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.

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.

1. 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: $Q = 0.759972 \times 10^{40}$.

2. 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 $^2H(\alpha,\gamma)^6Li$ cross section at BB energies. The results they obtained have firmly **ruled out BB lithium production** as a possible explanation for the reported ^6Li 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 don't 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].

3. 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 $\tau \geq \tau_M$** .

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.**
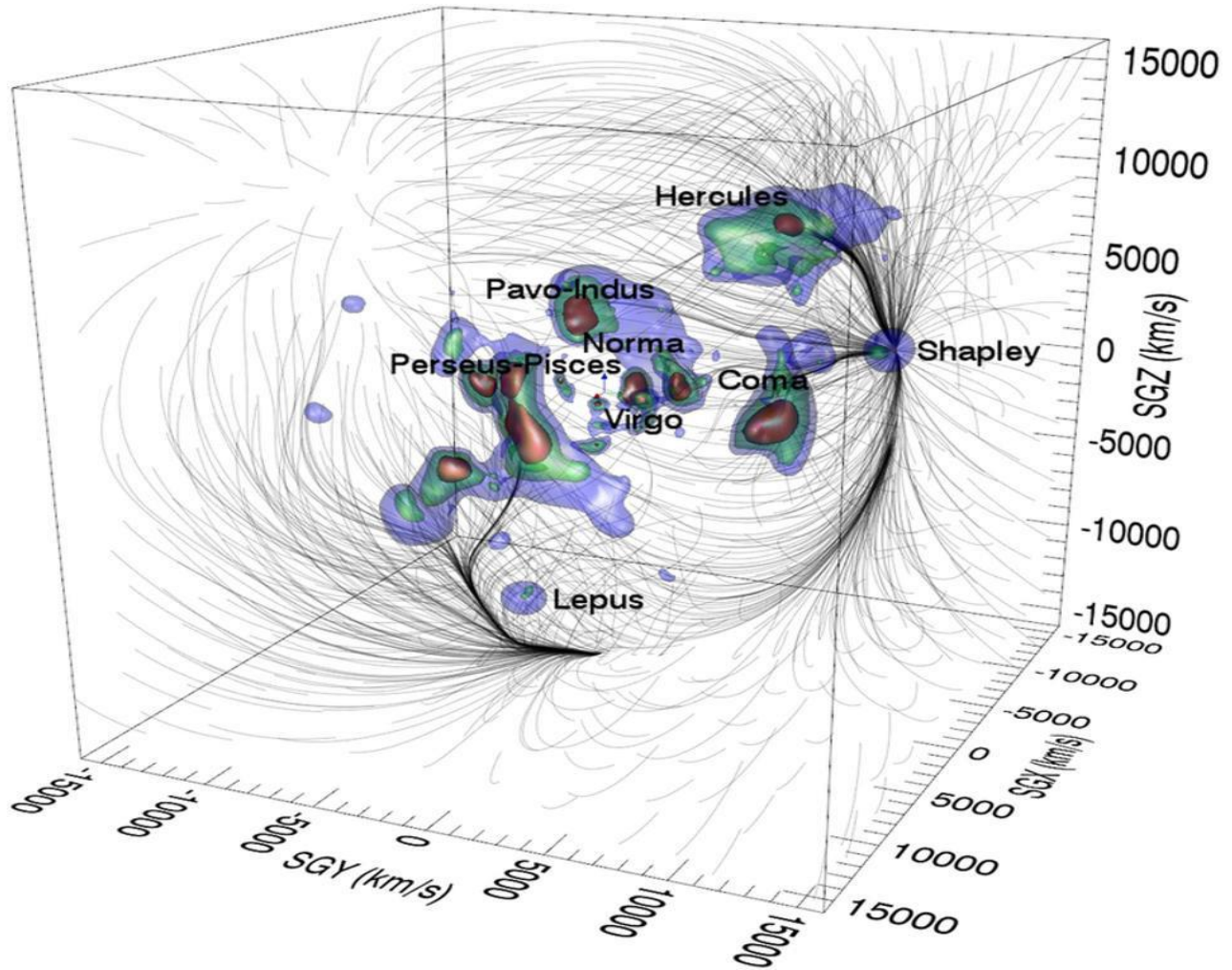
Fig. 1. Structure within a cube extending 16,000 km s−1 (∼200 Mpc) on the cardinal axes from our position at the origin. Densities on a grid within the volume are determined from a Wiener Filter reconstruction based on the observed velocity field. Three isodensity contours are shown. The density map 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].
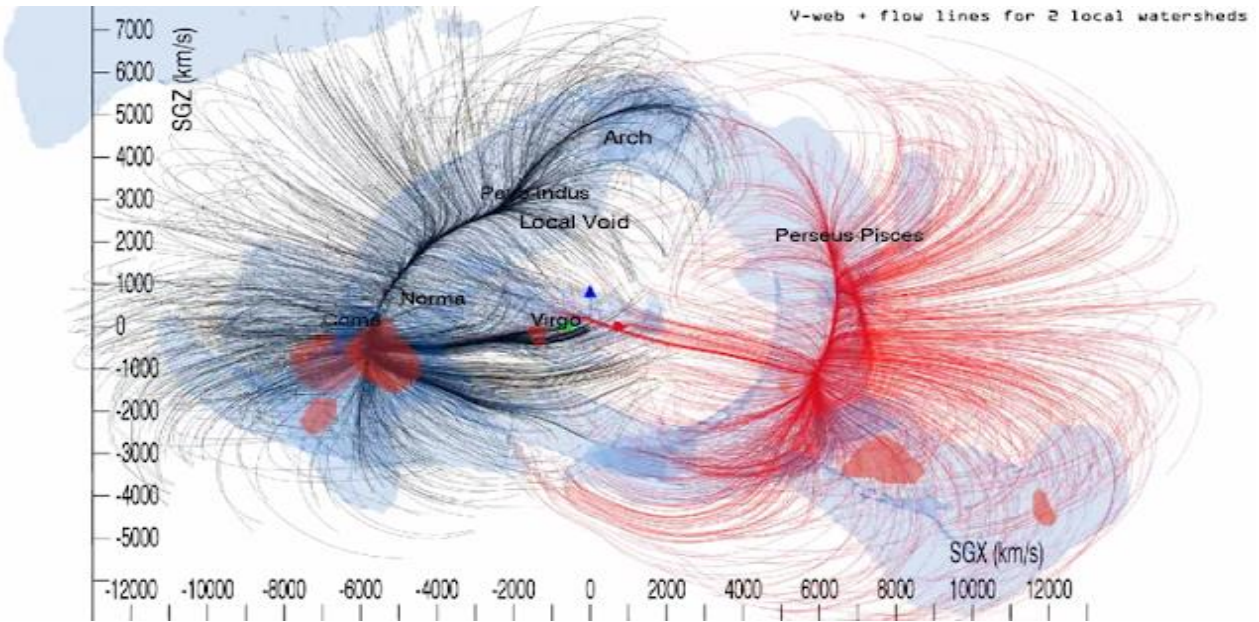
Fig. 2. A representation of structure and flows due to mass within 6,000 km s−1 (~80 Mpc). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads 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].

4. 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.
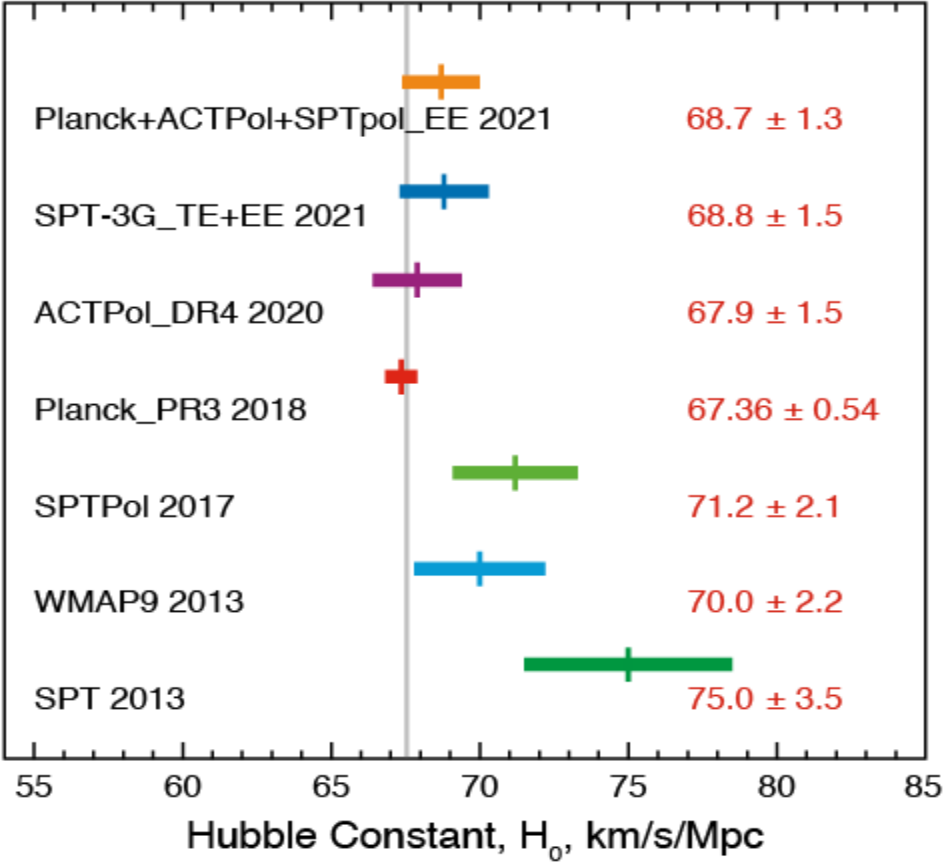
Fig. 3. Recent H_0 determinations using only CMB data. Adapted from [50],

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}.

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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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