

New Cosmology – Third Revolution in Physics

Vladimir S. Netchitailo

netchitailov@gmail.com

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.

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 :

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

- Dimensionless Rydberg constant α :

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

where μ_0 is 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: $g = 9.80665 \text{ m s}^{-2}$ and a general relativity acceleration is $\sim 3 \times 10^{-10} \text{ m s}^{-2}$ [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]:

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

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:

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

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

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

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

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

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

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: $Ry = hcR_\infty = 0.5\alpha^3E_0 = 13.605693 \text{ eV}$.

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]. 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 [38].

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.

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}

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.

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 $R_{min} \propto \tau^{1/2}$.

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**: $M_S = 215_{-31}^{+45} M_\odot$ [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 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].

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 [46].*

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 [46].

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 $E_{\nu_{\mu}}$;
- Tauonic neutrino rest energy $E_{\nu_{\tau}}$.

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 $2.72548 \pm 0.00057 K$ [47].
- 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 [48] 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* [49].

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 [50]. 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 [50].

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” [51]. 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;
- 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. 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 [52]. 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 [53]. 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 [54]. 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 [55]) 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 [56]. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre ‘chimneys’ [57]) 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: $D_{FB} = 28.6 \text{ kly}$ is in good agreement with the measured size of the FBs 25 kly [52] and 32.6 kly [57]. **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: $M_{FB} = 3.6 \times 10^{41} \text{ kg}$. Recall that the mass of Milky Way M_{MW} is about: $M_{MW} = (1.6 - 3.2) \times 10^{42} \text{ kg}$;
- FBs radiate X-rays due to the self-annihilation of DMF3 (3.7 keV). Gamma rays up to 1 TeV [58] 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 [59];
- 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 [60];
- 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 [61].

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 [62]. 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 [63].

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 [51].

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 [64]. The actual mean surface temperature of Earth is 288 K [65]. 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"* [66];

Jupiter radiates more heat than it receives from the Sun [67]. 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 [68]) 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 [69]; **Uranus** – 1.1 times [70]; **Neptune** – 2.6 times [71]. Many Icy Solar system bodies including **Pluto** possess subsurface oceans [72].

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 [73].

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 [74].

Random Variations of Earth's Rotational Speed. G. Jones and K. Bikos in the paper "Earth Is in a Hurry in 2020" wrote [75]: "*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 DMRs fueled by DMPs. All chemical elements, compositions, substances, rocks, etc. are produced by Macroobjects themselves as the result of DMPs self-annihilation. 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.

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 [76]. 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 [77]. 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 $\cong 14.22 \text{ Byr}$ and the age of the Solar system $\cong 4.57 \text{ Byr}$, 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 [78]:

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 $\alpha \cdot Q$ 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 interconnectivity 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.

Acknowledgements

I am eternally grateful to my Scientific Father Paul Dirac who was a genius and foresaw the Future of Physics in a New Cosmology. Special thanks to my son Ilya Netchitailo, who questioned every aspect of the Model and helped shape it to its present form.

References

- [1] Netchitailo, V. (2018) Hypersphere World-Universe Model. Tribute to Classical Physics. *Journal of High Energy Physics, Gravitation and Cosmology*, **4**, 441-470. doi: [10.4236/jhepgc.2018.43024](https://doi.org/10.4236/jhepgc.2018.43024).
- [2] Maxwell, J.C. (1861) On physical lines of force. *Philosophical Magazine*, **90**: 11–23. Bibcode:2010P Mag...90S..11M. doi:10.1080/14786431003659180.
- [3] Kohlrausch, R. and Weber, W. (1857) *Elektrodynamische Maaßbestimmungen : insbesondere Zurückführung der Stromintensitäts-Messungen auf mechanisches Maass. On the Amount of Electricity which Flows through the Cross-Section of the Circuit in Galvanic Currents* (Translated by Susan P. Johnson and

edited by Laurence Hecht).

<http://ppp.unipv.it/Collana/Pages/Libri/Saggi/Volta%20and%20the%20History%20of%20Electricity/V%206H%20Sect3/V%206H%20287-297.pdf>

- [4] Fizeau, H. (1849) Comptes Rendus: Hebdomadaires de scéances de l'Academie de Sciences. Paris, **29**, 90.
- [5] Maxwell, J.C. (1865) A dynamical theory of the electromagnetic field. Philosophical Transactions of the Royal Society of London. **155**: 459–512.
- [6] Heüman, G.D. (1888) The Rydberg formula as presented to Matematiskt-Fysiska förening. <https://commons.wikimedia.org/wiki/File:Rydbergformula.jpg>.
- [7] Thomson, J. J. (1897) Cathode Rays. Philosophical Magazine, **44**, 293. <http://web.lemoyne.edu/~giunta/thomson1897.html>.
- [8] Plank, M. (1901) On the Law of Distribution of Energy in the Normal Spectrum. Annalen der Physik, **4**, 553.
- [9] McCullagh, J. (1846) An Essay towards a Dynamical Theory of Crystalline Reflexion and Refraction. Transactions of the Royal Irish Academy, **21**, 17.
- [10] Tesla, N. (1937) Prepared Statement on the 81st Birthday Observance. <http://www.institutotesla.org/tech/TeslaGravity.html>.
- [11] Dirac, P.M. (1951). "Is there an Aether?" Nature, **168**, 906. Bibcode:1951Natur.168.906D. doi:10.1038/168906a0. <https://web.archive.org/web/20081217042934/http://dbhs.wvusd.k12.ca.us/webdocs/Chem-History/Planck-1901/Planck-1901.html>.
- [12] Netchitailo, V.S. (2016) 5D World-Universe Model. Gravitation. Journal of High Energy Physics, Gravitation and Cosmology, **2**, 328. <http://dx.doi.org/10.4236/jhepgc.2016.23031>
- [13] Riemann, B. (1854) On the Hypotheses which lie at the Bases of Geometry. Translated by William Kingdon Clifford. Nature, Vol. VIII. Nos. **183**, **184**, pp. 14–17, 36, 37.
- [14] Netchitailo, V. S. (2017) Mathematical Overview of Hypersphere World – Universe Model. *Journal of High Energy Physics, Gravitation and Cosmology*, **3**, 415.
- [15] Netchitailo, V.S. (2016) Overview of Hypersphere World-Universe Model. *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 593. <https://doi.org/10.4236/jhepgc.2016.24052>
- [16] Thirring, H. (1918) On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation. Physikalische Zeitschrift, **19**, 204.
- [17] Heaviside, O. (1893) A gravitational and electromagnetic analogy. The Electrician, **31**, 81.
- [18] By Guochang Xu (2003) GPS: Theory, Algorithms and Applications. Springer-Verlag Berlin Heidelberg. https://books.google.com/books?id=aRKPAXBt174C&pg=PA240&lpg=PA240&dq=%22general+relativity+acceleration%22&source=bl&ots=NnD-YVx9Go&sig=ACfu3U3pvauEbW74ZuxzVIZr9n_KTb7qTw&hl=en&sa=X&ved=2ahUKewidiaDnhJHqAhVScq0KHXRBBdMQ6AEwCChoECAsQAO#v=onepage&q=%22general%20relativity%20acceleration%22&f=false
- [19] Dirac, P.A.M. (1938) A new basis for cosmology. Proc. R. Soc. Lond. **A165**, 199. DOI:10.1098/rspa.1938.0053.
- [20] Hoyle, F. and Narlikar, J.V. (1964) A New Theory of Gravitation. Proc. R. Soc. Lond., **A282**, 178.
- [21] Dirac, P.A.M. (1974) Cosmological Models and the Large Numbers Hypothesis. Proc. R. Soc. Lond. **A338**, 439.
- [22] Boehm, C., Fayet, P., Silk, J. (2003) Light and Heavy Dark Matter Particles. arXiv:0311143.
- [23] Arrenberg, S., *et al.* (2013) Complementarity of Dark Matter Experiments. <http://www-public.slac.stanford.edu/snowmass2013/docs/CosmicFrontier/Complementarity-27.pdf>.
- [24] Heeck, J. and Zhang, H. (2013) Exotic Charges, Multicomponent Dark Matter and Light Sterile Neutrinos. arXiv:1211.0538.
- [25] Aoki, M., *et al.* (2012) Multi-Component Dark Matter Systems and Their Observation Prospects. arXiv:1207.3318.
- [26] Kusenko, A., Loewenstein, M., Yanagida, T. (2013) Moduli dark matter and the search for its decay line using Suzaku x-ray telescope. Phys. Rev., **D 87**, 043508.
- [27] Feldman, D., Liu, Z., Nath, P., Peim, G. (2010) Multicomponent Dark Matter in Supersymmetric Hidden Sector Extensions. arXiv:1004.0649.

- [28] Feng, J.L. (2010) Dark Matter Candidates from Particle Physics and Methods of Detection. arXiv: 1003.0904.
- [29] Zurek, K.M. (2009) Multi-Component Dark Matter. arXiv: 0811.4429.
- [30] Spolyar, D., Freese, K., Gondolo, P. (2007) Dark matter and the first stars: a new phase of stellar evolution. arXiv:0705.0521.
- [31] Ripamonti, E. and Abel, T. (2005) The Formation of Primordial Luminous Objects. arXiv:0507130.
- [32] Lee, B.W. and Weinberg, S. (1977) Cosmological lower bound on heavy-neutrino masses. Phys. Rev. Lett. **39**, 165.
- [33] Dicus, D.A., Kolb, E.W., and Teplitz, V.L. (1977) Cosmological upper bound on heavy-neutrino lifetimes. Phys. Rev. Lett. **39**, 168.
- [34] Dicus, D.A., Kolb, E.W., and Teplitz, V.L. (1978) Cosmological implications of massive, unstable neutrinos. Astrophys. J. **221**, 327.
- [35] Gunn, J. E., *et al.* (1978) Some astrophysical consequences of the existence of a heavy stable neutral lepton. Astrophys. J. **223**, 1015.
- [36] Stecker, F. W. (1978) The cosmic gamma-ray background from the annihilation of primordial stable neutral heavy leptons. Astrophys. J. **223**, 1032.
- [37] Zeldovich, Ya.B., Klypin, A.A., Khlopov, M.Yu., and Chechetkin, V.M. (1980) Astrophysical constraints on the mass of heavy stable neutral leptons. Sov. J. Nucl. Phys. **31**, 664.
- [38] Corda, C. (2009) Interferometric Detection of Gravitational Waves: The Definitive Test for General Relativity. International Journal of Modern Physics, **18**, 2275-2282.
- [39] Netchitailo, V. (2019) Dark Matter Cosmology and Astrophysics. *Journal of High Energy Physics, Gravitation and Cosmology*, **5**, 999-1050. doi: [10.4236/jhepgc.2019.54056](https://doi.org/10.4236/jhepgc.2019.54056).
- [40] Netchitailo V. S. (2013) Word-Universe Model. <https://vixra.org/pdf/1303.0077v7.pdf>.
- [41] Bestenlehner, J. M., *et al.* (2020) The R136 star cluster dissected with Hubble Space Telescope/STIS. II. Physical properties of the most massive stars in R136. arXiv:2009.05136.
- [42] Mehrgan, K., *et al.* (2019) A 40-billion solar mass black hole in the extreme core of Holm 15A, the central galaxy of Abell 85. arXiv:1907.10608.
- [43] Shemmer, O., *et al.* (2004) Near Infrared Spectroscopy of High Redshift Active Galactic Nuclei. I. A Metallicity-Accretion Rate Relationship. arXiv:0406559.
- [44] Argüelles, C. R., *et al.* (2021) On the formation and stability of fermionic dark matter haloes in a cosmological framework. Monthly Notices of the Royal Astronomical Society, **502**, 4227. <https://doi.org/10.1093/mnras/staa3986>.
- [45] Bliss, L. (2014) The Milky Way's 'City' Just Got a New Name. CityLab. 3. <https://www.bloomberg.com/news/articles/2014-09-03/the-milky-way-s-city-just-got-a-new-name>.
- [46] Carr, B., Kühnel, F., Visinelli, L. (2021) Constraints on stupendously large black holes. *Monthly Notices of the Royal Astronomical Society*, **501**, 2029. <https://doi.org/10.1093/mnras/staa3651>.
- [47] Fixsen, D.J. (2009) The Temperature of the Cosmic Microwave Background. arXiv: 0911.1955.
- [48] C. L. Bennett, *et al.* (2013) Nine-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Final Maps and Results. arXiv:1212.5225v3.
- [49] Freedman, W. L., *et al.* (2020) Calibration of the Tip of the Red Giant Branch (TRGB). arXiv:2002.01550.
- [50] Netchitailo V. S. (2020) Hypersphere World-Universe Model: Evolution of the World. <https://vixra.org/pdf/2011.0209v2.pdf>
- [51] Netchitailo, V. (2019) Solar System. Angular Momentum. New Physics. *Journal of High Energy Physics, Gravitation and Cosmology*, **5**, 112-139. doi: [10.4236/jhepgc.2019.51005](https://doi.org/10.4236/jhepgc.2019.51005).
- [52] Aguilar, D.A. and Pulliam, C. (2010) Astronomers Find Giant, Previously Unseen Structure in our Galaxy. Harvard-Smithsonian Center for Astrophysics. Release No. 2010-22.
- [53] Yang, L. and Razzaque, S. (2019) Constraints on very high energy gamma-ray emission from the Fermi Bubbles with future ground-based experiments. arXiv:1811.10970v1.
- [54] Hooper, D. and Goodenough, L. (2011) Dark matter annihilation in the Galactic Center as seen by the Fermi Gamma Ray Space Telescope. Physics Letters B, **697**, 412. doi:10.1016/j.physletb.2011.02.029.
- [55] Beall, J.H. (2015) A Review of Astrophysical Jets. Proceedings of Science: 58.

- Bibcode: [2015mbhe.confE..58B](#) . Retrieved 19 February 2017.
- [56] Su, M. and Finkbeiner, D.P. (2012) Evidence for Gamma-Ray Jets in the Milky Way. arXiv:1205.5852.
- [57] Ponti, G., *et al.* (2019) An X-ray chimney extending hundreds of parsecs above and below the Galactic Centre. *Nature* **567**, 347–350.
- [58] Hooper, D. and Slatyer, T.R. (2013) Two Emission Mechanisms in the Fermi Bubbles: A Possible Signal of Annihilating Dark Matter. arXiv:1302.6589.
- [59] Fossat, E., *et al.* (2017) Asymptotic g modes: Evidence for a rapid rotation of the solar core. arXiv:1708.00259.
- [60] Zhang, J., *et al.* (2005) Inner Core Differential Motion Confirmed by Earthquake Waveform Doublets. *Science*, 309, 1357–1360. <https://doi.org/10.1126/science.1113193>.
- [61] Guillot, T., *et al.* (2018) A Suppression of Differential Rotation in Jupiter’s Deep Interior. *Nature*, 555, 227–230. <https://www.nature.com/articles/nature25775>.
- [62] Wu, W., Ni, S. and Irving, J. C. E. (2019) Inferring Earth’s discontinuous chemical layering from the 660-kilometer boundary topography. *Science*, **363**, 736. DOI: 10.1126/science.aav0822.
- [63] Princeton University (2019) Massive Bolivian earthquake reveals mountains 660 kilometers below our feet. <https://phys.org/news/2019-02-massive-bolivian-earthquake-reveals-mountains.html>.
- [64] Cole, G.H.A. and Woolfson, M.M. (2002) *Planetary Science: The Science of Planets around Stars*. Institute of Physics Publishing, 36–37, 380–382. <https://doi.org/10.1887/075030815X>.
- [65] Kinver, M. (2009) Global Average Temperature May Hit Record Level in 2010. <http://news.bbc.co.uk/2/hi/science/nature/8406839.stm>.
- [66] Gando, A., *et al.* (2011) Partial radiogenic heat model for Earth revealed by geoneutrino measurements. *Nature Geoscience*, **4**, 647.
- [67] Elkins-Tanton, Linda T. (2006). *Jupiter and Saturn*. New York: Chelsea House. ISBN 978-0-8160-5196-0.
- [68] O’Donoghue, J., Moore, L., Stallard, T. S., and Melin, H. (2016) Heating of Jupiter’s upper atmosphere above the Great Red Spot. *Nature*, 18940.
- [69] de Pater, I., Lissauer, J. J. (2010) *Planetary Sciences* (2nd ed.). Cambridge University Press. pp. 254–255. ISBN 978-0-521-85371-2.
- [70] Class 12 – Giant Planets – Heat and Formation. 3750 – Planets, Moons & Rings. Colorado University, Boulder. 2004. Retrieved 13 March 2008.
- [71] Pearl, J. C.; Conrath, B. J. (1991). "The albedo, effective temperature, and energy balance of Neptune, as determined from Voyager data". *Journal of Geophysical Research: Space Physics*. 96: 18, 921–18, 930. Bibcode:1991JGR...9618921P. doi:10.1029/91ja01087.
- [72] Kamata, S., *et al.* (2019) Pluto’s ocean is capped and insulated by gas hydrates. *Nature Geoscience*, **12**, Issue 5. DOI <https://doi.org/10.1038/s41561-019-0369-8> .
- [73] Hoffman, D.C., *et al.* (1971) Detection of Plutonium-244 in Nature. *Nature*, **234**, 132.
- [74] Ricard, Y. (2009) 2. Physics of Mantle Convection. In David Bercovici and Gerald Schubert. *Treatise on Geophysics: Mantle Dynamics*, **7**. Elsevier Science. ISBN 9780444535801.
- [75] Jones, G., and Bikos K. (2020) Earth Is in a Hurry in 2020. <https://www.timeanddate.com/time/earth-faster-rotation.html>.
- [76] Netchitailo, V. (2015) 5D World-Universe Model Space-Time-Energy. *Journal of High Energy Physics, Gravitation and Cosmology*, **1**, 25–34. doi: [10.4236/jhepgc.2015.11003](https://doi.org/10.4236/jhepgc.2015.11003).
- [77] Gough, D.O. (1981) Solar interior structure and luminosity variations. *Solar Physics*, **74**, 21.
- [78] Netchitailo, V. (2020) Hypersphere World-Universe Model: Basic Ideas. *Journal of High Energy Physics, Gravitation and Cosmology*, **6**, 710–752. <https://doi.org/10.4236/jhepgc.2020.64049>.