observed by Chandra [91]. According to NASA:

- The X-rays from Venus and, to some extent, the Earth, are due to the fluorescence of solar X-rays striking the atmosphere;
- Fluorescent X-rays from oxygen atoms in the Martian upper atmosphere are similar to those on Venus. A huge Martian dust storm was in progress when the Chandra observations were made. The intensity of the X-rays did not change during the dust storm;
- Jupiter has an environment capable of producing X-rays in a different manner because of its substantial magnetic field. X-rays are produced when high-energy particles from the Sun get trapped in its magnetic field and accelerated toward the polar regions where they collide with atoms in Jupiter's atmosphere;
- Like Jupiter, Saturn has a strong magnetic field, so it was expected that Saturn would also show a concentration of X-rays toward the poles. However, Chandra's observation revealed instead an increased X-ray brightness in the equatorial region. Furthermore, Saturn's X-ray spectrum was found to be similar to that of X-rays from the Sun.

In our opinion, the Planetary Coronas are similar to the Solar Corona [39]:

- At the distance of 640,000 km from the Earth [87], atoms and molecules are so far apart that they can travel hundreds of kilometers without colliding with one another. Thus, the exosphere no longer behaves like a gas, and the particles constantly escape into space. In our view, FUV radiation and X-rays are the consequence of DMF3 annihilation;
- All planets and some observed moons (Europa, Io, Io Plasma Torus, Titan) have X-rays in upper atmosphere of the planets, similar to the Solar Corona;
- The Geocorona is a stable Shell around the Earth with inner radius $R_{in} \cong 6.5 \times 10^3\ km$ and observed outer radius $R_{out} \cong 6.4 \times 10^5\ km$. The total mass of this Shell is: $M_{GC} \cong 4.1 \times 10^{18}\ kg$.

The Geocorona and Planetary Coronas possess features similar to those of the Solar Corona.

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 that is expanding along the fourth spatial dimension of the Nucleus with speed equals to the gravitodynamic constant c. The Universe serves as an unlimited source of DM, which continuously created in the Nucleus of 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 [94]. 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 the 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 [80]. 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 [95]:

The Beginning. The World was started by a fluctuation in the Eternal Universe, and the Nucleus of the World, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a. The World is a finite 3D Hypersphere that is the surface of the 4D 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 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. Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct 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 DMF4 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). Transition from Dark Epoch to Luminous Epoch is 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. Introduced **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 up 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, and 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 Macroobjects themselves as the result of DMPs self-annihilation.

5.4. Predictions

It does not 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

In 2013, WUM revealed a self-consistent set of time-varying values of Primary Cosmological Parameters of the World: Gravitation parameter, Hubble's parameter, Age of the World, Temperature of Microwave Background Radiation, and concentration of Intergalactic plasma. Based on the inter-connectivity of these parameters, WUM solved the Missing Baryon problem and predicted the values of the following Cosmological parameters: gravitation G , concentration of Intergalactic plasma, and the minimum energy of photons [40], which were experimentally confirmed in 2015 – 2018.

The results obtained by K. Mehrgan, *et al.* [42] and O. Shemmer, *et al.* [43]; discussed by C. R. Argüelles, *et al.* [44] and B. Carr, *et al.* [46]; and "*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*" (Nobel Prize in Physics 2020) made by R. Genzel and A. Ghez confirm 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*" [40].

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 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 a 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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Hypersphere World-Universe Model. Centre of Our Galaxy

Abstract

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.

In 2013, WUM predicted the values of the following Cosmological parameters: gravitational, concentration of intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015 – 2018. *"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*".

1. Introduction

In our view, we should make use of several 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, and Dirac and develop them in frames of WUM. Please pay tribute to these great physicists!

The presented Hypotheses are not new, and we do not 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 a New Cosmology.

Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases.

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].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** but **not the speed of light in vacuum.** By definition, the electrodynamic constant c is the ratio of the absolute electromagnetic unit of charge e to the absolute electrostatic unit of charge e/c, where e is the elementary charge. It is worth noting that the speed of light in vacuum, commonly denoted as c, is not related to the World in our Model, because there is no Vacuum in it. Instead, there is the Medium of the World consisting of elementary particles.

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 measured 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 constants in WUM** as follows [1]:

- Basic unit of size a :

$$a = 0.5\left[8(\mu_0 h/c)^3 R_\infty R_T^6\right]^{1/5} = 1.7705641 \times 10^{-14}\, m$$

- Dimensionless Rydberg constant α :

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

where μ_0 is a 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".
The calculated value of α^{-1} is:

$$\alpha^{-1} = 137.0359991$$

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 a basic unit of time: $t_0 = a/c$):

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

which in present epoch equals to: $Q = 0.759972 \times 10^{40}$.

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 the article in Nature, titled "Is there an Aether?" that "*we are rather forced to have an aether"* [11].

There are no Luminiferous Aether and Vacuum in **WUM**. The Model 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 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 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to a. The Finite World is a 3D Hypersphere that is the surface of the 4D 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 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 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]. In case of strong gravitational fields, we should use the Einstein's field equations for General Relativity.

3.5. Dirac Large Number Hypothesis

In 1937, Paul Dirac in the paper "*A new basis for cosmology*" said [19]:

"Since general relativity explains so well local gravitational phenomena, we should expect it to have some applicability to the universe as a whole. We cannot, however, expect it to apply with respect to the metric provided by the atomic constants, since with this metric the "gravitational constant" is not constant but varies with the epoch. We have, in fact, the ratio of the gravitational force to the electric force between electron and proton varying in inverse proportion to the epoch, and since, with our atomic units of time, distance and mass, the electric force between electron and proton at a constant distance apart is constant, the gravitational force between them must be inversely proportional to the epoch. Thus, the ***gravitational constant will be inversely proportional to the epoch****".*
In Summary, he concluded:
"It is proposed that all the ***very large dimensionless numbers*** *which can be constructed from the important natural constants of cosmology and atomic theory* ***are connected by simple mathematical relations*** *involving coefficients of the order of magnitude unity. The main consequences of this assumption are investigated, and it is found that a* ***satisfactory theory of cosmology can be built up from it****".*

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]:

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

WUM holds that there indeed exist **simple mathematical relations** between all Primary Cosmological Parameters (PCPs) that depend on Q (see Section 4.1.):

- 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}.

These PCPs belong to the Medium of the World. There are no Aether and Vacuum in WUM.

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*" [20].

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

WUM: The 3D World, which is a Hypersphere of 4D Nucleus, was started by a fluctuation in the Eternal Universe. 4D Nucleus is expanding in the fourth spatial dimension, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing 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 a basic unit of energy: $E_0 = hc/a$.

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.

Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a matter-antimatter asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has two-dimensional sphere surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "*Surface Energy*" of the 4D Nucleus.

The proposed process is a 4D process responsible for the expansion, creation of Matter and arrow of Time. It is a **Hypothesis of WUM**. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created.

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.

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 (0.2 eV).

WUM postulates that rest energies of DMFs and bosons are proportional to the basic unit of energy E_0 multiplied by different exponents of α and can be expressed with the following formulae:

DMF1 (fermion): $E_{DMF1} = \alpha^{-2}E_0 = 1.3149950\ TeV$

DMF2 (fermion): $E_{DMF2} = \alpha^{-1}E_0 = 9.5959823\ GeV$

DIRAC (boson): $E_{DIRAC} = \alpha^{0}E_0 = 70.025267\ MeV$

ELOP (boson): $E_{ELOP} = 2/3\alpha^{1}E_0 = 340.66606\ keV$

DMF3 (fermion): $E_{DMF3} = \alpha^{2}E_0 = 3.7289402\ keV$

DMF4 (fermion): $E_{DMF4} = \alpha^{4}E_0 = 0.19857111\ eV$

It is worth noting that the rest energy of electron E_e equals to: $E_e = \alpha E_0$ and the Rydberg unit of energy is: $Ry = hcR_\infty = 0.5\alpha^3 E_0 = 13.605693\ eV$.

We still do not 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 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 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 cannot 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 supermassive dark objects observed in galaxies and galaxy clusters are widely discussed in literature [23]-[29]. The prospect that DMPs might be observed in Centers of Macroobjects 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].

Observational data like dynamics of galaxies and star formation disfavor exotic cold and warm DM proposed in the Standard Cosmology. In his famous paper [38], Prof. P. Kroupa stated that "*all observational quantities that are derived at present, such as star-formation rate densities, distances and ages from redshifts, and galaxy masses, are likely to require possibly major revision*".

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 [39].

Table 1 describes the parameters of **Macroobjects Cores** (which are Fermionic Compact Stars in WUM) in the present Epoch made up of different DM fermions: self-annihilating DMF1, DMF2, DMF3, fermion DMF4, and Electron-Positron plasma.

Table 1. Parameters of Macroobjects Cores made up of different Fermions in present Epoch.

Fermion	Fermion Mass m_f, MeV	Macroobject Mass M_{max}, kg	Macroobject Radius R_{min}, m	Macroobject Density ρ_{max}, kgm^{-3}
DMF1	1.3×10^{6}	1.9×10^{30}	8.6×10^{3}	7.2×10^{17}
DMF2	9.6×10^{3}	1.9×10^{30}	8.6×10^{3}	7.2×10^{17}
Electron-Positron	0.51	6.6×10^{36}	2.9×10^{10}	6.3×10^{4}
DMF3	3.7×10^{-3}	1.2×10^{41}	5.4×10^{14}	1.8×10^{-4}
DMF4	2×10^{-7}	4.2×10^{49}	1.9×10^{23}	1.5×10^{-21}

The calculated parameters of the shells show that [39]:

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

Macroobjects' Cores have the following properties:

- The minimum radius of Core R_{min} made up of any fermion equals to three Schwarzschild radii;
- Core density does not depend on M_{max} and R_{min} and does not change in time while $M_{max} \propto \tau^{3/2}$ and $R_{min} \propto \tau^{1/2}$;
- DM cores of superclusters and galaxies are responsible for the gravitational lensing effect.

In WUM, the calculated maximum stellar mass is: $M_S \cong 174\, M_\odot$ [40] . It is in good agreement with the mass of one of the most massive known stars R136a1: $M_S = 215^{+45}_{-31}\, M_\odot$ [41].

K. Mehrgan, *et al.* observed a supergiant elliptical galaxy Holmberg 15A. It has been alleged that the primary component of the galactic core is a supermassive black hole with a mass of $4 \times 10^{10} M_\odot$ [42].

TON 618 is a very distant and extremely luminous quasar. It possesses one of the most massive black holes ever found, with a mass of $6.6 \times 10^{10}\, M_\odot$ at the center of TON 618 [43].

How supermassive black holes initially formed is one of the biggest problems in the study of galaxy evolution today. Supermassive black holes have been observed as early as 800 million years after the Big Bang, and how they could grow so quickly remains unexplained.

C. R. Argüelles, *et al.* propose a novel mechanism for the creation of supermassive black holes from dark matter without requiring prior star formation or needing to invoke seed black holes with unrealistic accretion rates. The authors investigate the potential existence of stable galactic cores made of fermionic dark matter, and surrounded by a diluted dark matter halo, finding that the centers of these structures could become so concentrated that they could also collapse into supermassive black holes once a critical threshold is reached. They analyzed this mechanism with DM haloes mass up to $5.9 \times 10^{10}\, M_\odot$ [44].

According to **WUM**, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with shell of DMF3 with the calculated maximum mass of $6 \times 10^{10}\ M_{\odot}$ (see **Table 1**). This value is in good agreement with the experimentally found values in [42], [43] and with the analyzed values in [44].

Laniakea Supercluster (LS) is a galaxy supercluster that is home to the Milky Way and approximately 100,000 other nearby galaxies. It is known as the largest supercluster with estimated binding mass $10^{17}\ M_{\odot}$ [45]. The mass-to-light ratio of the LS is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [46]. In 1933, Fritz Zwicky investigated the velocity dispersion of Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: "*if this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter*" [47]. These ratios are one of the main arguments in favor of presence of large amounts of Dark Matter in the World.

In frames of **WUM**, Laniakea Supercluster emerged 13.77 billion years ago due to Rotational Fission of the Supercluster Overspinning Dark Matter Core (ODMC) and self-annihilation of DMPs. The Core was created during Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter Macroobjects existed [39].

B. Carr, F. Kühnel, and L. Visinelli "*consider the observational constraints on stupendously large black holes (SLABs) in the mass range* $M > 10^{11} M_{\odot}$ *. These have attracted little attention hitherto, and we are aware of no published constraints on a SLAB population in the range (*$10^{12} - 10^{18}) M_{\odot}$ *. However, there is already evidence for black holes of up to nearly* $10^{11} M_{\odot}$ *in galactic nuclei* [42], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes"* [48].

According to **WUM**, the calculated maximum mass of supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the estimated value in [45] and discussed values in [48].

In a future, these stupendously large compact objects can give rise new Luminous Superclusters as the result of their DM Cores' rotational fission. 13.77 billion years ago, the estimated number of DM Supercluster Cores in the World was around $\sim 10^3$ [49]. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. In our view, there were many Beginnings for different Luminous Superclusters.

4. Hypothesis of Hypersphere World-Universe Model

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

Albert Einstein

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 predicted value of G [50]:

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

  is in excellent agreement with the experimentally measured by Qing Li, *et al.* in 2018 values using two independent methods [51]:

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

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

  WUM recommends the predicted value of G for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022;

- The calculated value of $T_{MBR} = 2.72518\ K$ is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [52];

- 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 [53] 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*" [54].

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 [55]. 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.**

According to **WUM**, the value of H 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 [55].

4.2. Angular Momentum Problem

Angular Momentum Problem is one of the most critical problem in Standard Cosmology (SC) that must be solved. SC does not explain how Galaxies and Extra Solar systems obtained their enormous orbital 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 be consistent with this Law a Model must answer the following questions:

- How did Galaxies and Extra Solar systems obtain their substantial orbital and rotational angular momenta;
- Why are all Macroobjects rotating;
- How did Milky Way give birth to different Extra Solar systems in different times;
- The beginning of the Milky Way (MW) galaxy was about 13.77 billion years. The age of MW is about the Age of the World. What is the origin of MW huge orbital angular momentum? We must discuss the Beginning of the MW;
- The beginning of the Solar System (SS) was 4.57 billion years. What is the origin of SS orbital angular momentum? We must discuss the Beginning of the SS;
- Why is the orbital momentum of Jupiter much larger than rotational momentum of the Sun. There is no possible means by which the angular momentum from the Sun could be transferred to the planets.

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) 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*" [49]. To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter (DM) Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Superclusters' ODMCs and self-annihilation of DMPs;
- The main players of the World are Superclusters' ODMCs, which accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their Rotational Fission. The experimental observations of galaxies in the universe show that most of them are **disk galaxies**: about 60% are ellipticals and about 20% are spirals [56]. These results speak in favor of the developed Rotational Fission mechanism;
- 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.

4.3. Milky Way Center

The Milky Way (MW) is a barred spiral galaxy with an estimated visible diameter of 100–200 kly. MW is a part of the Local Group of galaxies, which form part of the Virgo Supercluster, which is itself a component of the Laniakea Supercluster. It is estimated to contain 100–400 billion stars. The galactic center is an intense radio source known as Sagittarius A*(Sgr A*), an alleged supermassive black hole of 4.268 million solar masses [57]. The oldest stars in the Milky Way are nearly as old as the universe itself and thus probably formed shortly after the Dark Ages of the Big Bang.

Several teams of researchers have attempted to image Sgr A* in the radio spectrum using very-long-baseline interferometry. The current highest-resolution (approximately $30\ \mu as$) measurement, made at a wavelength of 1.3 mm, indicated an overall angular size for the source of $50\ \mu as$ [58]. At a distance of $26.91\ kly = 2.546 \times 10^{20}\ m$, this yields a diameter of $6 \times 10^{10}\ m$. Observations of the star S14 showed the mass of the object to be about 4.268 million solar masses within a volume with the radius no larger than $6.7 \times 10^{12}\ m$ [57].

In 2010, two gigantic spherical bubbles of high energy emission were detected to the north and the south of the MW core, using data from the Fermi Gamma-ray Space Telescope. The diameter of each of the bubbles is about 25 kly (see Section 4.4).

In 2015, NASA reported observing an X-ray flare 400 times brighter than usual, a record-breaker, from Sgr A*. The unusual event may have been caused by the entanglement of magnetic field lines within gas flowing into Sgr A* [59].

E. A. C. Mills in her "*Journey to the Center of the Galaxy: Following the gas to understand past and future activity in galaxy nuclei*" wrote [60]:

"The ***young stars in the central lightyear****, the innermost of whose orbits are famously used to determine parameters of central supermassive black hole, are suggested to have formed in-situ in one of the most extreme environments imaginable: in an incredibly dense gas disk a fraction of a light year from the black hole. Even allowing for recent activity in the past few hundred years which we can detect from the X-ray light of these outbursts reflecting off of clouds a few hundred light years from the black hole…* ***our black hole is no AGN****"* (Active Galactic Nucleus).

R. Genzel and A. Ghez were awarded the 2020 Nobel Prize in Physics for their discovery that Sgr A* is a **supermassive compact object**, for which a black hole is the only currently accepted explanation.

In 2013, we proposed a principally different explanation of supermassive compact objects: "*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"* [40].

In frames of **WUM** (see **Table 1**):

- The calculated value of the radius of the Electron-Positron shell $2.9 \times 10^{10}\ m$ is in excellent agreement with the experimentally measured value of the radio source $3 \times 10^{10}\ m$ [58];
- The calculated value of the mass of the Electron-Positron shell $6.6 \times 10^{36}\ kg$ is in good agreement with the experimentally measured value of the supermassive compact object $8.5 \times 10^{36}\ kg$ [57];
- The additional mass of the DMF3 shell of $1.9 \times 10^{36}\ kg$ is much smaller than the maximum mass of $1.2 \times 10^{41}\ kg$;
- X-ray flare 400 times brighter than usual can be explained by DMF3 particles (3.7 keV) self-annihilation [59];
- The excess of gamma-ray emission with energy about 10 GeV reported by D. Hooper from the Galactic Center [61] can be explained by DMF2 particles (9.6 GeV) self-annihilation;

- Bipolar astrophysical gamma-ray jets [62] can be explained by DMF1 (1.3 TeV) and DMF2 particles (9.6 GeV) self-annihilation;
- The Galactic Centre "*chimneys*" [63] are the result of the self-annihilation of DMF3 (3.7 keV);
- Dark Matter Fermi Bubbles can be explained based on DMF1, DMF2, and DMF3 particles (see Section 4.4).

The oldest known star HD 140283 (Methuselah star) is a subgiant star about 190 light years away from Earth for which a reliable age has been determined [64]. H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8\ Byr$ that does not conflict with the Age of the Universe, $13.77 \pm 0.06\ Byr$, based on the microwave background radiation and Hubble constant [53]. It means that this star must have formed between 13.66 and 13.83 Byr, an amount of time that is too short for formation of the second generation of stars according to prevailing theories. In our Model, this discovery can be explained by generation of HD 140283 by overspinning Core of MW 13.77 billion years ago.

In frames of the developed Rotational Fission model, it is easy to explain hyper-runaway stars unbound from the Milky Way with speeds of up to $\sim 700\ km/s$ [65]: they were launched by overspinning Core of the Large Magellanic Cloud with the speed higher than the escape velocity.

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass of about 2.3 solar mass that is located at a distance of $\sim$ 9 kpc from the Sun. When integrated backwards in time, the orbit of the star points unambiguously to the Galactic Centre, implying that S5-HVS1 was kicked away from Sgr A* with a velocity of $\sim$ 1800 km/s , and travelled for 4.8 Myr to its current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [66]. In frames of the developed Model, this discovery can be explained by Gravitational Burst (GB) of the overspinning Core of the Milky Way 4.8 million years ago, which gave birth to S5-HVS1 with the speed higher than the escape velocity of the Core.

C. J. Clarke, *et al.* observed CI Tau, a young 2-million-year-old star. CI Tau is located about 500 light years away in a highly-productive stellar "*nursery*" region of the galaxy. They discovered that the Extrasolar system contains four gas giant planets that are only 2 million years old [67], an amount of time that is too short for formation of gas giants according to the prevailing theories. In frames of the developed Rotational Fission model, this discovery can be explained by GB of the MW Core 2 million years ago, which gave birth to the CI Tau system with all the planets generated at the same time.

The totality of the obtained experimental results testify in favor of the existence of the supermassive compact object made of Dark Matter particles at the Milky Way Center.

4.4. 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 [68]. 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 [69]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

WUM explains FBs the following way [39]:

- 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 [61]. 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 the extended beams along the axis of rotation [70]) 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 particles;
- 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 [68] 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 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 [71] are the result of self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) particles 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 [39];
- 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 particles 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, **Fermi Bubbles are DMPs' clouds containing uniformly distributed Dark Matter Objects,** in which DMPs self-annihilate and radiate X-rays and gamma rays. Dark Matter Fermi Bubbles constitute a principal proof of WUM.

4.5. Dark Matter Reactors

The following facts support the existence of **Dark Matter Cores** in Macroobjects:

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [72];
- By analyzing the earthquake doublets, J. 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 [73];
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [74].

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 self-annihilation, which carry away excessive angular momentum. The Solar wind is the result of this mechanism [39].

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 [75]. The researchers were surprised by just how

rough that boundary is – rougher than the surface layer that we all live on. The roughness was not 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 [76].

X. Markenscoff in the paper *""Volume collapse" instabilities in deep-focus earthquakes: A shear source nucleated and driven by pressure*" explains "*the mystery of the long-standing observations in deep-focus earthquakes (400-700 km) by symmetry-breaking instabilities in high-pressure phase transformation, which produce the counterintuitive phenomenon of "volume collapse" producing only shear radiation, with little, or no, volumetric component, even under conditions of full isotropy"* [77].

According to **WUM**, the 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [49]. The deep-focus earthquakes are connected with random mass ejections happening at the 660-km boundary as the result of DMPs self-annihilation in the DM core.

Random Variations of Earth's Rotational Speed. G. Jones and K. Bikos in the paper "*Earth Is in a Hurry in 2020*" wrote [78]: "*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*". It turned out that the variations of the daylength throughout 2020 were in the range $86400^{+1.62ms}_{-1.46ms}\ s$.

Jean-Luc Margot, *et al*. observed the analogous effect on Venus. The average sidereal day on Venus in the 2006-2020 interval is 243.0226 ± 0.0013 Earth days [79].

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

Gravitationally-Rounded Objects Internal Heat. The analysis of Sun's heat for planets in Solar system yields the effective temperature of **Earth** of 255 K [80]. The actual mean surface temperature of Earth is 288 K [81]. 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"* [82];

Jupiter radiates more heat than it receives from the Sun [83]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 degrees C [84]) have been difficult to explain, due to lack of a known heat source. **Saturn** radiates 2.5 times more energy than it receives from the Sun [85]; **Uranus** – 1.1 times [86]; **Neptune** – 2.6 times [87]. Many Icy Solar system bodies including **Pluto** possess subsurface oceans [88].

According to **WUM**, the internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate

through the entire objects' envelope, get absorbed into the cores, and continuously support DMF1 self-annihilation.

Half of the chemical elements heavier than iron are produced by the rapid neutron capture process (r-process), which produces many of the heavy chemical elements, but the astrophysical settings where it occurs remain unclear. **Plutonium-244** with half-life of 80.6 million years and **Iron-60** with half-life of 2.6 million years are not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Pu-244 and Iron-60 present in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [89].

In 2021, A. Wallner, *et al.* analyzed the plutonium content of a deep-sea crust sample, "*identifying a few dozen atoms of the r-process isotope Pu-244 that were delivered to Earth within the past few million years. There was a simultaneous signal of iron-60, which is known to be produced in supernovae. Comparing the ratios of these isotopes constrains the relative contributions of supernovae and neutron star mergers to r-process nucleosynthesis"* [90].

In frames of **WUM**, all chemical products of the Earth including isotopes K-40, U-238, Th-232, Pu-244, and Iron-60, are produced within the Earth as the result of DMF1 particles self-annihilation. They arrive to the Crust of the Earth due to convection currents in the mantle carrying heat and isotopes from the interior to the planet's surface [91].

Dark Matter Reactors. Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation and an uncontrolled thermonuclear fusion of them into heavier Dark Matter Superparticles (DMSPc) within their cores. The diversity of all gravitationally-rounded objects in 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 and all their geological processes like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc.

Scientists from the Tibet ASγ experiment observed gamma rays with energies between 0.1 and 1 PeV, coming from the galactic disk regions. Specifically, they found 23 ultra-high-energy cosmic gamma rays with energies above 398 TeV along the Milky Way [92].

In frames of **WUM**, the gamma rays with energies between 1 TeV and 1 PeV can be explained by nuclear fission of DMSPs, consisting of many fused DMF1 (1.3 TeV), produced in the cores of Milky Way and stars.

4.6. Solar Corona. Geocorona. Planetary Coronas

Structure of Solar Atmosphere. According to the standard model, the visible surface of the Sun, the photosphere, is the layer below which the Sun becomes opaque to visible light [93]. Above the photosphere visible sunlight is free to propagate into space, and almost all of its energy escapes the Sun entirely. The sunlight has the spectrum of a black-body radiating at about 5,800 K.

Above the photosphere lies the chromosphere that is about 2,500 km thick, dominated by a spectrum of emission and absorption lines. The temperature of the chromosphere increases gradually with altitude, ranging up to $\sim 2 \times 10^4\ K$ near the top. The particle density decreases rapidly from 10^{22} to $10^{17} m^{-3}$ [94], [95].

Above the chromosphere, in a thin (about 200 km) transition region, the temperature rises rapidly to coronal temperatures closer to $10^6\,K$. The particle density decreases from 10^{17} up to $10^{16}-10^{15}\,m^{-3}$ in the low corona [94].

Solar Corona is an aura of plasma that surrounds the Sun and extends at least $8\times10^6\,km$ into outer space [96] (compare with the Sun's radius $7\times10^5\,km$). Spectroscopy measurements indicate strong ionization and plasma temperature in excess of $10^6\,K$ [97]. The corona emits radiation mainly in the X-rays, observable only from space. The plasma is transparent to its own radiation and to solar radiation passing through it, therefore we say that it is optically-thin. The gas, in fact, is very rarefied, and the photon mean free-path by far overcomes all other length-scales, including the typical sizes of the coronal features.

J. Schmelz made the following comment on the composition of Solar corona: "*Along with temperature and density, the elemental abundance is a basic parameter required by astronomers to understand and model any physical system. The abundances of the solar corona are known to differ from those of the solar photosphere"* [98].

Coronal Heating Problem in solar physics relates to the question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. The high temperatures require energy to be carried from the solar interior to the corona by non-thermal processes.

According to **WUM**, the origin of the Solar corona plasma is not the coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. The plasma is the result of a self-annihilation of DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV) particles. The Solar corona made up of DMPs resembles a **honeycomb** filled with plasma.

The following experimental results speak in favor of this model [39]:

- The corona emits radiation mainly in X-rays due to the annihilation of DMF3 particles;
- The plasma is transparent to its own radiation and to the radiation coming from below;
- The elemental composition of the Solar corona and the Solar photosphere are known to differ;
- During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted [99] (one photon had an energy as high as 467.7 GeV [49]). In our view, it is the result of enormous density fluctuations of DMPs in the Solar corona and their self-annihilation;
- Assuming the particle density in the low corona $10^{15}\,m^{-3}$ and mass of DMF1 particles: $m_{DMF1}=2.3\times10^{-24}\,kg$ we can find mass density $\rho^{in}_{DMF1}=2.3\times10^{-9}\,kg/m^3$ that is equal to the density of the fractal structure [49];
- A distance between DMF1 particles is about $10^{-5}\,m$ that is much smaller than the range of the introduced in WUM weak interaction of DMPs: $R_W=1.65314\times10^{-4}\,m$ [39]. Weak Interaction between DMPs provides integrity of the Solar corona;
- At the same density of the fractal structure, a distance between DMF3 particles with mass $m_{DMF3}=6.7\times10^{-33}\,kg$ is about $10^{-8}\,m$. The smallest distance between DMF3 explains the fact that corona emits radiation mainly in the X-rays;
- The Solar corona is a stable Shell around the Sun with an inner radius $R_{in}\cong7\times10^8\,m$ and an outer radius $R_{out}\cong3\times10^{12}\,m$. The total mass of the Corona is: $M_{SC}\cong9\times10^{25}\,kg$ [49];

- Observable outer radius of the Solar corona $8 \times 10^9\ m$ [96] depends on the concentration of DMPs, the strength of their self-annihilation interaction, and a sensitivity of the measuring instrument.

Geocorona is a luminous part of an outermost region of the Earth's atmosphere that extends to at least 640000 km from the Earth [100]. It is seen primarily via Far-Ultra-Violet (FUV) light from the Sun that is scattered by neutral hydrogen [101]. The first high-quality and wide-field-of-view image of Earth's corona of 243000 km was obtained by Hisaki, the first interplanetary microspacecraft. It acquires spectral images (52-148 nm) of the atmospheres of planets from Earth orbit and has provided quasi-continuous remote sensing observations of the geocorona since 2013 [102]. The most popular explanation of this geocoronal emission is the scattering of Solar FUV photons by exospheric hydrogen [103].

X-rays from Earth's Geocorona were first detected by Chandra X-ray Observatory in 1999 [104]. X-rays were observed in the range of energies $0.08 - 10\ keV$. The main mechanism explaining the geocoronal X-rays is that they are caused by collisions between neutral atoms in the geocorona with carbon, oxygen and nitrogen ions that are streaming away from the Sun in the solar wind [104], [105], [106]. This process is called "charge exchange" since an electron is exchanged between neutral atoms in geocorona and ions in the solar wind.

X-rays from Planets were also observed by Chandra [104]. According to NASA:

- The X-rays from Venus and, to some extent, the Earth, are due to the fluorescence of solar X-rays striking the atmosphere;
- Fluorescent X-rays from oxygen atoms in the Martian upper atmosphere are similar to those on Venus. A huge Martian dust storm was in progress when the Chandra observations were made. The intensity of the X-rays did not change during the dust storm;
- Jupiter has an environment capable of producing X-rays in a different manner because of its substantial magnetic field. X-rays are produced when high-energy particles from the Sun get trapped in its magnetic field and accelerated toward the polar regions where they collide with atoms in Jupiter's atmosphere;
- Like Jupiter, Saturn has a strong magnetic field, so it was expected that Saturn would also show a concentration of X-rays toward the poles. However, Chandra's observation revealed instead an increased X-ray brightness in the equatorial region. Furthermore, Saturn's X-ray spectrum was found to be similar to that of X-rays from the Sun.

In our opinion, the Planetary Coronas are similar to the Solar Corona [39]:

- At the distance of 640000 km from the Earth [87], atoms and molecules are so far apart that they can travel hundreds of kilometers without colliding with one another. Thus, the exosphere no longer behaves like a gas, and the particles constantly escape into space. In our view, FUV radiation and X-rays are the consequence of DMF3 particles self-annihilation;
- All planets and some observed moons (Europa, Io, Io Plasma Torus, Titan) have X-rays in upper atmosphere of the planets, similar to the Solar Corona;
- The Geocorona is a stable Shell around the Earth with inner radius $R_{in} \cong 6.5 \times 10^3\ km$ and observed outer radius $R_{out} \cong 6.4 \times 10^5\ km$. The total mass of this Shell is: $M_{GC} \cong 4.1 \times 10^{18}\ kg$.

The Geocorona and Planetary Coronas possess features similar to those of the Solar Corona.

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 that is expanding along the fourth spatial dimension of the Nucleus with speed equals to the gravitodynamic constant c. The Universe serves as an unlimited source of DM, which continuously created in the Nucleus of 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 [107]. 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 the 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 [93]. 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 [108]:

The Beginning. The World was started by a fluctuation in the Eternal Universe, and the Nucleus of the World, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a . The World is a finite 3D Hypersphere that is the surface of the 4D 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 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. Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct 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 DMF4 particles 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. 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). Transition from Dark Epoch to Luminous Epoch is 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. Introduced **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 up 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, and 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, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation in their DM cores.

5.4. Predictions

It does not 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

In 2013, **WUM** revealed a self-consistent set of time-varying values of Primary Cosmological Parameters of the World: Gravitation parameter, Hubble's parameter, Age of the World, Temperature of Microwave Background Radiation, and concentration of Intergalactic plasma. Based on the inter-connectivity of these parameters, WUM solved the Missing Baryon problem and predicted the values of the following Cosmological parameters: gravitation , concentration of Intergalactic plasma, and the minimum energy of photons [40], which were experimentally confirmed in 2015 – 2018.

The results obtained by K. Mehrgan, *et al.* [42] and O. Shemmer, *et al.* [43]; discussed by C. R. Argüelles, *et al.* [44] and B. Carr, *et al.* [46]; and "*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*" (Nobel Prize in Physics 2020) made by R. Genzel and A. Ghez confirm 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" [40].

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 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 a 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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Paradigm Shift in Cosmology

Abstract

The main objective of a paper is to discuss the most important Concepts for any Cosmological model: universality of physical laws; cosmological principle (homogeneous and isotropic universe); Space, Time, and Gravitation; speed of light in vacuum; structure and content of the World; dark matter and ordinary matter; origin of matter (singularity or continuous creation); Law of Conservation of Angular Momentum; Primary Cosmological Parameters; Four Pillars of Standard Cosmology (SC) – expansion of Universe, nucleosynthesis of light elements, formation of large-scale structures, origin of cosmic background radiation. The performed analysis shows that SC fails to account for most of these concepts. The most intriguing result is that there was no **Initial Singularity**: all galaxies are gravitationally bound with their Superclusters. Proposed Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology. According to WUM, Superclusters are, in fact, the principal objects of the World. Macroobjects form from the top (Superclusters) down to galaxies and extrasolar systems in parallel around different Cores made up of different Dark Matter Particles. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

1. Introduction

Today, a growing feeling of Physics' stagnation is shared by a large number of researchers. In some respects, the situation today is similar to that at the end of 19th century, when the common consensus held that the body of Physics is nearly complete. The time may be ripe to propose new Physical models that will be both simpler than the current state of the art, as well as open up new areas of research.

In my view, there is a principal difference between Physics and Mathematics. I am convinced that Physics cannot exist without Mathematics, but Mathematics must not replace Physics. I absolutely agree with John von Neumann who said: "*The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct, which, with addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work".*

Hypersphere World-Universe Model (WUM) is proposed as an alternative to the prevailing Big Bang Model of Standard Cosmology (SC). WUM is a natural continuation of Classical Physics. It makes use several Hypotheses proposed by classical physicists from the 17th until the 20th century. The presented Hypotheses are not new, and I don't claim credit for them. In fact, I am 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.

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 should be developed into the well-elaborated theory by entire physical community.

This manuscript concludes the series of published papers (see collected articles [1]-[24]). Many results obtained there are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases. This article does not provide an overview of WUM, please refer to referenced manuscripts for that. In this work, we discuss the most important Concepts of the World, which are the basis of the developed Hypersphere World-Universe Model.

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 microscopic level, and the collective result can be observed at macroscopic level.

2. Classical Physics

In this Section we describe principal milestones in Classical Physics. Based on the analysis of the measured physical constants we conclude that the most important Fundamental constants could be calculated before Quantum Mechanics [12].

Maxwell's equations were published by J. C. Maxwell in 1861 [25]. He calculated the velocity of electromagnetic waves from the value of the electrodynamic constant c measured by Weber and Kohlrausch in 1857 [26] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [27]. This observation made him suggest that light is an electromagnetic phenomenon [28].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** but **not the speed of light in vacuum.** By definition, the electrodynamic constant c is the ratio of the absolute electromagnetic unit of charge e to the absolute electrostatic unit of charge e/c, where e is the elementary charge. It is worth noting that the speed of light in vacuum, commonly denoted as c, is not related to the World in our Model, because there is no Vacuum in it. Instead, there is the Medium of the World consisting of elementary particles.

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 [29].

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 measured by J. J. Thomson in 1897 [30]. We name it after Thomson: $R_T \equiv e/m_e$.

Planck Constant h was suggested by M. 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) [31].

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

- Basic unit of size a :

$$a = 0.5\left[8(\mu_0 h/c)^3 R_\infty R_T^6\right]^{1/5} = 1.7705641 \times 10^{-14}\, m$$

- Dimensionless Rydberg constant α : $\alpha = (2aR_\infty)^{1/3}$

where μ_0 is a 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". The calculated value of α^{-1} is: $\alpha^{-1} = 137.035999$.

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 a basic unit of time: $t_0 = a/c = 5.9059662 \times 10^{-23}\ s$):

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

which in present epoch equals to: $Q = 0.759972 \times 10^{40}$.

3. Analysis of Big Bang Model

The theory of Big Bang Model (BBM) depends on two major **assumptions**: the **universality of physical laws** and the **cosmological principle**. The universality of physical laws is one of the underlying principles of the theory of relativity. The cosmological principle states that on large scales the universe is **homogeneous** and **isotropic** – appearing the same in all directions regardless of location.

The framework for BBM relies on General Relativity (GR). Assuring that the weak-gravity, low-speed limit of GR is Newtonian mechanics, the proportionality constant in Einstein's equations is found to be $8\pi G/c^4$, where G is the **gravitational constant** and c is the **speed of light in vacuum**.

The Lambda Cold Dark Matter (ΛCDM) model is a parametrization of BBM in which the universe contains three major components: a Cosmological constant Λ associated with dark energy; the postulated **Cold Dark Matter** (CDM); and Ordinary matter. The ΛCDM model is based on **six parameters**: baryon density, dark matter density, dark energy density, scalar spectral index, curvature fluctuation amplitude, and reionization optical depth. The values of these parameters are mostly not predicted by current theory and are adjusted to the obtained experimental results.

The Four Pillars of SC are as follows [32]:

- Expansion of the Universe;
- Nucleosynthesis of light elements;
- Formation of galaxies and large-scale structures;
- Origin of cosmic background radiation.

Expansion of the Universe. The fact that galaxies are receding from us in all directions was first discovered by E. Hubble. Projecting galaxy trajectories backwards in time means that they converge to the **Initial Singularity** at t=0 that is an infinite energy density state. This uncovers one of the shortcomings of SC – the Horizon problem [33]: "*Why does the universe look the same in all directions when it arises out of causally disconnected regions? This problem is most acute for the very smooth cosmic microwave background radiation".*

This problem was resolved by the **Cosmological Inflation**, which is a theory of an extremely rapid expansion of space in the early universe up to 93 billion light-years in diameter with a speed of about $10^{60}\ ms^{-1}$. Following the inflationary period, the universe continued to expand, but at a slower rate.

J. Peebles, who was awarded the Nobel Prize in Physics in 2019 for his theoretical discoveries in physical cosmology, said: "*It's a beautiful theory. Many people think it's so beautiful that it's surely right. But the evidence of it is very sparse*" [34].

According to J. Silk, "*Our best theory of the beginning of the universe, inflation, awaits a definitive and falsifiable probe, in order to satisfy most physicists that it is a trustworthy theory. Our basic problem is that we cannot prove the theory of inflation is correct, but we urgently need to understand whether it actually occurred"* [35].

WUM. The initial singularity is a gravitational singularity predicted by GR to have existed before the Big Bang (BB) and thought to have contained all the energy and spacetime of the Universe. From a physical point of view, existence of a mathematical singularity is a drawback of any theory. It means that the theoretical model did not consider some significant physical phenomenon, which prevents an occurrence of the singularity.

In our view, there is no way to prevent an occurrence of the initial singularity in BBM. The World must have gotten started in a principally different way – a Fluctuation in the Eternal Universe with a finite size and energy. The size of this Fluctuation can increase with a finite speed. There is then no need to introduce the cosmological inflation [15].

Nucleosynthesis of Light Elements is believed to have taken place in the interval from roughly 10 seconds to 20 minutes after the BB and is calculated to be responsible for the formation of most of the universe's helium as the isotope helium-4, along with small amounts of deuterium, helium-3, and a very small amount of lithium-7. All of the elements that are heavier than lithium were created much later, by stellar nucleosynthesis in evolving and exploding stars [16].

During the 1970s, major efforts were underway to find processes that could produce deuterium. While the concentration of deuterium in the universe is consistent with BBM as a whole, it is too high to be consistent with a model that presumes that most of the universe is composed of protons and neutrons. The standard explanation for the abundance of deuterium is that **non-baryonic dark matter** makes up most of the mass of the universe [16].

According to SC, lithium was one of the three elements synthesized after BB. But in case of lithium, we observe a cosmological lithium discrepancy in the universe: older stars seem to have less lithium than they should, and some younger stars have much more. M. Anders, *et al.* report on the results of the first measurement of the $^{2}H(\alpha,\gamma)^{6}Li$ cross section at BB energies. The results they obtained have firmly **ruled out BB lithium production** as a possible explanation for the reported ^{6}Li detections[36].

According to **WUM**, Nucleosynthesis of all elements (including light elements) occurs inside of Dark Matter (DM) Cores of all Macroobjects during their evolution [16].

Formation of Galaxies and Large-Scale Structures. At about 10,000 years after BB, a temperature
had fallen to such an extent that the energy density of the Universe began to be dominated by massive particles, rather than the light and other radiation that had predominated earlier. This change in the form of the main matter density meant that the gravitational forces between the massive particles could now begin to take effect, so that any small perturbations in their density would grow. This brings into focus one of the shortcomings of SC – the density fluctuation problem: "*The perturbations*

which gravitationally collapsed to form galaxies must have been primordial in origin; from whence did they arise?" [33].

WUM. All Macroobjects of the World have Cores made up of different Dark Matter Particles (DMPs). The Matter creation is occurring homogeneously in all points of the World. It follows that new stars can be created inside of galaxies, new galaxies can be created inside of superclusters, which can arise in the World. Macroobjects form from the top (galaxy clusters) down to Extrasolar Systems (ESS) 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 [15].

Origin of Cosmic Background Radiation. According to BBM, about 380,000 years after BB the temperature of the universe fell to the point where nuclei could combine with electrons to create neutral atoms. As a result, photons no longer interacted frequently with matter, the universe became transparent, and the Cosmic Microwave Background (CMB) radiation was created. This cosmic event is usually referred to as Decoupling. The photons present at the time of decoupling have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time. They are the same photons that we see in the CMB now [16]. But then, why is the CMB a perfect black-body?

WUM. Wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They do not have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*". In WUM, the black-body spectrum of CMB is due to a thermodynamic equilibrium of photons with the Intergalactic plasma, the existence of which is experimentally proved. It explains why the CMB is a perfect black-body [16].

Conclusion. Four Pillars are model-dependent and do not support BBM.

Black Holes. In 1916, K. Schwarzschild obtained the first mathematical solution of Einstein's field equations, which describes the gravitational field in the **spherically symmetric, static, vacuum** case. **Black Hole singularity** is a gravitational singularity predicted by GR.

The existence of supermassive objects in galactic centers is now commonly accepted. It is commonly believed that the central mass is a supermassive Black Hole (BH). Sir R. Penrose has got Nobel Prize in Physics in 2020 for "*The discovery that black hole formation is a robust prediction of the general theory of relativity".* At the same time, Prof. R. Genzel and A. M. Ghez have got their Nobel Prize for "*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*".

WUM. According to the Nobel Prize in Physics 2020, there is no experimental confirmation of BH existence. On the contrary, the astronomical observation of the **supermassive compact object** 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*" [1]. The discovery of the fastest hyper-velocity star S5-HVS1 that was kicked away from Sgr A* speaks in favor of WUM [37].

Nebular Hypothesis maintains that 4.57 billion years ago, the Solar system (SS) formed from the gravitational collapse of a giant molecular cloud, which was light years across. Most of the mass collected in the Centre, forming the Sun; the rest of the mass flattened into a protoplanetary disc, out

of which the planets and other bodies in the SS formed [13]. The Nebular hypothesis is not without its critics. In his "*The Wonders of Nature*", V. Ferrell outlined the following counter-arguments [38]:

- *It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;*
- *Each planet and moon in solar system has unique structures and properties. How could each one be different if all of them came from the same nebula;*
- *A full 98 percent of all the angular momentum in the solar system is concentrated in the planets. Jupiter itself has 60 percent of the planetary angular motion. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;*
- *There is no possible means by which the angular momentum from the Sun could be transferred to the planets. Yet this is what would have to be done if any of the evolutionary theories of Solar system origin are to be accepted.*

WUM. A detailed analysis of SS shows that the overspinning (surface speed at equator exceeding escape velocity) 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.

BBM cannot answer the following question: how did SS obtain an orbital angular momentum (calculated based on the distance from the galactic center of 26.4 kly and orbital speed of 220 km/s), which is about 12 orders of magnitude greater than the total rotational angular momentum of SS ?

WUM. A detailed analysis of the Milky Way (MW) galaxy [13] shows that the overspinning DM Core of MW can give birth to DM cores of Stars, and they can generate DM cores of planets and moons through the Rotational Fission mechanism.

MW is gravitationally bound with the Local Supercluster (LS). The calculated orbital angular momentum of MW (based on the distance of 65 million light years from LS and orbital speed of about 400 km/s [15]) is about four orders of magnitude greater than the total rotational angular momentum of MW [13]. **BBM** cannot explain how MW has got this huge orbital angular momentum.

WUM explains this fact by the Rotational Fission of the DM Core of the Local Supercluster [15].

4. Concepts of the World

We can't solve problems by using the same kind of thinking we used when we created them.
Albert Einstein

Angular Momentum Problem is one of the most critical problem in SC that must be solved. 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.

SC does not explain how Galaxies and ESS obtained their enormous orbital angular momenta. In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – **Rotational Fission** of overspinning 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. This process took a substantial amount of time; we named it "Dark Epoch". To be consistent with this Fundamental Law, we developed a New Cosmology of the World:

- WUM introduces principally new concept of "**Dark Epoch"** (spanning from the Beginning of the World for 0.45 billion years) when only Dark Matter (DM) Macroobjects (MOs) existed, and **Luminous Epoch** (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of the Overspinning Superclusters' DM Cores and self-annihilation of DMPs;
- Superclusters' DM Cores accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their Rotational Fission. The experimental observations of galaxies in the universe show that most of them are **disk galaxies**: about 60% are ellipticals and about 20% are spirals [56]. These results speak in favor of the developed Rotational Fission mechanism;
- Dark Matter Core of MW galaxy was born 13.77 billion years ago as the result of the Rotational Fission of the Local Supercluster DM Core;
- DM Cores of ESS, planets and moons were born as the result of the Rotational Fissions of MW galaxy DM Core in different times (4.57 billion years ago for SS);
- Macrostructures of the World form from the top (superclusters) down to galaxies, ESS, planets;
- Gravitational waves can be a product of Rotational Fission of overspinning Macroobject Cores.

Creation of Matter. In our view, "*there is no way to prevent an occurrence of the initial singularity in BBM. It must be a principally different Beginning of the World – a Fluctuation in the Eternal Universe"* (see Section 3). Then, a question about the mechanism of Continuous Creation of Matter in the World arises. F. Hoyle and J. V. Narlikar in 1964 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"[39]. P. Dirac in 1974 discussed a continuous creation of matter by an additive mechanism (uniformly throughout space) and a multiplicative mechanism (proportional to the amount of the existing matter) [40].

WUM follows the idea of the continuous creation of matter by the additive mechanism. To provide the creation of Matter by the Universe uniformly throughout the World, we have to consider the following Concept of the World proposed by G. Riemann in 1854 [41]: **3D Finite World is a Hypersphere of 4D Nucleus**.

In our view, the World was started by a Fluctuation in Eternal Universe, and 4D Nucleus of the World was born. The Nucleus is expanding in the fourth spatial dimension and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for a 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 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.

Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a **matter-antimatter asymmetry problem** discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has two-dimensional spherical surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus.

The proposed 4D process is responsible for the expansion, creation of Matter, and arrow of Time. It constitutes the main **Hypothesis of WUM**. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created. 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 3D Hypersphere World.

The main difference between BBM and WUM is in the Beginning of the World: the Singularity or the Fluctuation. Comparison of the Concepts of the Models is presented in **Table 1**.

Parameter	Big Bang Model	World-Universe Model
Structure of World	3+1 Spacetime Very big Space	3D Hypersphere of 4D Nucleus of World. Finite Space. Time is Factor of World
Cosmological Principal	Homogeneous and isotropic Universe	Homogeneous and isotropic Medium of World consisting of elementary particles with 2/3 of total Matter. Inhomogeneous and anisotropic distribution of Macroobjects with 1/3 of total Matter
Universality of Physical Laws	They apply everywhere and at every time, past, present, future	They apply everywhere at cosmological times τ more than $10^{-18}\ s$ after creation of very first ensemble of elementary particles
Gravitational Constant, G	$G = const$	$G \propto \tau^{-1}$
Constant c	Speed of light in vacuum	Gravitodynamic constant
Beginning	Singularity	4D Nucleus of World with extrapolated radius a as result of fluctuation in Eternal Universe
Expansion	Inflation – exponential expansion of Space	Radius of 4D Nucleus of World is increasing with speed c that is gravitodynamic constant
Content	Dark Energy, Cold Dark Matter, Ordinary matter	Multicomponent Dark Matter (DM), Ordinary matter
Origin of Matter	Singularity	DM comes from Universe to 4D Nucleus of World along fourth spatial dimension. Ordinary Matter is byproduct of DM self-annihilation
Cosmic Microwave Background	Increasing over time photons wavelength	Thermodynamic equilibrium of photons with Intergalactic plasma
Nucleosynthesis of Light Elements	Big Bang Nucleosynthesis	Nucleosynthesis of all elements occurs inside of DM Cores of Macroobjects
Centers of Galaxies	Black Holes	DM Cores
Solar System Formation	Nebula Hypothesis	Rotational Fission of Milky Way DM Core
Matter-Antimatter Asymmetry	Problem	No problem
Law of Conservation of Angular Momentum	Inconsistent	Consistent

Out of this Table, it follows that BBM and WUM are principally different models!

The Medium of the World. The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation. Inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. Cosmic MBR is part of the Medium; it then follows that the Medium is the absolute frame of reference. It is **Homogeneous** and **Isotropic**. Relative to MBR rest frame, MW and the Sun are moving with the speed of 552 and 370 km/s respectively [15].

The Medium consists of stable elementary particles with lifetimes longer than the age of the World: protons, electrons, photons, neutrinos, and DMPs. The energy density of the Medium is 2/3 of the total energy density of the World. Superclusters, Galaxies, ESS, planets, moons, *etc*. are made of the same particles. The energy density of Macroobjects adds up to 1/3 of the total energy density of the World throughout the World's evolution [15].

WUM is a classical model, therefore classical notions can be introduced only when the very first ensemble of particles was created at the cosmological time τ_M equals to: $\tau_M = \alpha^{-2} \times t_0 \cong 10^{-18} s$. In WUM, the cosmological principle "**Universality of physical laws" is valid at the cosmological times $\boldsymbol{\tau \geq \tau_M}$** .

In frames of WUM, Time and Space are closely connected with the Mediums' impedance (wave resistance) 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. The Gravitation is a result of simple interactions of DMPs with Matter that work cooperatively to create a more complex interaction. DMPs are responsible for the Le Sage's mechanism of the gravitation [15].

Gravity, Space and Time are all emergent phenomena [15]. In this regard, it is worth to recall the Albert Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

Dark Matter Particles. 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 (0.2 eV). WUM postulates that rest energies of DMFs and bosons are proportional to the basic unit of energy E_0 multiplied by different exponents of α and can be expressed with the following formulae:

DMF1 (fermion): $E_{DMF1} = \alpha^{-2} E_0 = 1.3149950\ TeV$
DMF2 (fermion): $E_{DMF2} = \alpha^{-1} E_0 = 9.5959823\ GeV$
DIRAC (boson): $E_{DIRAC} = \alpha^{0} E_0 = 70.025267\ MeV$
ELOP (boson): $E_{ELOP} = 2/3\alpha^{1} E_0 = 340.66606\ keV$
DMF3 (fermion): $E_{DMF3} = \alpha^{2} E_0 = 3.7289402\ keV$
DMF4 (fermion): $E_{DMF4} = \alpha^{4} E_0 = 0.19857111\ eV$

It is worth noting that the rest energy of electron E_e equals to: $E_e = \alpha E_0$ and the Rydberg unit of energy is: $Ry = hcR_\infty = 0.5\alpha^3 E_0 = 13.605693\ eV$.

We still do not 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 emissions of various Macroobjects in the World. We connect 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 WUM [8].

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 cannot measure neutrinos' masses directly, no one doubts their existence.

Macroobjects. Macrostructures of the World (Superclusters, Galaxies, ESS) 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 [10]. Introduced principally new **Weak Interaction** between DMPs provides integrity of all shells.

The calculated parameters of the shells show that [10]:

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

According to WUM, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with shell of DMF3 with the calculated maximum mass of $6 \times 10^{10}\ M_{\odot}$. This value is in good agreement with the experimentally obtained value of the most massive black hole ever found, with a mass of $6.6 \times 10^{10}\ M_{\odot}$ at the center of TON 618 [42].

Laniakea Supercluster is a galaxy supercluster that is home to MW and approximately 100,000 other nearby galaxies. It is known as the largest supercluster with estimated **binding mass** $10^{17}\ M_{\odot}$ [43]. The mass-to-light ratio of the Local Supercluster (LS) is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [44]. In 1933, F. Zwicky investigated the velocity dispersion of Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: "*If this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter* " [45]. These ratios are one of the **main arguments in favor of presence of large amounts of Dark Matter in the World**.

In frames of **WUM**, Laniakea Supercluster emerged 13.77 billion years ago due to Rotational Fission of the Supercluster Overspinning DM Core and self-annihilation of DMPs. The Core was created during Dark Epoch when only Dark Matter Macroobjects existed [15].

B. Carr, *et al.* "*consider the observational constraints on stupendously large black holes (SLABs) in the mass range* $M > 10^{11} M_{\odot}$ *. These have attracted little attention hitherto, and we are aware of no published constraints on a SLAB population in the range* $(10^{12} - 10^{18})\ M_{\odot}$ *. However, there is*

already evidence for black holes of up to nearly $10^{11} M_{\odot}$ *in galactic nuclei* [42], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes"* [46].

WUM. The calculated maximum mass of supercluster DM Core of 2.1×10^{19} solar mass [22] is in good agreement with the values estimated in [43] and discussed in [46]. In the future, these stupendously large compact objects can give rise new Luminous Superclusters as the result of their DM Cores' rotational fission. 13.77 billion years ago, the estimated number of DM Supercluster Cores in the World was around $\sim 10^3$ [15]. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. In our view, there were many "Beginnings" for different Luminous Superclusters.

Let us look at the Laniakea supercluster of galaxies depicted in **Figure 1** and **Figure 2.**

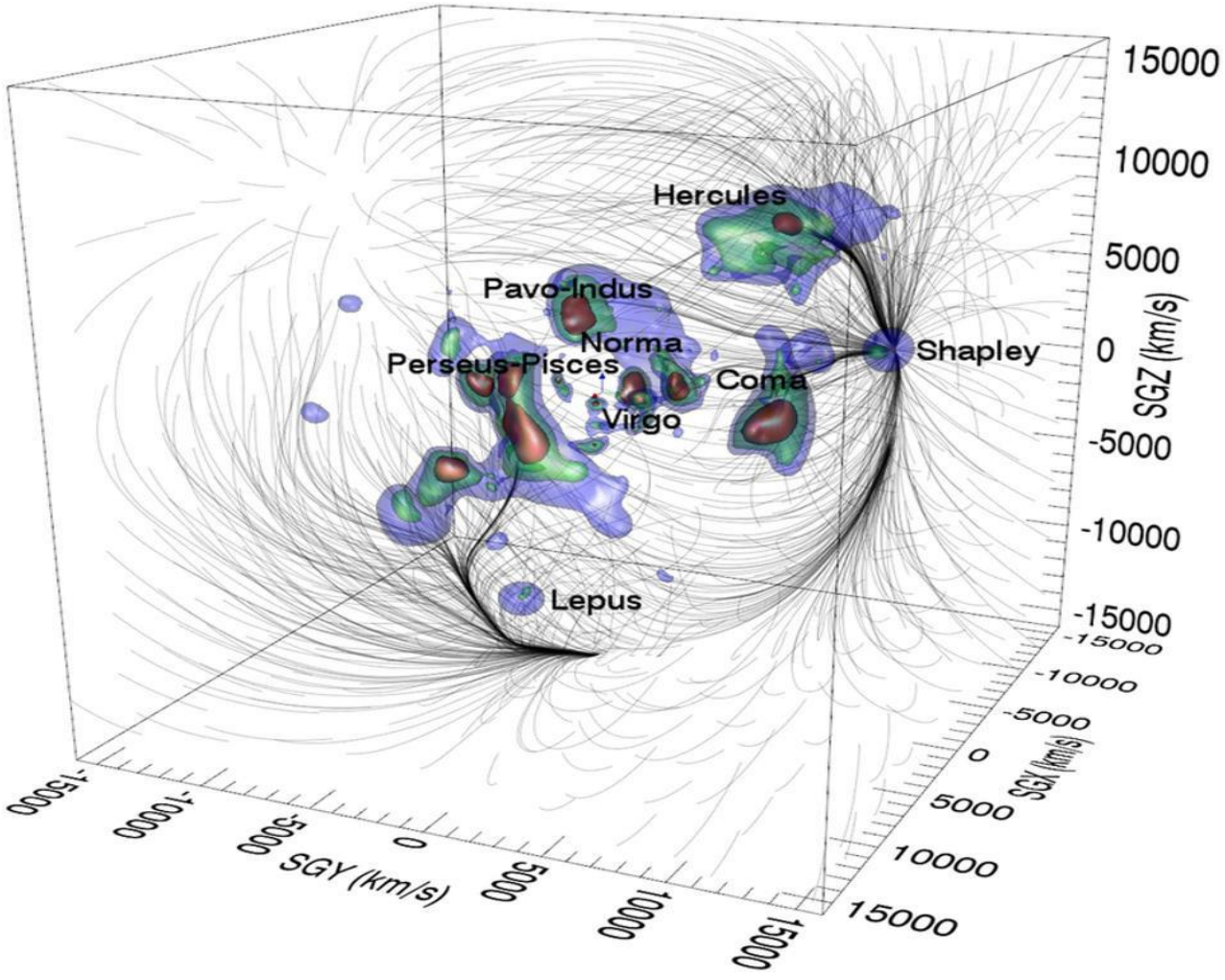

Fig. 1. Structure within a cube extending 16,000 km s−1 (~200 Mpc) on the cardinal axes from our position at the origin. Densities on a grid within the volume are determined from a Wiener Filter reconstruction based on the observed velocity field. Three isodensity contours are shown. The density map is detailed near the center of the box where observational constraints are dense and accurate but tapers to the mean density as constraints weaken. Nevertheless, velocity flows illustrated by the black threads are defined on large scales. Ultimately all flows appear to drain toward Shapley although flows through the Perseus-Pisces filament take a circuitous route through the poorly studied Lepus region. Adapted from [47].

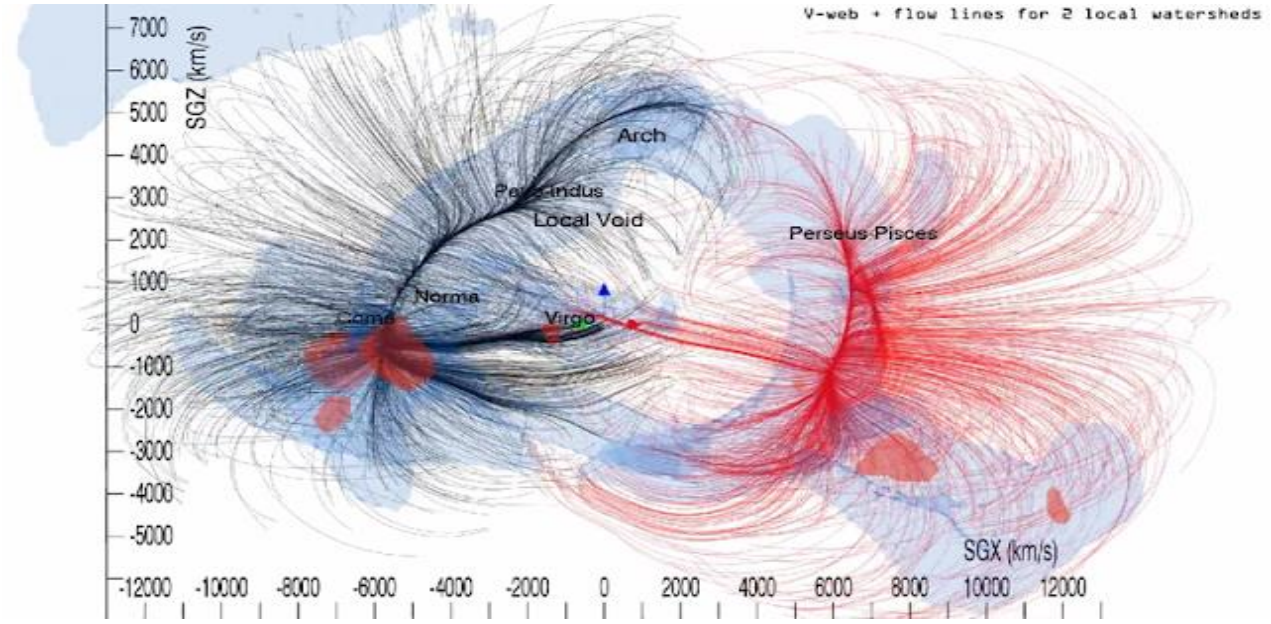

Fig. 2. A representation of structure and flows due to mass within 6,000 km s−1 (~80 Mpc). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near the Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near the Perseus Cluster are in red. The Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [47].

According to R. B. Tully, *et al.*, "*Galaxies congregate in clusters and along filaments, and are missing from large regions referred to as voids. These structures are seen in maps derived from spectroscopic surveys that reveal networks of structure that are interconnected with no clear boundaries. Extended regions with a high concentration of galaxies are called 'superclusters', although this term is not precise*" [47].

P. Wang, *et al.* made a great discovery: "*Most cosmological structures in the universe spin. Although structures in the universe form on a wide variety of scales from small dwarf galaxies to large super clusters, the* ***generation of angular momentum across these scales is poorly understood****. We have investigated the possibility that filaments of galaxies - cylindrical tendrils of matter hundreds of millions of light-years across, are themselves spinning. By stacking thousands of filaments together and examining the velocity of galaxies perpendicular to the filament's axis (via their red and blue shift), we have found that these objects too display motion consistent with rotation making them the largest objects known to have angular momentum.* ***These results signify that angular momentum can be generated on unprecedented scales***" [48].

In June 2021 at the "*Giant Arc at the 238th virtual meeting of the American Astronomical Society*", A. Lopez reported about the discovery of "*a giant, almost symmetrical arc of galaxies – the Giant Arc – spanning 3.3 billion light years at a distance of more than 9.2 billion light years away that is* ***difficult to explain in current models of the Universe****. The Giant Arc, which is approximately 1/15th the radius of the observable universe, is twice the size of the striking Sloan Great Wall of galaxies and clusters that is seen in the nearby Universe. This new discovery of the Giant Arc adds to an* ***accumulating set of (cautious) challenges to the Cosmological Principle****. The discovery of the Giant Arc adds to the*

number of structures on scales larger than those thought to be "smooth", and therefore pushes the boundary size for the Cosmological Principle. The growing number of large-scale structures over the size limit of what is considered theoretically viable is becoming harder to ignore. According to cosmologists, the current theoretical limit is calculated to be 1.2 billion light years, which makes the Giant Arc almost three times larger. ***Can the standard model of cosmology account for these huge structures in the Universe as just rare flukes or is there more to it than that?"*** [49].

WUM. These latest observations of the World can be explained in frames of the developed WUM only:

- *"Galaxies* **do not** *congregate in clusters and along filaments".* On the contrary, Cosmic Web that is "*networks of structure that are interconnected with no clear boundaries"* is the result of the Rotational Fission of DM Cores of neighbor Superclusters;
- *"Generation of angular momentum across these scales"* provide DM Cores of Superclusters through the Rotational Fission mechanism;
- *"Spinning cylindrical tendrils of matter hundreds of millions of light-years across"* are the result of spiral jets of galaxies generated by DM Cores of Superclusters with internal rotation;
- The Giant Arc is the result of the intersection of the Galaxies' jets generated by the neighbor DM Cores of Superclusters;
- Cosmological principal is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of total Matter. The distribution of Macroobjects with 1/3 of total Matter is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable;
- The main conjecture of SC: "*Projecting galaxy trajectories backwards in time means that they converge to the* ***Initial Singularity*** *at* $t=0$ *that is an infinite energy density state*" is wrong because all Galaxies are gravitationally bound with their Superclusters (see **Fig. 1** and **Fig. 2**);
- The **Hubble tension** that is the disagreement in the values of the Hubble's constant H_0 obtained by the various teams is due to the observations of Galaxies belonging to different Superclusters.

According to WUM, the value of H depends on the cosmological time: $H = \tau^{-1}$. It means that the **value of H should be measured based on Cosmic Microwave Background (CMB) Radiation only. Figure 3** illustrates recent H_0 determinations using only CMB data. WUM calculates the value of the Hubble's constant $H_0 = 68.7494\, km/s\, Mpc$ that is in excellent agreement with the most recent experimentally measured values [50].

5. Principally New Concepts of the World

Imagination is more important than knowledge. Knowledge is limited.
Imagination encircles the world.

Albert Einstein

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 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.

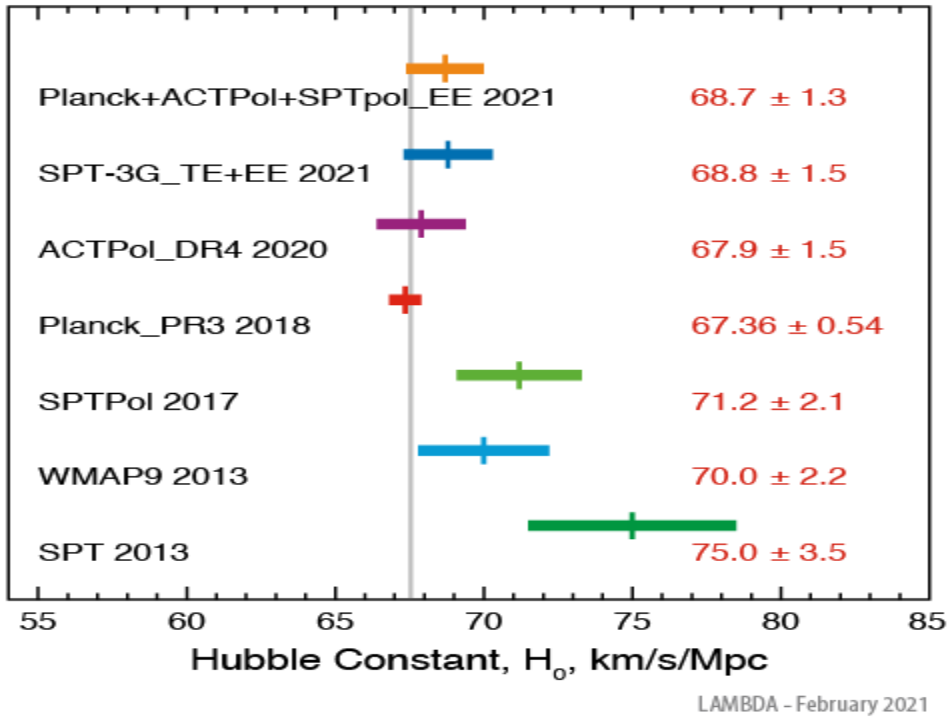

Fig. 3. Recent H_0 determinations using only CMB data. Adapted from [50],

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 [9]:

- 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 predicted value of G [18]:

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

is in excellent agreement with the experimentally measured by Qing Li, *et al.* in 2018 values using two independent methods [51]:

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

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

WUM recommends the predicted value of G for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022;

- The calculated value of $T_{MBR} = 2.72518\ K$ in the present epoch is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [52]. It is worth noting that at the Beginning of the Luminous Epoch (0.45 Byr) the calculated value was $T_{MBR} = 6.4775\ K$ and at the Birth of the SS (9.65 Byr) – $T_{MBR} = 3.0141\ K$. Therefore, any Model describing **creation of Macroobjects must hold true in cold World conditions**.

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 [53]. The outlines of the bubbles are quite sharp, and the Bubbles glow in nearly uniform gamma rays over their colossal surfaces. Gamma-ray spectrum remains unconstrained up to around 1 TeV [54]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

In **WUM,** Fermi Bubbles are DMPs' clouds containing uniformly distributed Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays. FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2. Weak interaction between DMF3 particles provides integrity of FBs. Gamma rays up to 1 TeV are the result of the self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) in Dark Matter Objects (DMOs). DMOs are macroobjects 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. The Core of the Milky Way supplies FBs with new DMPs through the galactic wind, explaining the brightness of FBs remaining constant during the time of observations. In our opinion, FBs are built continuously throughout the lifetime of Milky Way (13.77 By) [15].

Dark Matter Reactors. Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation and an uncontrolled thermonuclear fusion of them into heavier Dark Matter Superparticles (DMSPc) within their cores. The diversity of all gravitationally-rounded objects in 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 and all their geological processes like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc.

The following facts support the existence of **Dark Matter Cores** in Macroobjects:

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [55];

- By analyzing the earthquake doublets, J. 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 [56];
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [57];
- 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 [58]. The researchers were surprised by just how rough that boundary is – rougher than the surface layer that we all live on. In **WUM**, the 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [13];
- Random Variations of Earth's and Venus's Rotational Speed: the variations of the Earth daylength throughout 2020 were in the range $86400^{+1.62ms}_{-1.46ms}\ s$ [59] and the average sidereal day on Venus in the 2006-2020 interval was 243.0226 ± 0.0013 Earth days [60];
- Plutonium-244 with half-life of 80.6 million years and Iron-60 with half-life of 2.6 million years are not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments [61]. Any Pu-244 and Iron-60 present in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [62]. In **WUM**, Pu-244 and Iron-60 are produced within the Earth as the result of DMF1 particles self-annihilation. They arrive to the Crust of the Earth due to convection currents in the mantle carrying isotopes from the interior to the planet's surface [63].

Scientists from the Tibet ASγ experiment observed gamma rays with energies between 0.1 and 1 PeV, coming from the galactic disk regions. Specifically, they found 23 ultra-high-energy cosmic gamma rays with energies above 398 TeV along the Milky Way [64]. In frames of **WUM**, the gamma rays with energies between 1 TeV and 1 PeV can be explained by nuclear fission of DMSPs, consisting of many fused DMF1 (1.3 TeV), produced in the cores of Milky Way and stars.

Solar Corona. Geocorona. Planetary Coronas. Solar Corona is an aura of plasma that surrounds the Sun and extends at least $8 \times 10^6\ km$ into outer space [65] (compare with the Sun's radius $7 \times 10^5\ km$). Spectroscopy measurements indicate strong ionization and plasma temperature in excess of $10^6\ K$ [66]. The corona emits radiation mainly in the X-rays, observable only from space. The plasma is transparent to its own radiation and to solar radiation passing through it, therefore we say that it is optically-thin. The gas, in fact, is very rarefied, and the photon mean free-path by far overcomes all other length-scales, including the typical sizes of the coronal features.

In WUM, Solar corona made up of DMPs resembles a honeycomb filled with plasma. The following experimental results speak in favor of this model [15]:

- The corona emits radiation mainly in X-rays due to the self-annihilation of DMF3 particles;
- The plasma is transparent to its own radiation and to the radiation coming from below;
- The elemental composition of the Solar corona and the Solar photosphere are known to differ;
- During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted [67] (one photon had an energy as high as 467.7 GeV [15]). In our view, it is the result of enormous density fluctuations of DMPs in the Solar corona and their self-annihilation.

Geocorona is a luminous part of an outermost region of the Earth's atmosphere that extends to at least 640,000 km from the Earth [68]. It is seen primarily via Far-Ultra-Violet light from the Sun that is scattered by neutral hydrogen [69]. X-rays (in the range of energies $0.08 - 10\ keV$) from Earth's Geocorona were first detected by Chandra X-ray Observatory [70]. X-rays from Planets and some observed moons (Europa, Io, Io Plasma Torus, Titan) were also observed by Chandra [70]. According to NASA:

- The X-rays from Venus and, to some extent, the Earth, are due to the fluorescence of solar X-rays striking the atmosphere;
- Fluorescent X-rays from oxygen atoms in the Martian upper atmosphere are similar to those on Venus. A huge Martian dust storm was in progress when the Chandra observations were made. The intensity of the X-rays did not change during the dust storm;
- Jupiter has an environment capable of producing X-rays in a different manner because of its substantial magnetic field. X-rays are produced when high-energy particles from the Sun get trapped in its magnetic field and accelerated toward the polar regions where they collide with atoms in Jupiter's atmosphere;
- Like Jupiter, Saturn has a strong magnetic field, so it was expected that Saturn would also show a concentration of X-rays toward the poles. However, Chandra's observation revealed instead an increased X-ray brightness in the equatorial region. Furthermore, Saturn's X-ray spectrum was found to be similar to that of X-rays from the Sun.

The **Geocorona** and **Planetary Coronas** possess features like those of the Solar Corona.

6. Evidence of the Hypersphere World

The physical laws we observe appear to be independent of the Worlds' curvature in the fourth spatial dimension of the Nucleus due to the very small value of the dimension-transposing gravitomagnetic parameter of the Medium [3]. 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 a direct measurement of truly large-scale parameters of the World: Gravitational, Hubble's, Temperature of MBR. 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 [7].

Let us consider an effect that has indeed been observed for billions of years, albeit indirectly [7]. It is named the **Faint Young Sun paradox**. 4.57 billion years ago the Sun's output was only 70 percent as intense as it is today [71]. 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 $R_{MO} \propto \tau^{1/2}$ and $L_{MO} \propto \tau$ 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 today [7].

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 curved nature of the World 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 of the Nucleus of the World [15].

Energy in Matter. All particles in the World are fully characterized by their four-momentum $\left(\frac{E}{c}, \boldsymbol{p}\right)$ that satisfies the following equation:

$$(\frac{E}{c})^2 - \boldsymbol{p}^2 = Inv = (mc)^2$$

In WUM, the invariant is, in fact, a gravitostatic charge mc squared, and E is the gravitomagnetic charge (see Section 4). When the gravitostatic charge of particles equals to momentum p_{DB}, gravitomagnetic flux ϕ_{DB} is

$$\phi_{DB} = \frac{h}{p_{DB}} = \lambda_{DB}$$

known as de Broglie wavelength. The notion of "wavelength" is thus a macroscopic notion, namely, gravitomagnetic flux of particles characterized by four-momentum only [1]. We can rewrite the first equation as follows:

$$(\frac{E}{c})^2 = \boldsymbol{p}^2 + (mc)^2$$

where mc is, in fact, the momentum of the particle in the fourth spatial dimension. In case of the motionless particle ($\boldsymbol{p} = 0$) in the absolute reference frame (3D Medium), the total gravitostatic charge $(\frac{E}{c})$ equals to:

$$(\frac{E}{c}) = mc$$

Then, the gravitomagnetic charge of the motionless particle E equals to (see Section 4):

$$E = (\frac{E}{c}) \times c = mc^2$$

that is named "rest energy". It means that particles have rest energies due to the expansion of the Nucleus of the World in the fourth spatial dimension with the speed c that is the gravitomagnetic constant in WUM. In this regard, it is worth recalling the Nicola Tesla quote: *"There is no energy in matter other than that received from the environment. All this energy (sometimes viewed as "Zero Point Energy") comes from the environment giving life to matter, forming a "closed circuit" through one way or the other (being "accessed" more efficiently or less based on the methodology). It is omnipresent, day or night, and is "re-emitted" by every star in our universe naturally including our sun"* [72].

7. Conclusion

The proposed Hypersphere World-Universe Model is consistent with all Concepts of the World. WUM successfully describes primary cosmological parameters and their relationships, ranging in scale from large-scale structures to elementary particles. WUM allows for precise calculation of values that were only measured experimentally earlier and makes verifiable predictions. The remarkable agreement of the calculated values of the primary cosmological parameters with the observational data gives us considerable confidence in the Model. WUM needs significant further elaboration, but in its present shape, it can already serve as a basis for a new Physics proposed by Paul Dirac in 1937.

Acknowledgements

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