Development of Hypersphere World-Universe Model. Narrative. Part VIII. Conclusion

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Abstract

WUM is based on two parameters only: dimensionless Rydberg constant α and time-varying quantity Q. The World's energy density is proportional to Q^{-1} in all cosmological times. Particles relative energy densities are proportional to α. In WUM we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units of time t_0, size a, and energy E_0. Taking the relative values of physical parameters in terms of the Basic Units we can express all dimensionless parameters of the World through two parameters α and Q in various rational exponents, as well as small integer numbers and π. There are no Fundamental Physical Constants in WUM. In our opinion, constant α and quantity Q should be named "Universe Constant" and "World Parameter" respectively.

We do not know that our 3D space is curved. But we know that it is expanding without center of expansion. We introduce the radius of the curvature in the fourth spatial dimension $R = a \times Q$ to give an explanation providing insight into the curved nature of the World. 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.

WUM does not attempt to explain all available cosmological data, as that is an impossible feat for any one article. Nor does WUM pretend to have built an all-encompassing theory that can be accepted as is. The Model needs significant further elaboration, but in its present shape, it can already serve as a basis for a new Cosmology proposed by Paul Dirac in 1937.

Astronomers have great achievements in investigations of the Solar System that became an Experimental laboratory for astrophysicists to check their theories. We are at the Beginning of a New Era of Astronomy, Cosmology, and Astrophysics! Young physicists should be a part of It. They should concentrate their efforts on the development of a New Cosmology and Classical Physics. I am very excited about the Future of Physics!

Mysteries of Solar System Explained by WUM

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Abstract

E. Stone in the article *"18 Mysteries and Unanswered Questions About Our Solar System. Little Astronomy"* wrote: *One of the great things about astronomy is that there is still so much out there for us to discover. There are so many unanswered questions and mysteries about the universe. There is always a puzzle to solve and that is part of beauty. Even in our own neighborhood, the Solar System, there are many questions we still have not been able to answer* [1]. In the present paper, we explain the majority of these Mysteries and some other unexplained phenomena in the Solar System (SS) in frames of the developed Hypersphere World-Universe Model (WUM) [2].

1. Introduction

Physics is an Experimental Science. In my opinion, there is a principal difference between Physics and Mathematics. I am convinced that Physics cannot exist without Mathematics, but Mathematics must not replace Physics. It is exactly what has happened for the last 100 years. I absolutely agree with J. 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*". The value of models is not only describing observed phenomena but making verifiable predictions and setting up targeted experiments based on the obtained experimental results.

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 quantum theory, perhaps looking forward to the current bonanza in cosmology*". In 1937, P. Dirac proposed: the Large Number Hypothesis and Hypothesis of the variable gravitational "constant"; and later added the notion of continuous creation of Matter in the World. The developed Hypersphere WUM follows these ideas, albeit introducing a different mechanism of Matter creation. Considering the JWST discoveries, successes of WUM, and 86 years of Dirac's proposals, it is high time to make a Paradigm Shift for Cosmology and Classical Physics.

2. Short History of Solar System Formation

The most widely accepted model of SS formation, known as the Nebular hypothesis, was first proposed in 1734 by E. Swedenborg [3], [4] and later elaborated and expanded upon by I. Kant in 1755 in his "Universal Natural History and Theory of the Heavens" [5]. The Nebular hypothesis maintains that 4.57 billion years ago, 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 SS formed.

The initial collapse of a solar-mass protostellar nebula takes around 100,000 years. Every nebula begins with a **certain amount of angular momentum**. Gas in the central part of the nebula, with relatively low angular momentum, undergoes fast compression and forms a hot hydrostatic (not contracting) core containing a small fraction of the mass of the original nebula. This core forms the seed of what will become a star. As the

collapse continues, **conservation of angular momentum** means that the rotation of the infalling envelope accelerates [6].

The Nebular hypothesis is not without its critics. In his "*The Wonders of Nature*", V. Ferrell outlined the following counter-arguments [7]:

- It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;
- Each planet and moon in the solar system has unique structures and properties. How could each one be different if all of them came from the same nebula;
- A full 98 percent of all the angular momentum in the solar system is concentrated in the planets, yet a staggering 99.8 percent of all the mass in our Solar system is in our Sun;
- Jupiter itself has 60 percent of the planetary angular motion. Evolutionary theory cannot account for this. 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 SS origin are to be accepted.

The Nebular hypothesis does not solve the most critical Angular Momentum problem. Standard model cannot answer the following questions:

- Where the original nebula has got a **certain amount of angular momentum**;
- Why is the orbital momentum of Jupiter larger than the rotational momentum of the Sun;
- How SS obtained its enormous orbital angular momenta**?**

The present article introduces an Explosive Volcanic Rotational Fission model of creation and evolution of Macrostructures of the World (Superclusters, Galaxies, Extrasolar Systems), based on Dark Matter (DM) Overspinning Cores of the World's Macroobjects. WUM is the only cosmological model in existence that is consistent with this Fundamental Law.

Lunar origin fission hypothesis was proposed by G. Darwin in 1879 to explain the origin of the Moon by rapidly spinning Earth, on which equatorial gravitative attraction was nearly overcome by centrifugal force [8]. D. U. Wise made a detailed analysis of this hypothesis in 1966 and concluded that "*it might seem prudent to include some modified form of rotational fission among our working hypothesis*" [9].

Solar fission theory was proposed by L. Jacot in 1951[10]. He stated that:

- The planets were expelled from the Sun one by one from the equatorial bulge caused by rotation;
- One of these planets shattered to form the asteroid belt;
- Moons and rings of planets were formed from the similar expulsion of material from their parent planets.

T. Van Flandern further extended this theory in 1993. He proposed that planets were expelled from the Sun in pairs at different times. Six original planets exploded to form the rest of the modern planets. It solves several problems the standard model does not [11]:

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

The outstanding issues of the Solar fission are:

- It is usually objected that tidal friction between a proto-planet and a gaseous parent, such as the proto-Sun, ought to be negligible because the gaseous parent can reshape itself so that any tidal bulge has no lag or lead, and therefore transfers no angular momentum to the proto-planet;
- There would exist no energy source to allow for planetary explosions.

Neither L. Jacot nor T. Van Flandern proposed an origin for the Sun itself. It seems that they followed the standard Nebular hypothesis. In our work, we concentrated on furthering the Solar Fission theory [12].

3. Hypersphere World-Universe Model
3.1. Essence of WUM

Main ideas of WUM are as follows [12-20]:
- The Finite World is a 3D Hypersphere of the 4D Nucleus of the World, which is 4D ball expanding in the fourth spatial dimension. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World;
- The Universe is responsible for the creation of Dark Matter (DM) in the 4D Nucleus of the World. Dark Matter Particles (DMPs) carry new DM into the World. Luminous Matter is a byproduct of DMPs self-annihilation. DM plays a central role in creation and evolution of all Macroobjects (MOs);
- WUM introduces Dark Epoch (spanning from the Beginning of the World 14.22 Byr ago for 0.45 Byr) and Luminous Epoch (ever since, 13.77 Byr). Transition from Dark Epoch to Luminous Epoch is due to an Explosive Volcanic Rotational Fission (VRF) of Overspinning DM Supercluster's Cores and self-annihilation of DMPs;
- The Medium of the World, consisting of protons, electrons, photons, neutrinos, and DMPs, is an active agent in all physical phenomena in the World. Time, Space and Gravitation are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium, respectively. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. WUM confirms the Supremacy of Matter postulated by A. Einstein: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*";
- WUM based on Cosmological Time that marches on at the constant pace from the Beginning of the World up to the present Epoch along with time-varying Principal Cosmological Parameters;
- MOs 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. Macroobjects' cores are essentially DM Reactors fueled by DMPs. All chemical elements, compositions, substances, rocks, *etc.* are produced by MOs themselves as the result of DMPs self-annihilation in their Cores;
- WUM is the only cosmological model in existence that is consistent with the Fundamental Law of Conservation of Angular Momentum;
- Thanks to the revealed by WUM Inter-Connectivity of Primary Cosmological Parameters, we show that Gravitational parameter that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly;
- 3D Finite Boundless World (Hypersphere of 4D Nucleus) presents Patchwork Quilt of various Luminous Superclusters ($\gtrsim 10^3$), which emerged in different places of the World at different Cosmological times. The Medium of the World is Homogeneous and Isotropic. Distribution of MOs is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous;
- WUM is based on two parameters only: dimensionless Rydberg constant α (later named Fine-structure constant) and time-varying Quantity Q that is, in fact, the Dirac Large Number and a measure of the

Worlds' curvature in the fourth spatial dimension and the Age of the World. In our opinion, constant α and quantity Q should be named "Universe Constant" and "World Parameter" respectively;

- The manuscript "*Review Article: Cosmology and Classical Physics*" [2] is a synthesis of our approach to Cosmology, and the article "*JWST Discoveries—Confirmation of World-Universe Model Predictions*" [20] is a quintessence of WUM.

3.2. Main Pillars of WUM

3.2.1. Medium

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. Intergalactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. MBR is part of the Medium; it then follows that the Medium is the absolute frame of reference. Relative to MBR rest frame, Milky Way (MW) galaxy and the Sun are moving with the speed of 552 and 370 $km\ s^{-1}$, respectively.

3.2.2. Multicomponent Dark Matter

WUM proposes multicomponent DM system consisting of two couples of co-annihilating 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 $\mu = e/2\alpha$ (e is elementary charge); 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; self-annihilating fermions DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain:

- The diversity of Very High Energy gamma-ray sources in the World;
- The diversity of DM Cores of MOs of the World (superclusters, galaxies, and extrasolar systems), which are Fermion Compact Objects in WUM.

WUM postulates that rest energies of DMFs and bosons are proportional to a basic energy unit: $E_0 = hc/a$ (h is Planck constant, c is the electrodynamic constant, and a is a basic size unit) multiplied by different exponents of α and can be expressed with following formulae [19]:

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

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

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

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

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

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

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 MOs in the World. We connect observed gamma-ray spectra with the structure of MOs (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 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.

Neutrons serve as another example. The mass of a neutron cannot be directly determined by mass spectrometry since it has no electric charge. But since the masses of a proton and of a deuteron can be measured with a mass spectrometer, the **mass of a neutron can be deduced** by subtracting proton mass from deuteron mass, with the difference being the mass of the neutron plus the binding energy of deuterium.

DMPs do not possess an electric charge. Their masses cannot be directly measured by mass spectrometry. Hence, they can be observed only indirectly due to their self-annihilation and irradiation of gamma-quants.

3.2.3. Macroobject Shell Model

In 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. A proposed Weak Interaction of DMPs provides integrity of all shells. **Table 1** describes parameters of MOs' Cores, which are 3D fluid balls with a very high viscosity and function as solid-state objects [20].

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

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

The calculated parameters of the shells show that:
- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in Extrasolar Systems (ESS);
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;
- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of Superclusters.

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 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 [21]. It is worth noting that there are no black holes in WUM.

"*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 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*" [22].

In WUM, Cores of all MOs possess the following properties [20]:
- Their Nuclei are made up of DMFs and contain other particles, including DM and Baryonic matter, in shells surrounding the Nuclei;

- DMPs are continuously absorbed by Cores of all MOs. Ordinary Matter (about 7.2% of the total Matter) is a byproduct of DMPs self-annihilation. It is re-emitted by Cores of MOs continuously;
- Nuclei and shells are growing in time: size $\propto \tau^{1/2}$; mass $\propto \tau^{3/2}$; and rotational angular momentum $\propto \tau^{2}$, until they reach the critical point of their stability, at which they detonate. Satellite cores and their orbital L_{orb} and rotational L_{rot} angular momenta released during detonation are produced by Overspinning DM Cores (OCs). The detonation process does not destroy OCs; it is rather gravitational hyper-flares;
- Size, mass, composition, L_{orb} and L_{rot} of satellite DM cores depend on local density fluctuations at the edge of OC and cohesion of the outer shell. Consequently, the diversity of satellite DM cores has a clear explanation. Satellite DM cores are given off by "**Volcanoes**" on prime DM cores erupting repeatedly over millions or billions of years.

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

- As the result of GB, the OCs lose a small fraction of their mass and a large part of their rotational angular momentum;
- After GB, DM Cores of Prime Objects (superclusters, galaxies, stars, and planets) absorb new DMPs. Their masses increase $\propto \tau^{3/2}$, and their angular momenta L_{rot} increase much faster $\propto \tau^{2}$, until they detonate again at the next critical point of their stability. That is why DM cores of Satellites (galaxies, stars, planets, and moons, respectively) are rotating around their own axes and DM Cores of Prime Objects;
- Afterglow of GB is a result of processes developing in the Nuclei and shells after detonation;
- In case of ESS, a star wind is the afterglow of star detonation: Star's DM Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 Byr ago. It creates the SS bubble continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic DM Core detonations. In MW it continuously creates two DM Fermi Bubbles.

3.2.4. Angular Momentum

Angular Momentum Problem is one of the most critical problems in Standard model that must be solved. Standard model does not explain how Galaxies and ESS obtained their enormous orbital angular momenta.

In our opinion, there is only one mechanism that can supply angular momenta to MOs – **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 rotational 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". To be consistent with the Law of Conservation of Angular Momentum, we developed a New Cosmology [12]:

- WUM introduces Dark Epoch (spanning for Laniakea Supercluster (LSC) from the Beginning 14.22 Byr ago for 0.45 Byr) when only DM MOs existed, and Luminous Epoch (ever since for 13.77 Byr for LSC) when Luminous MOs emerged due to the VRF of Overspinning DM Superclusters' Cores and self-annihilation of DMPs;
- Proposed **Weak Interaction** of DMPs (see Section 3.2.6) provides the integrity of DM Cores, which are **3D fluid balls with a very high viscosity** and act as solid-state objects;
- The principal objects 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 VRF. Experimental observations of galaxies in the universe showed that most of them are disk galaxies. These results speak in favor of the developed VRF.

3.2.5. Formation of Macrostructures

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to MW and approximately 10^5 other nearby galaxies. It is known as one of the largest superclusters with estimated binding mass $10^{17} \, M_\odot$. Neighboring superclusters are Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. The mass-to-light ratio of Virgo Supercluster is ~ 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [23]. 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*" [24].

We emphasize that $\sim 10^5$ nearby galaxies are moving around Centre of LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structures. It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$).

In frames of WUM:

- LSC emerged 13.77 billion years ago due to VRF of the Supercluster Overspinning DM Core and self-annihilation of DMPs. Core was created during Dark Epoch when only DM MOs existed;
- DM Core of MW was born 13.77 billion years ago as the result of VRF of Virgo Supercluster DM Core;
- DM Cores of ESS, planets and moons were born as a result of the repeating VRFs of MW 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, moons.

3.2.6. Multiworld

According to A. G. Oreshko, "*P. L. Kapitsa supposed that a ball lightning is a window in another world*" [25]. We analyzed the possibility of the existence of other Worlds: Micro-World, Small-World, and Large-World based on the proposed Weak, Super-Weak and Extremely-Weak interaction respectively [38]. It was suggested that Ball Lightning is an object of the Small-World. Below we discuss main characteristics of the proposed new Worlds in the Multiworld [26].

Macro-World. According to WUM, strength of gravity is characterized by gravitational parameter G:

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

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

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

The total mass of the Macro-World M_{tot} is:

$$M_{tot} = 6\pi^2 m_0 \times Q^2 = 4.26943 \times 10^{53} \, kg$$

where m_0 is a basic mass unit: $m_0 = h/ac$, and average density ρ_{tot}:

$$\rho_{MW} = 3\rho_0 \times Q^{-1} = 8.87794 \times 10^{-27} \, kg/m^3$$

which equals the critical density. WUM foresees three additional types of interactions: Weak, Super-Weak, and Extremely-Weak, characterized by the following parameters respectively:

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

$$G_{SW} = G_O \times Q^{-1/2}$$

$$G_{EW} = G_O \times Q^{-3/4}$$

In our view, each type of interaction provides integrity of the corresponding World (see **Table 2**).

Table 2. Parameters of Multiworld (ρ_0 is a basic density unit: $\rho_0 = h/ca^4$).

Type of World	Type of Interaction	Rel. Interaction Parameter, G/G_0	Rel. Range of Interact, R_{max}/a	Rel. Mass, $M_{max}/4\pi m_0$	Rel. Density, $\rho/3\rho_0$
Macro-World	Gravity	Q^{-1}	Q	$1.5\pi \times Q^2$	Q^{-1}
Large-World	Extremely-Weak	$Q^{-3/4}$	$Q^{3/4}$	$Q^{3/2}$	$Q^{-3/4}$
Small-World	Super-Weak	$Q^{-1/2}$	$Q^{1/2}$	Q	$Q^{-1/2}$
Micro-World	Weak	$Q^{-1/4}$	$Q^{1/4}$	$Q^{1/2}$	$Q^{-1/4}$

Large-World is characterized by a parameter G_{EW}, which is about 10 orders of magnitude greater than G. The range of the extremely-weak interaction R_{EW} in the present epoch equals to:

$$R_{EW} = a \times Q^{3/4} = 1.44115 \times 10^{16} \, m = 1.5233 \, ly = 96,335 \, AU$$

In our view, ESS are Large-World objects with spherical boundary between ESS and Intergalactic Medium. This boundary has a surface energy density $\sigma_0 = \frac{hc}{a^3}$. Maximum total mass of ESS equals to:

$$M_{EW} = M_{ESS} = \frac{4\pi\sigma_0 R_{EW}^2}{c^2} = 4\pi m_0 \times Q^{3/2} = 1.03928 \times 10^{33} \, kg = 522.645 \, M_\odot$$

and maximum mass of Star M_{Star} that is one third of M_{ESS} :

$$M_{Star} = 3.46427 \times 10^{32} \, kg = 174.215 \, M_\odot$$

Average density ρ_{EW} equals to:

$$\rho_{EW} = 3\rho_0 \times Q^{-3/4} = 8.28918 \times 10^{-17} \, kg/m^3$$

which is about 10 orders of magnitude greater than the critical density. Extremely-weak interaction between DM Cores and all particles around them provide integrity of ESSs.

Small-World is characterized by the parameter G_{SW} , which is about 20 orders of magnitude greater than G . The range of the super-weak interaction R_{SW} in the present epoch equals to:

$$R_{SW} = a \times Q^{1/2} = 1.54351 \times 10^6 \, m$$

A maximum total mass of Small-World M_{SW} is:

$$M_{SW} = 4\pi m_0 \times Q = 1.19215 \times 10^{13} \, kg$$

and average density ρ_{SW} equals to:

$$\rho_{SW} = 3\rho_0 \times Q^{-1/2} = 7.73947 \times 10^{-7} \ kg/m^3$$

which is about 20 orders of magnitude greater than the critical density. According to WUM, Ball Lightning is an object of the Small-World.

Micro-World is characterized by the parameter G_W, which is about 30 orders of magnitude greater than G. The range of the weak interaction R_W in the present epoch equals to:

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

that is much greater than the range of the weak nuclear force $(\sim 10^{-16} - 10^{-17} \ m)$. Calculated concentration of DMF4 n_{DMF4} in the largest shell of Superclusters (see **Table 1**): $n_{DMF4} \cong 4.2 \times 10^{15} \ m^{-3}$ shows that a distance between particles is around $\sim 10^{-5} \ m$, which is much smaller than R_W. Thus, the introduced weak interaction between DMPs will provide integrity of all DM shells. In our view, weak interaction between particles DMF3 provides integrity of DM Fermi Bubbles.

With Nikola Tesla's principle at heart – *There is no energy in matter other than that received from the environment* – we apply to the Micro-World the following equation for a maximum total mass M_W:

$$M_W = \frac{4\pi\sigma_0 R_W^2}{c^2} = 4\pi m_0 \times Q^{1/2} = 1.36752 \times 10^{-7} \ kg = 6.28331 \ M_{Pl}$$

where M_{Pl} is the Planck mass. The average density of the Micro-World ρ_W is:

$$\rho_W = 3\rho_0 \times Q^{-1/4} = 7.22621 \times 10^3 \ kg/m^3$$

In our opinion, Micro-World objects with mass about Planck mass are the building blocks of all Macroobjects.

Two particles or microobjects will not exert gravity on one another when both of their masses are smaller than the Planck mass. **Planck mass** can then be viewed as the mass of the smallest macroobject capable of generating a gravitomagnetic field and serves as a natural borderline between classical and quantum physics. Incidentally, in his "Interpreting the Planck mass" paper, B. Hammel showed that the Plank mass is *a lower bound on the regime of validity of General Relativity* [27].

4. Structure of Solar System

According to Wikipedia [28]:
- **Solar System** (SS) is the gravitationally bound system of the Sun and the objects that orbit it. It formed 4.6 billion years. The vast majority (99.86%) of SS mass is in the Sun, with most of the remaining mass contained in the Jupiter. The four inner system planets—Mercury, Venus, Earth, and Mars—are terrestrial planets, composed primarily of rock and metal. The four giant planets of the outer system – Jupiter, Saturn, Uranus, and Neptune – are substantially larger than the terrestrials. **All eight planets have nearly circular orbits that lie near the plane of Earth's orbit, called the ecliptic;**
- There are an unknown number of smaller **dwarf planets** and innumerable small SS bodies orbiting the Sun. Six of the major planets, the six largest possible dwarf planets, and many of the smaller bodies are orbited by natural satellites, commonly called "moons" after Earth's Moon. Each of the giant planets and some smaller bodies are encircled by planetary rings of ice, dust, and moonlets;
- The **Asteroid belt**, which lies between the orbits of Mars and Jupiter, contains objects composed of rock, metal, and ice. About 60% of the main belt mass is contained in the four largest asteroids: Ceres, Vesta, Pallas, and Hygiea. The total mass of the asteroid belt is calculated to be 3% that of the Moon;

- Beyond Neptune's orbit lie the **Kuiper belt** that is a **circumstellar disc** in the outer SS, extending from the orbit of Neptune at 30 AU to approximately 50 AU from the Sun. Most Kuiper belt objects are composed largely of frozen volatiles (termed ices), such as methane, ammonia, and water. The Kuiper belt is home to most of the objects that astronomers generally accept as dwarf planets: Orcus, Pluto, Haumea, Quaoar, and Makemake. The total mass of the Kuiper belt is $(1.97\pm0.30)\times10^{-2}$ Earth masses;
- A **trans-Neptunian object** (TNO) is any minor planet in the SS that orbits the Sun at a greater average distance than Neptune, which has a semi-major axis of 30.1 AU. The first discovered in 1930 trans-Neptunian object was Pluto. It took until 1992 to discover a second trans-Neptunian object orbiting the Sun directly, 15760 Albion. The most massive TNO known is Eris, followed by Pluto, Haumea, Makemake, and Gonggong. More than 80 satellites have been discovered in orbit of trans-Neptunian objects. Twelve minor planets with a semi-major axis greater than 150 AU and perihelion greater than 30 AU are known, which are called extreme trans-Neptunian objects;
- The **Oort cloud** is a theoretical concept of a cloud of predominantly icy planetesimals proposed to surround the Sun at distances ranging from 1,000 to 100,000 AU. It is divided into two regions: a **disc-shaped inner Oort cloud** and a **spherical outer Oort cloud**. Both regions lie beyond the heliosphere and are in **Interstellar space**. The **Inner cloud** is a vast **theoretical circumstellar disc**, whose outer border would be located at around 20,000 AU from the Sun, and inner border, less well defined, is hypothetically located at 250–1500 AU. The outer edge of the **Outer cloud** might be about 100,000 AU from the Sun. Its total mass is not known, but, assuming that Halley's Comet is a suitable prototype for comets within the outer Oort cloud, roughly the combined mass is five times that of Earth. No known estimates of the mass of the inner Oort cloud have been published. Astronomers conjecture that the matter composing the Oort cloud formed closer to the Sun and was scattered far into space by the gravitational effects of the giant planets early in SS evolution;
- There are two main classes of comets: short-period comets (also called ecliptic comets) and long-period comets (also called nearly isotropic comets). Ecliptic comets have relatively small orbits, below 10 AU, and follow the ecliptic plane, the same plane in which the planets lie. All long-period comets have very large orbits, on the order of thousands of AU, and appear from every direction in the sky.

5. Mysteries of Solar System

According to E. Stone, these Mysteries are [1]:

5.1. Why does Venus spin backwards?

All the planets in SS rotate in the same direction except one: Venus. If you could look at all the planets from a point at the top of the North Pole, you would see all of them rotating counter-clockwise. But not Venus that is spinning clockwise. Astronomers have two theories to explain why that happens. One of them is Venus could have suffered a huge impact with another object. That collision would have been so powerful it changed the direction of Venus rotational movement. The second theory is Venus is so close to the Sun and its atmosphere is so dense, the gravitational pull from the Sun created tides that flipped the planet's axis 180º.

5.2. Why is Uranus tilted sideways?

Something very curious happens with Uranus rotation. It seems like the planet is on its side if you compare it to the other planets in the Solar System. While the rotational axis of the other planets is mostly perpendicular to the direction of the Sun, Uranus' axis is tilted and almost pointing to the star, making the planet look like it is rotating on its side. It is possible at some point in its history a huge object impacted

Uranus and changed the direction of its axis. Some theories suggest that very same impact created most or all of its 27 moons.

WUM. In our opinion, the explanations of SS Mysteries (Venus spin backwards; Uranus tilted sideways; Moon creation; Mars hit by a giant cosmic lightning bolt; Planets difference in composition) based on the Impact theory are unrealistic and were proposed from hopelessness in frames of the Standard model. To the best of our knowledge, in literature it was never discussed and explained a real picture of planets angular momenta (see **Figure 1** and **Table 3**). Why do the Sun and all planets have different orientations of their motion being created from the same nebula with a **certain amount of angular momentum**?
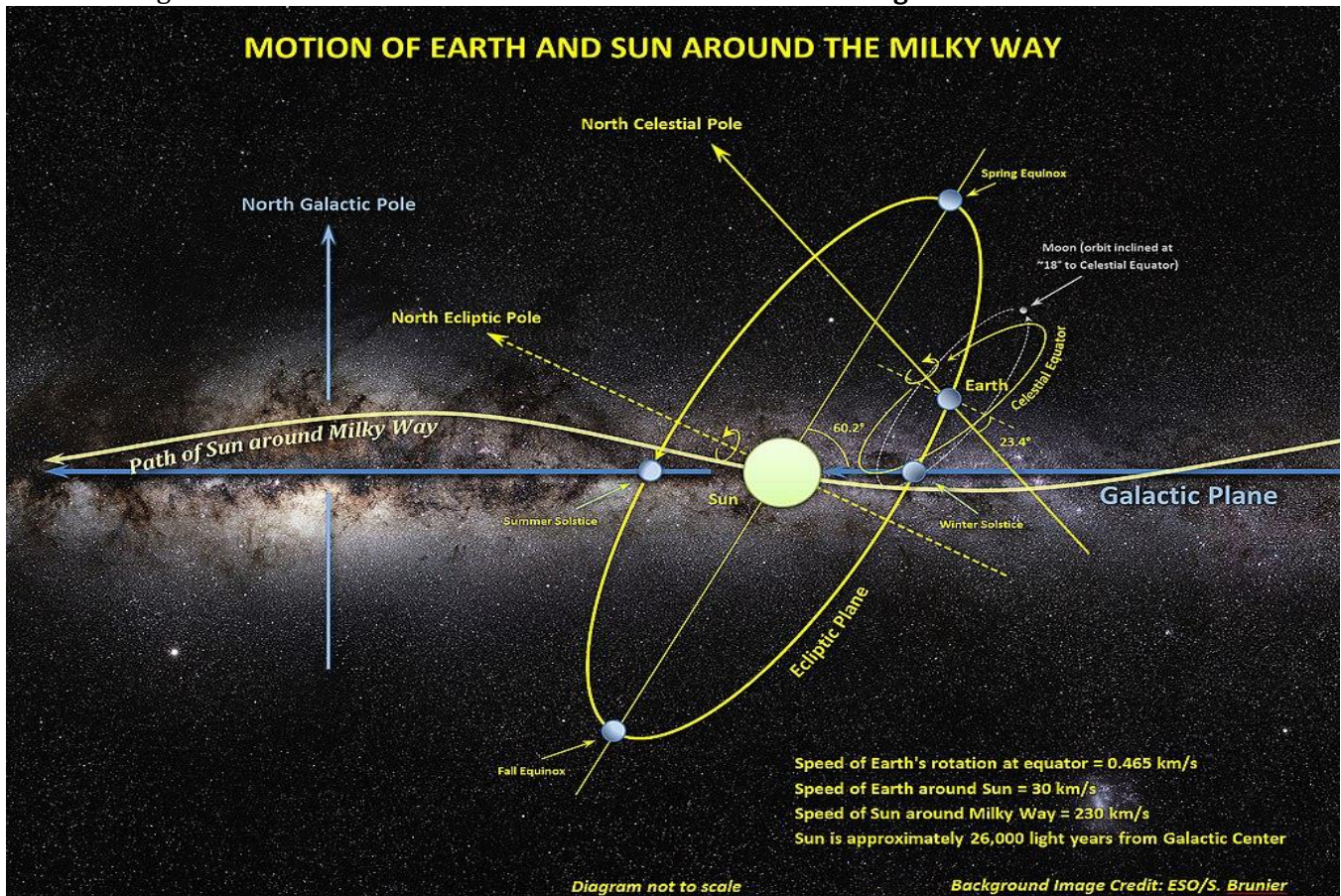
Figure 1. Orientation of the motion of SS Objects. Adapted from [28].

Table 3. Angular momentum of gravitationally rounded objects of SS. Adapted from [29].

Object	Value	Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Inclination	deg.		7.00	3.39	0	1.85	1.31	2.48	0.76	1.77
Axial tilt	deg.	7.25	0.0	177.3	23.44	25.19	3.12	26.73	97.86	28.32

In astronomy, **axial tilt** is the angle between an object's rotational axis and its orbital axis, which is the line perpendicular to its orbital plane; equivalently, it is the angle between its equatorial plane and orbital plane. It differs from **orbital inclination** that is the tilt of an object's orbit around a celestial body. It is expressed as the angle between a reference plane and the orbital plane or axis of direction of the orbiting

object. The **ecliptic** or ecliptic plane is the **orbital plane of Earth around the Sun**. The **galactic plane** is the plane on which the majority of a disk-shaped galaxy's mass lies. The directions perpendicular to the galactic plane point to the galactic poles. In actual usage, the terms galactic plane and galactic poles usually refer specifically to the plane and poles of MW, in which planet Earth is located.

To be consistent with the Law of Conservation of Angular Momentum, we developed a New Cosmology (see Section 3.2.4). Big angle between Galactic Pole and Ecliptic Pole is due to the random VRF of MW Galaxy DM Core of many ESS DM cores at the same time, so that the direction of the sum of all ESS angular momentum coincides with the direction of galactic poles. The same explanation is valid for the Sun's DM Core and DM cores of the planets with moons considering that they were created at the same time 4.57 billion years ago.

5.3. Why is the Sun's atmosphere hotter than its surface?

One of the bigger and most counterintuitive mysteries of the Solar System for which we haven't been able to find answers is why is the outer layer of the Sun's atmosphere hotter than the surface of the star. The Sun is composed of multiple layers. The visible surface or the part we can see is called the photosphere and burns at a temperature of about 5,700 K. On top of that, the Sun also has an atmosphere and the outermost part of it is called the corona. One would think that being separated from the surface, the heat would start to dissipate, and the temperature of the corona would be lower than on the surface. Well, that's not the case. In fact, it is the extreme opposite as the temperatures in the corona can reach 1,000,000 K. Some theories have been formed as to why this happens that have to do with the ionization of Helium in the atmosphere, but we don't know for sure.

WUM. Solar Corona is an aura of plasma that surrounds the Sun and extends at least $8 \times 10^6\ km$ into outer space (compare with Sun's radius $7 \times 10^5\ km$). Spectroscopy measurements indicate strong ionization and plasma temperature in excess of $10^6\ K$ [30]. The corona emits radiation mainly in X-rays, observable only from space. Plasma is transparent to its own radiation and to solar radiation passing through it.

In WUM, Solar corona made up of DMPs resembles a honeycomb filled with plasma. The following experimental results speak in favor of this model [13]:

- 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 [31] (one photon had an energy as high as 467.7 GeV [13]). In our view, it is the result of enormous density fluctuations of DMPs in the Solar corona and their self-annihilation.

Coronal Heating problem in solar physics relates to the question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. The high temperatures require energy to be carried from the solar interior to the corona by non-thermal processes. In our opinion, the origin of the Solar corona plasma is not coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. Plasma is the result of self-annihilation of DMPs. In WUM, Geocorona and Planetary Coronas possess features like those of Solar Corona.

5.4. How many unknown dwarf planets are out there?

Our telescopes have been getting better really fast in the last few decades. With all these advancements, we started to find a lot of objects in SS we did not know about. This lead to the creation of the Dwarf Planet category to label all these objects that did not really meet the criteria to be called a planet but were pretty close. The International Astronomical Union has officially recognized 5 dwarf planets so far, including Pluto, but there are at least 30 other objects that have been proposed by multiple astronomers and that will be studied further in the coming years to see if they meet the criteria. Most of these dwarf planets would be

located in the area known as the Kuiper belt, beyond the orbit of Neptune. Some astronomers believe there might be up to 200 dwarf planets out there waiting to be found.

WUM. From physical point of view, all gravitationally-rounded objects in SS, from Mimas, a small moon of Saturn ($R_M = 198\ km$, $M_M = 3.75 \times 10^{19}\ kg$) to the Sun itself ($R_S = 7 \times 10^5\ km$, $M_S = 2 \times 10^{30}\ kg$) are MOs with DM cores inside of them that are DM Reactors. It includes stars, planets, dwarf planets, and moons that are bigger than Mimas. Considering the total mass of the Kuiper belt $\sim 2 \times 10^{-2} M_{Earth}$ we can evaluate a number of MOs: $N_{MO} \lesssim 10^3$. So, there might be up to 200 dwarf planets in the Kuiper belt.

5.5. Does the Oort Cloud exist?

Have you ever wondered where do comets come from? To solve that question, astronomers have theorized that a group of millions and maybe billions of small, icy, rocky objects exists on the outer limits of the Solar System. These objects form a huge "cloud" named the Oort Cloud after one of the astronomers who proposed it. Sometimes these objects will change be shot out of the Oort Cloud due to collisions or gravitational forces and become wandering comets. The objects in the Oort Cloud are too small and far away to reflect any light from the Sun so their existence is still not confirmed.

WUM. In our opinion, observations of short-period ecliptic comets and long-period isotropic comets are experimental confirmation of Oort Cloud existence. In WUM, Ecliptic comets were produced by the Sun itself as the result of VRF of the Sun's DM Core. Nearly isotropic comets were produced by Giant Planets, which are, in fact, "Failed stars" with different directions of rotational axis as the result of VRF of their DM cores (see **Table 3**). **Oort Cloud belongs to Solar System!**

5.6. How was the Moon created?

One of the things that says a lot about how little we still know about our universe is the fact we don't even know for sure how our own Moon was formed. The current theory most astronomers agree on is that at some point early in the Solar System's life, a planet around the size of Mars crashed against Earth. This collision left a lot of debris and pieces of both planets hanging around but still trapped by Earth's gravity and were left orbiting it. After millions of years, all these pieces came together thanks to gravity and formed the Moon. While the theory is widely accepted, it leaves some questions up in the air, like why wasn't Earth taken out of its orbit by this impact? and what happened to the other hypothetical planet?

WUM. The Moon is a differentiated body, being composed of a geochemically distinct crust, mantle, and planetary core. Moonquakes have been found to occur deep within the mantle of the Moon about 1,000 km below the surface. The size of the lunar core is only about 20% the size of the Moon itself, in contrast to about 50% as is the case for most other terrestrial bodies. In February 2022, astronomers used NASA's SOFIA telescope to scan an immense region near the south pole of the Moon and revealed an abundance of water trapped on the shady sides of mountains and in the shadowed parts of craters [32].

In WUM, the internal structure of the Moon can be explained the same way as it was done for the Earth and Mars. It is worth noting that the DM core of the Moon is much less than DM core of the Earth. This result is in good agreement with the proposed in our Model mechanism of the Moon creation: DM Core of the Moon was born as the result of VRF of the Earth DM Core 4.57 billion years ago.

5.7. Did Mars have oceans in the past?

For years astronomers have found evidence of erosion, channels, and canyons on Mars. As far as we know, all of those are caused by liquid water slowly forming them. From that data, we can hypothesize that at some point in the past Mars has liquid water running on the planet. Some astronomers think even one-third of the Martian surface could have been covered in water. Some scientists believe even today it would be possible for water to exist under Mars' surface where it is safe from many of the effects that would have caused the surface water to disappear. The more we explore and study Mars, the more this theory seems correct, but that opens

other questions. What happened to Mars that made all that water evaporate or freeze? Could there have been life on the red planet at some point?

WUM. The proposed concept of **DM Reactors** in Cores of all gravitationally-rounded MOs successfully explains all contemporary hypothesis and results for the Early Earth:

- In the paper "*Uncovering Mysteries of Earth's Primeval Atmosphere 4.5 Billion Years Ago and the Emergence of Life*" ETH Zurich (a leading scientist P. Sossi) wrote [33]: *Four-and-a-half billion years ago, Earth would have been hard to recognize. Instead of the forests, mountains, and oceans that we know today, the surface of our planet was covered entirely by* **magma** *– the molten rocky material that emerges when* **volcanoes erupt**. *This much the scientific community agrees on. What is less clear is what the atmosphere at the time was like.*

  In WUM, the Upper mantle with Crust are due to the DM core volcanic activity of the "homemade" compositions (including magma), which produced as the result of the self-annihilation of DMPs in the DM core. It explains the result that continental crust had formed by $4.4 - 4.5$ Byr".

- According to "Lumen Learning. Earth Science" [34]: *Scientists have developed a number of hypotheses about how the oceans formed. Though these hypotheses have changed over time, one idea now has the wide support of Earth scientists, called the volcanic outgassing theory. This means that water vapor given off by volcanoes erupting over millions or billions of years, cooled and condensed to form Earth's oceans.*

  In WUM, Earth's Atmosphere and Oceans were formed by the volcanic activity and outgassing of DM core. In our opinion, analogous processes happened on early Mars too. But because of much less size of the DM core and mass of Mars ($R_{Mars}^{core} = 1.83 \times 10^3\ km$ and $M_{Mars} = 6.42 \times 10^{23}\ kg$) in comparison with Earth ($R_{Earth}^{core} = 3.52 \times 10^3\ km$ and $M_{Earth} = 5.97 \times 10^{24}\ kg$), the rate of creation of Mars's Atmosphere and Oceans and the forces of gravity preventing the water from leaving the planet are much less than it is for Earth. So, water evaporated from the surface of Mars. We believe that there is underground water on Mars.

5.8. Was Mars hit by a giant cosmic lightning bolt?

There is a huge, strange canyon on Mars called Valles Marineris. Just to give you an idea of how big it is, it is about 4 times deeper and 5 times longer than the Grand Canyon in Arizona. But its weirdness only starts there. Some scientists believe this canyon wasn't formed in a traditional way (water slowly eroding the land over the course of millions of years) but in a much cooler manner. They believe Valles Marineris is a scar. For years scientists have theorized the existence of cosmic lightning bolts. Imagine a lightning bolt, but on a cosmic scale, traveling across the cosmos with unimaginable amounts of energy. Then imagine this bolt hits a planet, let's say, Mars. The impact would be big enough to leave a mark forever on the planet and create a valley the size of Valles Marineris. One more piece of evidence that could support the lightning bolt theory is that Mars also has a hole in its atmosphere that is leaking hydrogen into space. Could this hole have been created by that very same impact? Is that the reason why Mars lost its ocean?

WUM. In our view, a giant cosmic lightning bolt is unimaginable, and *Valles Marineris* is a scar on the Mars surface. Some of the most notable surface features on Mars include *Olympus Mons*, the largest volcano and highest-known mountain in SS, and *Valles Marineris*, one of the largest canyons in SS. Mars is seismically active. In 2019, it was reported that InSight had detected and recorded over 450 marsquakes and related events. In 2021 it was reported that the core of Mars was indeed liquid and had a radius of about 1830 ± 40 km and a temperature around 1900–2000 K [35]. In WUM, the Martian core is a liquid DM core with very high viscosity that functions as solid-state object. It is a DM Reactor that provides enough energy for volcanic and plate-tectonic activities. As the result, there were created *Olympus Mons* and *Valles Marineris*.

5.9. Why are the planets so different in composition?

Most astronomers agree on the origin of SS. They believed a disk of rocks and pebbles formed around the

Sun and they started fusing impacting one another and fusing together to form the planets. But this creates a problem. If all the planets formed from the same disk and grew together at the same time, how come they ended up being so different from one another? Some of the differences between planets can be attributed to variables like how close they are to the Sun. This explains for example why some planets could hold liquid water like Earth and (maybe) Mars while others can't because they are too cold, but it doesn't explain other things like the vast differences in size and composition. Some theories suggest solar winds "blew away" the lighter materials, allowing for the outer planets to have a different composition. Another study found a correlation between the calcium isotope and the size of the planets, suggesting planets grew at the same rate, but then stopped growing at different times.

WUM. According to the developed model of MOs, all chemical elements, compositions, substances, rocks are produced by MOs themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded objects of SS is explained by their distance from the Sun, and the differences in their DM Cores (mass, size, composition). DM Reactors inside of gravitationally-rounded objects in hydrostatic equilibrium provide sufficient energy for all geological processes on planets and satellites.

5.10. Do Jupiter and Saturn even have a core?

When we have lived only on one planet, it is hard to imagine how a different one might be so different and weird and in the case of Jupiter, Saturn, and others, so not-solid. While these two giants of our Solar System look just like a planet, they are mostly just gas as far as we can tell. If you were to take a guess without knowing, it would be easy to think behind all those storms, clouds and gas we see on top of those planets there would be a surface we might be able to land on some day and explore. Well, there isn't. If you were to drop something on Jupiter, it wouldn't hit the surface. It would just drop down into the center of the planet until it was crushed by the pressure. Scientists believe both planets might have a core with a thin, rocky or icy layer in the middle because it fits with our current model for how planets are formed. The problem is, we have never actually seen or confirmed such core exists and data found by the Juno spacecraft on Jupiter left us with more questions than answers as it suggests Jupiter's core might be dissolved.

WUM. All planets (including Jupiter and Saturn) have DM cores.

5.11. Why does Pluto have mountains?

The dwarf planet Pluto has some of the most unique features of any other object in the Solar System. It has huge mountains made almost entirely out of ice. The question that puzzles scientists is where did they come from? For a mountain to be created there needs to be geological activity. That means tectonic plates moving because of volcanic activity or some other form of heat release. And that's where the big mystery lies, where are the heat and energy coming from?. As far as we can tell, Pluto is too far away from the Sun to receive much energy from it and its core is just ice and rock so there's no lava flowing. One theory suggests Pluto might have some sort of system of cryovolcanoes, which are basically volcanoes that spit water or gases, but the reality still remains a question to be answered.

WUM. Pluto have mountains due to the volcanic activity of DM Reactor inside of it.

5.12. How big is the Solar System really?

*As we mentioned above when we talked about the Oort Cloud, we still don't know much about the outer edges of the Solar System. So much we don't even know where it ends. Some astronomers mark the end of SS at the **Heliopause**, the imaginary line where the solar winds stop. That would make SS about 79 AU wide in diameter; but the Oort cloud would be located way beyond that. If we take the Oort Cloud as the line for the SS's end, it is estimated it could be up to 200,000 AU away or a little more than 3 light years.*

WUM. According to Multiworld model, the radius of SS is about 96,335 AU (see Section 3.2.6) that is in good agreement with the size of the **spherical outer Oort Cloud** 100,000 AU (see Section 4). It was created as

a result of VRF of the overspinning DM Cores of Giant planets (Jupiter, Saturn, Uranus, and Neptune), which are, in fact, "Failed stars", and have significantly different **Inclinations** and **Axial tilts** (see **Table 3**). All **long-period nearly isotropic comets** have very large orbits and appear from every direction in the sky.

5.13. Conclusion

As you can tell from our list, there are still many questions about our SS that need to be answered. We only picked the most interesting ones for this list but there are many more that didn't make the cut like the crater shaped like a spider in Mercury or why is Titan the only moon with an atmosphere. With all the advances in equipment and new techniques we will hopefully get some answers to a lot of these questions in the coming decades so stay tuned and keep learning. Maybe you will be the one who figures them out.

6. Explained Problems

WUM solves a number of physical problems in contemporary Cosmology and Astrophysics through DMPs and their interactions (see [2] and references therein):

- **Angular Momentum problem** in birth and subsequent evolution of Galaxies and ESS explained by VRF of Overspinning DM Supercluster's Cores;
- **Hubble Tension** explained by observations of Galaxies, which belong to different Superclusters. The value of H should be measured based on Cosmic Microwave Background Radiation only;
- **Missing Baryon problem,** related to the fact that the observed amount of baryonic matter did not match theoretical predictions, solved by the calculation of the concentration of Intergalactic plasma;
- **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center – are stable clouds of DMPs (DMF1, DMF2, and DMF3) containing uniformly distributed DM Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays;
- **Galaxies are ellipticals and spirals** due to VRF of their Overspinning DM Cores;
- **Coronal Heating Problem** relates to a question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. According to WUM, the origin of the Solar corona plasma is not coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. Plasma is the result of the self-annihilation of DMPs. The Solar corona made up of DMPs resembles a honeycomb filled with plasma;
- **Cores of Sun and Earth** rotate faster than their surfaces despite high viscosity of the internal medium. WUM explains the phenomenon through absorption of DMPs by Cores. DMPs supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^2$). Cores irradiate products of self-annihilation, which carry away excessive angular momentum. Solar wind is the result of this mechanism;
- **Internal Heating of Gravitationally-Rounded Objects** in SS is explained by DM Reactors inside of all MOs fueled by DMPs. Internal Heating is due to DMPs self-annihilation;
- **Diversity of Gravitationally-Rounded Objects** in SS is explained by DM Reactors inside of MOs fueled by DMPs. All chemical elements, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation in their different DM cores;
- **Plutonium-244** with half-life of 80 million years exists in Nature. It is not produced by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Pu-244 present in the Earth's crust should have decayed by now. In 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;

- **Expanding Earth** hypothesis asserts that the position and relative movement of continents is at least partially due to the volume of Earth increasing. In WUM, the Earth's DM core absorbs new DMPs, and its size is increasing in time $\propto \tau^{1/2}$. Hence, there is an expansion of DM core, and its surface (the Upper mantle with Crust) is likewise expanding. Due to DMPs self-annihilation, new chemical elements are created inside of the Upper mantle with Crust. As the result, the relative movement of continents is happening;
- **Faint young Sun paradox** describes the apparent contradiction between observations of liquid water early in Earth's history and the astrophysical expectation that the Sun's output would be only 70% as intense during that epoch as it is during the modern epoch. In WUM, all MOs of the World were fainter in the past. As their cores absorb new DMPs, the sizes of MOs and thus their luminosity are increasing in time $\propto \tau$. Considering the age of the World $\cong 14.2$ Byr and the age of SS $\cong 4.6$ Byr, it is easy to find that the young Sun's output was only 67.6% of what it is today;
- **Matter-Antimatter Asymmetry problem.** Ordinary Matter is a byproduct of DMPs self-annihilation. This problem does not arise, since antimatter does not get created by DMPs self-annihilation;
- **Black-body spectrum of Microwave Background Radiation** is due to thermodynamic equilibrium of photons with Intergalactic plasma;
- **Unidentified Infrared Discrete Emission Bands** with peaks 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm explained by self-annihilation of DM particles DMF4 (0.2 eV);
- **Solar Corona, Geocorona and Planetary Coronas** made up of DMPs resemble honeycombs filled with plasma particles (electrons, protons, multicharged ions), which are the result of DMPs self-annihilation;
- **Lightning Initiation problem** and **Terrestrial Gamma-Ray Flashes** are explained by the self-annihilation of DMPs in Geocorona;
- **Ball Lightnings** are objects that have cores made up of DMPs surrounded by the electron-positron plasma shells contaminated by chemical elements of soil and air as the result of Terrestrial Gamma-Ray Flash strikes of the ground. WUM predicts a **new phenomenon** – a generation of Ball Lightnings (BLs) according to the proposed model of them. Once we master the creation of BLs in a controlled environment, we can concentrate our efforts on harvesting that energy from a practically infinite Source – the Medium of the World with DMPs.

7. Conclusion

Hypersphere World-Universe Model is consistent with all Concepts of the World. The Model successfully describes primary cosmological parameters and their relationships. WUM allows for precise calculation of values that were only measured experimentally earlier and makes verifiable predictions. The remarkable agreement of calculated values with the observational data gives us considerable confidence in the Model.

Great experimental results and observations achieved by Astronomy in the last decades should be analyzed through the prism of WUM. Considering the JWST discoveries, successes of WUM, and 86 years of Dirac's proposals, it is high time to make a Paradigm Shift for Cosmology and Classical Physics.

Astronomers have great achievements in investigations of the Solar System that became an Experimental laboratory for astrophysicists to check their theories. We are at the Beginning of a New Era of Astronomy, Cosmology, and Astrophysics! Young physicists should be a part of It. They should concentrate their efforts on the development of a New Cosmology and Classical Physics. I am very excited about the Future of Physics!

Acknowledgements

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Principal Role of Angular Momentum in Cosmology

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Abstract

According to "Evolution Encyclopedia" (The Origin of the Solar System), "*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. Scientists cannot account for this puzzling situation: less than one percent of the mass of the solar system is in the planets, while a staggering 98 percent of its angular momentum is in them. It simply does not fit into any of the cosmologies. Speaking of the mass-angular momentum problem, D. Bergamini says: "A theory of evolution that fails to account for this peculiar fact is ruled out before it starts*" [1].

Angular Momentum problem is one of the most critical problems in Standard model that must be solved. To the best of our knowledge, the developed Hypersphere World-Universe Model (WUM) is only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum [2]. In the present paper, we discuss Angular Momenta of Solar System, Milky Way galaxy, and Superclusters in frames of WUM.

1. Introduction

To be consistent with the Law of Conservation of Angular Momentum, any theory of evolution of Universe must answer the following questions:

- How did Galaxies and Extrasolar systems get their substantial orbital and rotational angular momenta;
- How did Milky Way (MW) galaxy give birth to different Extrasolar systems in different times;
- The beginning of MW was about 13.77 Byr ago . The age of MW is about the Age of the World. What is the origin of MW huge orbital and rotational angular momenta? We must discuss the Beginning of MW;
- The oldest star in MW (named Methuselah) is nearly as old as the universe itself. How did it happen?
- The beginning of the Solar System (SS) was 4.57 Byr ago. What is the origin of SS rotational and orbital angular momenta? We must discuss the Beginning of SS;
- 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***" [3]. We must discuss the Beginning of the World.

In our opinion, there is 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 **rotational momenta of prime objects should exceed orbital momenta of their satellites** [2].

In frames of WUM, Prime Objects are Dark Matter (DM) Cores of Superclusters, which must accumulate tremendous angular momenta before the Birth of the Luminous World. It follows that a long enough time period must elapse. We named this period "Dark Epoch" and developed a New Cosmology of the World [2]:

- WUM introduces Dark Epoch (spanning from the Beginning of the World 14.22 Byr ago for 0.45 Byr) when only DM Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 Byr for Laniakea Supercluster) when Luminous MOs emerged due to the Rotational Fission of Superclusters' DM Cores and self-annihilation of Dark Matter Particles (DMPs);

- Main players of the World are Superclusters' DM Cores that 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 World show that most of them are disk galaxies [4]. These results speak in favor of the developed Rotational Fission mechanism;
- MW's DM Core was born 13.77 Byr ago as the result of Rotational Fission of Virgo Supercluster's DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the repeating Rotational Fissions of MW's DM Core in different times (4.57 Byr ago for SS);
- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons.

The present article discusses an Explosive Volcanic Rotational Fission (VRF) model of creation and evolution of Macrostructures of the World (Superclusters, Galaxies, Extrasolar Systems), based on DM Overspinning (surface speed at equator exceeding escape velocity) Cores of the World's Macroobjects.

2. Explosive Volcanic Rotational Fission Model
2.1. Multicomponent Dark Matter

WUM proposes multicomponent DM system consisting of two couples of co-annihilating 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 $\mu = e/2\alpha$ (e is the elementary charge); 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; self-annihilating fermions DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain the diversity of DM Cores of MOs of the World (superclusters, galaxies, and extrasolar systems), which are Fermion Compact Objects in our Model [5].

WUM postulates that rest energies of DMFs and bosons are proportional to a basic energy unit: $E_0 = hc/a$ (h is Planck constant, c is an electrodynamic constant, and a is a basic size unit) multiplied by different exponents of α (dimensionless Rydberg constant) and can be expressed with 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): $E_{DMF4} = \alpha^4 E_0 = 0.19857111 \ eV$

DMPs do not possess an electric charge. Their masses cannot be directly measured by mass spectrometry. Hence, they can be observed only indirectly due to their self-annihilation and irradiation of gamma-quants.

2.2. Macroobject Shell Model

In 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. A proposed Weak Interaction of DMPs (see Section 3.2) provides integrity of all shells. **Table 1** describes parameters of MOs' Cores, which are 3D fluid balls with a very high viscosity and function as solid-state objects.

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

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

The calculated parameters of the shells show that:
- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in Extrasolar Systems (ESS);
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;
- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of Superclusters.

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 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 [6]. It is worth noting that there are no black holes in WUM.

In WUM, Cores of all MOs possess the following properties [7]:
- Their Nuclei are made up of DMFs and contain other particles, including DM and Baryonic matter, in shells surrounding the Nuclei;
- DMPs are continuously absorbed by Cores of all MOs. Ordinary Matter (about 7.2% of the total Matter) is a byproduct of DMPs self-annihilation. It is re-emitted by Cores of MOs continuously;
- Nuclei and shells are growing in time: size $\propto \tau^{1/2}$; mass $\propto \tau^{3/2}$; and rotational angular momentum $\propto \tau^2$, until they reach the critical point of their stability, at which they detonate. Satellite cores and their orbital L_{orb} and rotational L_{rot} angular momenta released during detonation are produced by Overspinning DM Cores (OCs). The detonation process does not destroy OCs; it is rather gravitational hyper-flares;
- Size, mass, composition, L_{orb} and L_{rot} of satellite DM cores depend on local density fluctuations at the edge of OC and cohesion of the outer shell. Consequently, the diversity of satellite DM cores has a clear explanation. Satellite DM cores are given off by "**Volcanoes**" on prime DM cores erupting repeatedly;
- WUM refers to OC detonation process as Gravitational Burst (GB), analogous to Gamma Ray Burst. In frames of WUM, the repeating GBs can be explained the following way:
- As the result of GB, the OCs lose a small fraction of their mass and a large part of their rotational angular momentum;
- After GB, DM Cores of Prime Objects (superclusters, galaxies, stars, and planets) absorb new DMPs. Their masses increase $\propto \tau^{3/2}$, and their angular momenta L_{rot} increase much faster $\propto \tau^2$, until they detonate again at the next critical point of their stability. That is why DM cores of Satellites (galaxies, stars, planets, and moons, respectively) are rotating around their own axes and DM Cores of Prime Objects;
- Afterglow of GB is a result of processes developing in the Nuclei and shells after detonation;
- In case of ESS, a star wind is the afterglow of star detonation: Star's DM Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 Byr ago. It creates the SS bubble continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic DM Core detonations. In MW it continuously creates two DM Fermi Bubbles.

3. Formation of Macrostructures
3.1. Dark Epoch

Dark Epoch started at the Beginning of the World 14.22 Byr ago and lasted for 0.45 Byr for Laniakea Supercluster. 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 $\tau_M \cong 10^{-18}s$. At time $\tau \gg 10^{-18}s$ density fluctuations could happen in the Medium of the World filled with DMPs. The heaviest particles DMF1 could collect into a cloud with distances between particles smaller than R_W (see Section 3.2). As the result of the weak interaction, clumps of DMF1 will arise. Larger clumps will attract smaller clumps and DMPs and initiate a process of expanding the DM clump followed by growth of surrounding shells made up of other DMPs, up to the maximum mass of the shell made up of DMF4 at the end of Dark Epoch (0.45 Byr).

The process described above is the formation of the DM Core of Superclusters [8]. DMPs supply not only additional mass ($\propto \tau^{3/2}$) to Cores, but also additional angular momentum ($\propto \tau^2$) fueling the overspinning of DM Cores (see Section 3.3). We estimate the number of Supercluster Cores at the end of Dark Epoch to be around $\sim 10^3$ [8]. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other.

3.2. Weak Interaction

Widely discussed models for nonbaryonic DM are based on the Cold DM hypothesis, and corresponding particles are commonly assumed to be WIMPs, *which interact via gravity and any other force (or forces), potentially not part of the standard model itself, which is as weak as or weaker than the weak nuclear force, but also, non-vanishing in its strength* [9]. It follows that a new weak force needs to exist, providing interaction between DMPs.

According to WUM, strength of gravity is characterized by the gravitational parameter G [8]:

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

where $G_0 = \frac{a^2 c^4}{8\pi hc}$ is an extrapolated value of G at the Beginning of the World ($Q=1$). A dimensionless time-varying quantity Q, which 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 time unit: $t_0 = a/c = 5.9059662 \times 10^{-23}$ s)

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

in present epoch equals to: $Q = 0.759972 \times 10^{40}$. The range of the gravity equals to the size of the World R:

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

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

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

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

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

that is much greater than the range of the weak nuclear force. Calculated concentration of DMF4 particles n_{DMF4} in the largest shell of Superclusters: $n_{DMF4} \cong 4.2 \times 10^{15} \ m^{-3}$ (**see Table 1**) shows that a distance between particles is around $\sim 10^{-5} \ m$, which is much smaller than R_W . Thus, the introduced weak

interaction between DMPs will provide integrity of all DM shells. In our view, weak interaction between particles DMF3 provides integrity of Fermi Bubbles [7].

3.3. Rotational Fission

According to WUM, a rotational angular momentum of overspinning (surface speed at equator exceeding escape velocity) object before rotational fission is [10]:

$$L_{rot} \propto G^{0.5} M_{MO}^{1.5} R_{MO}^{0.5}$$

where M_{MO} is a mass of overspinning Macroobject, R_{MO} is its radius. These parameters are time-varying: $G \propto \tau^{-1}$, $M_{MO} \propto \tau^{3/2}$ and $R_{MO} \propto \tau^{1/2}$. It follows that the rotational angular momentum of Cores L_{rot} is proportional to τ^2.

Virgo Supercluster (VS) is a mass concentration of galaxies containing MW. At least 100 galaxy groups and clusters are located within its diameter of 110 Mly. Considering parameters of DMF4 shell (see **Table 1**), we calculate the rotational angular momentum L_{rot}^{VSC} of VS Core before rotational fission:

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

MW is gravitationally bounded with VS [11]. Let us compare L_{rot}^{VSC} with an orbital momentum of MW L_{orb}^{MW} calculated based on the distance of 65 Mly from VS Core and orbital speed of about 400 km/s [12]:

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

It means that as the result of rotational fission of VS Core, approximately $\sim 10^6$ galaxies like MW could be generated at the same time. Considering that density of galaxies in the VS falls off with the square of the distance from its center and the location of MW on the outskirts of the VS [13], the actual number of created galaxies could be much larger.

Analogous calculations for MW Core based on parameters of DMF3 shell (see **Table 1**) produce the following value of rotational angular momentum L_{rot}^{MWC} [10]:

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

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

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

As the result of rotational fission of MW Core 13.77 Gyr ago, approximately $\sim 10^4$ Extrasolar systems like SS could be created at the same time. Considering that MW has grown inside out (in the present Epoch, most old stars can be found in the middle, more recently formed ones on the outskirts [14]), the number of generated Extrasolar systems could be much larger. Extrasolar system Cores can give birth to planetary cores, which in turn can generate cores of moons by the same Rotational Fission mechanism. Luminous Epoch is the result of Explosive VRF of DM Cores of Superclusters and self-annihilation of DMPs.

To summarize:
- The rotational fission of Macroobjects DM Cores is the most probable process that can generate satellite cores with large rotational and orbital momenta in a very short time;
- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons;
- Gravitational waves can be a product of rotational fission of overspinning DM Macroobject Cores.

4. Macrostructures

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to MW and approximately 10^5 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated by L. Bliss, *et al.* binding mass 10^{17} $M_\odot$ [15]. The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster (see **Figure 2**). Distance from the Earth to the Centre of LSC is 250 Mly.
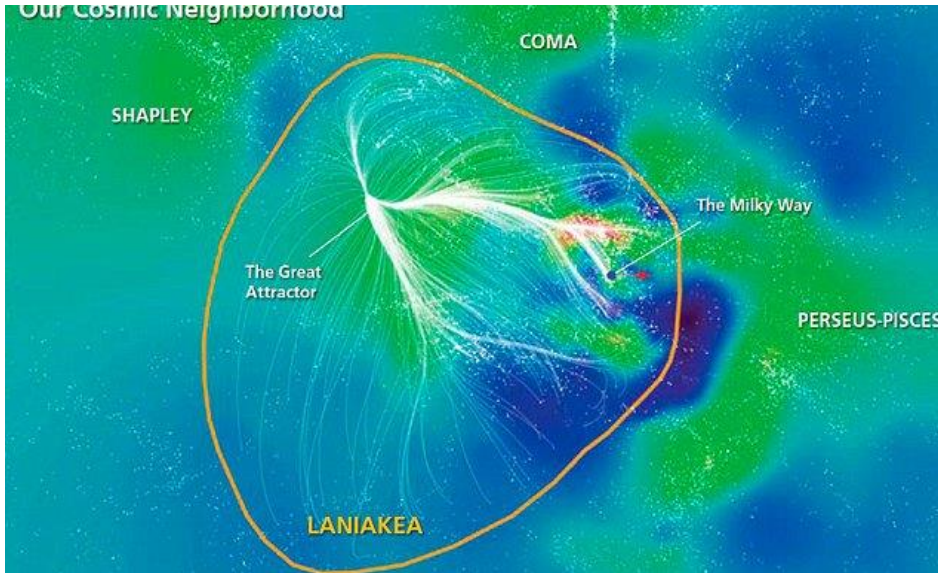

Figure 1. Laniakea Supercluster. Adapted from [16].
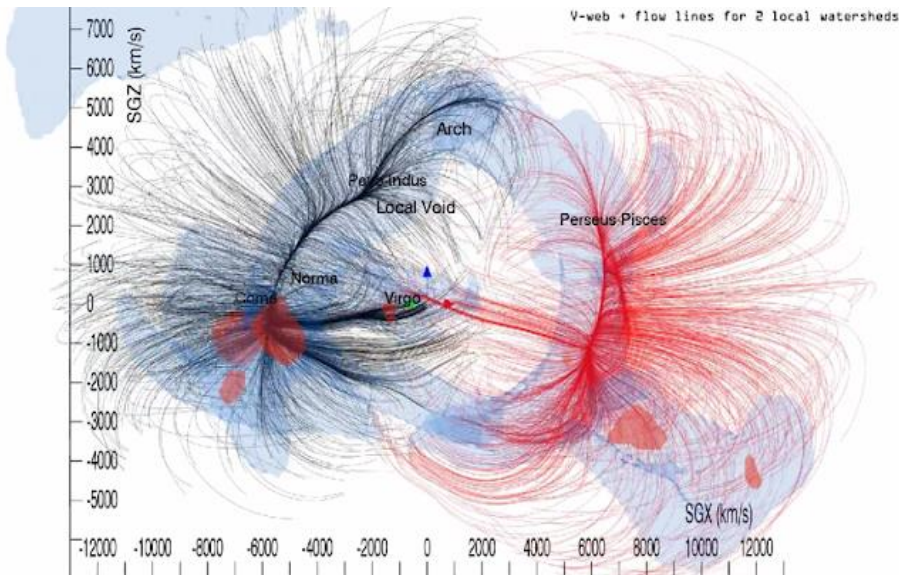
Figure 2. A representation of structure and flows due to mass within 6,000 km s−1 (~80 Mpc). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near Perseus Cluster are in red. Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [16].

The mass-to-light ratio of Virgo Supercluster is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [17]. 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*" [18]. These ratios are one of the **main arguments in favor of presence of large amounts of Dark Matter in the World and validate the developed Model of Superclusters' Macrostructure.**

We emphasize that ~ 10^5 nearby galaxies are moving around Centre of LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structures. It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$).

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*" [16].

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**" [3].

In 2021, 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?**" [19].

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 , so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes*" [20].

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;
- The calculated maximum mass of the supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the values discussed by L. Bliss [15] and B. Carr, F. Kühnel and L. Visinelli [20]. In the future, these stupendously large compact objects can give rise to new Luminous Superclusters as the result of their DM Cores' rotational fission;
- 13.77 Gyr ago, when the Laniakea Supercluster emerged, the estimated number of DM Supercluster Cores in the World was around $\sim 10^3$ [21]. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. The 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters, which emerged in various places of the World at different Cosmological times;
- The distribution of MOs in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous. Cosmological principal is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of the total Matter. The distribution of MOs with 1/3 of the total Matter is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable;
- The main conjecture of BBM: "*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 **Figure 1** and **Figure 2**). Big Bang never happened.

5. Milky Way Center

MW is a barred spiral galaxy with an estimated visible diameter of $100 - 200 \, kly$. MW is a part of the Local Group of galaxies that form part of the Virgo Supercluster, which is itself a component of LSC. It is estimated to contain 100–400 billion stars. The galactic center is an intense radio source known as Sgr A*. In 2008, A. M. Ghez, *et al.* found the enclosed mass of It: $(4.1 \pm 0.6) \times 10^6 \, M_\odot$ [22].

Several teams of researchers have attempted to image Sgr A* in the radio spectrum using very-long-baseline interferometry. The current highest-resolution (approximately $30 \, \mu as$) measurement, made at a wavelength of 1.3 mm, indicated an overall angular size for the source of $50 \, \mu as$ [23]. At a distance of $26.673 \, kly$ this yields a diameter of $6.337 \times 10^{10} \, m$.

E. A. C. Mills in her "Journey to the Center of the Galaxy: Following the gas to understand past and future activity in galaxy nuclei" wrote [24]: *"The **young stars in the central lightyear**, the innermost of whose orbits are famously used to determine parameters of central supermassive black hole, are suggested to have formed in-situ in one of the most extreme environments imaginable: in an incredibly dense gas disk a fraction of a light year from the black hole. Even allowing for recent activity in the past few hundred years which we can detect from the X-ray light of these outbursts reflecting off of clouds a few hundred light years from the black hole... **our black hole is no AGN**"* (Active Galactic Nucleus).

On 2015, NASA reported observing an X-ray flare 400 times brighter than usual, a record-breaker, from Sgr A*. The unusual event may have been caused by the breaking apart of an asteroid falling into Supermassive Black Hole or by entanglement of magnetic field lines within gas flowing into Sgr A* [25].

On 2021, NASA published new images of the galactic center, based on surveys from Chandra X-ray Observatory. Astronomers present a catalogue of the detected X-ray sources in the 0.3-7 keV band. NASA has released a stunning new picture of our galaxy's violent, super-energized "**downtown**." The image, a composite of 370 observations made over the past two decades by the orbiting Chandra X-ray observatory, depicts billions of stars in the center of MW. The author D. Wang of the University of Massachusetts Amherst said: "*What we see in the picture is a violent or energetic ecosystem in our galaxy's downtown*" [25].

In 2013, we proposed a principally different explanation of supermassive compact objects: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [26]. R. Genzel and A. Ghez were awarded the 2020 Nobel Prize in Physics for their **discovery that Sgr A* is a supermassive compact object**, for which supermassive Black Hole was the only accepted explanation. In our view, it is the DM Core of MW.

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

- The calculated value of the radius of the Electron-Positron shell $2.9 \times 10^{10} \ m$ is in excellent agreement with the experimentally measured value of the radio source $3 \times 10^{10} \ m$ [22];
- The calculated value of the mass of the Electron-Positron shell $6.6 \times 10^{36} \ kg$ is in good agreement with the experimentally measured value of the supermassive compact object $8.5 \times 10^{36} \ kg$ [21];
- The additional mass of the DMF3 shell of $1.9 \times 10^{36} \ kg$ is much smaller than the maximum mass of it: $1.2 \times 10^{41} \ kg$;
- X-ray flare 400 times brighter than usual can be explained by the detonation of DMF3 particles (3.7 keV) and their self-annihilation [27];
- The excess of gamma-ray emission with energy about 10 GeV reported by D. Hooper and L. Goodenough in the Galactic Center [28] can be explained by DMF2 particles (9.6 GeV) self-annihilation;
- DM Fermi Bubbles can be explained based on DMF1, DMF2, and DMF3 particles [8].

The oldest known star HD 140283 (Methuselah star) is a subgiant star about 190 light years away from Earth for which a reliable age has been determined [29]. H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8 \ Byr$ that does not conflict with the Age of the Universe, $13.77 \pm 0.06 \ Byr$, based on the microwave background radiation and Hubble constant [30]. It means that this star must have formed between 13.66 and 13.83 Byr, an amount of time that is too short for formation of the second generation of stars according to prevailing theories. In our Model, this discovery can be explained by generation of HD 140283 by overspinning Core of MW 13.77 Byr.

In frames of the developed Rotational Fission model, it is easy to explain hyper-runaway stars unbound from the MW with speeds of up to $\sim 700 \ km/s$ [31]: they were launched by overspinning DM Core of the Large Magellanic Cloud with the speed higher than the escape velocity.

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass of about 2.3 solar mass that is located at a distance of ~ 9 kpc from the Sun. When integrated backwards in time, the orbit of the star points unambiguously to the Galactic Centre, implying that S5-HVS1 was kicked away from Sgr A* with a velocity of ~ 1800 km/s , and travelled for 4.8 Myr to its current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [32]. In frames of the developed Model, this discovery can be explained by Gravitational Burst (GB) of the overspinning Core of MW 4.8 Myr ago, which gave birth to S5-HVS1 with a speed higher than the escape velocity of the Core.

C. J. Clarke, *et al.* observed CI Tau, a young 2 million year old star. CI Tau is located about 500 light years away in a highly-productive stellar "*nursery*" region of the galaxy. They discovered that the Extrasolar system contains four gas giant planets that are only 2 million years old [33], an amount of time that is too short for formation of gas giants according to the prevailing theories. In frames of the developed Rotational Fission model, this discovery can be explained by GB of the MW Core 2 million years ago, which gave birth to the CI Tau system with all the planets generated at the same time.

6. Solar System
6.1. Facts about Planets and Moons

According to "Evolution Encyclopedia" (The Origin of the Solar System), there are the following facts that do not fit into any evolutionary theory of how our solar system came into existence [1]:

- *A full 99.5 percent of all the angular momentum in the solar system is concentrated in the planets, yet a staggering 99.8 percent of all the mass in our solar system is located in our sun! There is no known mechanical process which could accomplish this transfer of momentum from the sun to its planets;*
- *Jupiter itself has 60 percent of the planetary angular motion. Evolutionary theory cannot account for this. This strange distribution was the primary cause of the downfall of the nebular hypothesis;*
- *Both Uranus and Venus rotate backwards to that of all the other planets. Seven of the nine planets rotate directly forward, in relation to their orbit around the sun. Why then does Venus rotate slowly backwards, and Uranus rotate at a 98 degree angle from its orbital plane;*
- *One-third of the 60 moons in our solar system have retrograde (backward) orbits, which are the opposite of the rotational direction of their respective planets. Theories of cosmology cannot explain backwards-orbiting moons;*
- *Consider Triton, the inner of Neptune's moons, which, with a diameter of 4,830 km, is nearly twice the mass of our moon, yet it revolves backwards every six days, has a nearly circular orbit,—and is only 354,046 km from its planet! I. Asimov has tried to explain it with a theory that it "was thrown away from that planet by some cosmic collision or other accident" and, at a later time, flew back and was recaptured "by similar accident"! The same explanation is used for all other backward-orbiting moons. Evolutionists try to explain everything in the universe as nothing more than a series of fortunate accidents. If that is the explanation for Triton's retrograde motion, how about the other one-third of the moons in our solar system, which rotate the same way?* **How many such "accidents" may the evolutionists be permitted to invoke to prop up theories already tottering under the weight of their own unproved assumptions?**
- *There are such striking differences between planets and planets, planets and moons, moons and moons,—that the experts can produce no explanation that can explain them. If they all came from the same gas clouds, they should all be alike! But some are relatively smooth, others extremely mountainous, still others have volcanoes, and yet others are covered with a variety of peculiar chemical atmospheres.*

6.2.   Solar System in WUM

In our opinion, the explanations of all these Facts and SS Mysteries (Venus spin backwards; Uranus tilted sideways; Moon creation; Mars hit by a giant cosmic lightning bolt) [5] based on the Impact theory are unrealistic and were proposed from hopelessness in frames of the Standard model. To the best of our knowledge, in literature it was never discussed and explained a real picture of SS objects' angular momenta (see **Figure 3, Table 2, and Table 3**). Why do Sun and all Objects have so different values and orientations of their motion being created from the same nebula with a **certain amount of angular momentum** [5]?

In astronomy, **axial tilt** is the angle between an object's rotational axis and its orbital axis, which is the line perpendicular to its orbital plane; equivalently, it is the angle between its equatorial plane and orbital plane. It differs from **orbital inclination** that is the tilt of an object's orbit around a celestial body. It is expressed as the angle between a reference plane and the orbital plane or axis of direction of the orbiting object. The **ecliptic** or ecliptic plane is the **orbital plane of Earth around the Sun**. The **galactic plane** is the plane on which the majority of a disk-shaped galaxy's mass lies. The directions perpendicular to the galactic plane point to the galactic poles. In actual usage, the terms galactic plane and galactic poles usually refer specifically to the plane and poles of MW, in which planet Earth is located.
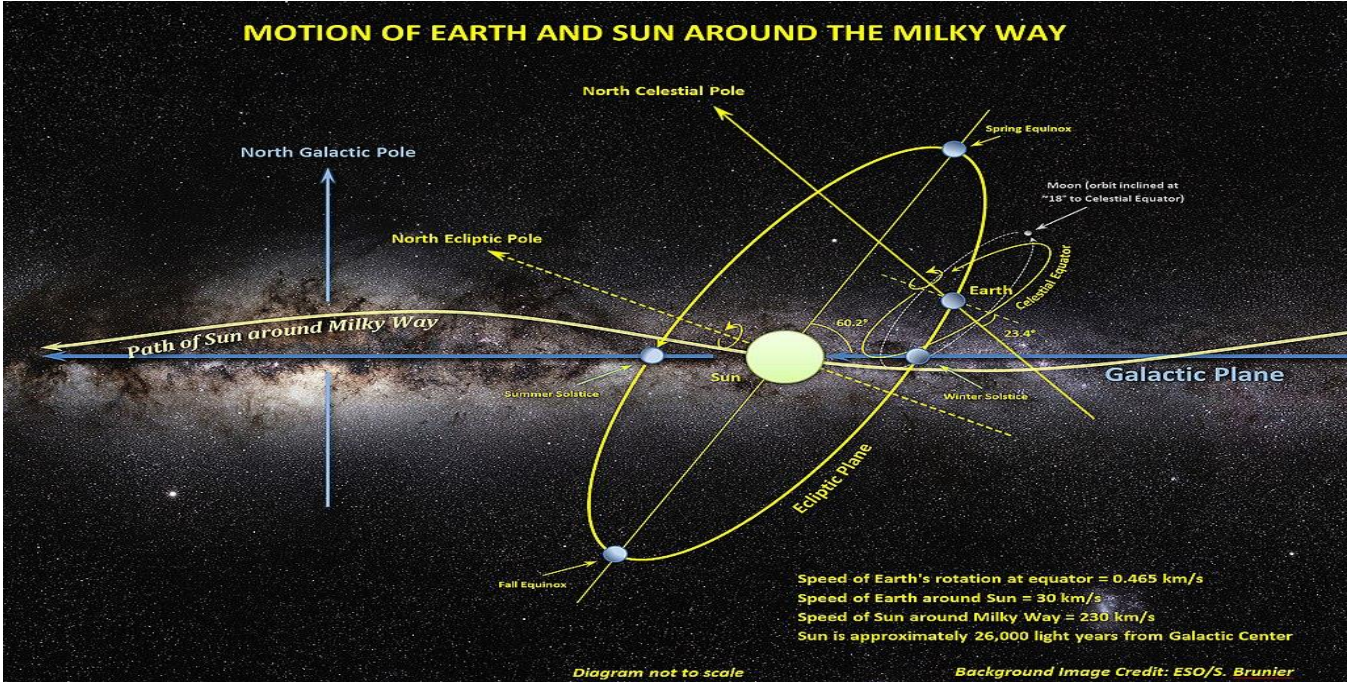
Figure 3. Orientation of the motion of SS Objects. Adapted from [34].

Table 2. Orientation of Angular momentum of gravitationally rounded objects of SS. Adapted from [35].

Object	Value	Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Inclination	deg.		7.00	3.39	0	1.85	1.31	2.48	0.76	1.77
Axial tilt	deg.	7.25	0.0	177.3	23.44	25.19	3.12	26.73	97.86	28.32

Let us consider rotational and orbital angular momentum of all gravitationally-rounded objects in SS, from Mimas, a small moon of Saturn ($3.75 \times 10^{19}\ kg$), to the Sun itself ($2 \times 10^{30}\ kg$). Their angular momenta are presented in **Table 3.** From the point of view of Fission model, the prime object is transferring some of its rotational momentum to orbital momentum of the satellite. It follows that **the rotational momentum of the prime object should exceed the orbital momentum of its satellite**.

From **Table 3** we see that orbital momenta of most satellites are indeed substantially smaller than the rotational momenta of their prime objects, with three exceptions:
- The rotational momentum of the Sun is smaller than Jupiter's, Saturn's, Uranus's, and Neptune's orbital momentum;
- The rotational momentum of the Earth is substantially smaller than Moon's orbital momentum;
- The rotational momentum of Pluto is considerably smaller than Charon's orbital momentum.

SS was born 4.57 Byr ago as the result of the repeating Gravitational burst of MW's Core. At that time, the rotational angular momentum of the Core L_{rot}^{MWC} was much larger than L_{orb}^{SS} (see Section 3.3). Considering that Jupiter's orbital momentum is about 60% of the total angular momentum of SS L_{tot}^{SS}, we obtain:

$$L_{tot}^{SS} \cong 3.2 \times 10^{43}\ J\ s$$

Let us calculate parameters of the Sun's Core necessary to provide this angular momentum. Considering

mass of the Sun $M_{Sun} = 2 \times 10^{30} \, kg$ and radius $R_{Sun} = 7 \times 10^{8} \, m$, we obtain [2]:

$$L_{rot}^{Sun} = 1.1 \times 10^{44} \, J \, s$$

which is 3.3 times greater than L_{tot}^{SS}. It follows that the Sun's Core can be smaller.

Table 3. Value of Rotational and Orbital angular momentum of gravitationally-rounded objects in SS [2].

Object of Solar System	Rotational Momentum (J s)	Orbital Momentum (J s)
Sun	1.10E+42	
Mercury	9.75E+29	9.15E+38
Venus	2.13E+31	1.85E+40
Earth	7.09E+33	2.66E+40
Moon	2.36E+29	2.89E+34
Mars	2.10E+32	3.53E+39
Jupiter	6.83E+38	1.93E+43
Io	4.84E+30	6.53E+35
Europa	9.68E+29	4.42E+35
Ganimede	4.18E+30	1.72E+36
Callisto	1.09E+30	1.66E+36
Saturn	1.35E+38	7.82E+42
Mimas	4.55E+25	9.96E+31
Enceladus	1.46E+26	3.25E+32
Tethys	2.70E+27	2.06E+33
Dione	3.67E+27	4.14E+33
Rhea	8.67E+27	1.03E+34
Titan	1.63E+30	9.16E+35
Lapetus	3.58E+26	2.10E+34
Uranus	2.30E+36	1.70E+42
Miranda	7.54E+25	5.67E+31
Ariel	5.22E+27	1.42E+33
Umbriel	2.88E+27	1.49E+33
Titania	7.28E+27	5.57E+33
Oberon	3.78E+27	5.54E+33
Neptune	2.72E+36	2.50E+42
Triton	1.94E+29	3.33E+34
Pluto	8.42E+28	3.66E+38
Charon	2.52E+27	5.32E+30
Ceres	1.62E+28	6.96E+36
Haumea	4.65E+29	1.18E+38
Eris	6.05E+29	6.12E+38

Let us consider the structure of the Sun. According to the standard Solar model it has:
- Core that extends from the center to about 20–25% of the solar radius, contains 34% of the Sun's mass

with density $\rho_{max} = 1.5 \times 10^5 \ kg/m^3$ and $\rho_{min} = 2 \times 10^4 \ kg/m^3$. It produces all Sun's energy;
- Radiative zone from the Core to about 70% of the solar radius with density $\rho_{max} = 2 \times 10^4 \ kg/m^3$ and $\rho_{min} = 2 \times 10^2 \ kg/m^3$ in which convection does not occur and energy transfer occurs by radiation;
- Core and Radiative zone contain practically all Sun's mass [11].

In our opinion, the Sun has an Inner Core (Nucleus made up of DMF1) whose radius is 20–25% of the solar radius, and an Outer Core – the Radiative zone. We then calculate the Solar Core rotational angular momentum L_{rot}^{SC} :

$$L_{rot}^{SC} \cong 8.9 \times 10^{43} \ J \ s$$

which is 2.8 times larger than the overall angular momentum of SS.

Let us follow the same procedure for Earth – Moon pair. Considering the mass of Earth $M_E = 6 \times 10^{24} kg$ and radius $R_E = 6.4 \times 10^6 m$, we calculate $L_{rot}^{Earth} = 6.6 \times 10^{34} \ J \ s$ that is 2.3 times larger than a Moon's orbital momentum $L_{orb}^{Moon} = 2.9 \times 10^{34}$ J s (see **Table 3**).

Let us look at the structure of the Earth. According to the standard model it has:
- An inner core and an outer core that extend from the center to about 45% of the Earth radius with density $\rho_{max} = 1.3 \times 10^4 \ kg/m^3$ and $\rho_{min} = 9.9 \times 10^3 \ kg/m^3$;
- Lower mantle, spanning from the outer core to about 90% of the Earth radius (below 660 km) with density $\rho_{max} = 5.6 \times 10^3 \ kg/m^3$ and $\rho_{min} = 4.4 \times 10^3 \ kg/m^3$;
- Inner core, outer core, and lower mantle contain practically all of the Earth's mass [36].

Very little is known about the lower mantle apart from that it appears to be relatively seismically homogeneous. Outer core – lower mantle boundary has a sharp drop of density $(9.9 \to 5.6) \times 10^3 \ kg/m^3$ [36]. In our opinion, lower mantle is a part of the Earth's core. It could be significantly different 4.57 Byr ago, since during this time it was gradually filled with all chemical elements produced by Earth's core due to DMF1 self-annihilation. Considering the Earth's core (EC) with radius $R_{core}^{Earth} = 5.7 \times 10^6 \ m$, the rotational angular momentum equals to:

$$L_{rot}^{EC} = 6.5 \times 10^{34} \ J \ s$$

which is 2.2 times larger than the orbital momentum of the Moon.

As for the Pluto – Charon pair, it is definitely a binary system. Charon was not generated by Pluto's core; instead, they are two independent objects that happened to be bounded together by gravity.

6.3. WUM Explanations

To be consistent with the Law of Conservation of Angular Momentum, we developed a New Cosmology (see Section 2). Big angle between Galactic Pole and Ecliptic Pole is due to the random Volcanic Rotational Fission of MW Galaxy DM Core creating many ESS DM cores at the same time, so that the direction of the sum of all ESS angular momentum coincides with the direction of galactic poles. The same explanation is valid for the Sun's DM Core and DM cores of the planets with moons considering that they were created at the same time 4.57 Byr ago.

In our view, random Explosive Volcanic Rotational Fission of DM Core of Prime Object looks like a Firework of DM cores of satellite objects at the same time so that the direction of the sum of satellites angular momentum coincides with the angular momentum of the Prime Object. DM Cores of Prime Objects detonate at critical points of their stability, which **principally depend on the accumulated Rotational Angular Momenta**.

According to the developed model of MOs, all chemical elements, compositions, substances, rocks are "homemade" and produced by MOs themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded objects of SS is explained by their distance from the Sun that provides some energy

to planets and moons, and the differences in their DM Cores (mass, size, composition). DM Reactors inside of gravitationally-rounded objects in hydrostatic equilibrium provide sufficient energy for all geological processes on planets and moons.

7. Conclusion

Astronomers have great achievements in investigations of the Solar System that became an Experimental laboratory for astrophysicists to check their theories. We are at the Beginning of a New Era of Astronomy, Cosmology, and Astrophysics! Young physicists should be a part of It. They should concentrate their efforts on the development of a New Cosmology and Classical Physics. I am very excited about the Future of Physics!

Acknowledgements

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Dark Stars. Supermassive and Ultramassive Dark Macroobjects: Review Article

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Abstract

R. Genzel and A. Ghez were awarded the 2020 Nobel Prize in Physics for their discovery that Sgr A* is a **supermassive compact object**, for which Supermassive Black Hole (SBH) was the only accepted explanation. In 2013, we proposed a principally different explanation of supermassive compact objects: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [1]. According to the developed Hypersphere World-Universe Model (WUM), the World consists of Dark Matter (about 92.8% of the total Matter) and Ordinary matter (about 7.2%). It means that Dark Matter (DM) should play the main role in any Cosmological model. It is the case in WUM, and Ordinary matter is a byproduct of Dark Matter Particles self-annihilation. In present paper, we discuss Dark Stars, Supermassive and Ultramassive Dark Macroobjects in frames of WUM.

1. Introduction

John Michell (1724 –1793) was an English natural philosopher and clergyman who provided pioneering insights into a wide range of scientific fields including astronomy, geology, optics, and gravitation. Considered "*one of the greatest unsung scientists of all time*", he is the first person known to have proposed the existence of "**Dark Stars**" and the first to have suggested that earthquakes travelled in (seismic) waves. The American Physical Society described Michell as being "*so far ahead of his scientific contemporaries that his ideas languished in obscurity, until they were re-invented more than a century later*". The Society stated that while "*he was one of the most brilliant and original scientists of his time, Michell remains virtually unknown today, in part because he did little to develop and promote his own path-breaking ideas*" [2].

In a paper for the Philosophical Transactions of the Royal Society of London, read on 27 November 1783 [3], Michell was the first to propose the existence of "dark stars". Michell suggested that there might be many "dark stars" in the universe and proposed that astronomers could detect "dark stars" by looking for star systems which behaved gravitationally like two stars, but where only one star could be seen. Michell argued that this would show the presence of a "dark star". It was an extraordinarily accurate prediction of binary systems, in which a "dark star" and a normal star orbit around their center of mass. In the Milky Way (MW) galaxy there are a dozen such binary systems emitting X-rays [2].

The first known binary system was Cygnus X-1, identified independently by several researchers in 1971. It remains among the most studied astronomical objects in its class. The compact object is now estimated to have a mass $\sim 21.2\ M_{\odot}$. Cygnus X-1 is about 5 million years old [4]. Though highly and erratically variable, Cygnus X-1 is typically the brightest persistent source of hard X-rays with energies up to 60 keV [5].

Cygnus X-1 was the subject of a friendly scientific wager between physicists S. Hawking and K. Thorne in 1975, with Hawking, hoping to lose, betting that it was not a Black Hole (BH). He conceded the bet in 1990 after observational data had strengthened the case that there was indeed BH in the system. **This hypothesis lacks direct empirical evidence but has generally been accepted from indirect evidence** [4].

Observational works on nearby galaxies in the last 25 years have revealed that Supermassive Compact Objects, for which SBHs was the only accepted explanation, in a mass range $M_{SBH} \sim 10^6 - 10^{10} M_\odot$ reside at centers of all massive elliptical galaxies and massive bulges of disk galaxies. Large-core spheroids are extremely massive $M_* \gtrsim 10^{12} M_\odot$ and tend to host Ultramassive Black Holes (UBHs) with mass $M_{UBH} \gtrsim 10^{10} M_\odot$ [6].

2. Dark Stars

The history of Dark Matter (DM) can be traced back to at least the end of 18th century (see Introduction). G. Bertone and D. Hooper provide an excellent review of this history [7]. The principal steps are:

- In 1844, F. Bessel argued that the observed proper motion of the stars Sirius and Procyon could only be explained by the presence of faint companion stars influencing the observed stars through their gravitational pull: *If we were to regard Procyon and Sirius as double stars, their change of motion would not surprise us. The existence of numberless visible stars can prove nothing against the evidence of numberless invisible ones*;

- Beside dark stars and planets, astronomers also discussed DM in the form of dark clouds, or dark "nebulae". In 1877, A. Secchi wrote: *Among these studies there is the interesting probable discovery of dark masses scattered in space, whose existence was revealed thanks to the bright background on which they are projected. Until now they were classified as black cavities, but this explanation is highly improbable, especially after the discovery of the gaseous nature of the nebular masses*;

- In 1904, Lord Kelvin was among the first to attempt a dynamical estimate of the amount of dark matter in the Milky Way. His argument was simple yet powerful: if stars in the Milky Way can be described as a gas of particles, acting under the influence of gravity, then one can establish a relationship between the size of the system and the velocity dispersion of the stars: *It is nevertheless probable that there may be as many as 10^9 stars (within a sphere of radius 3.09×10^{16} km) but many of them may be extinct and 10 dark, and nine-tenths of them though not all dark may be not bright enough to be seen by us at their actual distances. [...] Many of our stars, perhaps a great majority of them, may be dark bodies*;

- In 1933, F. Zwicky investigated the velocity dispersion of the Coma cluster and found a surprisingly high mass-to-light ratio (~ 500). He concluded: *if this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter*;

- What did Zwicky think that the dark matter in Coma and other galaxy clusters might be? An illuminating sentence in his 1937 paper provides a rather clear answer to this question: *In order to derive the mass of galaxies from their luminosity we must know how much dark matter is incorporated in nebulae in the form of cool and cold stars, macroscopic and microscopic solid bodies, and gases.*

B. Carr and F. Kühnel review the formation and evaporation of primordial BHs and their possible contribution to DM. Various constraints suggest they could only provide most of it in the mass windows $(10 - 10^2) M_\odot$ [8].

The role of cold DM in the formation of Primordial Luminous Objects is discussed by E. Ripamonti and T. Abel in [9]. A mechanism whereby DM in protostellar halos plays a role in the formation of the first stars is discussed by D. Spolyar, K. Freese, and P. Gondolo [10]. Heat from neutralino DM annihilation is shown to overwhelm any cooling mechanism, consequently impeding the star formation process. A dark star powered by DM annihilation instead of nuclear fusion may result [10]. Dark stars are in hydrostatic and thermal equilibrium, but with an unusual power source. Weakly Interacting Massive Particles (WIMPs) are among the best candidates for DM [11].

3. Explosive Volcanic Rotational Fission Model [12]

3.1. Multicomponent Dark Matter

The prospect that Dark Matter Particles (DMPs) might be observed in Centers of Macroobjects has drawn many new researchers to the field in the last forty six years. Indirect effects in cosmic rays and gamma-ray background from the annihilation of cold Dark Matter (DM) in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [13]-[18].

Two-component DM systems consisting of bosonic and fermionic components are proposed for the explanation of emission lines from the bulge of Milky Way galaxy. C. Boehm, P. Fayet, and J. Silk analyze the possibility of two coannihilating neutral and stable DMPs: a heavy fermion for example, like the lightest neutralino (>100 GeV) and the other one a possibly light spin-0 particle (~100 MeV) [19].

Multicomponent DM models consisting of both bosonic and fermionic components were analyzed in literature (for example, see [20]-[26] and references therein). A paper by G. Bertone and T. M. P. Tait [27] provides an excellent review of what we have learned about the nature of DM from past experiments, and the implications for planned DM searches in the next decade.

WUM proposes multicomponent DM system consisting of two couples of co-annihilating 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 $\mu = e/2\alpha$ (e is an elementary charge and α is a dimensionless Rydberg constant); 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; self-annihilating fermions DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain the diversity of DM Cores of Macroobjects (MOs) of the World (superclusters, galaxies, and extrasolar systems), which are Fermion Compact Objects in our Model.

WUM postulates that rest energies of DMFs and bosons are proportional to a basic energy unit: $E_0 = hc/a$ (h is Planck constant, c is an electrodynamic constant, and a is a basic size unit) multiplied by different exponents of α and can be expressed with following formulae:

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

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

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

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

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

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

DMPs do not possess an electric charge. Their masses cannot be directly measured by mass spectrometry. Hence, they can be observed only indirectly due to their self-annihilation and irradiation of gamma-quants.

According to the Big Bang (BB) model:

- **Formation and evolution of galaxies** can be explained only in terms of gravitation within an inflation + DM + dark energy scenario. What is the origin of Cold DM? Where did it come from?
- **Nucleosynthesis of the Light Elements**. The standard explanation now used for the abundance of deuterium is that the universe does not consist mostly of baryons, but that non-baryonic DM makes up most of the mass of the universe. Where did non-baryonic DM come from?

F. Mamoun in the paper "Black holes and dark matter — are they one and the same?" wrote [28]:

Dark matter — which has never been directly observed — is thought to constitute the majority of matter in the universe and act as the unseen scaffolding upon which galaxies form and develop. Physicists have spent years testing a variety of dark matter candidates, including hypothetical particles such as sterile neutrinos, Weakly Interacting Massive Particles (WIMPS), and axions.

The new study [29] harkens back to a theory first proposed in the 1970s by physicists S. Hawking and B. Carr. At the time, Hawking and Carr argued that in the first fraction of a second after the Big Bang, tiny fluctuations in the density of the universe may have created an undulating landscape with "lumpy" regions that had extra mass. These lumpy areas would collapse into black holes. Although the theory did not gain traction within the wider scientific community — the new study suggests that, if modified slightly, it could have explanatory power after all.

ESA. Science & Exploration. Space Science in the paper "Did black holes form immediately after the Big Bang?" asked: *How did supermassive black holes form? What is dark matter?* wrote: *In an alternative model for how the Universe came to be, as compared to the 'textbook' history of the Universe, a team of astronomers [29] propose that both of these cosmic mysteries could be explained by so-called 'primordial black holes'. Black holes could themselves be the as-of-yet unexplained dark matter* [30].

In **WUM**, the Universe is the source of DM in the World. There are no BHs in the World. Instead, there are DM Cores (Dark Stars) inside of all Macroobjects (Superclusters, Galaxies, Stars, Planets, and Moons).

3.2.   Macroobject Shell Model

In 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. A proposed Weak Interaction of DMPs provides integrity of all shells. **Table 1** describes parameters of MOs' Cores, which are 3D fluid balls with a very high viscosity and function as solid-state objects.

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

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

The calculated parameters of the shells show that:
- Nuclei made up of DMF1 and/or DMF2 compose Cores of dark stars in Galaxies and normal stars in Extrasolar Systems (ESS);
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;
- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of Superclusters.

3.3. Angular Momentum

Angular Momentum problem is one of the most critical problems in Standard model that must be solved. To the best of our knowledge, the developed WUM is the only one cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum. To be consistent with this Law, any theory of evolution of Universe must answer the following questions:

*   How did Galaxies and ESS get their substantial orbital and rotational angular momenta;
*   How did MW give birth to different ESS in different times;
*   The age of MW is about the Age of the World. What is the origin of MW huge orbital and rotational angular momenta? We must discuss the Beginning of MW;
*   The oldest star in MW (named Methuselah) is nearly as old as the universe itself. How did it happen?
*   The beginning of the Solar System (SS) was 4.57 Byr ago. What is the origin of SS rotational and orbital angular momenta? We must discuss the Beginning of SS.

In our opinion, there is only one mechanism that can provide angular momenta to MOs – **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 **rotational momenta of prime objects should exceed orbital momenta of their satellites** [31].

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 follows that a long enough time period must elapse. We named this period "Dark Epoch" and developed a New Cosmology of the World [31]:

*   WUM introduces Dark Epoch (spanning from the Beginning of the World 14.22 Byr ago for 0.45 Byr) when only DM MOs existed, and Luminous Epoch (ever since for 13.77 Byr for Laniakea Supercluster) when Luminous MOs emerged due to the Rotational Fission of Superclusters' DM Cores and self-annihilation of DMPs;
*   Main players of the World are Superclusters' DM Cores that 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 World show that most of them are disk galaxies. These results speak in favor of the developed Rotational Fission mechanism;
*   MW's DM Core was born 13.77 Byr ago as the result of Rotational Fission of Virgo Supercluster's DM Core;
*   DM Cores of ESS, planets and moons were born as the result of the repeating Rotational Fissions of Galaxy's DM Cores in different times (4.57 Byr ago for SS in MW);
*   MOs of the World form from the top (superclusters) down to galaxies, ESS, planets, and moons.

3.4. Formation of Macrostructures [32]

In WUM, Cores of all MOs possess the following properties:

*   Their Nuclei are made up of DMFs and contain other particles, including DM and Baryonic matter, in shells surrounding the Nuclei;
*   DMPs are continuously absorbed by Cores of all MOs. Ordinary Matter (about 7.2% of the total Matter) is a byproduct of DMPs self-annihilation. It is re-emitted by Cores of MOs continuously. MOs' cores are essentially DM Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation in their DM cores;

- Nuclei and shells are growing in time: size $\propto \tau^{1/2}$; mass $\propto \tau^{3/2}$; and rotational angular momentum $\propto \tau^2$ (τ is an absolute cosmological time), until they reach the critical point of their stability, at which they detonate. Satellite's cores and their orbital L_{orb} and rotational L_{rot} angular momenta released during detonation are produced by Overspinning DM Cores (ODMCs). The detonation process does not destroy ODMCs; it is rather gravitational hyper-flares;
- Size, mass, composition, L_{orb} and L_{rot} of satellite DM cores depend on local density fluctuations at the edge of ODMC and cohesion of the outer shell. Consequently, the diversity of satellite DM cores has a clear explanation. Satellite DM cores are given off by "**Volcanoes**" on prime DM Cores erupting repeatedly;
- WUM refers to ODMC detonation process as Gravitational Burst (GB), analogous to Gamma Ray Burst. In frames of **WUM**, the repeating GBs can be explained the following way:
- As the result of GBs, ODMCs lose a small fraction of their mass and a large part of their rotational angular momentum;
- After GBs, DM Cores of Prime Objects (superclusters and galaxies) absorb new DMPs. Their masses increase $\propto \tau^{3/2}$, and their angular momenta L_{rot} increase much faster $\propto \tau^2$, until they detonate again at the next critical point of their stability. That is why DM cores of Satellites (galaxies and ESS) are rotating around their own axes and DM Cores of Prime Objects;
- Afterglow of GBs is a result of processes developing in the Nuclei and shells after detonation;
- In case of ESS, a star wind is the afterglow of star detonation: Star's DM Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 Byr ago. It creates the SS bubble continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic DM Core detonations. In MW it continuously creates two DM Fermi Bubbles (see Section 5).

3.5. Decisive Role of Gravitational Parameter G in Cosmology

Measure what can be measured and make measurable what cannot be measured.
Galileo Galilei

Maxwell's Equations (MEs) form the foundation of classical electrodynamics. Gravitoelectromagnetism (GEM) is a gravitational analog of Electromagnetism. GEM equations differing from MEs by some constants were first published by O. Heaviside in 1893 as a separate theory expanding Newton's law. GEM is an approximation to Einstein's gravity equations 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 [33]. It allows us to use formal analogies between electromagnetism and relativistic gravity. MEs produce only two physically measurable quantities: energy density and energy flux density [34].

The value of MEs is even greater because J. Swain showed that "*linearized general relativity admits a formulation in terms of gravitoelectric and gravitomagnetic fields that closely parallels the description of the electromagnetic field by Maxwell's equations*" [35]. We emphasize that **GEM considers not only interactions between masses but also between mass currents**, which produce gravitomagnetic field.

In 2021, G. Ludwig in his paper "Galactic rotation curve and dark matter according to gravitomagnetism" wrote: *Most theories used to explain the rotation curve have been restricted to the Newtonian potential framework, disregarding the general relativistic corrections associated with mass currents. In this paper it is shown that the gravitomagnetic field produced by the currents modifies the galactic rotation curve, notably at large distances. The coupling between the Newtonian potential and the gravitomagnetic flux function*

results in a nonlinear differential equation that relates the rotation velocity to the mass density. The solution of this equation reproduces the galactic rotation curve without recourse to obscure dark matter components. **The effects attributed to dark matter can be simply explained by the gravitomagnetic field produced by the mass currents** [36].

WUM is based on Gravitomagnetism. The explanation of the galactic rotation curve made by G. O. Ludwig is in good agreement with the approach of WUM. Thanks to the revealed by WUM Inter-Connectivity of Primary Cosmological Parameters, we show that Gravitational parameter G that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly.

It is worth noting that in WUM, parameter G is proportional to the energy density of the Medium of the World ρ_M that is inversely proportional to the cosmological time: $\rho_M \propto \tau^{-1}$. Therefore, parameter $G \propto \tau^{-1}$, as it was proposed by P. Dirac in 1937. Introduced by WUM, Cosmological time marches on at constant pace since the Beginning of the World until the present Epoch and defines the Age of the World: $A_\tau = \tau$. The Hubble's parameter H, which is, in fact, the wave resistance of the Medium, equals to: $H = \tau^{-1}$ and should be measured using Cosmic Microwave Background Radiation data only.

We emphasize that in frames of WUM, there is no need to invent new Physical Laws for describing early stages of the World observed by JWST. We can use the well-known equations considering a time-varying G.

4. Milky Way Center [12]

MW is a barred spiral galaxy with an estimated visible diameter of $100 - 200 \, kly$. MW is a part of the Local Group of galaxies that form part of the Virgo Supercluster, which is itself a component of Laniakea Supercluster. MW is estimated to contain 100–400 billion stars. The galactic center is an intense radio source known as Sgr A*. In 2008, A. M. Ghez, *et al.* found the enclosed mass of it: $(4.1 \pm 0.6) \times 10^6 \, M_\odot$.

Several teams of researchers have attempted to image Sgr A* in the radio spectrum using very-long-baseline interferometry. The current highest-resolution (approximately $30 \, \mu as$) measurement, made at a wavelength of 1.3 mm, indicated an overall angular size for the source of $50 \, \mu as$. At a distance of $26.673 \, kly$ this yields a diameter of $6.337 \times 10^{10} \, m$.

In 2015, NASA reported observing an X-ray flare 400 times brighter than usual, a record-breaker, from Sgr A*. According to astronomers, the unusual event may have been caused by the breaking apart of an asteroid falling into SBH or by the entanglement of magnetic field lines within gas flowing into Sgr A*.

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

In 2013, we proposed a principally different explanation of supermassive compact objects: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*".

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

- The calculated value of the radius of the Electron-Positron shell $2.9 \times 10^{10} \, m$ is in excellent agreement with the experimentally measured value of the radio source radius $3.17 \times 10^{10} \, m$;
- The calculated value of the mass of the Electron-Positron shell $6.6 \times 10^{36} \, kg$ is in good agreement with the experimentally measured value of the supermassive compact object $8.5 \times 10^{36} \, kg$;
- The additional mass of the DMF3 shell of $1.9 \times 10^{36} \, kg$ is much smaller than the maximum mass of it;
- X-ray flare 400 times brighter than usual can be explained by the detonation of DMF3 particles (3.7 keV) and their self-annihilation ;

- The excess of gamma-ray emission with energy about 10 GeV reported by D. Hooper from the Galactic Center can be explained by DMF2 particles (9.6 GeV) self-annihilation.

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

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

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

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

Cygnus X-1 is about 5 million years old. In frames of the developed Rotational Fission model, this discovery can be explained by GB of ODMC of MW 5 million years ago, which gave birth to the binary system at the same time, moreover dark star is the rotating DM core made of DMF1 and DMF2 with the surface speed at equator less than the escape velocity. Both stars have Halos made of DMF3 particles emitting X-rays as the result of their self-annihilation.

5. Fermi Bubbles [12]

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. 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, without showing any sign of cutoff up to 1 TeV, remains unconstrained. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

WUM explains FBs the following way:
- Core of MW, made up of DMF1, DMF2 , and DMF3, rotates with surface speed at equator close to the escape velocity between GBs, and over the escape velocity at the moments of GBs;
- Bipolar astrophysical jets (which are astronomical phenomena where outflows of matter are emitted as the extended beams along the axis of rotation) 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. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre "*chimneys*") are the result of the self-annihilation of DMF3 particles;
- FBs are bubbles whose boundary with the Intergalactic Medium has a basic surface energy density $\sigma_0 = hc/a^3$. These bubbles are filled with DMPs: DMF1, DMF2, and DMF3. The calculated diameter D_{FB} of FBs: $D_{FB} = 28.6\ kly$ is in good agreement with the measured size of the FBs 25 kly and 32.6 kly. **FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2;**
- With Nikola Tesla's principle at heart – "*There is no energy in matter other than that received from the environment* "– we calculate mass M_{FB} of FBs: $M_{FB} = 3.6 \times 10^{41} kg$. Recall that the mass of MW: M_{MW} is about: $M_{MW} = (1.6 - 3.2) \times 10^{42} kg$;
- FBs radiate X-rays due to the self-annihilation of DMF3 (3.7 keV). Gamma rays up to 1 TeV are the result of self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) particles in Dark Matter Objects (DMOs) whose density is sufficient for the self-annihilation of DMPs to occur. On the other hand, DMOs are much smaller than stars in the World, and have a high concentration in FBs to provide nearly uniform gamma ray glow over their colossal surfaces;
- Total flux of the gamma radiation from FBs is the sum of the contributions of all individual DMOs, which irradiate gamma quants with different energies and attract new DMF1 and DMF2 particles from FBs;
- Core of MW supplies FBs with new DMPs through galactic wind, explaining a brightness of FBs remaining fairly constant during the time of observations. FBs are built continuously throughout the lifetime of MW. In our view, **FBs are DMPs' clouds containing uniformly distributed Dark Matter Objects,** in which DMPs

self-annihilate and radiate X-rays and gamma rays. DM Fermi Bubbles constitute principal proof of WUM.

6. Supermassive Dark Macroobjects

Distances to remote objects, other than those in nearby galaxies, are nearly always inferred by measuring the cosmological redshift of their light. An important distinction is whether the distance is determined via spectroscopy or using a photometric redshift technique. The spectroscopic redshift is conventionally regarded as being necessary for an object's distance to be considered definitely known, whereas photometrically determined redshifts identify "candidate" distant sources. For comparisons with the light travel distance of the astronomical objects listed below, the age of the universe since the Big Bang (BB) is currently estimated as 13.787±0.020 Byr [37].

6.1. Most Distant Objects

Below we discuss Macroobjects with $z > 10$ (see **Table 2** and **Table 3**, adapted from [37]):
- HD1 is one of the earliest and most distant known galaxies yet identified in the observable universe. HD1's unusually high brightness has been an open question for its discoverers; it has a significantly more luminous ultraviolet emission than similar galaxies at its redshift range [38];
- F200DB-045 is a candidate high-redshift galaxy, with an estimated redshift of approximately z = 20.4, corresponding to 168 Myr after BB. If confirmed, it would be one of the earliest and most distant known galaxies observed. F200DB-045 would have a light-travel distance (lookback time) of 13.7 Byr;
- C. Ilie, J. Paulin, and K. Freese in an article "Supermassive Dark Star candidates seen by JWST?" wrote [39]: *The first generation of stars in the Universe is yet to be observed. There are two leading theories for those objects that mark the beginning of the cosmic dawn: hydrogen burning Population III stars and Dark Stars, made of hydrogen and helium but powered by Dark Matter heating. The latter can grow to become supermassive ($M_* \sim 10^6 M_\odot$) and extremely bright ($L \sim 10^9 L_\odot$). We show that each of the following three*

objects: JADES-GS-z13-0 , JADES-GS-z12-0 , and JADES-GS-z11-0 (at redshifts z ∈ [11, 14]) are consistent with a Supermassive Dark Star interpretation, thus identifying, for the first time, Dark Star candidates.

It is worth noting that in 2013 we proposed a principally different explanation of supermassive compact objects: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores. The first phase of stellar evolution in the history of the World may be dark stars, powered by Dark Matter heating rather than fusion. Neutralinos and WIMPs, which are their own antiparticles, can annihilate and provide an important heat source for the stars and planets in the World*" [1].

Table 2. Most distant galaxies with spectroscopic redshift determinations

Name	Redshift	Light travel distance, Gly
HD1	$z = 13.27$	13.579; 13.599; 13.477; 13.476
JADES-GS-z13-0	$z = 13.20^{+0.24}_{-0.07}$	13.576; 13.596; 13.474; 13.473
JADES-GS-z12-0	$z = 12.63^{+0.24}_{-0.08}$	13.556; 13.576; 13.454; 13.453
GLASS-z12	$z = 12.117^{+0.01}_{-0.01}$	13.536; 13.556; 13.434; 13.433
JADES-GS-z11-0	$z = 11.58^{+0.05}_{-0.05}$	13.512; 13.532; 13.410; 13.409
GN-z11	$z = 10.957^{+0.001}_{-0.001}$	13.481; 13.501; 13.380; 13.379
UDFj-39546284	$z = 10.38^{+0.07}_{-0.06}$	13.449; 13.469; 13.348; 13.347

Table 3. Notable candidates for most distant galaxies

Name	Redshift	Light travel distance, Gly
F200DB-045	$z = 20.4^{+0.3}_{-0.3}$	13.725; 13.745; 13.623; 13.621
CEERS-93316	$z = 16.39^{+0.32}_{-0.22}$	13.661; 13.681; 13.559; 13.558
F200DB-175	$z = 16.2^{+0.3}_{-0.0}$	13.657; 13.677; 13.555; 13.554
S5-z17-1	$z = 16.0089^{+0.0004}_{-0.0004}$	13.653; 13.673; 13.551; 13.550
F150DB-041	$z = 16.0^{+0.2}_{-0.2}$	13.653; 13.673; 13.551; 13.549
SMACS-z16a	$z = 15.92^{+0.17}_{-0.12}$	13.651; 13.671; 13.549; 13.548
F200DB-015	$z = 15.8^{+3.4}_{-0.1}$	13.648; 13.668; 13.546; 13.545

Detailed analysis of observations of the first batch of $z \approx 11$–20 Candidate Objects revealed by JWST is done by H. Yan, *et al.* in [40].

6.2. Observations of SBHs

The size of SBHs can be estimated by their mass, and the most massive ones are typically found at the centers of large galaxies. The very large number of SBHs have their mass values from $4.3 \times 10^6 M_\odot$ (Sagittarius A* at the center of MW) to $1 \times 10^{10} M_\odot$ (NGC 1281, compact elliptical galaxy in the constellation Perseus) [41]. Below we will discuss the most interesting ones.

Distant quasars are unique tracers to study the formation of the earliest SBHs and the history of cosmic reionization. Despite extensive efforts, up to now only four quasars have been found at $z \geq 7.5$:

- J. Yang, *et al.* report a discovery of a luminous quasar, J1007+2115 at $z = 7.515$ [42]. The quasar is powered by $(1.5 \pm 0.2) \times 10^9 M_\odot$ SBH that is twice as massive as that in quasar J1342+0928 at $z = 7.54$. At this redshift, the age of the universe is 690 Myr [43];
- F. Wang, *et al.* report the discovery of a luminous quasar J0313−1806 at $z=7.642$. Deep spectroscopic observations reveal SBH with a mass of $(1.6 \pm 0.4) \times 10^9 M_\odot$ in it. The existence of such a massive SBH just ~670 Myr after BB challenges significantly theoretical models of SBH growth [44];
- R. L. Larson, *et al.* report the discovery of SBH at $z=8.679$, in CEERS 1019 galaxy that has a stellar mass $M_\circledast \approx 10^{9.5 \pm 0.3} \, M_\odot$. SBH has the mass of $M_{SBH} \approx 10^{6.95 \pm 0.37} \, M_\odot$ and existed at 570 Myr after BB [45].

6.3. Galaxy without SBH in Center

A2261-BCG (short for Abell 2261 Brightest Cluster Galaxy) is a huge elliptical galaxy in the cluster Abell 2261. One of the largest galaxies known, A2261-BCG is estimated to have a diameter of a million light-years. It is the brightest and the most massive galaxy in the cluster and has one of the largest galactic cores ever observed, spanning more than 10 kly. Yet, unusually, its center does not contain SBH [46].

A2261-BCG, located at least 3 Bly from Earth, is also well known as a radio source. Its core is highly populated by a dense number of old stars, but is mysteriously diffuse, giving it a large core. In 2012, using Hubble Space Telescope, scientists realized there was no SBH with expected mass ~$10^{10} M_\odot$ present in its center. A central mass density of the core is $< 0.1 \, M_\odot \, pc^{-3}$, which is extremely diffuse in comparison to the denser cores of less luminous galaxies [47].

K. Gultekin, *et al.* use Chandra X-ray observations to look for evidence of a recoiling BH from A2261-BCG because of its large, flat stellar core, revealed by Hubble Space Telescope observations [48]. They found no X-ray emission arising from a point source in excess of the cluster gas and can place limits on the accretion of any BH in the central region to a 2-7 keV flux below a bolometric Eddington fraction of about 10^{-6}. Thus there is either no ~$10^{10} M_\odot$ BH in the core of A2261-BCG, or it is accreting at a very low level [48].

6.4. Runaway SBH

In 2023, P. van Dokkum, *et al.* report the serendipitous discovery of an extremely narrow linear feature in HST/ACS images that may be an example of such a wake (see **Figure 1**). The feature extends 62 kpc from the nucleus of a compact star-forming galaxy at $z=0.964$. The stellar continuum colors vary along the feature and are well-fit by a simple model that has a monotonically increasing age with distance from the tip. The line ratios, colors, and the overall morphology are consistent with an ejected SBH moving through the circumgalactic medium (CGM) at high speed while triggering star formation. The best-fit time since ejection is ~39 Myr and an implied velocity is v ~1600 km/s. The expected SBH mass is $M_{BH} \sim 2 \times 10^7 M_\odot$.

The feature is not perfectly straight in the HST images, and they show that the amplitude of the observed spatial variations is consistent with the runaway SBH interpretation. The interaction of a runaway SBH with CGM can lead to the formation of a wake of shocked gas and young stars behind it. Opposite the primary wake is a fainter and shorter feature, marginally detected in [OIII] and the rest-frame far-ultraviolet. This feature may be shocked gas behind a **binary SBH** that was ejected at the same time as the SBH that produced the primary wake. The host galaxy is compact and somewhat irregular. The authors find the half-light radius of the galaxy $r_e \approx 1.2$ kpc [50].

P. van Dokkum, *et al*. propose the following runaway SBH scenario:

- A merger leads to the formation of a long-lived binary SBH;
- A third galaxy comes in binary SBH. Its SBH sinks to the center of the new merger remnant, and this leads to a three-body interaction. It can be about 1 Byr between these two events;
- One black hole (usually the lightest) becomes unbound from the other two and receives a large velocity kick. Conservation of linear momentum implies that the remaining binary gets a smaller velocity kick in the opposite direction. If the kicks are large enough all SBHs can leave the galaxy. This event happened ~ 40 Myr before the epoch of observation.

Figure 1. Runaway Black Hole near dwarf galaxy RCP 28. This Hubble Space Telescope archival photo captures a curious linear feature that is so unusual it was first dismissed as an imaging artifact from Hubble's cameras. But follow-up spectroscopic observations reveal it is a 200,000-light-year-long chain of young blue stars. A supermassive black hole lies at the tip of the bridge at lower left. The black hole was ejected from the galaxy at upper right. It compressed gas in its wake to leave a long trail of young blue stars. Nothing like this has ever been seen before in the universe. This unusual event happened when the universe was approximately half its current age. Adapted from [49].

In frames of **WUM**, the runaway galaxy can be explained the following way:

- Original host galaxy had a spinning DM Core with a surface speed at equator less than the escape velocity;
- During about 1 Byr the DM Core has an additional rotational angular momentum $\propto \tau^2$ up to the critical point when the surface speed at equator achieved the escape velocity ~ 39 Myr ago;

- As the result of the Explosive Volcanic Rotational Fission of DM Core of the host galaxy, DM core of the runaway galaxy with the mass $\sim 2 \times 10^7 \mathrm{M}_\odot$ was kicked away with the velocity $\sim 1600\ km/s$;
- DM Core of the host galaxy, having a mass $> 2 \times 10^7 \mathrm{M}_\odot$, was kicked away in the opposite direction with the smaller velocity;
- DM core of the runaway galaxy started to create DM cores of stars with velocities $\ll 1600\ km/s$;
- Summing of these two velocities leads to the formation of the primary wake of DM cores of young stars behind DM core of the runaway galaxy;
- Opposite the primary wake is a fainter and shorter feature that is the young stars created by DM Core of the residual DM Core of the host galaxy;
- Due to the self-annihilation of DMPs of the DM cores of the young stars, ordinary matter created on their surfaces and stars become visible.

6.5. Formation Models

These discoveries poses the most stringent constraints on masses of seed BHs. How SBHs initially formed is one of the biggest problems in the study of galaxy evolution today. SBHs have been observed as early as 570 Myr after BB, and how they could grow so quickly remains unexplained. The fact that a galaxy so massive existed so soon after first stars started to form is a challenge to current theoretical models of the formation of galaxies.

In astrophysics and particle physics, Self-Interacting Dark Matter (SIDM) is an alternative class of DMPs which have strong interactions, in contrast to the standard cold dark matter (CDM). SIDM was postulated in 1999 [51]. On galactic scales, DM self-interaction leads to energy and momentum exchange between DMPs. SIDM has also been postulated as an explanation for the DAMA annual modulation signal. Moreover, it is shown that it can serve the seed of SBHs at high redshift [52].

S. Balberg and S. L. Shapiro demonstrate that the formation of a central BH is the natural and inevitable consequence of the gravothermal catastrophe in SIDM halo. Through gravothermal evolution driven by collisional relaxation, SIDM halo will form a massive inner core whose density and velocity dispersion will increase secularly in time. Eventually, the inner core arrives at a relativistic radial instability and undergoes dynamical collapse to BH. According to the authors, forming SBHs by core collapse in SIDM halos requires no baryons, no prior epoch of star formation and no other mechanism of forming BHs seeds [53].

J. Pollack, D. N. Spergel, and P. J. Steinhardt consider the cosmological consequences if a small fraction of the DM is ultra-strongly self-interacting. This possibility evades all current constraints that assume that the self-interacting component makes up the majority of DM. Nevertheless, even a small fraction of ultra-strongly SIDM can have observable consequences on astrophysical scales. It can undergo gravothermal collapse and form seed BHs in the center of a halo. [54].

W. X. Feng, *et al.* propose a scenario where a SIDM halo experiences gravothermal instability and its central region collapses into a seed BH. According to the authors, the presence of baryons in protogalaxies could significantly accelerate the gravothermal evolution of the halo and shorten collapse timescales [55].

In 2021, C. R. Argüelles, *et al.* propose a novel mechanism for the creation of SBHs from DM without requiring prior star formation or needing to invoke seed BHs with unrealistic accretion rates. The authors investigate the potential existence of stable galactic cores made of fermionic DM, and surrounded by a diluted DM halo, finding that the centers of these structures could become so concentrated that they could also collapse into SBHs once a critical threshold is reached. They analyzed this mechanism with DM haloes mass up to $5.9 \times 10^{10}\ M_\odot$ [56].

7. Ultramassive Dark Macroobjects

The most massive BHs discovered so far are [6], [57]:

- **NGC 6166** is a supermassive galaxy, with several smaller galaxies within its envelope, in the Abell 2199 cluster. It lies 490 million light years away in the constellation Hercules. The primary galaxy in the cluster is one of the most luminous galaxies known in terms of X-ray emissions. NGC 6166 has a large number of globular clusters(around 39,000) suggesting also that the halo of this galaxy blends smoothly with the intra-cluster medium. Because of that, the galaxy has the richest globular cluster system known. Also, a peculiar thing about NGC 6166 is that **it shows a blueshift i.e. it is moving towards us**. The galaxy harbors UBH at its center with a mass of nearly 30 billion solar mass;

- **H1821+643** is an extraordinarily luminous, radio-quiet quasar in the constellation of Draco. Identified in 2014, back then it was considered the most supermassive BH at a distance of over 10.4 Bly. The mass of this supergiant is more than 30 billion solar masses;

- **Abel 1201**. Outside the local Universe, measurements of M_{BH} are usually only possible for SBHs in an active state: limiting sample size and introducing selection biases. Gravitational lensing makes it possible to measure the mass of non-active SBHs. Using multi-band Hubble Space Telescope imaging and the lens modeling software PyAutoLens, J. W. Nightingale, *et al.* present models of a z=0.169 galaxy-scale strong lens Abell 1201 and find $M_{UBH} = (3.27 \pm 2.12) \times 10^{10} M_{\odot}$ [58];

- **S5 0014+81** has a mass of $\sim 4 \times 10^{10} M_{\odot}$. It is actually a blazar. Blazars are the most energetic of all sub classes of quasars. It is one of the most luminous quasars with total output power of $10^{41} W$;

- **Holm 15A** is the brightest cluster galaxy of the galaxy cluster Abell 85 in the constellation Cetus, about 700 Mly from Earth. K. Mehrgan, *et al.* find UBH with a mass of $(4.0 \pm 0.80) \times 10^{10} M_{\odot}$. This is the most massive BH with direct dynamical detection in the local universe [59];

- **IC 1101** is a supergiant galaxy at the center of the Abell 2029 galaxy cluster and located 1.15 Bly from the Earth. It possesses a diffuse core which is the largest known core of any galaxy to date, and also hosts UBH that is a bright radio source and has a mass of $(4 - 10) \times 10^{10} M_{\odot}$;

- **TON 618** is a hyperluminous, broad-absorption line, radio-loud quasar—located in the constellation Canes Venatici. It contains the most massive known BH, with a mass of 66 billion solar masses. It is one of the brightest objects in the known Universe that shines with a luminosity of $4 \times 10^{10} W$;

- **SLAB.** 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* [60], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes* [61]. They consider constraints on primordial BHs in the mass range $(10^{-18} - 10^{15}) M_{\odot}$ in case of DM comprised of WIMPs, which form halos around them and generate γ-rays by annihilations [62].

It is worth noting that the theoretical limit $M_{BH} = 5 \times 10^{10} M_{\odot}$ is the maximum mass of BH that models predict, at least for luminous accreting SBHs. At around $10^{10} M_{\odot}$, both effects of intense radiation and star formation in the accretion disc slows down BH growth. Given the age of the universe and the composition of available matter, there is simply not enough time to grow BHs larger than this mass [57].

8. Superclusters

A supercluster is a large group of smaller galaxy clusters or galaxy groups. They are among the largest

known structures in the universe. MW is part of the Local Group galaxy group (which contains more than 54 galaxies), which in turn is part of the Virgo Supercluster, which is part of the Laniakea Supercluster. The most interesting superclusters discovered so far are:

- **Laniakea Supercluster** (LSC) is a galaxy supercluster that is home to MW and approximately 10^5 other nearby galaxies (see **Figure 2**). It is known as one of the largest superclusters with estimated by L. Bliss, *et al.* binding mass 10^{17} $M_\odot$ [65].

  The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster (see **Figure 3**). Distance from the Earth to the Centre of LSC is 250 Mly. The mass-to-light ratio of Virgo Supercluster is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [66]. These ratios are one of the main arguments in favor of presence of large amounts of Dark Matter in the World and validate the developed Model of Superclusters' Macrostructure.

  We emphasize that $\sim 10^5$ nearby galaxies are moving around Centre of LSC. All these galaxies did not start their movement from "Initial Singularity". The neighboring superclusters have the same structures. It means that the World is a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$).

  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*" [64].

- **Phoenix A**. The Phoenix Cluster is a massive, Abell class type I galaxy cluster. It is one of the most massive galaxy clusters known, with the binding mass $(1.26 - 2.5) \times 10^{15} M_\odot$ and is the most luminous X-ray cluster discovered. It is located at a distance of 8.57 Bly from Earth. About 42 member galaxies were identified and currently listed in the SIMBAD Astronomical Database, though the real number may be as high as 10^3. Estimated mass of UBH is about $10^{11} M_\odot$ [60].
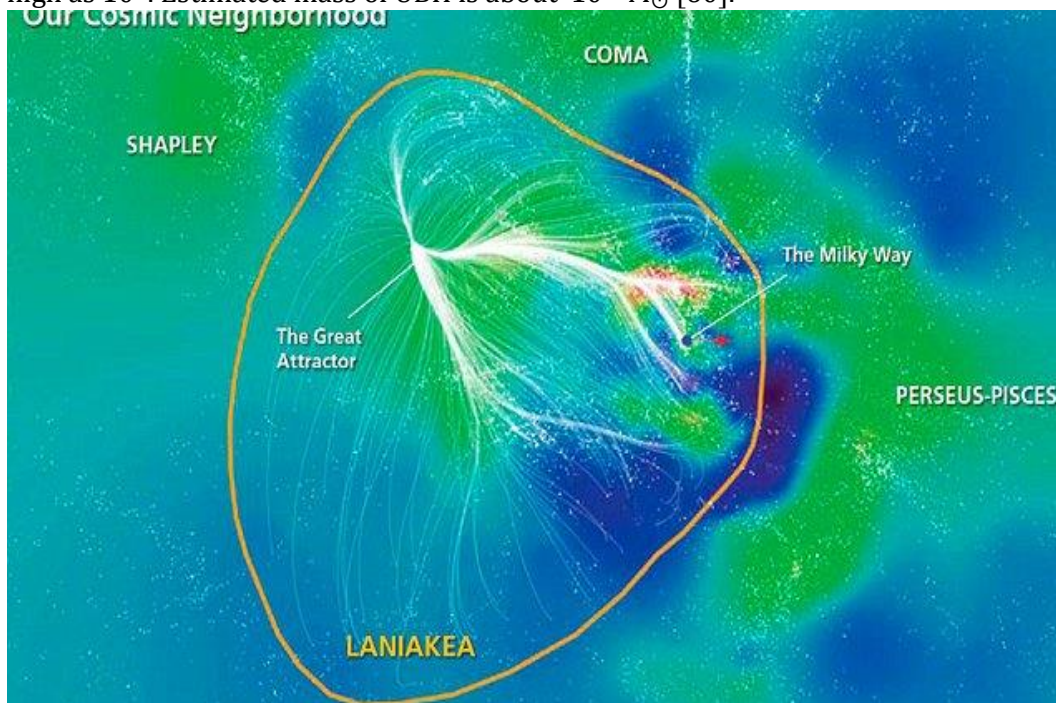

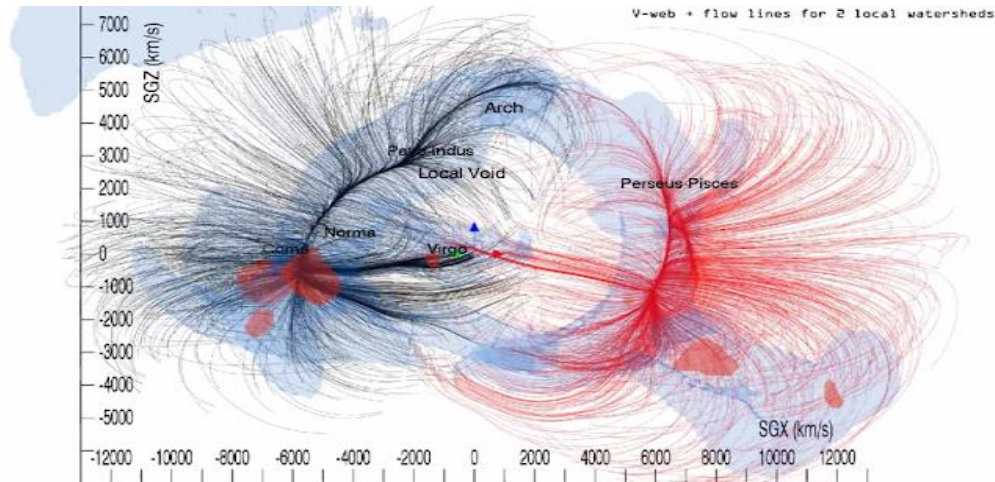**Figure 2.** Laniakea Supercluster. Adapted from [64].

Figure 3. 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 Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near Perseus Cluster are in red. Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [64].

9. Large-scale structures

The organization of structure arguably begins at the stellar level, though most cosmologists rarely address astrophysics on that scale. Stars are organized into galaxies, which in turn form galaxy groups, galaxy clusters, superclusters, sheets, walls and filaments, which are separated by immense voids, creating a vast foam-like structure sometimes called the "cosmic web" [63].

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**"* [67].

In 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 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**" [68].

10. JWST Discoveries [32]

The problem of ancient galaxies formation is a long-standing problem. The age of the Universe is $13.77 \pm 0.06\ Byr$, based on the cosmic microwave background data. Astronomers believe that our own MW galaxy is approximately 13.6 Byr old. MW is one of the two largest spiral galaxies in the Local Group (the other being the Andromeda Galaxy) Massive mature disk galaxies like MW cannot form so soon for 0.17 Byr only.

The summary of the JWST discoveries in the Early World:

- The most secure oldest galaxy is GLASS-z13 ($z \approx 13$, light-travel distance of 13.4572 Byr) that has already built up $\sim 10^9 \ M_\odot$ in stars;
- The search of 88 candidate galaxies at $z > 11$ shows that some of them could be at redshifts as high as 20. Some of those distant galaxies are strikingly massive;
- Most of the early galaxies are nicely shaped, disklike galaxies;
- It could be that some of these very distant, highly red-shifted galaxies are just very dusty. They may contaminate searches for ultra-high-redshift galaxy candidates from JWST observations;
- A new redshift record obtained for galaxy candidate CEERS-93316 at $z = 16.7$ (light-travel distance of 13.5512 Byr) with a stellar mass $log_{10}(M^*/M_\odot) = 9.0 \pm 0.4$;
- Seven galaxies with $M^* > 10^{10} \ M_\odot$ and 7<z<11 were found in the survey area, including two galaxies with $M^* \sim 10^{11} \ M_\odot$. The stellar mass density in massive galaxies is much higher than anticipated from previous studies: a factor of 10-30 at z~8 and more than three orders of magnitude at z~10;
- Extremely Compact Bright Galaxies were found at z~12−17 with effective radii $r_e \sim 200 - 300 \ pc$. One bright galaxy GL-z12-1 at z~12 has an extremely compact size with $r_e = 61 \pm 11 \ pc$;
- Super-early, massive, evolved galaxies with blue spectra, and very small dust attenuation.

11. WUM Explanations

These latest observations of the World can be explained in frames of the developed WUM only [69]:

- "*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;
- The calculated maximum mass of the supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the values discussed by L. Bliss [45] and B. Carr, F. Kühnel and L. Visinelli [51]. In the future, these stupendously large compact objects can give rise to new Luminous Superclusters as the result of their DM Cores' rotational fission and DMPs self-annihilation;
- 13.77 Byr ago, when the Laniakea Supercluster emerged, the estimated number of DM Supercluster Cores in the World was around $\gtrsim 10^3$. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. The 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters, which emerged in various places of the World at different Cosmological times;
- The distribution of MOs in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous. Cosmological principal is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of the total Matter. The distribution of MOs with 1/3 of the total Matter is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable;
- The mechanism of X-ray emission (self-annihilation of DMF3 particles) is valid for the galaxy NGC 6166, the Phoenix Cluster, Fermi Bubbles, the Solar and Planetary Coronas, and many other X-ray sources;

- In Section 6, we discuss the intense radio source known as Sgr A* in Centre of MW considering the shell of electron-positron plasma around Nuclei made up of DMF1 responsible for the radio emission. In our opinion, the same mechanism of radio emission is valid for the bright radio source IC 1101, the radio-loud quasar TON 618, the radio source A2261-BCG and many other radio-active sources;

- 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 obtained value of the most massive BH ever found, with a mass of $6.6 \times 10^{10} \ M_\odot$ at the center of TON 618 [57]. It is worth noting that there are no black holes in WUM;

- The main conjecture of BBM: "*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 **Figure 2** and **Figure 3**). BB never happened. **WUM** explains JWST discoveries the following way [71]:

- **It is a question of time!** The Beginning of the World was 14.22 Byr ago! WUM introduces Dark Epoch (spanning for LSC from the Beginning of the World for 0.45 Byr) when only DM Macroobjects existed, and Luminous Epoch (ever since, 13.77 Byr). Transition from Dark Epoch to Luminous Epoch is due to an Explosive Volcanic Rotational Fission of Overspinning DM Supercluster's Cores and self-annihilation of DMPs. Ordinary Matter is a byproduct of DMPs self- annihilation;

- Macroobjects form from the top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs;

- Early-galaxies formed in near present configuration. There are no protogalaxies in the World. That is why JWST did not see their images;

- Compact Disc Galaxies emerged as the result of the Rotational Fission of the overspinning DM Core of Superclusters. Each of them have one DM Core. There are no frequent mergers at the early epoch;

- Massive mature disk galaxies with mass up to $M^* \sim 10^{11} \ M_\odot$ cannot form so soon because it takes billions of years to form them, and so should not be there at all at the 'beginning';

- The presence of very dusty highly red-shifted galaxies should be proved by discussing a mechanism of dust creation. According to Herschel Space Observatory, *dust is formed in stars and is then blown off in a slow wind or a massive star explosion. The dust is then 'recycled' in the clouds of gas between stars and some of it is consumed when the next generation of stars begins to form. Dust formed in stellar wind or by Supernova Shockwave* [72]. The dust could have been efficiently ejected during the very first phases of galaxy build-up as A. Ferrara, A. Pallottini, P. Dayal speculated;

- We hope that oldest galaxies with high-redshifts $z > 20.4$ (light-travel distance $> 13.7 \ Byr$) will be confirmed. It depends on the physical parameters of JWST.

12. Conclusion

Astronomers have great achievements in investigations of the Solar System that became an Experimental laboratory for astrophysicists to check their theories. We are at the Beginning of a New Era of Astronomy, Cosmology, and Astrophysics! Young physicists should be a part of It. They should concentrate their efforts on the development of a New Cosmology and Classical Physics. I am very excited about the Future of Physics!

Acknowledgements

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Dark Matter Particles

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Abstract

Researchers have been able to infer the existence of Dark Matter (DM) only from the gravitational effect it seems to have on visible matter. DM seems to outweigh visible matter roughly six to one, making up about 27% of the universe. Here's a sobering fact: The matter we know and that makes up all stars and galaxies only accounts for 5% of the content of universe! But what is DM? [1]. Many experiments to detect and study Dark Matter Particles (DMPs) directly are being actively undertaken, but none have yet succeeded. Indirect detection experiments search for the products of the self-annihilation or decay of DMPs in outer space [2].

In this paper, we discuss the main ideas of the Hypersphere World-Universe Model (WUM) and introduce an additional new DMP "XION" (boson) with the rest energy 10.6 μeV that is an analog of Axion. On June 28, 2023, it was announced the existence of Cosmic Gravitational Background. In frames of WUM, we give an explanation of this discovery based on the analysis of "Gravitoplasma" composed of objects with Planck mass, which were created as the result of Weak Interaction between XIONs and other particles in the Medium.

1. Introduction

Galaxy clusters are particularly important for DM studies since their masses can be estimated in two independent ways [2]:

- From the scatter in radial velocities of the galaxies within clusters;
- Gravitational lensing (usually of more distant galaxies) can measure cluster masses without relying on observations of dynamics (e.g., velocity).

In 2017, K. Freese has reviewed the Status of Dark Matter in the Universe [3]:

Most of the mass in the universe is in the form of an unknown type of dark matter. The need for dark matter has become more and more clear since the 1930s, with evidence from rotation curves, gravitational lensing, hot gas in clusters, the Bullet Cluster, structure formation, and the cosmic microwave background. A consensus picture has emerged, in which dark matter contributes 26% of the overall energy density of the universe. Its nature is still unknown. Dark matter searches for the best motivated candidates, **axions** *and* **WIMPs***, are ongoing and promising over the next decade.*

In astrophysics and particle physics, Self-Interacting Dark Matter (SIDM) is an alternative class of Cold DM. SIDM particles have strong interactions, in contrast to the standard Cold DMPs [4]. On galactic scales, DM self-interaction leads to energy and momentum exchange between DMPs [5].

WIMPs, or Weakly Interacting Massive Particles, represent a favored class of DM candidates. Some WIMPs may mutually annihilate when pairs of them interact, a process expected to produce gamma rays [6]. A lightest neutralino of rest energy roughly ($10\ GeV \Leftrightarrow 10\ TeV$) is the leading WIMP DM candidate.

AXION is a hypothetical elementary particle postulated by the Peccei–Quinn theory to resolve the strong CP problem in quantum chromodynamics. With a rest energy $\gtrsim 10^{-11}$ times the electron rest energy about 5 μeV, axions could account for DM, and thus be both DM candidate and a solution to strong CP problem [7].

2. World-Universe Model vs Big Bang Model

WUM and Big Bang Model (BBM) are principally different Models:

- 1) Instead of the Initial Singularity with the infinite energy density and extremely rapid expansion of

spacetime (Inflation) in BBM; in WUM, there was a Fluctuation (4D Nucleus of the World with an extrapolated radius equals to a basic size unit of a, see Section 3.2) in Eternal Universe with finite extrapolated energy density ($\sim 10^4$ less than nuclear density) and finite expansion of Nucleus in Its fourth spatial dimension with speed c that is a gravitodynamic constant;

- 2) Instead of alleged practically Infinite Homogeneous and Isotropic Universe around Initial Singularity in BBM; in WUM, 3D Finite Boundless World (Hypersphere of 4D Nucleus) presents Patchwork Quilt of various main Superclusters ($\gtrsim 10^3$), which emerged in different places of the World at different Cosmological times. The Medium of the World, consisting of protons, electrons, photons, neutrinos, and DMPs is Homogeneous and Isotropic. Distribution of Macroobjects is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous;

- 3) The Universe is responsible for the creation of DM in 4D Nucleus of the World and is, in fact, the Creator of DM. DMPs carry new DM into the World. Luminous Matter is a byproduct of DMPs self-annihilation;

- 4) Time, Space and Gravitation are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium, respectively. It follows that neither Time, Space nor Gravitation could be discussed in absence of the Medium. WUM confirms the Supremacy of Matter postulated by A. Einstein: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*";

- 5) WUM based on Cosmological Time τ that marches on at the constant pace from the Beginning of the World up to the present Epoch along with time-varying Principal Cosmological Parameters. Gravitational parameter $G \propto \tau^{-1}$. Gravity is not an interaction but a manifestation of the Medium;

- 6) Gravitation is a result of simple interactions of DMPs XION (see Section 3.5) with Matter which work cooperatively to create a more complex interaction. XIONs are responsible for the Le Sage's "push" mechanism of gravitation that defines Gravity as an emergent phenomenon [8];

- 7) Thanks to the revealed by WUM Inter-Connectivity of Primary Cosmological Parameters, we show that Gravitational parameter that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly;

- 8) In our opinion, the most probable model is the one that built on the minimum number of parameters. BBM 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 which are mostly not predicted by current theory. WUM is based on two parameters only: dimensionless Rydberg constant α (that later was named Fine-structure constant) and dimensionless quantity Q, which increases in time $Q \propto \tau$, and is, in fact, a measure of the Size and Age of the World.

Most direct observational evidence of validity of WUM are:

- 1) Microwave Background Radiation and Intergalactic Plasma speak in favor of existence of the **Medium**;
- 2) Laniakea Supercluster with binding mass $\sim 10^{17}\ M_\odot$ is home to the Milky Way galaxy and $\sim 10^5$ other nearby galaxies, which did not start their movement from Initial Singularity;
- 3) Milky Way is gravitationally bounded with the Virgo Supercluster (VSC) and has an Orbital **Angular Momentum** calculated based on distance of 65 Mly from VSC and orbital speed of $\sim 400\ km\ s^{-1}$, which far exceeds rotational angular momentum of Milky Way;
- 4) Mass-to-light ratio of VSC is ~ 300 times larger than that of Solar ratio. Similar ratios are obtained for other superclusters. These ratios are main arguments in favor of presence of significant amounts of **Dark Matter** in the World;
- 5) Astronomers discovered the most distant galaxy HD1 that is $\sim 13.5\ Bly$ away. WUM predicts discovery of galaxies with distance $\sim 13.8\ Bly$.

Medium of the World, Dark Matter, and Angular Momentum are main Three Pillars of WUM.

3. Multicomponent Dark Matter
3.1. Existent Models

DM is among the most important open problems in both cosmology and particle physics. There are three prominent hypotheses on nonbaryonic DM, namely Hot Dark Matter (HDM), Warm Dark Matter (WDM), and Cold Dark Matter (CDM).

The lightest **Neutralino** with the rest energy ($> 300\ GeV$) is an excellent candidate to form the universe's CDM [9]. The most widely discussed particles for nonbaryonic CDM are commonly assumed to be **WIMPs**. The Lee-Weinberg limit restricts their rest energy to >2 GeV [10].

It is known that a **Sterile Neutrino** with rest energy in $1.6 \Leftrightarrow 10\ keV$ range is a good WDM candidate [11].

HDM is a theoretical form of DM which consists of particles that travel with ultra-relativistic velocities. An example of a HDM particle is a **Neutrino** [12]. In WUM, the particles of HDM are **XION**s (see Section 3.2).

The prospect that DMPs might be observed in Centers of Macroobjects has drawn many new researchers to the field in the last forty six years. Indirect effects in cosmic rays and gamma-ray background from the annihilation of CDM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [13]-[18].

Two-component DM system consisting of bosonic and fermionic components is proposed for the explanation of emission lines from the bulge of the Milky Way galaxy. C. Boehm, P. Fayet, and J. Silk analyze the possibility of two coannihilating neutral and stable DMPs: a heavy fermion for example, like the lightest neutralino (>100 GeV) and the other one a possibly light spin-0 particle (~100 MeV) [19].

Multicomponent DM models consisting of both bosonic and fermionic components were analyzed in literature (for example, see [20]-[26] and references therein). An article by G. Bertone and T. M. P. Tait [27] provides an excellent review of what we have learned about the nature of DM from past experiments, and the implications for planned DM searches in the next decade.

3.2. Basic Ideas

It is the main goal of WUM to develop a Model based on two dimensionless parameters only: the dimensionless Rydberg constant α and the time-varying parameter Q, which is a measure of the Size and Age of the World. In WUM, we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units. Taking the relative values of physical parameters in terms of the Basic Units we can express all dimensionless parameters of the World through two parameters α and Q in various rational exponents, as well as small integer numbers and π [28].

In our view, there is no way to prevent an occurrence of the Initial Singularity in BBM. A **Finite World** must have gotten started in a principally different way – a **Fluctuation** in the Eternal Universe with an extrapolated finite size that equals to the basic size unit a [29]:

$$a = 1.7705641 \times 10^{-14}\ m$$

The size of this Fluctuation can increase with a finite speed c (gravitodynamic constant). Then, there is no need to introduce Cosmological Inflation. However, a question about the mechanism of Continuous Creation of Matter in the World arises [29].

In 1952, Y. Nambu proposed an empirical mass spectrum of elementary particles with a mass unit close to one quarter of the mass of a pion ($m_0/2 \cong 35\ MeV/c^2$) [30]. He noticed that meson masses are even multiplies of a mass unit $m_0/2$, baryon (and also unstable lepton) masses are odd multiplies, and mass differences among similar particles are quantized by $m_0 \cong 70\ MeV/c^2$. During many years M. H. Mac Gregor studied this property extensively [31]. In WUM we introduce a Basic Energy Unit E_0 that equals to:

$$E_0 = hc/a = 70.025252\ MeV$$

where h is the Planck constant. 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: $Ry = hcR_\infty = 0.5\alpha^3 E_0 = 13.605692 \, eV$ (R_∞ is the Rydberg constant).

According to WUM, the Eternal Universe is the Source of the World's DM. Ordinary Matter (7.2%) is a byproduct of DMPs self-annihilation. It means that rest energies of DMPs must be constant and proportional to the basic energy unit E_0 [29]. Considering the main goal of WUM – two dimensionless parameters only – the rest energies of DMPs should be proportional to constant α only.

Following the mechanism discussed by C. Boehm, *et al*, we proposed multicomponent DM system consisting of two couples of co-annihilating 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 $\mu = e/2\alpha$ (e is the elementary charge); 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; DMF3 (3.7 keV), DMF4 (0.2 eV), and boson XION (10.6 μeV).

In frames of WUM, Dark Matter Particles **DMF1**, **DMF2**, and **DMF3** have rest energies, which corresponds to rest energies of Neutralinos, WIMPs, and Sterile Neutrinos discussed in literature (see Section 3.1). **DMF4** constitute the biggest shell of DM Cores of Superclusters [32].

DIRAC, which is a magnetic dipole of Dirac's monopoles, is introduced to explain the Dirac's quantization condition. The quantum theory of magnetic charge started with a paper by P. Dirac in 1931[33]. In this paper, he showed that if any magnetic monopoles exist in the universe, then all electric charge in the universe must be quantized. The electric charge is, in fact, quantized, which is consistent with (but does not prove) the existence of monopoles. Since Dirac's paper, several systematic monopole searches have been performed but it remains an open question whether monopoles exist [34]. In our opinion, all electric charges are quantized due to existence of DIRACs – dipoles of Dirac's monopole, which are the smallest building blocks of the structure of constituent quarks and hadrons (mesons and baryons).

ELOP, which is an electric dipole of preons with the rest energy ($E_e/3 = 170.333 \, keV$), is introduced to explain all subatomic particles with electrical charge $\propto e/3$. Preons are the smallest building blocks of the structure of quarks and leptons. According to I. A. D'Souza and C. S. Kalman "*In particle physics, preons are postulated "point-like" particles, conceived to be subcomponents of quarks and leptons*" [35].

S. Sukhoruchkin has this to say about "A Role of Hadronic effects in Particle Masses" [36]:*We discuss relations in particle mass spectrum and consider results of analysis of spacing distributions in nuclear spectra which show a distinguished character of intervals related to the electron mass and nucleon mass splitting. Systematic appearance of stable nuclear intervals rationally connected with particle mass splitting 170-340-510-1020 keV… was found in levels of different nuclei including low-spin levels observed in (γ, γ) and (n, γ) reactions. In this work we show such tuning effect in numerous levels from new compilation for light nuclei. Together with long-range correlations in nuclear binding energies they provide a support for the observed correlation between masses of hadrons and leptons (including masses of nucleons and m_e).*

We did not consider binding energies of DIRACs and ELOPs, and thus the values of their rest energies are approximate. They have negligible electrostatic and electromagnetic charges because the separation between charges is very small. They do however possess electrostatic and electromagnetic dipole momentum [37].

XION, which is introduced in the present paper for the first time, is an analog of Axion discussed in literature (see Introduction). It has the value of the rest energy 10.6 μeV that is in reasonable agreement with the value of $\gtrsim 5 \, \mu eV$ discussed in [7] and with highly-motivated mass range between $5 \Longleftrightarrow 11 \, \mu eV$ discussed in [38]. In our view, XIONs are responsible for the Le Sage's push mechanism of gravitation [29].

The reason for this multicomponent DM system was to explain:

- The diversity of Very High Energy gamma-ray sources in the World [39];
- The diversity of DM Cores of Macroobjects of the World (Superclusters, Galaxies, and Extrasolar Systems (ESS)), which are Fermion Compact Objects and DM Reactors in WUM [29].

WUM postulates that rest energies of DMFs and bosons are proportional to the basic energy unit E_0

multiplied by different exponents of α and can be expressed with the following formulae:

DMF1 (fermion): $\quad\quad E_{DMF1} = \alpha^{-2}E_0 = 1.3149948\ TeV$

DMF2 (fermion): $\quad\quad E_{DMF2} = \alpha^{-1}E_0 = 9.5959804\ GeV$

DIRAC (boson): $\quad\quad E_{DIRAC} = \alpha^0 E_0 = 70.025252\ MeV$

ELOP (boson): $\quad\quad E_{ELOP} = 2/3\alpha^1 E_0 = 340.66596\ keV$

DMF3 (fermion): $\quad\quad E_{DMF3} = \alpha^2 E_0 = 3.7289394\ keV$

DMF4 (fermion): $\quad\quad E_{DMF4} = \alpha^4 E_0 = 0.19857107\ eV$

XION (boson) $\quad\quad E_{XION} = \alpha^6 E_0 = 10.574179\ \mu eV$

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 [39]. 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 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.

Neutrons serve as another example. The mass of a neutron cannot be directly determined by mass spectrometry since it has no electric charge. But since the masses of a proton and of a deuteron can be measured with a mass spectrometer, the mass of a neutron can be deduced by subtracting proton mass from deuteron mass, with the difference being the mass of the neutron plus the binding energy of deuterium.

DMPs do not possess an electric charge. Their masses cannot be directly measured by mass spectrometry. Hence, they can be observed only indirectly due to their self-annihilation and irradiation of gamma-quants.

3.3. Multiworld [40]

According to A. G. Oreshko, "*P. L. Kapitsa supposed that a ball lightning is a window in another world*". We analyzed the possibility of the existence of other Worlds: Micro-World, Small-World, and Large-World based on the proposed Weak, Super-Weak and Extremely-Weak interaction respectively. It was suggested that Ball Lightning is an object of the Small-World. Below we discuss main characteristics of the proposed new Worlds in the Multiworld.

Macro-World. According to WUM, strength of gravity is characterized by gravitational parameter G [41]:

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

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

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

The total mass of the Macro-World M_{tot} is:

$$M_{tot} = 6\pi^2 m_0 \times Q^2 = 4.26943 \times 10^{53}\ kg$$

where m_0 is a basic mass unit: $m_0 = h/ac$, and average density ρ_{MW} :

$$\rho_{MW} = 3\rho_0 \times Q^{-1} = 8.87794 \times 10^{-27} \ kg/m^3$$

that equals to the critical density. WUM foresees three additional types of interactions: Weak, Super-Weak, and Extremely-Weak, characterized by the following parameters respectively:

$$G_W = G_O \times Q^{-1/4}$$
$$G_{SW} = G_O \times Q^{-1/2}$$
$$G_{EW} = G_O \times Q^{-3/4}$$

In our view, each type of interaction provides integrity of the corresponding World (see **Table 1**).

Table 1. Parameters of Multiworld (ρ_0 is a basic density unit: $\rho_0 = h/ca^4$).

Type of World	Type of Interaction	Rel. Interaction Parameter, G/G_0	Rel. Range of Interact, R_{max}/a	Rel. Mass, $M_{max}/4\pi m_0$	Rel. Density, $\rho/3\rho_0$
Macro-World	Gravity	Q^{-1}	Q	$1.5\pi \times Q^2$	Q^{-1}
Large-World	Extremely-Weak	$Q^{-3/4}$	$Q^{3/4}$	$Q^{3/2}$	$Q^{-3/4}$
Small-World	Super-Weak	$Q^{-1/2}$	$Q^{1/2}$	Q	$Q^{-1/2}$
Micro-World	Weak	$Q^{-1/4}$	$Q^{1/4}$	$Q^{1/2}$	$Q^{-1/4}$

Large-World is characterized by a parameter G_{EW}, which is about 10 orders of magnitude greater than G. The range of the extremely-weak interaction R_{EW} in the present epoch equals to:

$$R_{EW} = a \times Q^{3/4} = 1.44115 \times 10^{16} \ m = 1.5233 \ ly = 96335 \ AU$$

In our view, ESS are Large-World objects with spherical boundary between ESS and Intergalactic Medium. This boundary has a surface energy density $\sigma_0 = \frac{hc}{a^3}$. Maximum total mass of ESS equals to:

$$M_{EW} = M_{ESS} = \frac{4\pi\sigma_0 R_{EW}^2}{c^2} = 4\pi m_0 \times Q^{3/2} = 1.03928 \times 10^{33} \ kg = 522.645 \ M_\odot$$

and maximum mass of Star M_{Star} that is one third of M_{ESS} :

$$M_{Star} = 3.46427 \times 10^{32} \ kg = 174.215 \ M_\odot$$

Average density ρ_{EW} equals to:

$$\rho_{EW} = 3\rho_0 \times Q^{-3/4} = 8.28918 \times 10^{-17} \ kg/m^3$$

which is about 10 orders of magnitude greater than the critical density. Extremely-weak interaction between DM Cores and all particles around them provide integrity of ESS.

Small-World is characterized by the parameter G_{SW} , which is about 20 orders of magnitude greater than G . The range of the super-weak interaction R_{SW} in the present epoch equals to:

$$R_{SW} = a \times Q^{1/2} = 1.54351 \times 10^6 \ m$$

A maximum total mass of Small-World M_{SW} is:

$$M_{SW} = 4\pi m_0 \times Q = 1.19215 \times 10^{13} \ kg$$

and average density ρ_{SW} equals to:

$$\rho_{SW} = 3\rho_0 \times Q^{-1/2} = 7.73947 \times 10^{-7} \ kg/m^3$$

which is about 20 orders of magnitude greater than the critical density. According to WUM, Ball Lightning is an object of the Small-World.

Micro-World is characterized by the parameter G_W, which is about 30 orders of magnitude greater than G. The range of the weak interaction R_W in the present epoch equals to:

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

that is much greater than the range of the weak nuclear force ($10^{-16} \Longleftrightarrow 10^{-17} \ m$). The introduced principally new Weak Interaction between DMPs provide integrity of all Macroobjects' Cores, which are 3D fluid balls, made up of different fermions, with a very high viscosity and act as solid-state objects. In our view, weak interaction between particles DMF3 provides integrity of DM Fermi Bubbles [29].

With Nikola Tesla's principle at heart – *There is no energy in matter other than that received from the environment* – we apply to the Micro-World the following equation for a maximum total mass M_W :

$$M_W = \frac{4\pi\sigma_0 R_W^2}{c^2} = 4\pi m_0 \times Q^{1/2} = 1.36752 \times 10^{-7} \ kg = 6.28331 \ M_{Pl}$$

where M_{Pl} is the Planck mass. The average density of the Micro-World ρ_W is:

$$\rho_W = 3\rho_0 \times Q^{-1/4} = 7.22621 \times 10^3 \ kg/m^3$$

In our opinion, Micro-World objects with mass about Planck mass (we name them PLANCKs) are the smallest building blocks of all Macroobjects.

3.4. Planck Mass

In WUM, the time-varying Gravitational parameter $G \propto \tau^{-1}$ is proportional to the energy density of the Medium $\rho_M \propto \tau^{-1}$. It is not constant. That is why WUM aligns gravity with the Le Sage's push theory of gravitation, which proposes a mechanical explanation for Newton's gravitational force in terms of streams of tiny unseen particles 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 [42].

Gravitation is a result of simple interactions of XIONs with Matter which work cooperatively to create a more complex interaction. XIONs are responsible for the Le Sage's mechanism of gravitation [8]. This theory defines Gravity as an emergent phenomenon. Gravity is not an interaction but a manifestation of the Medium. The validity of this statement follows from the work of L. Spitzer [43] and A. M. Ignatov [44] who identified Le Sage's mechanism as a significant factor in the behavior of dust particles and dusty plasma.

We emphasize that DMPs do not interact via gravity. Two particles or microobjects will not exert gravity on one another when both of their masses are smaller than the Planck mass. Planck mass can then be viewed as the mass of the smallest macroobject capable of generating the gravitoelectromagnetic field and serves as a natural borderline between classical and quantum physics. Incidentally, in his "Interpreting the Planck mass" article [45], B. Hammel showed that the Plank mass is *a lower bound on the regime of validity of General Relativity*.

According to the Le Sage theory, Gravitation is a "push" mechanism that depends on the screening effect of XIONs (10.6 μeV) by macroobjects with minimum Planck mass.

3.5. XION

In WUM, XIONs have a high concentration in the World n_{XION} (see Section 4):

$$n_{XION} = 3.013034 \times 10^{14} \, m^{-3}$$

It means that a distance between XIONs is:

$$a_{XION} = 1.491645 \times 10^{-5} \, m$$

which is much smaller than the range of the Weak interaction R_W (see Section 3.3):

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

Due to the Weak interaction, XIONs can collect into clouds with distances between particles smaller than R_W. As a result, clumps of XIONs will arise. Larger clumps will attract smaller clumps and DMPs and initiate a process of expanding DM clumps up to the Planck mass, which can interact each other gravitationally.

On June 22, 2023, in version 1 of this paper, we wrote: *As a result, they can generate Cosmic Gravitational Background that is very hard to observe (conjecture).*

On June 28, 2023, NANOGrav announced:

Astrophysicists using large radio telescopes to observe a collection of cosmic clocks in our Galaxy have found evidence for gravitational waves that oscillate with periods of years to decades, according to a set of papers published today in The Astrophysical Journal Letters. The gravitational-wave signal was observed in 15 years of data acquired by the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) Physics Frontiers Center (PFC), a collaboration of more than 190 scientists from the US and Canada who use pulsars to search for gravitational waves. International collaborations using telescopes in Europe, India, Australia and China have independently reported similar results.

While earlier results from NANOGrav uncovered an enigmatic timing signal common to all the pulsars they observed, it was too faint to reveal its origin. The 15-year data release demonstrates that the signal is consistent with slowly undulating gravitational waves passing through our Galaxy.

"This is key evidence for gravitational waves at very low frequencies," says Vanderbilt University's Dr. Stephen Taylor, who co-led the search and is the current Chair of the collaboration. "After years of work, NANOGrav is opening an entirely new window on the gravitational-wave universe."

Unlike the fleeting high-frequency gravitational waves seen by ground-based instruments like LIGO (the Laser Interferometer Gravitational-wave Observatory), this continuous low-frequency signal could be perceived only with a detector much larger than the Earth. To meet this need, astronomers turned our sector of the Milky Way Galaxy into a huge gravitational-wave antenna by making use of exotic stars called pulsars. NANOGrav's 15-year effort collected data from 68 pulsars to form a type of detector called a pulsar timing array. Now, their 15 years of pulsar observations are showing the first evidence for the presence of gravitational waves, with periods of years to decades (15 years equal to $4.734 \times 10^8 \, s$) [46].

In the present paper, we discuss the proposed conjecture in detail. In our analysis, we use analogy between Electromagnetism and Gravitoelectromagnetism. In WUM, the World consists of stable elementary particles with lifetimes longer than the age of the World. Protons with mass m_p and electrons with mass m_e have identical concentrations in the World: $n_p = n_e$. Intergalactic plasma (IGP) consisting of protons and electrons has plasma frequency ω_{pl}:

$$\omega_{pl}^2 = \frac{4\pi n_e e^2}{4\pi \varepsilon_0 m_e} = 4\pi n_e \alpha \frac{h}{2\pi m_e c} c^2 = 2 n_e a c^2$$

where ε_0 is the permittivity of free space. We emphasize that plasma frequency depends only on the concentration of particles, which constitute the plasma. By analogy between Electromagnetism and Gravitoelectromagnetism, we define an ensemble of the objects with Planck mass (PLANCKs) in the Medium as "Gravitoplasma", a maximum concentration of which can be calculated from Medium's energy density ρ_M:

$$\rho_M = 2\rho_0 \times Q^{-1} = \frac{M_{Pl}}{R_{SW}^3} = \frac{2 m_0 \times Q^{1/2}}{a^3 \times Q^{3/2}} = n_{Pl} M_{Pl}$$

where n_{Pl} is a maximum concentration of Gravitoplasma:

$$n_{Pl} = R_{SW}^{-3} = 0.2720 \times 10^{-18} \, m^{-3}$$

Then, an equation for Gravitoplasma frequency ω_{Pl} is:

$$\omega_{Pl}^2 = 2 n_{Pl} a c^2 = 8.655 \times 10^{-16} \, s^{-2}$$

$$\omega_{Pl} = 2.942 \times 10^{-8} \, s^{-1}$$

$$\nu_{Pl} = 4.682 \times 10^{-9} \, s^{-1} = 4.682 \, nHz$$

In our view, the Super-weak interaction between PLANCKs with distance between them equals to R_{SW} provides integrity of Gravitoplasma. Cosmic Gravitational Background is produced by Gravitational interaction between oscillating PLANCKs. Gravitational waves with frequency smaller than ν_{Pl} cannot propagate in Gravitoplasma. It is worth noting that the calculated value of ν_{Pl} is the maximum value of Gravitoplasma frequency in case when the Medium consists of PLANCKs only. The calculated value of ν_{Pl} is in good agreement with the results obtained in [46].

When a distance between PLANCKs is larger than R_{SW}, then the integrity of Gravitoplasma provides the Extremely-weak interaction between them. In this case, Gravitoplasma frequency is lower than the calculated value ν_{Pl}. Gravitoplasma can be viewed as a cloud of "cosmic dust particles" with the size up to $R_{EW} = 1.44115 \times 10^{16} \, m = 1.5233 \, ly$.

PLANCKs can also be responsible for the cosmic Far-Infrared Background, which is part of the Cosmic Infrared Background, with wavelengths near 100 microns that is the peak power wavelength of the black body radiation at temperature 29 K [47].

4. Distribution of World's Energy Density

Our Model holds that the energy density of all types of self-annihilating DMPs is proportional to proton energy density in the Medium of the World ρ_p in all times that in the present Epoch equals to:

$$\rho_p = \frac{2\pi^2 \alpha}{3} \, \rho_{cr} = 0.048014655 \, \rho_{cr} = 239.1207 \, MeV/m^3$$

where ρ_{cr} is the critical energy density of the World. In all, there are 6 different types of self-annihilating DMPs: DMF1, DMF2, DIRAC, ELOP, DMF3, and DMF4. Then the total energy density of DMPs ρ_{DM} is

$$\rho_{DM} = 6 \, \rho_p = 0.28808793 \, \rho_{cr}$$

that is in good agreement with the results in [1]. The total XION energy density ρ_{XION} is

$$\rho_{XION} = 1.35\pi^2 \, \rho_p = 0.63974563 \, \rho_{cr}$$

The total baryonic energy density ρ_B is:

$$\rho_B = 1.5\,\rho_p$$

The sum of electron and Microwave Background Radiation energy densities ρ_{eMBR} equals to:

$$\rho_{eMBR} = 1.5\frac{m_e}{m_p}\,\rho_p + 2\frac{m_e}{m_p}\rho_p = 3.5\frac{m_e}{m_p}\,\rho_p$$

We take energy density of neutrinos ρ_v to equal:

$$\rho_v = \rho_{MBR}$$

For Far-Infrared Background Radiation energy density ρ_{FIRB} we take

$$\rho_{FIRB} = \frac{1}{40}\frac{m_e}{m_p}\,\rho_p$$

Then the energy density of the World ρ_W equals to the theoretical critical energy density:

$$\rho_W = \left[1.35\pi^2 + 7.5 + (5.5 + 1/40)\frac{m_e}{m_p}\right]\rho_p = \rho_{cr}$$

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

$$\frac{1}{\alpha} = \frac{\pi^2}{60}\left[54\pi^2 + 300 + (220 + 1)\frac{m_e}{m_p}\right] = 137.03600$$

which is in excellent agreement with the commonly adopted value of 137.035999. It follows that there is a direct correlation between constants α and m_e/m_p expressed by the obtained equation. As shown, m_e/m_p is not an independent constant but is instead derived from α [48].

As the conclusion:

- The World's energy density is inversely proportional to a dimensionless time-varying parameter $Q \propto \tau$ in all cosmological times;
- The particles relative energy densities are proportional to constant α .

5. Conclusion

Dark Matter is abundant [29]:

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

Dark Matter is omnipresent:

- 2/3 of the total DM is in the Medium of the World;
- 1/3 of the total DM is in Macroobjects of the World;
- Cores of all Macroobjects of the World;
- DM Reactors in Cores of all gravitationally-rounded Macroobjects;
- Coronas of all Macroobjects of the World;
- Fermi Bubbles.

WUM predicts existence of DMPs with 1.3 TeV, 9.6 GeV, 70 MeV, 340 keV, 3.7 keV, 0.2 eV, and 10.6 μeV rest energies. We should concentrate our efforts on the observations of cosmic gamma-rays with spectral lines corresponding to the predicted values of DMP's rest energies.

In our view, great experimental results and observations achieved by Astronomy in the last decades should be analyzed through the prism of a New Paradigm based on WUM. Astronomers should plan new targeted experiments based on the results of these analyses.

Acknowledgements

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