

Development of Hypersphere World-Universe Model. Narrative. Part VI. Paradigm Shift in Cosmology. Principal Role of Medium & Dark Matter & Angular Momentum

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Abstract

The main objective of a paper is to discuss the most important Concepts for any Cosmological model: Space, Time, and Gravitation; Cosmological principle (homogeneous and isotropic universe); Universality of physical laws; Law of the conservation of angular momentum; Expansion of universe; Content of the World; Formation of galaxies and large-scale structures; Speed of light in vacuum; Origin of cosmic microwave background radiation. The performed analysis shows that Big Bang Model (BBM) fails to account for these Concepts and should be obsolete.

Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology [1]. WUM and BBM are principally different Models: 1) Instead of the Initial Singularity with the infinite energy density and the extremely rapid expansion of the space (Inflation) in BBM; in WUM, there was a Fluctuation (4D Nucleus of the World with an extrapolated radius equals to a basic unit of size a) in the Eternal Universe with a finite extrapolated energy density (four orders of magnitude less than the nuclear density) and a finite expansion of the Nucleus in Its fourth spatial dimension with speed c that is the gravitodynamic constant; 2) Instead of a practically Infinite Homogeneous and Isotropic Universe around the Initial Singularity in BBM; in WUM, the 3D Finite Boundless World (the Hypersphere of the 4D Nucleus) presents a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$), which emerged in different places of the World at different Cosmological times. The Medium of the World is Homogeneous and Isotropic. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous. The Absolute Age of the entire World (determined by the parameters of the Medium) is 14.22 Gyr. The Medium of the World, Dark Matter, and Angular Momentum are the main Three Pillars of WUM.

20 Years in Cosmology

Abstract

Hypersphere World-Universe Model (WUM) solves a number of physical problems in contemporary Cosmology and Astrophysics through Dark Matter Particles (DMPs) and their interactions: **Angular Momentum problem** in birth and subsequent evolution of Galaxies and Extrasolar systems – how do they obtain it; **Hubble Tension** – disagreement in the values of Hubble’s constant obtained by various teams; **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic Centre; **Coronal Heating problem** in solar physics – temperature of Sun’s corona exceeding that of photosphere by millions of degrees; **Cores of Sun and Earth** rotating faster than their surfaces; **Diversity of Gravitationally-Rounded Objects** in Solar system and their **Internal Heat**; **Lightning Initiation problem** – electric fields observed inside thunderstorms are not sufficient to initiate sparks; **Terrestrial Gamma-Ray Flashes** – bursts of high energy X-rays and gamma rays emanating from the Earth. The Model solves **Missing Baryon problem** related to the fact that the observed amount of baryonic matter did not match theoretical predictions. WUM reveals **Inter-Connectivity** of Primary Cosmological Parameters and calculates their values, which are in good agreement with the latest results of their measurements. In 2013, Model predicted the values of the following Cosmological parameters: Gravitational, Hubble’s, Concentration of Intergalactic plasma, and the Minimum energy of photons, which were experimentally confirmed in 2015 – 2021. The Nobel Prize in Physics 2020 “*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*” confirmed one of the most important predictions of WUM: “*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*”. Hypersphere World-Universe Model is, in fact, a Paradigm Shift in Cosmology. According to WUM, Superclusters are the principal objects of the World. Macroobjects form from the top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

1. Introduction

I am a Doctor of Sciences in Physics. I belong to the school of physicists established by Alexander Prokhorov–Nobel Prize Laureate in Physics. I am a Laser Physicist by education, having published over 150 papers. About 20 years ago, I developed an interest in Cosmology. I have been elaborating a model I dubbed [World-Universe Model](#) (WUM) for 11 years, and then in 2013, I uploaded my first papers on viXra and later published a series of articles in [Journal of High Energy Physics, Gravitation and Cosmology](#). A paper [New Cosmology – Third Revolution in Physics](#) is a synthesis of my approach to Cosmology. An article [Paradigm Shift in Cosmology](#) is an essence of my view of the World.

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. Between 1907 and 1912, Albert Einstein wrote: “*Since the mathematicians have invaded the theory of relativity, I do not understand it myself anymore*”.

I absolutely agree with John von Neumann who said: “*The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct, which,*

with addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work”.

WUM is proposed as an alternative to the prevailing Big Bang Model (BBM) of Standard Cosmology that relies on General Relativity. In frames of BBM, the Beginning of the Universe is connected with **Initial Singularity (infinite energy density)** and **Cosmological Inflation**, which is a theory of an extremely rapid exponential expansion of space (with practically **infinite speed**) in the early universe up to 93 billion light-years in diameter of the observable universe. The size of the whole universe is unknown, and it might be infinite in extent.

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

In our view, there is no way to prevent an occurrence of the initial singularity in BBM. The World must have gotten started in a principally different way – a Fluctuation in the Eternal Universe with a **finite size and energy density**. The size of this Fluctuation can increase with a **finite speed**. Then, there is no need to introduce the cosmological inflation. However, a question about the mechanism of Continuous Creation of Matter in the World arises.

F. Hoyle and J. V. Narlikar in 1964 offered an explanation for the appearance of the new matter by postulating the existence of what they dubbed the "Creation field", or just the "C-field". P. Dirac in 1974 discussed a continuous creation of matter by an additive mechanism (uniformly throughout space) and a multiplicative mechanism (proportional to the amount of the existing matter).

WUM follows the idea of the continuous creation of matter by the additive mechanism, albeit introducing a different mechanism of matter creation. The Mechanism of continuous creation of matter was the main issue of WUM during its development for 20 years.

There were a few principal steps in the development of WUM:

- In **2013**: 3D World is a Black Hole. Residing inside of a black hole, we can conduct no observations of the outside Universe, and learn nothing about its characteristics. The World is expanding in the Universe without limit with the speed equal to the gravitodynamic constant c . The Universe serves as an unlimited source of energy that the World is consuming as it grows. Predicted values of cosmological parameters: Gravitational, Hubble's, Concentration of Intergalactic plasma, and Minimum energy of photons were confirmed experimentally in 2015 – 2021. The Nobel Prize in Physics 2020 "*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*" confirmed one of the most important predictions of WUM: "*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], [2], [17], [18], [24], [25].
- In **2015**: 5D Model is aligned with the theoretical framework developed by P. S. Wesson, albeit assigning a new physical meaning to the fifth coordinate. It is associated with the total energy of the Medium of the World [3]-[6].
- In **2016-2018**: The finite 3D World is a Hypersphere that is the surface of a 4D Nucleus. All points of the hypersphere are equivalent; there are no preferred centers or boundary of the World. In

1854, G. Riemann proposed a hypersphere as a model of a finite universe. WUM follows this idea, albeit proposing that the World is expanding and filled with the Medium of the World consisting of stable elementary particles. The surface of the hypersphere is created continuously in a process analogous to sublimation. The creation of matter is happening homogeneously in all points of the hypersphere World and is a direct consequence of expansion [7]-[12].

- In **2019-2020**: To be consistent with the Law of Conservation of Angular Momentum, the Model developed a New Physics of the World [13]-[16], [19], [20]:
 - Principal objects of the World are overspinning Dark Matter (DM) Cores of Superclusters, which were created during Dark Epoch. It started at the Beginning of the World and lasted for about 0.45 billion years;
 - Luminous Epoch spans from 0.45 billion years up to the present Epoch (during 13.77 billion years). The transition from Dark Epoch to Luminous Epoch was the result of the Rotational Fission of DM Cores of Superclusters and self-annihilation of Dark Matter Particles (DMPs);
 - Luminous Matter is a byproduct of DMPs self-annihilation.
- In **2021**: The synthesis of my approach to Cosmology and the essence of my view of the World are formulated in papers [21]-[25].

Below, I would like to share with you some Original Ideas, which I proposed and developed in 20 years of my scientific life in Cosmology.

2. Black Hole World-Universe Model

WUM is based on three primary assumptions:

- The World is finite and is expanding inside the Universe with speed equal to the gravitodynamic constant c . The Universe serves as an unlimited source of energy that continuously enters into the World from the boundary;
- Medium of the World, consisting of protons, electrons, photons, neutrinos, and DMPs, is an active agent in all physical phenomena in the World;
- Two fundamental parameters in various rational exponents define all macro- and micro- features of the World: Fine-Structure constant α , and dimensionless quantity Q . While α is constant, Q increases with time, and is, in fact, a measure of the Size and the Age of the World.

In 2013, WUM revealed a self-consistent set of time-varying values of Primary Cosmological Parameters of the World: Gravitation parameter, Hubble's parameter, Age of the World, Temperature of Microwave Background Radiation, and concentration of Intergalactic plasma. Based on the inter-connectivity of these parameters, WUM solved the Missing Baryon problem and predicted the values of the following Cosmological parameters: gravitation, Hubble's, concentration of Intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015 – 2021. *"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 confirms 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"*.

Based on the Inter-connectivity of Primary Cosmological Parameters, WUM explains experimental data accumulated in the field of Cosmology over the last decades: the Age of the World; Critical energy

density; Temperatures of the Cosmic microwave background radiation and Peak of the Far-infrared radiation of cosmic dust; Hubble's parameter and Maximum stellar mass. Additionally, the Model explains "Pioneer Anomaly"; resolves paradoxes like "Matter – Antimatter Asymmetry" and "Faint Young Sun". WUM makes predictions pertaining to rest energies of DMPs and neutrinos; proposes new types of particle interactions (Super Weak and Extremely Weak). The Model suggests introducing a new fundamental parameter Q in the CODATA internationally recommended values for calculating time-varying parameters of the World.

3. 5D World-Universe Model

5D Space-Time-Energy World–Universe Model is a unified model of the World built around the concept of the Medium. WUM utilizes the following principles:

- **Time-varying gravitational parameter.** This hypothesis was proposed by P. Dirac in 1937.
- **Continuous creation of matter.** F. Hoyle and J. V. Narlikar in 1964 offered an explanation for the appearance of new matter by postulating the existence of what they dubbed the "creation field". P. Dirac in 1974 discussed continuous creation of matter by additive/multiplicative mechanisms.
- **The World is a 3-sphere** that is a surface of a 4-ball Nucleus of the World. The 4-ball is expanding in the fourth spatial dimension of the Nucleus and its surface, the 3-sphere, is likewise expanding. The total surface energy of the 4-ball is increasing as it expands, thus creating new matter in the 3-sphere World.
- **Supremacy of matter** was postulated by Albert Einstein: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".
- **The World consists** of the Medium (protons, electrons, photons, neutrinos, and DMPs) and Macroobjects (Superclusters, Galaxies, Extrasolar systems) made of these particles.
- **Mach's principle.** A very general statement of Mach's principle is: "*Local physical laws are determined by the large-scale structure of the universe*".
- **Fifth dimension.** In 1983, P. S. Wesson suggested that a fifth dimension might be associated with rest mass via $x^4 = Gm/c^2 \propto t$.

5D WUM aligns with the theoretical framework developed by P. S. Wesson, albeit assigning a new physical meaning to the fifth coordinate. In WUM, the fifth dimension is associated with the total energy of the Medium of the World, and the gravitomagnetic parameter of the Medium that serves as the dimension-transposing parameter.

J. M. Overduin and P. S. Wesson postulated that "*Metrics which do not depend on $4x$ can give rise only to induced matter composed of **massless** photons; while those which depend on $4x$ give back equations of state for fluids composed of massive particles*". WUM supplies the fluid that they have predicted: it is, in fact, the Medium of the World.

According to WUM, an empty space does not exist; instead, the World is filled with the Medium that consists of massive particles. The inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. Consequently, the Medium of the World as described by WUM can serve as further evidence in favor of the fifth-dimensional view of the World.

4. Hypersphere World-Universe Model

Hypersphere WUM is based on the following Principal Points:

- The World was started by a Fluctuation in the Eternal Universe, and the Nucleus of the World, which is a four dimensional 4-ball, was born.
- The 3D World is the Hypersphere that is the surface of a 4-ball Nucleus. Hence, the World is curved in the fourth spatial dimension of the Nucleus.
- The 4-ball is expanding in the Eternal Universe, and its surface, the hypersphere, is likewise expanding so that the radius of the 4-ball R is increasing with speed c that is the gravitodynamic constant.
- The World consists of the Medium and Macroobjects. The Medium consists of stable elementary particles with lifetimes longer than the Age of the World: protons, electrons, photons, neutrinos, and DMPs. The Medium is not Aether; it is a mixture of elementary particles. The energy density of the Medium is $2/3$ of the total energy density in all cosmological times.
- Superclusters, Galaxies, and Extrasolar systems are made of these particles. The energy density of Macroobjects is $1/3$ of the total energy density in all cosmological times. There are no empty space and dark energy in WUM.
- Time, Space and Gravitation are emergent phenomena and have no separate existence from Matter. In WUM, they are closely connected with the Impedance (wave resistance), the Gravitomagnetic parameter, and Energy density of the Medium, respectively.
- Two Fundamental parameters in various rational exponents define all macro- and micro-features of the World: Fine-structure constant α and dimensionless Quantity Q . While α is constant, Q increases in time, and is in fact a measure of the Worlds' curvature in the fourth spatial dimension of the Nucleus.
- WUM holds that there exist relations between all Q -dependent parameters: Newtonian parameter of gravitation and Hubble's parameter; Critical energy density and Fermi coupling parameter; Temperatures of the Microwave Background Radiation and Peak of Far-Infrared Background Radiation. The calculated values of these parameters are in good agreement with the latest results of their measurements.
- The black-body spectrum of a cosmic Microwave Background Radiation is due to thermodynamic equilibrium of photons with low density Intergalactic plasma.
- DM consists of 5 different particles: Neutralinos, WIMPs, DIRACs, ELOPs, and sterile neutrinos, and has the relative energy density of about 24%.
- All Macroobjects of the World (superclusters, galaxies, and extrasolar systems) possess the following properties: their Cores are made up of DMPs; they contain other particles, including DM and baryonic matter, in shells surrounding the Cores. Self-annihilation of DMPs can give rise to any combination of gamma-ray lines.
- Nucleosynthesis of all elements occurs inside stars during their evolution. Stellar nucleosynthesis theory should be enhanced to account for self-annihilation of heavy DMPs (WIMPs, Neutralinos) inside of the Stars' Cores.
- Macroobjects form from top (superclusters) down to galaxies and extrasolar systems in parallel around different Cores made of different DMPs. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

- Assuming an Eternal Universe, the numbers of cosmological structures on all levels will increase – new superclusters will form; existing superclusters will obtain new galaxies; new stars will be born inside existing galaxies; sizes of individual stars will increase, etc. The temperature of the Medium of the World will asymptotically approach absolute zero.

5. Hypersphere World-Universe Model. New Physics

The angular momentum problem is one of the most critical problems in BBM. Standard Cosmology cannot explain how Galaxies and Extra Solar systems obtained their substantial orbital and rotational angular momenta, and why the orbital momentum of Jupiter is considerably larger than the rotational momentum of the Sun. WUM is the only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum. To be consistent with this Fundamental Law, WUM discusses in detail the Beginning of the World. The Model introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects existed, and Luminous Epoch (ever since for 13.77 billion years).

WUM solves a number of physical problems in Standard Cosmology and Astrophysics through DMPs and their interactions: Angular Momentum problem in birth and subsequent evolution of Galaxies and Extrasolar systems; Fermi Bubbles—two large structures in gamma-rays and X-rays above and below Galactic center; Coronal Heating problem in solar physics—temperature of Sun’s corona exceeding that of photosphere by millions of degrees; Cores of Sun and Earth rotating faster than their surfaces; Diversity of Gravitationally-Rounded objects in Solar system and their Internal Heating. Model makes predictions pertaining to rest energies of DMPs, proposes new type of their interactions. WUM reveals Inter-Connectivity of Primary Cosmological Parameters and calculates their values, which are in good agreement with the latest results of their measurements.

The main ideas of WUM are as follows:

- The Finite World is a 3D Hypersphere of the 4D Nucleus of the World, which is 4D ball expanding in the fourth spatial dimension of the Nucleus. 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 DM in the 4D Nucleus of the World. 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;
- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) and Luminous Epoch (ever since, 13.77 billion years). Transition from Dark Epoch to Luminous Epoch is due to Rotational Fission of Overspinning DM Supercluster’s Cores and self-annihilation of DMPs;
- 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 Albert Einstein: “*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*”;

- Macroobjects of the World possess the following properties: their Cores are made up of DMPs; they contain other particles, including DMPs and Ordinary Particles, in shells surrounding the Cores. Macroobjects' cores are essentially **Dark Matter Reactors** fueled by DMPs. All chemical elements, compositions, substances, rocks, etc. are produced by Macroobjects themselves as the result of DMPs self-annihilation;
- WUM is the only cosmological model in existence that is consistent with the Fundamental Law of Conservation of Angular Momentum;
- WUM revealed the Inter-Connectivity of all Primary Cosmological Parameters;
- Fermi Bubbles are DMPs' clouds containing uniformly distributed Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays;
- 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.

6. New Cosmology – Third Revolution in Physics

Dirac's themes were the unity and beauty of Nature. He identified three revolutions in modern physics – Relativity, Quantum Mechanics and Cosmology. In his opinion: *“The new cosmology will probably turn out to be philosophically even more revolutionary than relativity or the quantum theory, perhaps looking forward to the current bonanza in cosmology, where precise observations on some of the most distant objects in the universe are shedding light on the nature of reality, on the nature of matter and on the most advanced quantum theories”*. In 1937, P. Dirac proposed: the Large Number Hypothesis and the Hypothesis of the variable gravitational “constant”; and later added the notion of continuous creation of Matter in the World. The developed Hypersphere WUM follows these ideas, albeit introducing a different mechanism of matter creation.

WUM is based on the following Primary Points:

- **The Beginning.** The World was started by a fluctuation in the Eternal Universe, and the Nucleus of the World, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a . The World is a finite 3D Hypersphere that is the surface of the 4D Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World. The extrapolated energy density of the World at the Beginning was four orders of magnitude smaller than the nuclear energy density.
- **Expansion.** The 4D Nucleus is expanding along the fourth spatial dimension of the Nucleus and its surface, the 3D Hypersphere, is likewise expanding so that the radius of the Nucleus is increasing with speed c that is the gravitodynamic constant.
- **Creation of Matter.** The surface of the Nucleus is created in a process analogous to sublimation. DM is created by the Universe in the 4D Nucleus of the World. DMPs carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, the Matter-Antimatter asymmetry problem discussed in literature does not arise. Creation of Matter is a direct consequence of expansion.
- **Content of the World.** The World consists of the Medium and Macroobjects. Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium is $2/3$ of the total energy density and Macroobjects (Superclusters,

Galaxies, and Extrasolar systems)– 1/3 in all cosmological times. The relative energy density of Dark Matter Fermion (DMF) particles DMF4 is about 68.8%, self-annihilating DMPs (DMF1, DMF2, DMF3, DIRACs, and ELOPs) – about 24%, and Ordinary Particles (protons, electrons, photons, and neutrinos) – about 7.2% .

- **Two Fundamental Parameters** in various rational exponents define all micro- and macro-features of the World: dimensionless Rydberg constant α and 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 $\alpha \cdot Q$ in the present epoch equals to: $Q = 0.759972 \times 10^{40}$.
- **Supremacy of Matter.** Time, Space and Gravitation have no separate existence from Matter. They are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium, respectively.
- **Inter-Connectivity of Primary Cosmological Parameters.** WUM reveals the Inter-Connectivity of them and calculates their values, which are in good agreement with the latest results of their measurements.
- WUM introduces **Dark Epoch** (spanning from the Beginning of the World for 0.45 billion years) and **Luminous Epoch** (ever since, 13.77 billion years). Transition from Dark Epoch to Luminous Epoch is due to the **Rotational Fission** of Overspinning DM Supercluster's Cores and self-annihilation of DMPs.
- **Macroobjects Shell Model.** Macroobjects of the World possess the following properties: their Cores are made up of DMPs; they contain other particles, including DMPs and Ordinary Particles, in shells surrounding the Cores. Introduced **Weak Interaction** between DMPs provides integrity of all shells. Self-annihilation of DMPs can give rise to any combination of gamma- and X-ray lines.
- **Macroobjects Formation and Evolution.** Macroobjects form from superclusters down to galaxies and extrasolar systems in parallel around different Cores made up of different DMPs. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing. Assuming an Eternal Universe, the numbers of cosmological structures on all levels will increase – new superclusters will form; existing clusters will obtain new galaxies; new stars will be born inside existing galaxies; sizes of individual stars will increase, etc. The temperature of the Medium will asymptotically approach absolute zero.
- **Nucleosynthesis** of all elements occurs inside of Macroobjects during their evolution. Stellar nucleosynthesis theory should be enhanced to account for the self-annihilation of DMPs inside of Stars.
- **Black-body spectrum of the Cosmic Microwave Background Radiation** is due to thermodynamic equilibrium of photons with Intergalactic plasma.
- **Milky Way Galaxy** is a Disk Bubble whose boundary with Intergalactic Medium has a surface energy density σ_0 (a basic surface energy density σ_0 equals to: $\sigma_0 = hc/a^3$, where h is Planck constant). The Disk Bubble contains Intragalactic Medium and (100 – 400) billion Stars.
- **Dark Matter Fermi Bubbles** are stable clouds of DMPs containing uniformly distributed Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays. Proposed **Weak interaction** between particles DMF3 (3.7 keV) provides integrity of Fermi Bubbles.
- **Extrasolar systems.** The boundary between Extrasolar systems and Intragalactic Medium has a surface energy density σ_0 . This bubble-like region of space, which surrounds the Sun, is named Heliosphere that is continuously inflated by Solar jets, known as the Solar wind.

- **Solar system.** A detailed analysis of the Solar system shows that the overspinning DM Core of the Sun can give birth to DM planetary cores, and they can generate DM cores of moons through the Rotational Fission mechanism.
- **Solar Corona, Geocorona and Planetary Coronas** made up of DMPs resemble honeycombs filled with plasma particles (electrons, protons, and multicharged ions), which are the result of DMPs self-annihilation.
- **Lightning Initiation problem** and **Terrestrial Gamma-Ray Flashes** are explained by the self-annihilation of DMPs in Geocorona.
- **Dark Matter Reactors.** Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation in their DM cores.

7. Paradigm Shift in Cosmology

The most important Concepts for any Cosmological model are as follows: universality of physical laws; cosmological principle (homogeneous and isotropic universe); Space, Time, and Gravitation; speed of light in vacuum; structure and content of the World; dark matter and ordinary matter; origin of matter (singularity or continuous creation); Law of Conservation of Angular Momentum; Primary Cosmological Parameters; Four Pillars of Standard Cosmology – expansion of Universe, nucleosynthesis of light elements, formation of large-scale structures, origin of cosmic background radiation. The performed analysis shows that Standard Cosmology fails to account for these concepts. The most intriguing result is that there was no **Initial Singularity**: all galaxies are gravitationally bound with their Superclusters.

Hypersphere WUM is, in fact, a Paradigm Shift in Cosmology. According to WUM, Superclusters are the principal objects of the World. Macroobjects form from the top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

The latest observations of the World [25]:

- *Galaxies congregate in clusters and along filaments, and are missing from large regions referred to as voids;*
- *Most cosmological structures in the universe spin. The generation of angular momentum across these scales is poorly understood;*
- *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.*

can be explained in frames of the developed WUM only:

- *“Galaxies do not congregate in clusters and along filaments”.* On the contrary, Cosmic Web that is *“networks of structure that are interconnected with no clear boundaries”* is the result of the Rotational Fission of DM Cores of neighbor Superclusters;
- *“Generation of angular momentum across these scales”* provide DM Cores of Superclusters through the Rotational Fission mechanism;
- *“Spinning cylindrical tendrils of matter hundreds of millions of light-years across”* are the result of spiral jets of galaxies generated by DM Cores of Superclusters with internal rotation;

- The Giant Arc is the result of the intersection of the Galaxies' jets generated by the neighbor DM Cores of Superclusters;
- Cosmological Principal is valid for the Homogeneous and Isotropic Medium of the World with 2/3 of the total Matter. The distribution of Macroobjects with 1/3 of the total Matter is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable;
- The main conjecture of Standard Cosmology: "*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.

Hubble Tension that is the disagreement in the values of the Hubble's constant H_0 obtained by the various teams is due to the observations of Galaxies belonging to different Superclusters. According to WUM, the value of H depends on the cosmological time: $H = \tau^{-1}$. It means that the **value of H should be measured based on Cosmic Microwave Background only**. The calculated value of Hubble's constant in 2013: $H_0 = 68.733 \text{ km/s Mpc}$ is in excellent agreement with the most recent measured value in 2021: $H_0 = 68.7 \pm 1.3 \text{ km/s Mpc}$ using only Cosmic Microwave Background data [25].

8. Conclusion

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 Physics proposed by Paul Dirac in 1937. The Model should be developed into the well-elaborated theory by the entire physical community. 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 – Hypersphere World-Universe Model.

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Collected Articles

[1] Netchitailo V. S. (2013) Word-Universe Model. viXra:1303.0077v7.

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Solar System. Angular Momentum. Dark Matter Reactors

Abstract

The developed Hypersphere World-Universe Model (WUM) is consistent with all Concepts of the World [1]. In WUM, we postulate the principal role of Angular Momentum and Dark Matter in Cosmological theories of the World. The most widely accepted model of Solar System formation, known as the Nebular hypothesis, does not solve the **Angular Momentum problem** – why is the orbital momentum of Jupiter larger than rotational momentum of the Sun? WUM is the only cosmological model in existence that is consistent with this Fundamental Law. The Nebular hypothesis does not solve **Internal Heating and Diversity** problems for all Planets and Moons in Solar system – why the actual mean surface temperature of them is higher than their effective temperature calculated based on the Sun’s heat for them and how could each one be so different if all of them came from the same nebula? The proposed concept of Dark Matter Reactors in Cores of all gravitationally-rounded Macroobjects successfully resolves these problems.

1. Short History of Solar System Formation

The most widely accepted model of Solar system formation, known as the Nebular hypothesis, was first proposed in 1734 by E. Swedenborg [2], [3] and later elaborated and expanded upon by I. Kant in 1755 in his “Universal Natural History and Theory of the Heavens” [4].

Nebular Hypothesis maintains that 4.6 billion years ago, the Solar System (SS) formed from the gravitational collapse of a giant molecular cloud, which was light years across. Most of the mass collected in the Centre, forming the Sun; the rest of the mass flattened into a protoplanetary disc, out of which the planets and other objects in SS formed.

The Nebular hypothesis is not without its critics. In his “The Wonders of Nature”, V. Ferrell outlined the following counter-arguments [5]:

- *It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;*
- *Each planet and moon in Solar system has unique structures and properties. How could each one be different if all of them came from the same nebula;*
- *A full 98 percent of all the angular momentum in the Solar system is concentrated in the planets, yet a staggering 99.8 percent of all the mass in our Solar system is in our Sun;*
- *Jupiter itself has 60 percent of the planetary angular motion. 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 Solar system origin are to be accepted.*

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 [6]. 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” [7].

Solar Fission Theory was proposed by L. Jacot in 1951 who stated that [8]:

- *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;*
- *The 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 [9]. 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:

- *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 of the formation of the Sun. In our Model, we concentrated on furthering the Solar fission theory [10].

2. Angular Momentum Problem

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

The outstanding issues of SS are:

- The rotational momentum of the Sun is smaller than Jupiter's, Saturn's, Uranus's, and Neptune's orbital momentum. 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.

There is another problem in the Standard Cosmology – **Orbital Angular Momentum problem** [11]:

- SS has an orbital momentum L_{orb}^{SS} calculated based on the distance of 26.4 kly from the galactic Centre and orbital speed of about 220 km/s : $L_{orb}^{SS} = 1.1 \times 10^{56} J s$, which far exceeds the rotational angular momentum: $L_{rot}^{SS} = 3.2 \times 10^{43} J s$;
- Milky Way (MW) galaxy is gravitationally bounded with the Local Supercluster and has an orbital angular momentum L_{orb}^{MW} calculated based on the distance of 65 million light-years from Local Supercluster and orbital speed of about 400 km/s [13]: $L_{orb}^{MW} = 2.5 \times 10^{71} J s$, which far exceeds the rotational angular momentum of MW [14]: $L_{rot}^{MW} \approx 1 \times 10^{67} J s$;
- How did MW and SS obtain their substantial orbital angular momenta?

In frames of WUM, we calculated rotational and orbital angular momentum of all gravitationally-rounded Macroobjects 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 ($R_S = 7 \times 10^5 km$, $M_S = 2 \times 10^{30} kg$) and found that orbital momenta of most satellites are indeed substantially smaller than the rotational momenta of their prime objects, with three exceptions [11]:

- The Sun accounts for about 0.3% of the total rotational angular momentum of SS while about 60% is attributed to Jupiter;
- 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.

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – **Rotational Fission** of overspinning (surface speed at equator exceeding escape velocity) Prime Objects. From the point of view of Fission model, the Prime Object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite**.

In frames of WUM, Prime Objects are Dark Matter (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" [12]. To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Overspinning DM Superclusters' Cores and self-annihilation of Dark Matter Particles (DMPs);
- Proposed Weak Interaction between DMPs provides the integrity of DM Cores, which are 3D fluid balls with a high viscosity and act as solid-state objects;
- The main 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 Rotational Fission. The experimental observations of galaxies in the universe showed that most of them are disk galaxies: about 60% are ellipticals and about 20% are spirals [13]. These results speak in favor of the developed Rotational Fission mechanism;
- Size, mass, density, composition, L_{orb} and L_{rot} of satellite cores depend on local density fluctuations at the edge of the overspinning prime DM cores and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation;

- Dark Matter Core of MW was born 13.77 billion years ago as the result of the Rotational Fission of the Local Supercluster DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the repeating Rotational Fissions 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, extrasolar systems, planets, and moons.

Based on the developed New Cosmology, we performed a detailed analysis of the angular momenta of all gravitationally-rounded Macroobjects in SS and found that [11]:

- The overspinning DM Core of MW could produce DM core of the Sun with the substantial orbital angular momenta of SS;
- The overspinning DM Core of the Sun could produce DM cores of all planets, which could produce DM cores of all moons, including the Moon of the Earth;
- The Pluto - Charon pair is definitely a binary system. Charon was not generated by Pluto's DM core; instead, they are two Macroobjects that happened to be bounded together by gravity.

3. Sun

Internal Structure. According to the standard Solar model, the Sun has:

- Core that extends from the center to about 20–25% of the solar radius, contains 34% of the Sun's mass with density $\rho_{max} = 1.5 \times 10^5 \text{ kg/m}^3$ and $\rho_{min} = 2 \times 10^4 \text{ kg/m}^3$. It produces all of Sun's energy;
- Radiative zone from the Core to about 70% of the solar radius with density $\rho_{max} = 2 \times 10^4 \text{ kg/m}^3$ and $\rho_{min} = 2 \times 10^2 \text{ kg/m}^3$ in which convection does not occur and energy transfer occurs by means of radiation;
- Core and Radiative zone contain practically all Sun's mass [14]. In our view, they are parts of DM Core of the Sun.

The large power output of the Sun is mainly due to the huge size and density of its Core (compared to the Earth), with only a fairly small amount of power being generated per cubic meter. Theoretical models of the Sun's interior indicate a maximum power density of approximately 276.5 W/m^3 at the center of the Core [15] (see **Table 1**), which is about the same power density inside a compost pile [16] and closer approximates reptile metabolism than a thermonuclear bomb.

Solar Core Rotation. E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [17]. The fact that the Solar Core rotates faster than surrounding envelope, despite high viscosity of the internal medium, is intriguing. WUM explains this phenomenon through the absorption of DMPs by Solar Core over time τ . DMPs supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^2$). DM Core irradiates products of DMPs self-annihilation, which carry away excessive angular momentum. The Solar Wind is the result of this mechanism [12].

Evolution of the Sun. By 1950s, stellar astrophysicists had worked out the physical principles governing the structure and evolution of stars [18]. According to these principles, the Sun's luminosity had to change over time, with the young Sun being about 30% less luminous than today [19], [20], [21], [22]. The long-term evolution of the bolometric solar luminosity $L(\tau)$ as a function of cosmological time τ can be approximated by a simple linear law: $L(\tau) \propto \tau$ [18].

One of the consequences of WUM holds that all stars were fainter in the past. As their cores absorb new DMPs, size of MO cores R_{MO} and their luminosity L_{MO} are increasing in time: $R_{MO} \propto \tau^{1/2}$ and $L_{MO} \propto R_{MO}^2 \propto \tau$, respectively. Taking the age of the World: $A_W \cong 14.2 \text{ Byr}$ and the age of SS: $A_{SS} \cong 4.6 \text{ Byr}$, it is easy to find that the young Suns' output was 67% of what it is today. Literature commonly refers to the value of 70% [21]. This result supports the developed model of the structure and evolution of the Sun [18].

Table 1. Computer Model of the Sun at 4.5 Billion Years. Adapted from [15].

Radius, Rel. to R_{\odot}	Radius $\times 10^9 \text{ m}$	Temperature $\times 10^6 \text{ K}$	Luminosity, %	Fusion Rate, W/kg	Fusion Power Density, W/m^3
0	0.00	15.7	0	0.0175	276.5
0.09	0.06	13.8	33	0.010	103.0
0.12	0.08	12.8	55	.0068	56.4
0.14	0.10	11.3	79	.0033	19.5
0.19	0.13	10.1	91	.0016	6.9
0.22	0.15	9.0	97	0.0007	2.2
0.24	0.17	8.1	99	0.0003	0.67
0.29	0.20	7.1	100	0.00006	.09
0.46	0.32	3.9	100	0	0
0.69	0.48	1.73	100	0	0
0.89	0.62	0.66	100	0	0

Solar Flare is a sudden flash of increased brightness on the Sun, usually observed near its surface and in close proximity to a sunspot group. Powerful flares are often, but not always, accompanied by a coronal mass ejection. The maximum total energy of a bolometric fluence that was observed in 2012 is: $6 \times 10^{25} \text{ J}$ [23]. During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted (one photon had an energy as high as 467.7 GeV) [24].

Coronal Mass Ejection is a significant release of plasma from the solar corona. They often follow solar flares and are normally present during a solar prominence eruption. Coronal mass ejections are often associated with other forms of solar activity, but a broadly accepted theoretical understanding of these relationships has not been established. Coronal Mass Ejections most often originate from active regions on the Sun's surface, such as groupings of sunspots associated with frequent flares.

In **WUM**, Solar Flares and Coronal Mass Ejections are the result of the activity of DM Core of the Sun. They can be explained by the Sun's DM Core eruptions of DMPs and their subsequent self-annihilation. As the result, radio waves and gamma rays are observed together with mass ejections of ordinary particles originated by the self-annihilation of DMPs. It is worth noting that the self-annihilation of DMPs depends on the density squared. It is in good agreement with Fusion Power Density distribution inside of the Sun considering drop of density from $1.5 \times 10^5 \text{ kg/m}^3$ at the Centre to $2 \times 10^2 \text{ kg/m}^3$ at the edge of DM core.

4. Earth

Internal Structure. Information about the Earth's structure mostly comes from the analysis of seismic waves. According to the standard model, the Earth has the following layers: an outer silicate solid Crust, solid Mantle, a liquid Outer core, and a solid Inner core. The Inner core is believed to be composed of an iron–nickel alloy with some other elements. The temperature at the Inner core's surface is estimated to be approximately 5,700 K. The liquid Outer core surrounds the Inner core and is believed to be composed of iron mixed with nickel and trace amounts of lighter elements.

Although seismic waves propagate through the core as if it was solid, the measurements cannot distinguish between a perfectly solid material from an extremely viscous one. Some scientists have therefore considered whether there may be **slow convection in the Inner Core as is believed to exist in the Mantle**. That could be an explanation for the anisotropy detected in seismic studies. In 2009, B. Buffett estimated the viscosity of the Inner core at $10^{18} \text{ kg m}^{-1} \text{ s}^{-1}$ [25].

In our view, the Inner core, Outer core, and Lower mantle are the parts of the Earth's liquid DM core, which have different viscosities from extremely high values for the Inner core going down to a 660-km boundary between the Lower mantle and Upper mantle with Crust (see below). The main characteristics of the Earth's layers are presented in **Table 2**.

Table 2. Density and Mass of Earth's Layers. Adapted from [26].

Depth, km	Component Layer	Outer Radius, Rel. to Earth Radius	Density, $\text{kg/m}^3 \times 10^3$	Mass, kg $\times 10^{22}$	Mass, Rel. to Earth Mass
0	Atmosphere		0.0012	0.0005	0.0000008
0 - 11	Oceans	1	1.02 – 1.05	0.14	0.0002
0 - 35	Crust	1	2.2 – 2.9	4	0.007
35 - 660	Upper Mantle	0.99	3.4 – 4.4	112	0.19
660 - 2900	Lower Mantle	0.9	3.4 – 5.6	265	0.44
2900 - 5100	Outer Core	0.55	9.9 – 12.2	183	0.31
5100 - 6400	Inner Core	0.2	12.8 – 13.1	12	0.02

Let us take a look at the structure of the Earth:

- An Inner core and an Outer core that extend from the Centre to about 55% of the Earth radius with density $\rho_{max} = 1.3 \times 10^4 \text{ kg/m}^3$ and $\rho_{min} = 9.9 \times 10^3 \text{ kg/m}^3$;
- Lower mantle, spanning from the Outer core to about 90% of the Earth radius (below 660 km) with density $\rho_{max} = 5.6 \times 10^3 \text{ kg/m}^3$ and $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$;
- Upper mantle, spanning from the Lower mantle to about 99% of the Earth radius (below 35 km) with density $\rho_{max} = 4.4 \times 10^3 \text{ kg/m}^3$ and $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$;

- Inner core, Outer core, and Lower mantle contain most of the Earth's mass [27].

Very little is known about the Lower mantle apart from that there is a seismicity cutoff-660 (660-km discontinuity): $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$ for the Lower mantle is less than $\rho_{max} = 4.4 \times 10^3 \text{ kg/m}^3$ for the Upper mantle. In our view, Lower mantle is the part of the Earth's DM core.

W. Wu, S. Ni, and J. Irving investigated scattered seismic waves traveling inside the Earth to constrain the roughness of the Earth's 660-km boundary [28]. The researchers were surprised by just how rough that boundary is – rougher than the surface layer that we all live on. The roughness was not equally distributed, either; just as the Crust's surface has smooth ocean floors and massive mountains, the 660-km boundary has rough areas and smooth patches [29].

X. Markenscoff in the paper “Volume collapse” instabilities in deep-focus earthquakes: a shear source nucleated and driven by pressure” explains “*the mystery of the long-standing observations in deep-focus earthquakes (400-700 km) by symmetry-breaking instabilities in high-pressure phase transformation, which produce the counterintuitive phenomenon of “volume collapse” producing only shear radiation, with little, or no, volumetric component, even under conditions of full isotropy*” [30].

According to WUM, the 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [11]. The deep-focus earthquakes are connected with random mass ejections of DM core happening at the 660-km boundary.

Random Variations of Earth's Rotational Speed. G. Jones and K. Bikos in the paper “Earth Is in a Hurry in 2020” wrote [31]:

“When highly accurate atomic clocks were developed, they showed that the length of a mean solar day can vary by milliseconds. These differences are obtained by measuring the Earth's rotation with respect to distant astronomical objects”. It turned out that the variations of the daylength throughout 2020 were in the range $86400^{+1.62ms}_{-1.46ms} \text{ s}$. The speed of the Earth's rotation varies constantly because of the complex motion of its molten core, oceans and atmosphere, plus other effects.

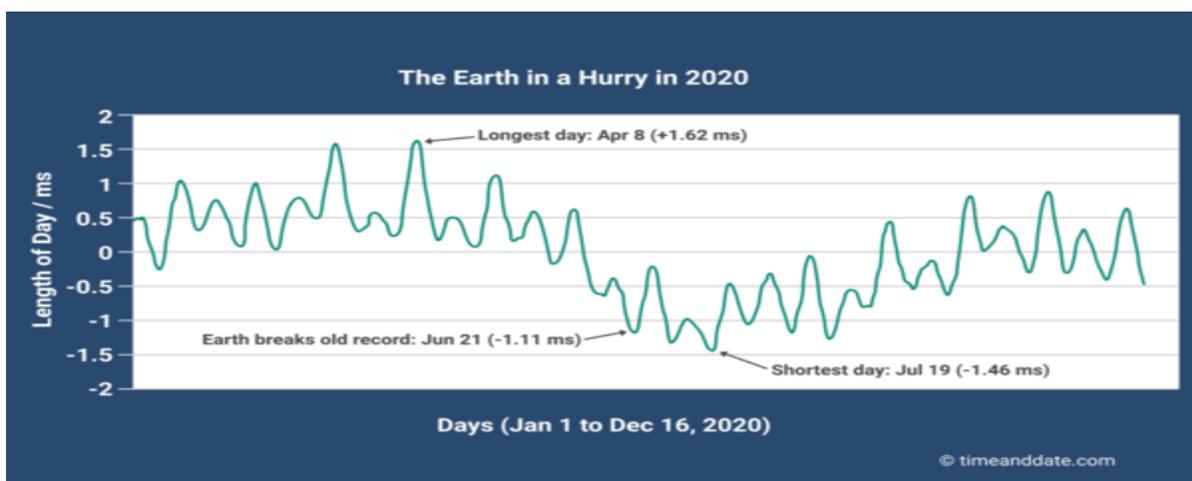


Fig. 1. Variation of daylength throughout 2020. The length of day is shown as the difference in milliseconds (ms) between the Earth's rotation and 86,400 seconds. Adapted from [31].

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

Let us analyze the proposed mechanism. The relative change of the daylength throughout 2020 was about 2×10^{-8} . Hence, the relative change of the Earth's moment of inertia must be about 2×10^{-8} . If a layer of a mass m at radius of r will shift on h , the relative change of the Earth's moment of inertia will be about $\frac{m}{M} \frac{r}{R} \frac{h}{R} \sim 10^{-8}$, where M and R are the mass and radius of the Earth, respectively.

In case of the Atmosphere (see **Table 2**): $\frac{m}{M} \sim 10^{-6}$, $r \sim R$, and $\frac{h}{R} \sim 10^{-2}$. It means that $h \sim 64 \text{ km}$.

In case of the Oceans: $\frac{m}{M} \sim 10^{-4}$, $r \sim R$, and $\frac{h}{R} \sim 10^{-4}$. It means that $h \sim 640 \text{ m}$. In case of the boundary Lower mantle - Upper mantle: $\frac{m}{M} \sim 10^{-5}$, $r \sim R$, and $\frac{h}{R} \sim 10^{-3}$. It means that $h \sim 6.4 \text{ km}$.

The estimated values of the masses and shifts show:

- There is no way to explain the random variations of the speed of the Earth's rotation by the complex motion of oceans and atmosphere as it was supposed in [31];
- They can be explained by random mass ejections of the Lower mantle's layer.

Internal Heating. The analysis of the Sun's heat for planets in SS yields the effective temperature of Earth of 255 K [32]. The actual mean surface temperature of Earth is 288 K [33]. The higher actual temperature of the Earth is due to the heat generated internally by the planet itself. According to the standard model, the Earth's internal heat is produced mostly through the radioactive decay. The major heat-producing isotopes within Earth are K-40, U-238, and Th-232. The mean global heat loss from Earth is $44.2 \pm 1.0 \text{ TW}$ [34]. The Earth's Uranium has been thought to be produced in one or more supernovae over 6 billion years ago.

Radiogenic decay can be estimated from the flux of geoneutrinos that are emitted during radioactive decay. The KamLAND Collaboration combined precise measurements of the geoneutrino flux from the Kamioka Liquid-Scintillator Antineutrino Detector, Japan, with existing measurements from the Borexino detector, Italy. They found that decay of U-238 and Th-232 together contribute about 20 TW to the total heat flux from the Earth to space. The neutrinos emitted from the decay of K-40 contribute 4 TW. Based on the observations the KamLAND Collaboration made a conclusion that *"heat from radioactive decay contributes about half of Earth's total heat flux"* [35].

Plutonium-244 with half-life of 80 million years is not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Plutonium-244 present in the Earth's Crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [36].

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 the DMPs self-annihilation with the rest energy 1.3 TeV (compare to proton rest energy 938 MeV) [11]. 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 [37].

According to WUM, the 660-km boundary is a boundary between Dark Matter Reactor and Upper mantle with Crust, which were produced by Dark Matter Reactor during 4.57 billion years and are, in fact, “Homemade” [11].

As a conclusion, the internal heating of all gravitationally-rounded Macroobjects of SS is due to DMPs self-annihilation in their DM cores made up of DMPs (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the Macroobjects. New DMPs freely penetrate through the entire Macroobjects’ envelope, get absorbed into the DM cores, and continuously support DMPs self-annihilation.

Faint Young Sun paradox: with the young Sun's output at only 70 percent of its current output (see Subsection **Evolution of the Sun**), the early Earth would be expected to be completely frozen, but the early Earth seems to have had liquid water. The issue was raised by astronomers C. Sagan and G. Mullen in 1972 [38]. An unresolved question is how a climate suitable for life was maintained on Earth over the long timescale despite the variable solar output and wide range of terrestrial conditions [39]. Proposed resolutions of this paradox have taken into account greenhouse effects, changes to planetary albedo, astrophysical influences, or combinations of these suggestions.

In frames of WUM, the Upper mantle with Crust are due to DM core activity: the self-annihilation of DMPs in the DM core. As a result of this activity, a thickness of the Upper mantle with Crust is growing in time: the early Earth had a smaller thickness than it is in the present time. Hence, the temperature of the Earth’s surface was higher than its calculated temperature based on the Sun’s output at that time.

Expanding Earth hypothesis asserts that the position and relative movement of continents is at least partially due to the volume of Earth increasing. In 1888 I. O. Yarkovsky suggested that some sort of aether is absorbed within Earth and transformed into new chemical elements, forcing the celestial bodies to expand. Also, the theses of O. C. Hilgenberg (1933, 1974) and N. Tesla (1935) were based on absorption and transformation of aether-energy into normal matter. In spite of the recognition of plate tectonics in the 1970s, scientific consensus has rejected any significant expansion or contraction of Earth [40].

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. The Medium of the World with DMPs are, in fact, some sort of aether proposed by Yarkovsky, Hilgenberg, and Tesla.

5. Mars

NASA’s InSight mission landed on Mars on 26 November 2018. It aims to determine the interior structure, composition and thermal state of Mars, as well as constrain present-day seismicity and impact cratering rates. Such information is key to understanding the differentiation and subsequent thermal evolution of Mars. InSight lander learns Mars interior by monitoring “marsquakes” with magnitude not larger than around 4 on the Richter scale. Mars is just the third celestial body to have its core directly measured with seismic data, following Earth in 1900s and the Moon in 2011.

Mars is seismically active, with InSight recording over 450 marsquakes and related events in 2019 [41], [42]. In March 2021, NASA reported, based on measurements of over 500 Marsquakes that the core of Mars is liquid and has a radius of about 1830 km, more than half the radius of Mars and about

half the size of the Earth's core. This is significantly larger than models predicted, suggesting a core of lighter elements [43]. Average retrieved core density is $6 \times 10^3 \text{ kg/m}^3$.

NASA researchers found that seismic waves must be bouncing off a boundary of $\sim 1550 \text{ km}$ beneath the surface: the dividing line between Mars's solid mantle and its liquid core. The mantle between the crust and core has a single rocky layer. It is thinner than Earth's and has a different composition which suggests that "*two planets arose from different materials when they formed*". ETH Zurich geophysicist and study co-author A. Khan told that "*this might be the simple explanation why we do not see plate tectonics on Mars*".

The crust of Mars $48 \pm 24 \text{ km}$ thick is likely highly enriched in radioactive elements that help to heat this layer at the expense of the interior. The crust is far more enriched with radioactive, heat-producing elements by a factor of 13 to 21 relative to the mantle beneath. This enrichment is greater than suggested by gamma-ray surface mapping and has a moderate-to-elevated surface heat flow. These results could help explain why its volcanoes show up at where they do despite the planet's lack of global plate tectonics [44].

Analysis of the obtained experimental results show that:

- Internal structure of the Mars is close enough to the structure of the Earth:
 - Radius of the Mars core relative to the Mars radius is 0.54 (for the Earth this ratio is 0.55, **Table 2**);
 - Relative thickness of the Mars mantle is 0.46 (for the Earth this ratio is 0.45, **Table 2**);
- Composition of the Mars layers is significantly different from the composition of the Earth layers;
- Average Mars core density $6 \times 10^3 \text{ kg/m}^3$ is significantly less than the average Earth core density $12 \times 10^3 \text{ kg/m}^3$;
- Seismic waves are bouncing off a boundary between Mars's solid mantle and its liquid core. What is the cause of them?
- Mars crust is far more enriched with radioactive, heat-producing elements by a factor of 13 to 21 relative to the mantle beneath. Where do they come from?

In frames of WUM, these questions can be answered the following way:

- Seismic waves are generated by random mass ejections of the Mars DM core like deep-focus earthquakes, which are connected with random mass ejections of the Earth DM core happening at the 660-km boundary;
- Mars crust is far more enriched with radioactive, heat-producing elements, which are produced within the Mars DM core as the result of DMPs self-annihilation. They arrive to the crust of Mars due to convection currents in the mantle carrying isotopes from the interior to the planet's surface;
- Significantly smaller Mars core density is important because the self-annihilation of DMPs depends on the density squared. It explains why the actual mean Mars surface temperature of 215 K is slightly higher than an effective temperature of 210 K due to the Sun's heat [45]. At the same time, the actual mean Earth surface temperature of 288 K [33] is significantly higher than an effective temperature of 255 K due to the Sun's heat [32].

6. The Moon

The Moon is a differentiated body, being composed of a geochemically distinct crust, mantle, and planetary core. Based on geophysical techniques, the crust is estimated to be on average about 50 km thick. Moonquakes have been found to occur deep within the mantle of the Moon about 1,000 km

below the surface. Several lines of evidence imply that the lunar core is small, with a radius of about 350 km or less. 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. The composition of the lunar core is not well constrained, but most believe that it is composed of metallic iron alloy with a small amount of sulfur and nickel [46].

In 2010, a reanalysis of the old Apollo seismic data on the deep moonquakes using modern processing methods confirmed that the Moon has an iron rich core with a radius of 330 ± 20 km. The same reanalysis established that the solid Inner core made of pure iron has a radius of 240 ± 10 km. The core is surrounded by the partially (10 to 30%) melted layer of the Lower mantle with a radius of 480 ± 20 km (thickness ~ 150 km). These results imply that 40% of the core by volume has solidified. The density of the liquid outer core is about $5 \times 10^3 \text{ kg/m}^3$. The temperature in the core is probably about 1600–1700 K [47].

In 2019, a reanalysis of nearly 50 years of data collected from the Lunar Laser Ranging experiment with lunar gravity field data from the GRAIL mission, shows that for a relaxed lunar **fluid core** with non-hydrostatic lithospheres, the core-mantle boundary has a radius 381 ± 12 km [48].

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 the Rotational Fission of the Earth DM Core 4.57 billion years ago.

7. Planets and Moons

Jupiter radiates more heat than it receives from the Sun [49]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 C [50]) have been difficult to explain, due to lack of a known heat source [11]. T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [51].

Saturn radiates 2.5 times more energy than it receives from the Sun [52]. Despite consisting mostly of hydrogen and helium, most of Saturn's mass is not in the gas phase, because hydrogen becomes a non-ideal liquid when the density is above 10 kg/m^3 , which is reached at a radius containing 99.9% of Saturn's mass. The temperature, pressure, and density inside Saturn all rise steadily toward the core, which causes hydrogen to be a metal in the deeper layers [53].

Standard planetary models suggest that the interior of Saturn is similar to that of Jupiter, having a small rocky core surrounded by hydrogen and helium, with trace amounts of various volatiles [54]. This core is similar in composition to Earth but is denser. In 2004, scientists estimated that the core must be 9–22 times the mass of the Earth [55], [56], which corresponds to a diameter of about 25,000 km [57]. This is surrounded by a thicker liquid metallic hydrogen layer, followed by a liquid layer of helium-saturated molecular hydrogen that gradually transitions to a gas with increasing altitude. The outermost layer spans 1,000 km and consists of gas. Saturn has a hot interior, reaching 11,700 °C at its core.

C. R. Mankovich and J. Fuller in the paper “A diffuse core in Saturn revealed by ring seismology” compare structural models with gravity and seismic measurements to show that the data can only be

explained by a diffuse, stably stratified core-envelope transition region in Saturn extending to approximately 60% of the planet's radius and containing approximately 17 Earth masses of ice and rock [58].

Uranus radiates 1.1 times more energy than it receives from the Sun [59]; **Neptune** – 2.6 times [60]. The most fascinating result was obtained for the smallest gravitationally-rounded Macroobject – **Mimas** with a mean density $1.15 \times 10^3 \text{ kg/m}^3$ and the temperature $\approx 64 \text{ K}$. **Figure 2** illustrates the unexpected and bizarre pattern of daytime temperatures found on it. It is worth noting that the self-annihilation of DMPs inside of the Mimas DM core is efficient with the core density about 10^3 kg/m^3 , and the Mimas temperature is significantly higher than the effective temperature calculated based on the heat it receives from the Sun.

S. Kamata, *et al.* report that “*many icy Solar System bodies possess subsurface oceans. To maintain an ocean, Pluto needs to retain heat inside*”. Kamata, *et al.* show that “*the presence of a thin layer of gas hydrates at the base of the ice shell can explain both the long-term survival of the ocean and the maintenance of shell thickness contrasts. Gas hydrates act as a thermal insulator, preventing the ocean from completely freezing while keeping the ice shell cold and immobile. The most likely guest gas is methane*” [62].

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

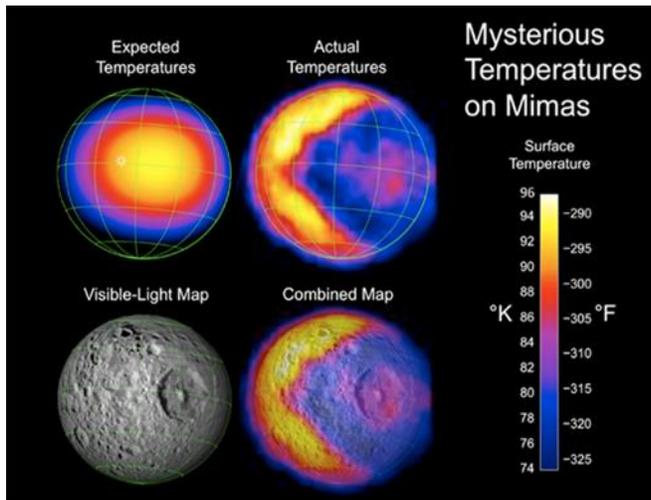


Figure 2. Mimas pattern of daytime temperatures. Adapted from [61].

8. Dark Matter Reactors

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

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope;
- J. Zhang, *et al.* concluded that the Earth’s inner core is rotating faster than its surface by about 0.3 – 0.5 degrees per year;
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere;

- W. Wu, S. Ni, and J. Irving were surprised by just how rough the Earth's 660-km boundary is – rougher than the surface layer that we all live on;
- The variations of the Earth daylength throughout 2020 were in the range $86400^{+1.62ms}_{-1.46ms}$ s ;
- D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature.
- Giant planets like **Jupiter** are hundreds of degrees warmer than current temperature models predict. **Saturn** radiates 2.5 times more energy than it receives from the Sun; **Uranus** – 1.1 times; **Neptune** – 2.6 times;
- Many Icy Solar system bodies including **Pluto** possess subsurface oceans.

The radiuses of the DM cores of the different Macroobjects of SS are presented in **Table 3**.

Table 3. The radius of the DM core of the different Macroobjects in the Solar system.

Macroobject	Sun	Saturn	Earth	Mars	Moon	Mimas
Radius, km $\times 10^3$	487	34.9	3.52	1.83	0.381	< 0.2

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

3. Conclusion

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. The Model should be developed into the well-elaborated theory by the entire physical community. 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 – Hypersphere World-Universe Model [1]. Solar System became Experimental Laboratory for astrophysicists to check their theories!

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From the Beginning of the World to the Beginning of Life on Earth

Abstract

Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology [1]. In this paper, we provide seven Pillars of WUM: Medium of World; Inter-Connectivity of Primary Cosmological Parameters; Creation of Matter; Multicomponent Dark Matter; Macroobjects; Volcanic Rotational Fission; Dark Matter Reactors. We describe the evolution of the World from the Beginning up to the birth of the Solar System and discuss the condition of the Early Earth before the Beginning of life on It.

1. Introduction

Hypersphere World-Universe Model (WUM) was developed for the last 20 years and is, in fact, a Paradigm Shift in Cosmology [1]. The seven Pillars of WUM are as follows:

- Medium of World;
- Inter-Connectivity of Primary Cosmological Parameters;
- Creation of Matter;
- Multicomponent Dark Matter;
- Macroobjects;
- Volcanic Rotational Fission;
- Dark Matter Reactors.

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

2. Medium of the World

Physical Aether was suggested as early as the 17th century, by I. Newton. Following the work of T. Young (1804) and A. J. Fresnel (1816), it was believed that light propagates as a transverse wave within an elastic medium called Luminiferous Aether, which was abandoned in 1905. In later years there have been classical physicists who advocated the existence of Aether [2]:

- N. Tesla declared in 1937: *All attempts to explain the workings of the universe without recognizing the existence of the Aether and the indispensable function it plays in the phenomena are futile and destined to oblivion* [3];
- P. Dirac stated in 1951 in an article "Is there an Aether?" that *we are rather forced to have an Aether* [4].

WUM introduces the Medium of the World, which consists of stable elementary particles with lifetimes longer than the age of the World: protons, electrons, photons, neutrinos, and Dark Matter Particles (DMPs). The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation; Far-Infrared

Background Radiation. Inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. Cosmic Microwave Background Radiation is part of the Medium; it then follows that the Medium is the absolute frame of reference. Relative to the Cosmic Microwave Background rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 km s^{-1} , respectively [5].

The energy density of the Medium is $2/3$ of the total energy density of the World. Superclusters, Galaxies, Extrasolar systems, planets, moons, *etc.* are made of the same particles. The energy density of Macroobjects adds up to $1/3$ of the total energy density of the World throughout the World's evolution [5]. **Cosmological principal** is valid for the Homogeneous and Isotropic Medium. The distribution of Macroobjects is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable for the entire World.

WUM is the classical model, therefore classical notions can be introduced only when the very first ensemble of particles was created at the cosmological time τ_M equals to: $\tau_M = \alpha^{-2} \times t_0 \cong 10^{-18} \text{ s}$, where α is the dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ (that was later named "Fine-structure constant"); t_0 is a basic unit of time: $t_0 = a/c = 5.9059662 \times 10^{-23} \text{ s}$; a is a basic unit of size $a = 1.7705641 \times 10^{-14} \text{ m}$; and c is a gravitodynamic constant. It is worth noting that the **speed of light in vacuum**, commonly denoted as c , is not related to the World in our Model, because there is no vacuum in it. Instead, there is the Medium of the World consisting of elementary particles. In WUM, the cosmological principal **Universality of physical laws** is valid at the cosmological times $\tau \geq \tau_M$ because they are determined by the Medium of the World.

In frames of WUM, Time and Space are closely connected with the Mediums' impedance (wave resistance) Z_g that equals to the Hubble's parameter H : $Z_g = H = \tau^{-1}$ and the gravitomagnetic parameter μ_g , which equals to: $\mu_g = R^{-1}$. It follows that neither Time nor Space could be discussed in absence of the Medium. The gravitational parameter G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. The Gravitation is a result of simple interactions of DMPs with Matter (by the introduced new **Weak Interaction**) that work cooperatively to create a more complex interaction. DMPs are responsible for Le Sage's mechanism of the gravitation. **Gravity, Space and Time** are all emergent phenomena [5]. In this regard, it is worth recalling Albert Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

3. Inter-Connectivity of Primary Cosmological Parameters

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

WUM holds that there indeed exist relations between all Primary Cosmological Parameters that depend on dimensionless time-varying quantity Q that is a measure of the Size R and Age A_τ of the World:

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

which in present epoch equals to: $Q = 0.759972 \times 10^{40}$. **WUM is based on two parameters only:** α and Q .

- The predicted value of G in 2013 [7]:

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

is in excellent agreement with the experimentally measured by Qing Li, *et al.* in 2018 values using two independent methods [8]:

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

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

- The calculated value of $T_{MBR} = 2.72518 K$ in the present epoch is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057 K$ [9]. It is worth noting that at the Beginning of the Luminous Epoch (0.45 Gyr) the calculated value was $T_{MBR} = 6.4775 K$ and at the Birth of the Solar System (9.65 Gyr) - $T_{MBR} = 3.0141 K$. Therefore, any Model describing **creation of Macroobjects must hold true in cold World conditions;**
- The Age of the World: $A_\tau = t_0 \times Q = 14.22 \text{ Gyr}$ is determined by the parameters of the Medium only.

In 2013, **WUM** revealed a self-consistent set of time-varying values of Primary Cosmological Parameters of the World, solved the Missing Baryon problem and predicted the values of the following Cosmological parameters: gravitation, concentration of intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015 – 2020. “*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*” (Nobel Prize in Physics 2020) made by R. Genzel and A. Ghez confirm one of the most important predictions of WUM in 2013: “*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*” [10].

4. Creation of Matter

F. Hoyle and J. V. Narlikar in 1964 offered an explanation for the appearance of the new matter by postulating the existence of what they dubbed the "Creation field", or just the "C-field"[11]. P. Dirac in 1974 discussed a continuous creation of matter by an additive mechanism (uniformly throughout space) and a multiplicative mechanism (proportional to the amount of the existing matter) [12].

WUM follows the idea of the continuous creation of matter by the additive mechanism. To provide the creation of Matter by the Universe uniformly throughout the World, we consider the following Concept of the World proposed by G. Riemann in 1854 [13]: **3D Finite World is a Hypersphere** of 4D Nucleus. In our view, the World was started by a Fluctuation in Eternal Universe, and 4D Nucleus of the World with a radius of a was born. The Nucleus is expanding in Its fourth spatial dimension and Its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for a cosmological time τ from the Beginning and equals to $R = c\tau$. By definition, the **gravitodynamic constant** c is the ratio of the absolute gravitomagnetic

unit of charge E_0 to the absolute gravitostatic unit of charge E_0/c , where E_0 is the basic unit of energy: $E_0 = hc/a$ (h is the Planck constant).

The surface of the Nucleus is created in a process **analogous to sublimation**. Continuous creation of matter is the result of this process. Sublimation is a well-known endothermic process that happens when surfaces are intrinsically more energetically favorable than the bulk of a material, and hence there is a driving force for surfaces to be created.

Dark Matter (DM) is created by the Universe in the 4D Nucleus of the World. DMPs carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation.

Consequently, a **Matter-Antimatter asymmetry problem** discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has 2D spherical surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus.

The proposed 4D process is responsible for the Expansion, Creation of Matter, and Arrow of Time. It constitutes the main **Hypothesis of WUM**. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created [14]. It is important to emphasize that:

- Creation of Matter is a direct consequence of expansion;
- Creation of DM occurs homogeneously in all points of the 3D Finite Hypersphere World.

5. Multicomponent Dark Matter

Two-component DM system consisting of bosonic and fermionic components is proposed for the explanation of emission lines from the bulge of Milky Way galaxy. C. Boehm, *et al.* analyze the possibility of two coannihilating neutral and stable DMPs: a heavy fermion for example, like the lightest neutralino (> 100 GeV), and the other possibly a light spin-0 particle (~ 100 MeV) [15].

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

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

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

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

We still do not have a direct confirmation of DMPs' rest energies, but we do have a number of indirect observations. The signatures of DMPs self-annihilation with expected rest energies of 1.3 TeV; 9.6 GeV; 70 MeV; 340 keV; 3.7 keV are found in spectra of the diffuse gamma-ray background and the emissions of various Macroobjects in the World. We connect observed gamma-ray spectra with the structure of Macroobjects (nuclei and shells composition). Self-annihilation of those DMPs can give rise to any combination of gamma-ray lines. Thus, the diversity of Very High Energy gamma-ray sources in the World has a clear explanation in WUM [16].

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.

6. Macroobjects

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. Introduced principally new **Weak Interaction** of DMPs with Matter provides integrity of all shells: a distance between particles is smaller than the range of the weak interaction $R_W = 1.65314 \times 10^{-4} m$ (see Section 7). **Table 1** describes the parameters of **Macroobjects Cores** (which are Fermionic Compact Stars in WUM) in the present Epoch made up of different Fermions.

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 [5]:

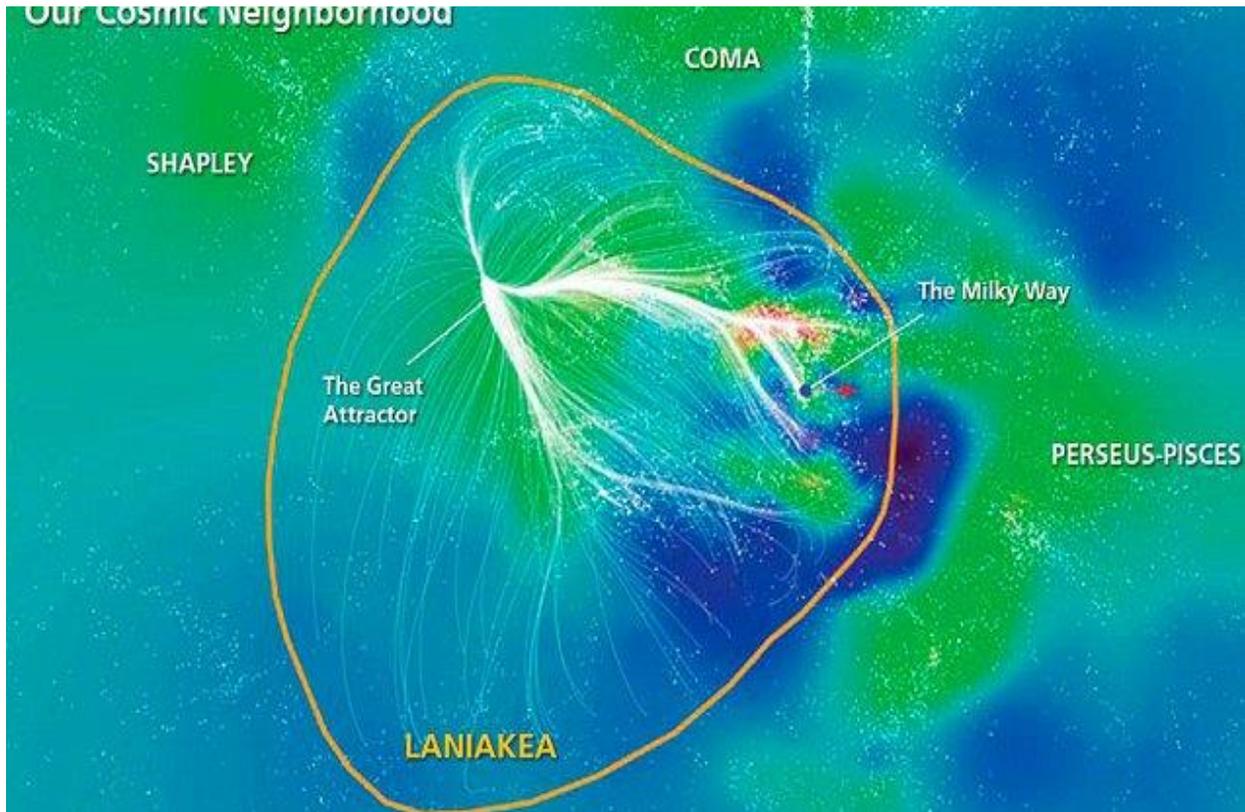
- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in Extrasolar Systems;
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;
- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of Superclusters.

According to WUM, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with

shell of DMF3 with the calculated maximum mass of $6 \times 10^{10} M_{\odot}$. This value is in good agreement with the experimentally obtained value of the most massive black hole ever found, with a mass of $6.6 \times 10^{10} M_{\odot}$ at the center of TON 618 [17]. It is worth noting that there are no black holes in WUM.

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to Milky Way (MW) and approximately 100,000 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated **binding mass** $10^{17} M_{\odot}$ [18] (see **Table 2**). The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. Distance from the Earth to the Centre of LSC is 250 Mly, Redshift - 0.0708 (center).

Figure 1. Laniakea Supercluster. Adapted from [19].



We emphasize that about 100,000 nearby galaxies are moving around Centre of Laniakea Supercluster. They belong to LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structure (see **Figure 1** and **Figure 2** in [1]). It means that the World is, in fact, a Multiworld consisting of $\approx 10^3$ Superclusters (see Section 7). Big Bang never happened.

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 [17], so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes" [21].

Table 2. Major axes of the largest superclusters. Adapted from [20].

Structure Name (year discovered)	Maximum Length (in light years)	Note
Caelum Supercluster	910,000,000	The Caelum Supercluster is a collection of over 550,000 galaxies. It is the largest galaxy supercluster.
Saraswati Supercluster	652,000,000	The Saraswati Supercluster consists of 43 massive galaxy clusters, which include Abell 2361 and ZWCl 2341.1+0000
Boötes Supercluster	620,000,000	
Horologium-Reticulum Supercluster (2005)	550,000,000	Also known as the <i>Horologium Supercluster</i>
Laniakea Supercluster (2014)	520,000,000	Galaxy supercluster in which Earth is located
Hyperion proto-supercluster_(2018)	489,000,000	The largest and earliest known proto- supercluster
Draco Supercluster	410,000,000	
Great Attractor	400,000,000	
Shapley Supercluster	400,000,000	First identified by Harlow Shapley as a cloud of galaxies in 1930, it was not identified as a structure until 1989
Virgo Supercluster	110,000,000	A part of the Laniakea Supercluster. It also contains the Milky Way Galaxy, which contains the Solar System

WUM. 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 estimated in [18] and discussed in [21]. In the future, these stupendously large compact objects can give rise new Luminous Superclusters as the result of their DM Cores' rotational fission. 13.77 billion years ago, the estimated number of DM Supercluster Cores in the World was around $\sim 10^3$. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. In our view, there were many "Beginnings" for different Luminous Superclusters (see Section 7).

In frames of **WUM**, Laniakea Supercluster emerged 13.77 billion years ago due to the Rotational Fission of Its overspinning DM Core and self-annihilation of DMPs (see Section 7). The Core was created during Dark Epoch when only Dark Matter Macroobjects existed [5]. The neighboring superclusters to LSC arise due to the Rotational Fission of their overspinning DM Cores and self-annihilation of DMPs, but in different times. In our view, the World consists of Multiworlds, which originated by different overspinning DM Cores of Superclusters at different times. The distribution of Macroobjects in the World is not only spatially Inhomogeneous and Anisotropic, but temporally non-simultaneous. **Cosmological principal is valid only for the Homogeneous and Isotropic Medium that arised 14.22 Gyr ago.** We emphasize that Time, Space, Gravity, Physical Laws are all emergent phenomena, which depend on the characteristics of the Medium only!

The mass-to-light ratio of the Virgo Supercluster (VS) is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [22]. 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*" [23]. These ratios are one of the **main arguments in favor of presence of large amounts of Dark Matter in the World.**

Hubble tension is the disagreement in the values of the Hubble's constant H_0 obtained by the various teams. It can be explained the following way:

- All measurements of Hubble's constant are model-dependent;
- Statistics of these measurements is not sufficient to yield reliable conclusions;
- Hubble's law in Standard Cosmology is valid for the Big Bang model only when all galaxies start their movement from a single point named "Initial Singularity";
- Observations of Galaxies belonging to different Superclusters;
- The experimental observations of galaxies in the universe show that most of them are **disk galaxies** [24]. It is well-known that when observing spiral galaxies, the side spinning toward us have a slight blueshift relative to the side spinning away from us. There is the meaning of a redshift of Centers of galaxies only;
- In LSC, some galaxies are moving toward MW, and some are moving away (see **Figure 1**). We can only meaningfully discuss the redshift of the Centre of supercluster (0.0708).

According to WUM, the value of H depends on the cosmological time: $H = \tau^{-1}$. It means that the **value of H should be measured based on Cosmic Microwave Background Radiation only.** WUM calculates the value of the Hubble's constant $H_0 = 68.7494 \text{ km/s Mpc}$ that is in excellent agreement with the most recent determinations using only Cosmic Microwave Background data: $H_0 = 68.7 \pm 1.3 \text{ km/s Mpc}$ and $H_0 = 68.8 \pm 1.5 \text{ km/s Mpc}$ [25].

7. Volcanic Rotational Fission

Lunar Origin Fission Hypothesis was proposed by G. Darwin in 1879 to explain the origin of Moon by fast spinning Earth, on which equatorial gravitative attraction was nearly overcome by centrifugal force [26].

Solar Fission Theory was proposed by L. Jacot in 1951 who stated that [27]:

- *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 [28]. 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 Nebular Hypothesis does not:

- *If planets fission from the Sun due to overspin while the proto-Sun is still accreting, this more easily explains how 98% of the Solar system's angular momentum ended up in the planets;*
- *It solves the mystery of the dominance of prograde rotation for these original planets since they would have shared in the Sun's prograde rotation at the outset;*
- *It also explains coplanar and circular orbits;*

- *It is the only model that explains the twinning of planets (and moons) and difference of planet pairs because after each planet pair is formed in this way, it will be some time before the Sun and extended cloud reach another overspin condition.*

The outstanding issues of the Solar fission 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 of the formation of the Sun. In **WUM**, we concentrated on furthering the Solar fission theory [29].

Angular Momentum Problem is one of the most critical problem in Standard Cosmology that must be solved. Standard Cosmology does not explain how Galaxies and Extrasolar systems obtained their enormous **orbital angular momenta** [30]:

- Solar System (SS) has an orbital momentum L_{orb}^{SS} calculated based on the distance of 26.4 kly from the galactic Centre and orbital speed of about 220 km/s : $L_{orb}^{SS} = 1.1 \times 10^{56} J s$, which far exceeds the rotational angular momentum: $L_{rot}^{SS} = 3.2 \times 10^{43} J s$;
- Milky Way (MW) galaxy is gravitationally bounded with the Virgo Supercluster and has an orbital angular momentum L_{orb}^{MW} calculated based on the distance of 65 million light-years from Virgo Supercluster and orbital speed of about 400 km/s [31]: $L_{orb}^{MW} = 2.5 \times 10^{71} J s$, which far exceeds the rotational angular momentum of MW [30]: $L_{rot}^{MW} \approx 1 \times 10^{67} J s$.

In our opinion, there is only one mechanism that can supply angular momenta to Macroobjects – **Rotational Fission** of overspinning (surface speed at equator exceeding escape velocity) Prime Objects. From the point of view of Fission model, the Prime Object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite.**

In frames of WUM, Prime Objects are Dark Matter (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” [5]. To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Overspinning DM Superclusters’ Cores and self-annihilation of Dark Matter Particles (DMPs);
- Proposed **Weak Interaction** of DMPs with Matter (DM and Baryonic Matter, see below) provides the integrity of DM Cores, which are **3D fluid balls with a high viscosity** and act as solid-state objects;
- The main 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 Rotational Fission. The experimental observations of galaxies in the

universe showed that most of them are disk galaxies: about 60% are ellipticals and about 20% are spirals [24]. These results speak in favor of the developed Rotational Fission mechanism;

- Size, mass, density, composition, L_{orb} and L_{rot} of satellite cores depend on local density fluctuations at the edge of the overspinning prime DM cores and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation;
- In our view, satellite DM cores are given off by “**Volcanoes**” on prime DM cores erupting repeatedly over millions or billions of years;
- Dark Matter Core of MW was born 13.77 billion years ago as the result of the **Volcanic Rotational Fission** of the Virgo Supercluster DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the repeating Volcanic Rotational Fissions 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, extrasolar systems, planets, and moons.

Weak Interaction. A 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* [32]. It follows that a new weak force needs to exist, providing interaction between DMPs. The strength of this force exceeds that of gravity, and its range is considerably greater than that of the weak nuclear force [5].

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

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

where $G_0 = a^2 c^4 / 8\pi h c$ is an extrapolated value of G at the Beginning of the World ($Q=1$). The range of the gravity equals to the size of the World R :

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

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

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

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

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

that is much greater than the range of the weak nuclear force. Calculated concentration of DMF4 n_{DMF4} in the largest shell of Superclusters: $n_{DMF4} \cong 4.2 \times 10^{15} m^{-3}$ shows that a distance between particles is around $\sim 10^{-5} m$, which is much smaller than R_W . Thus, the introduced weak interaction of DMPs with Matter will provide integrity of all Shells. In our view, weak interaction between particles DMF3 provides integrity of Fermi Bubbles and Solar Corona [33].

Based on the proposed New Cosmology, we performed a detailed analysis of the angular momenta of main objects of the World – overspinning DM Cores of superclusters and galaxies. According to the WUM theory of Compact Objects, parameters of Macroobjects Cores made up of different DMFs in Dark Epoch (0.45 Gyr) before Rotational fission are as follows (m_0 is a basic unit of mass $m_0 = h/ac$) [29]:

Supercluster DM Core (based on DMF4):

- Maximum mass $M_{0.45}^{SC}$ equals to: $M_{0.45}^{SC} = \frac{4\pi}{3} m_0 \alpha^{-8} \times Q_{0.45}^{3/2} = 2.4 \times 10^{47} \text{ kg}$;
- Minimum radius $R_{0.45}^{SC}$ equals to: $R_{0.45}^{SC} = 2\pi a \alpha^{-8} \times Q_{0.45}^{1/2} = 3.4 \times 10^{22} \text{ m}$;
- Rotational angular momentum $L_{0.45}^{SC}$ equals to: $L_{0.45}^{SC} = 4.7 \times 10^{77} \text{ J s}$.

Galaxy DM Core (based on DMF3):

- Maximum mass $M_{0.45}^{GC}$ equals to: $M_{0.45}^{GC} = \frac{4\pi}{3} m_0 \alpha^{-4} \times Q_{0.45}^{3/2} = 6.8 \times 10^{38} \text{ kg}$;
- Minimum radius $R_{0.45}^{GC}$ equals to: $R_{0.45}^{GC} = 2\pi a \alpha^{-4} \times Q_{0.45}^{1/2} = 9.6 \times 10^{13} \text{ m}$;
- Rotational angular momentum $L_{0.45}^{GC}$ equals to: $L_{0.45}^{GC} = 3.2 \times 10^{60} \text{ J s}$.

Milky Way (MW) is gravitationally bounded with Virgo Supercluster (VS) [31]. Let's compare $L_{0.45}^{VS}$ with an orbital momentum of Milky Way L_{orb}^{MW} calculated based on the distance of 65 million light years from VS and orbital speed of about 400 km/s [31]: $L_{orb}^{MW} = 2.5 \times 10^{71} \text{ J s}$. It follows 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 the number 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 [34], the actual number of created galaxies could be much larger.

Comparison of the SS orbital momentum $L_{orb}^{SS} = 1.1 \times 10^{56} \text{ J s}$ with rotational momentum of MW galaxy DM Core $L_{0.45}^{GC} = 3.2 \times 10^{60} \text{ J s}$ shows that 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 [35]), the number of generated Extrasolar systems could be much larger. Extrasolar system DM Cores can give birth to planet DM cores, and they can generate DM cores of moons by the same Volcanic Rotational Fission mechanism.

The calculated value of the total mass of DM Macroobjects in Dark Epoch $M_{0.45}^{MO}$ before Rotational fission is: $M_{0.45}^{MO} = 2\pi^2 m_0 \times Q_{0.45}^2$ and the minimum number of DM superclusters is: $N_{0.45}^{SC} = 1.5\pi \alpha^8 \times Q_{0.45}^{1/2} \sim 3 \times 10^3$. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. In our view, there were many "Beginnings" for different Luminous Superclusters. It is worth noting that the **absolute Age** of the entire World is 14.22 Gyr. No one supercluster can be older than 14.22 Gyr.

8. Dark Matter Reactors

The following facts support the existence of **Dark Matter Cores** in Macroobjects [1]:

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [36];
- J. Zhang, *et al.* concluded that the Earth's inner core is rotating faster than its surface by about 0.3 – 0.5 degrees per year [37];
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [38];
- W. Wu, S. Ni, and J. Irving found that the Earth's 660-km boundary is rougher than the surface layer that we all live on [39];
- Random variations of Earth's and Venus's Rotational Speed: the variations of the Earth daylength throughout 2020 were in the range $86400 \pm 1.62 \text{ ms}$ s [40] and the average sidereal day on Venus in the 2006-2020 interval was 243.0226 ± 0.0013 Earth days [41];

- Plutonium-244 with half-life of 80.6 million years and Iron-60 with half-life of 2.6 million years are not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments [42]. Any Pu-244 and Iron-60 present in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in the Nature [43] and A. Wallner, *et al.* in 2021 obtained signatures of Pu-244 and Iron-60 in samples of Pacific Ocean crust [42];
- Giant planets like **Jupiter** are hundreds of degrees warmer than current temperature models predict. **Saturn** radiates 2.5 times more energy than it receives from the Sun; **Uranus** – 1.1 times; **Neptune** – 2.6 times. Many Icy Solar system bodies including **Pluto** possess subsurface oceans.

According to **WUM**:

- The fact that Macroobject Cores rotate faster than surrounding envelopes, despite high viscosity of the internal medium, is intriguing. WUM explains this phenomenon through absorption of DMPs by Cores. Dark Matter Particles supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^2$). Cores irradiate products of annihilation, which carry away excessive angular momentum. The Solar wind is the result of this mechanism [5].
- The 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [31];
- Pu-244 and Iron-60 are produced within the Earth as the result of DMF1 particles self-annihilation. They arrive to the Crust of the Earth due to convection currents in the mantle carrying isotopes from the interior to the planet's surface [44];
- Random variations of the Earth's rotational speed on a daily basis can be explained by variations in an activity of the Earth's Dark Matter Reactor. As the result of DMPs self-annihilation, **random mass ejections** are happening. During a time of high DM Reactor activity, the Earth's rotational speed is lower (long days) due to increase of the Earth's moment of inertia. When **random mass ejections** are less frequent, the Earth's moment of inertia is decreasing, we observe short days.
- The internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate through the entire objects' envelope, get absorbed into the cores, and continuously support DMF1 self-annihilation.

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

9. Early Earth

Formation of Earth. The oldest material found in SS is dated to 4.568 Gyr ago [45]. In the article "The age of the Earth in the twentieth century: a problem (mostly) solved" G. B. Dalrymple said: *Whether this age represents the age of the Earth's accretion, of core formation, or of the material*

from which the Earth formed is not yet known, but recent evidence suggests it may approximate the latter [46].

In **WUM**, DM core of the Earth with the radius of $R_E = 3.52 \times 10^3 \text{ km}$ was born as the result of the Volcanic Rotational Fission of the Sun's DM Core with the radius of $R_S = 487 \times 10^3 \text{ km}$ 4.57 Gyr ago [47].

Origin of the Moon is usually explained by a Mars-sized body striking the Earth, making a debris ring that eventually collected into a single natural satellite, the Moon, but there are a number of variations on this giant-impact hypothesis, as well as alternative explanations, and research continues into how the Moon came to be. Other proposed scenarios include captured body, fission, formed together (condensation theory, Synestia), planetesimal collisions (formed from asteroid-like bodies), and collision theories. The standard giant-impact hypothesis suggests that a Mars-sized body, called Theia, impacted the proto-Earth, creating a large debris ring around Earth, which then accreted to form the Moon [48].

Establishing the age of the Moon is critical to understanding solar system evolution and the formation of rocky planets, including Earth. However, despite its importance, the age of the Moon has never been accurately determined. M. Barboni, *et al.* "*present uranium-lead dating of Apollo 14 zircon fragments that yield highly precise, concordant ages, demonstrating that they are robust against postcrystallization isotopic disturbances. Hafnium isotopic analyses of the same fragments show extremely low initial $^{176}\text{Hf}/^{177}\text{Hf}$ ratios corrected for cosmic ray exposure that are near the solar system initial value. Our data indicate differentiation of the lunar crust by 4.51 billion years, indicating the formation of the Moon within the first ~60 million years after the birth of the solar system*" [49].

Following the prevailing giant-impact hypothesis, planetary geophysicists at the German Aerospace Center, led by M. Maurice, have used a new **numerical model** to reconstruct the time at which the event occurred. They report that the Moon formed 4.425 ± 0.025 billion years ago, and that it hosted an **ocean of magma** for substantially longer time than previously thought (for ~200 million years) [50].

In **WUM**, DM core of the Moon with the radius of $R_M = 0.381 \times 10^3 \text{ km}$ was born as the result of the Volcanic Rotational Fission of the Earth's DM Core $\lesssim 4.57 \text{ Gyr}$ [47].

Continental crust of Earth. The long-favored paradigm for the development of continental crust is one of progressive growth beginning at ~4 billion years ago. To test this hypothesis, T. M. Harrison, *et al.* measured **initial $^{176}\text{Hf}/^{177}\text{Hf}$ values** of 4.01 – 4.37 Gyr detrital zircons from Western Australia. They obtained results that support the view that crust had formed by 4.4 – 4.5 Gyr and was rapidly recycled into the mantle [51].

Earth's Atmosphere and Oceans were formed by volcanic activity and outgassing. Most of the gas was carbon dioxide and water vapor that condensed into oceans. In this model, atmospheric greenhouse gases kept the oceans from freezing when the newly forming Sun had only 70% of its current luminosity.

According to the "Lumen Learning. Earth Science" [52]: *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.*

According to the “National Ocean Service” [53]: *Most scientists agree that the atmosphere and the ocean accumulated gradually over millions and millions of years with the continual 'degassing' of the Earth's interior. According to this theory, the ocean formed from the escape of water vapor and other gases from the molten rocks of the Earth to the atmosphere surrounding the cooling planet. After the Earth's surface had cooled to a temperature below the boiling point of water, rain began to fall—and continued to fall for centuries. As the water drained into the great hollows in the Earth's surface, the primeval ocean came into existence. The forces of gravity prevented the water from leaving the planet.*

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 [54]: *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 the paper “Redox state of Earth’s magma ocean and its Venus-like early atmosphere” [55], P. A. Sossi, *et al.* found that *after cooling down from the magma state, the young Earth had an atmosphere that was slightly oxidizing, with carbon dioxide as its main constituent, as well as nitrogen and some water. The surface pressure was also much higher, almost one hundred times that of today and the temperature was much higher, due to the hot surface. These characteristics made it more similar to the atmosphere of today’s Venus than to that of today’s Earth.* Based on their results, the authors made a conclusion that *a popular theory on the emergence of life on Earth, in which lightning strikes interact with certain gases (notably ammonia and methane) to create amino acids – the building blocks of life – seems much less likely. The necessary gases were simply not sufficiently abundant.*

Origin of Life. M. Dodd, *et al.* in the article “Evidence for early life in Earth’s oldest hydrothermal vent precipitates” wrote [56]: *Although it is not known when or where life on Earth began, some of the earliest habitable environments may have been submarine-hydrothermal vents. Here we describe putative fossilized microorganisms that are at least 3,770 million and possibly 4,280 million years old in ferruginous sedimentary rocks, interpreted as **seafloor-hydrothermal vent-related precipitates**. These structures occur as micrometre-scale haematite tubes and filaments with morphologies and mineral assemblages similar to those of filamentous microorganisms from modern hydrothermal vent precipitates and analogous microfossils in younger rocks. Collectively, these observations are consistent with an oxidized biomass and provide evidence for biological activity in submarine-hydrothermal environments more than 3,770 million years ago [54].*

The proposed concept of **Dark Matter Reactors** in Cores of all gravitationally-rounded Macroobjects successfully explains all these hypothesis and results for the Early Earth (see Section 8):

- 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 Gyr ;
- Earth's Atmosphere and Oceans were formed by the volcanic activity and outgassing of DM core;
- The thickness of the Upper mantle with Crust is growing in time: the Early Earth had a smaller thickness than it is in the present time. Hence, the temperature of the Earth’s surface was higher

than its calculated temperature based on the Sun's output at that time. It kept the oceans from freezing when the newly forming Sun had only 70% of its current luminosity;

- The *biological activity in submarine-hydrothermal environments more than 3,770 million years ago* can be explained by a generation of all kinds of chemical elements and compositions produced into the Earth's DM core.

10. Conclusion

WUM does not attempt to explain all available cosmological and geophysical 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 and a new Geophysics. The Model should be developed into the well-elaborated theory by the entire physical community.

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Decisive Role of Dark Matter in Cosmology

Abstract

Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology [1]. WUM is the alternative to the prevailing Big Bang Model (BBM). WUM and BBM are principally different Models: 1) Instead of the Initial Singularity with the infinite energy density and the extremely rapid expansion of the space (Inflation) in BBM, in WUM, there was a Fluctuation (4D Nucleus of the World with an extrapolated radius equals to a basic unit of size a) in the Eternal Universe with a finite extrapolated energy density (four orders of magnitude less than the nuclear density) and a finite expansion of the Nucleus in Its fourth spatial dimension with speed c that is the gravitodynamic constant. 2) Instead of the Infinite Homogeneous and Isotropic Universe around the Initial Singularity in BBM, in WUM, the 3D Finite Boundless World (the Hypersphere of the 4D Nucleus) presents a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$), which emerged in different places of the World at different Cosmological times. The Medium of the World is Homogeneous and Isotropic. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous. The Absolute Age of the entire World (determined by the parameters of the Medium) is 14.22 Gyr.

Introduction

In 2013, our paper “World-Universe Model” (WUM) was, in fact, the beginning of a New Paradigm in Cosmology [2]. WUM is an alternative to the prevailing Big Bang Model (BBM). They are principally different Models. Comparison of their main parameters is presented in **Table 1**.

WUM solves a number of physical problems in contemporary Cosmology through Dark Matter Particles (DMPs) and their interactions: **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center; **Coronal Heating problem** in solar physics – temperature of Sun's corona exceeding that of photosphere by millions of degrees; **Cores of Sun and Earth** rotating faster than their surfaces; Diversity of **Gravitationally-Rounded Objects** in Solar system and their **Internal Heating**. WUM reveals **Inter-Connectivity of Primary Cosmological Parameters** and calculates their values, which are in good agreement with the latest results of their measurements.

In 2013, WUM predicted the values of the following Cosmological parameters: gravitational, concentration of intergalactic plasma, and the minimum energy of photons, which were experimentally confirmed in 2015-2018. “*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*” (Nobel Prize in Physics 2020) made by Prof. R. Genzel and A. Ghez is a confirmation of one of the most important predictions of WUM in 2013: “*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*” [2].

This manuscript concludes the series of papers on WUM published by “Journal of High Energy Physics, Gravitation and Cosmology” journal [3]-[22]. Many results obtained there are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases.

Table 1. Parameters of Big Bang Model and World-Universe Model [16].

Parameter	Big Bang Model	World-Universe Model
Structure of the World	3+1 Spacetime	3D Hypersphere of 4D Nucleus of the World Time is a Factor of the World
The Beginning	Initial Singularity	4D Nucleus of the World with an extrapolated radius a as the result of a fluctuation in the Eternal Universe
Expansion	Inflation – extremely rapid expansion of space	Radius of the 4D Nucleus of the World is increasing with speed c that is the gravitodynamic constant
Cosmological Principal	Homogeneous and Isotropic Universe	Homogeneous and Isotropic Medium of the World Inhomogeneous and Anisotropic distribution of Macroobjects
Content	Dark Energy, Cold Dark Matter, Ordinary matter	Multicomponent Dark Matter (DM), Ordinary matter
Origin of Matter	Initial Singularity	DM comes from the Universe to the Nucleus along Its fourth spatial dimension. Ordinary Matter is byproduct of DMPs self-annihilation
Cosmic Microwave Background	Photon’s wavelength is increasing over time	Thermodynamic equilibrium of photons with Intergalactic plasma
Nucleosynthesis of light elements	Big Bang Nucleosynthesis	Nucleosynthesis of all elements (including light elements) occurs inside of DM Cores of Macroobjects
Primary Cosmological Parameters	Independent	Inter-connected
Galactic Centre	Black Hole	DM Core of Galaxy
Law of Conservation of Angular Momentum	Inconsistent	Consistent

1. History of Dark Matter

Early Ideas

The history of the Dark Matter (DM) can be traced back to at least the middle of the 19th century. G. Bertone and D. Hooper provide an excellent review of this history [23]:

- 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*;
- In 1846, U. Le Verrier and J. C. Adams, in order to explain some persistent anomalies in the motion of Uranus, proposed the existence of a new planet;
- Beside dark stars and planets, astronomers in the 19th century also discussed dark matter 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*;
- As soon as astronomical photography was invented, scientists started to notice that stars were not distributed evenly on the sky. Dark regions were observed in dense stellar fields. In 1894, A. Ranyard wrote: *The dark vacant areas or channels running north and south, in the neighborhood of [θ Ophiuchi] at the center seem to me to be undoubtedly dark structures, or absorbing masses in space, which cut out the light from the nebulous or stellar region behind them*;

- 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*;
- H. Poincare was impressed by Lord Kelvin's idea of applying the "theory of gases" to the stellar system of Milky Way. In 1906, he explicitly mentioned "dark matter" and argued that since the velocity dispersion predicted in Kelvin's estimate is of the same order of magnitude as that observed, the amount of dark matter was likely to be less than or similar to that of visible matter;
- J. Kapteyn was among the first to offer a quantitative model for the shape and size of the Galaxy, describing it as a flattened distribution of stars, rotating around an axis that points towards the Galactic Pole. He argued that the Sun was located close to the center of the Galaxy, and that the motion of stars could be described as that of a gas in a quiescent atmosphere. In 1922, he explicitly addressed the possible existence of dark matter in the Galaxy: *We therefore have the means of estimating the mass of the dark matter in the universe. As matters stand at present, it appears at once that this mass cannot be excessive. If it were otherwise, the average mass as derived from binary stars would have been very much lower than what has been found for the effective mass*;
- In 1932, Kapteyn's pupil J. Oort derived a most probable value for the total density of matter near the Sun of $6.3 \times 10^{-24} \text{ g cm}^{-3}$. It is interesting to recall the words used by Oort to illustrate the constraint on the amount of dark matter: *We may conclude that the total mass of nebulous or meteoric matter near the sun is less than $3 \times 10^{-24} \text{ g cm}^{-3}$; it is probably less than the total mass of visible stars, possibly much less*;
- In 1930, K. Lundmark measured the galaxy rotation curves of several different galaxies and compared the mass required to the luminous mass of the galaxies. His conclusion was the same as that of V. Rubin 40 years later, a large part of the mass of a galaxy is in the form which is not visible to us. Like Zwicky would do three years later, Lundmark spoke about this additional mass as "Dunkle Materie" or, literally translated, "Dark Matter" [24];
- 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*;
- From our contemporary perspective, it can be easy to imagine that F. Zwicky, V. Rubin, and the other early dark matter pioneers had halos of weakly interacting particles in mind when they discussed dark matter. In reality, however, they did not. But over time an increasing number of particle physicists became interested in cosmology, and eventually in the problem of dark matter.

Recent Developments

Our article “Astrophysics: Macroobject Shell Model” focuses on more recent developments [10]:

- 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-four years. In 1977-1980, indirect effects in cosmic rays and gamma-ray background from the annihilation of Cold DM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [25]-[30];
- In the wake of the failures of hot DM, it was quickly becoming appreciated that cold DM could do a much better job of accounting for the observed patterns of large-scale structure. In 1984, G. Blumenthal, S. Faber, J. Primack, and M. Rees wrote: “*We have shown that a universe with ~ 10 times as much cold dark matter as baryonic matter provides a remarkably good fit to the observed universe. This model predicts roughly the observed mass range of galaxies, the dissipational nature of galaxy collapse, and the observed Faber-Jackson and Tully-Fisher relations. It also gives dissipationless galactic halos and clusters. In addition, it may also provide natural explanations for galaxy-environment correlations and for the differences in angular momenta between ellipticals and spiral galaxies*” [23];
- Although the term WIMPs (weakly interacting massive particles), as coined by G. Steigman and M. Turner in 1984, was originally intended to include all particle dark matter candidates, including axions, gravitinos, etc., the definition of this term has since evolved to more often denote only those particles that interact through the weak force [23];
- By the end of the 1980s, the conclusion that most of the mass in the Universe consists of cold and non-baryonic particles had become widely accepted, among many astrophysicists and particle physicists alike. Cold dark matter in the form of some unknown species of elementary particle had become the leading paradigm [23];
- The role of cold DM in the formation of Primordial Luminous Objects is discussed by E. Ripamonti and T. Abel [31];
- 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 [32]. 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 [32]. 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 [33];
- Important cosmological problems like Dark Matter and Dark Energy could be, in principle, solved through extended gravity that is stressed by C. Corda [34].
- Two-component DM systems consisting of bosonic and fermionic components are 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) [35];
- Conversions and semi-annihilations of DMPs in addition to the standard DM annihilations are considered in a three-component DM system [36]. Multicomponent DM models consisting of both bosonic and fermionic components were analyzed in literature (for example, see [37]-[42] and references therein).

Dark Matter in WUM

Multicomponent Dark Matter

WUM proposes multicomponent DM system consisting of two couples of coannihilating DMPs: a

heavy Dark Matter Fermion (DMF) – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV) that is a dipole of Dirac’s monopoles with charge $\mu = e/2\alpha$ (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 $e/3$; a self-annihilating fermion – DMF3 (3.7 keV), and a fermion DMF4 (0.2 eV).

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

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

where h is Planck constant; α is the dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ (that was later named “Fine-structure constant”); a is a basic unit of size $a = 1.7705641 \times 10^{-14} \text{ m}$; and c is the **gravitodynamic constant** that is the ratio of the absolute gravitomagnetic unit of charge E_0 to the absolute gravitostatic unit of charge E_0/c . It is worth noting that the **speed of light in vacuum**, commonly denoted as c , is not related to the World in our Model, because there is no vacuum in it. Instead, there is the Medium of the World consisting of elementary particles. Also note that the rest energy of electron E_e equals to: $E_e = \alpha E_0$ and the Rydberg unit of energy is: $Ry = hcR_\infty = 0.5\alpha^3 E_0 = 13.605693 \text{ eV}$.

We still do not have a direct confirmation of DMPs’ rest energies, but we do have a number of indirect observations. The signatures of DMPs self-annihilation with expected rest energies of 1.3 TeV; 9.6 GeV; 70 MeV; 340 keV; 3.7 keV are found in spectra of the diffuse gamma-ray background and the emissions of various Macroobjects in the World. We connect observed gamma-ray spectra with the structure of Macroobjects (nuclei and shells composition). Self-annihilation of those DMPs can give rise to any combination of gamma-ray lines. Thus, the diversity of Very High Energy gamma-ray sources in the World has a clear explanation in WUM [10].

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 [5].

Weak Interaction

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

According to **WUM**, strength of gravity is characterized by gravitational parameter [18]:

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

where $G_0 = \frac{a^2 c^4}{8\pi h c}$ 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 unit of time: $t_0 = a/c = 5.9059662 \times 10^{-23}$ 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 :

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

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:

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

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: $n_{DMF4} \cong 4.2 \times 10^{15} \text{ m}^{-3}$ (see Table 2) shows that a distance between particles is around $\sim 10^{-5} \text{ m}$, which is much smaller than R_W . Thus, the introduced weak interaction between DMPs will provide integrity of all DM shells. In our view, weak interaction between particles DMF3 provides integrity of Fermi Bubbles (see Section 4.7.).

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. Introduced principally new Weak Interaction of DMPs with Matter provides integrity of all shells: a distance between particles is smaller than the range of the weak interaction (see Section 2.2). Table 2 describes the parameters of Macroobjects’ Cores, which are 3D fluid balls with a high viscosity and act as solid-state objects, made up of different fermions.

Table 2. 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 $\rho_{max}, \text{kgm}^{-3}$
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 [9]:

- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in Extrasolar Systems;
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;

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

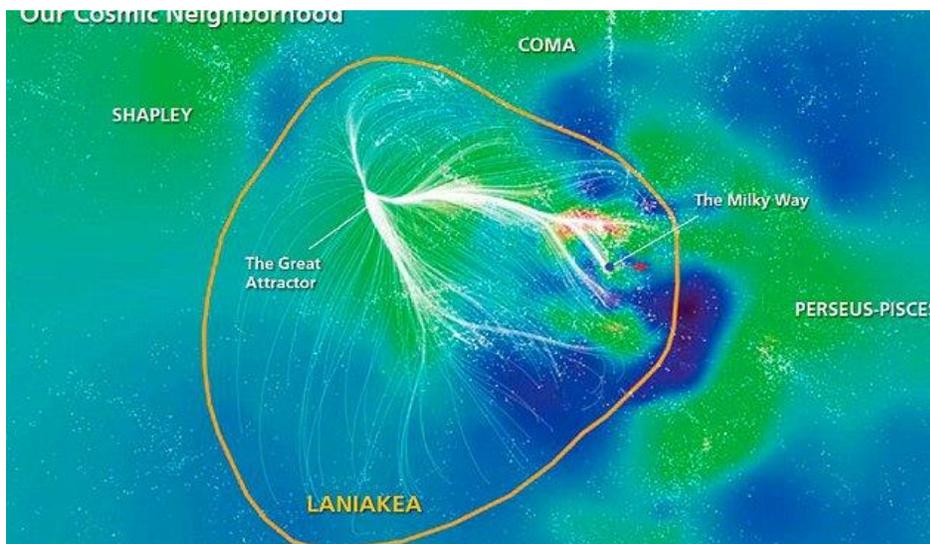
In our view, Macroobjects of the World possess the following properties [10]:

- Nuclei are made up of DMPs. Surrounding shells contain DM and Baryonic matter;
- Nuclei and shells are growing in time proportionally to square root of cosmological time $\propto \tau^{1/2}$ until one of them reaches the critical point of its local stability, at which it detonates. The energy released during detonation is produced by the self-annihilation of DMPs. The detonation process does not destroy the Macroobject; instead, Hyper-flares occur in active areas of the shells, analogous to Solar flares;
- All other DMPs in different shells can start self-annihilation process as the result of the first detonation;
- Different emission lines in spectra of bursts are connected to the Macroobjects' structure which depends on the composition of Nuclei and surrounding shells made up of DMPs. Consequently, the diversity of Very High Energy Bursts has a clear explanation;
- Afterglow is a result of processes developing in Nuclei and shells after detonation.

Macrostructures

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to Milky Way (MW) and approximately 100,000 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated binding mass $10^{17} M_{\odot}$ [43]. The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. Distance from the Earth to the Centre of LSC is 250 Mly. The mass-to-light ratio of the Virgo Supercluster is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [44]. In 1933, F. Zwicky investigated the velocity dispersion of Coma cluster and found a surprisingly high mass-to-light ratio (~ 500). He concluded: *"If this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter"* [45]. These ratios are one of the **main arguments in favor of presence of large amounts of Dark Matter in the World.**

Figure 1. Laniakea Supercluster. Adapted from [46].



We emphasize that about 100,000 nearby galaxies are moving around Centre of Laniakea Supercluster. They belong to LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structure (see **Figure 2**). It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$) [22].

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" [46].

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**" [47].

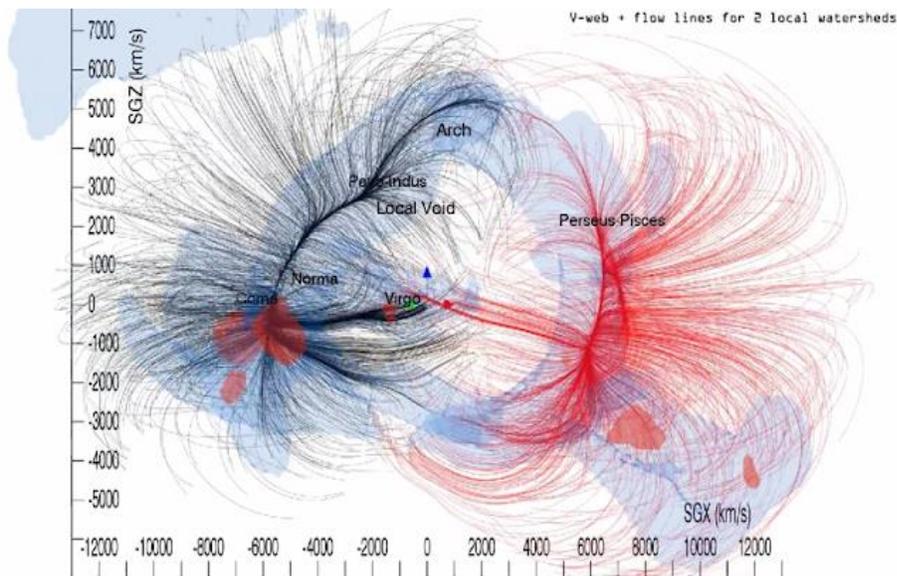


Fig. 2. A representation of structure and flows due to mass within $6,000 \text{ km s}^{-1}$ ($\sim 80 \text{ Mpc}$). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near the Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near the Perseus Cluster are in red. The Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [46].

In June 2021, at the "Giant Arc at the 238th virtual meeting of the American Astronomical Society", A. Lopez reported about the discovery of "a giant, almost symmetrical arc of galaxies – the Giant Arc – spanning 3.3 billion light years at a distance of more than 9.2 billion light years away that is **difficult**

to explain in current models of the Universe. The Giant Arc, which is approximately 1/15th the radius of the observable universe, is twice the size of the striking Sloan Great Wall of galaxies and clusters that is seen in the nearby Universe. This new discovery of the Giant Arc adds to an **accumulating set of (cautious) challenges to the Cosmological Principle.** The discovery of the Giant Arc adds to the number of structures on scales larger than those thought to be “smooth”, and therefore pushes the boundary size for the Cosmological Principle. The growing number of large-scale structures over the size limit of what is considered theoretically viable is becoming harder to ignore. According to cosmologists, the current theoretical limit is calculated to be 1.2 billion light years, which makes the Giant Arc almost three times larger. **Can the standard model of cosmology account for these huge structures in the Universe as just rare flukes or is there more to it than that?** [48].

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”[49].

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

- “Galaxies **do not** congregate in clusters and along filaments”. On the contrary, Cosmic Web that is “networks of structure that are interconnected with no clear boundaries” is the result of the Rotational Fission of DM Cores of neighbor Superclusters;
- “Generation of angular momentum across these scales” provide DM Cores of Superclusters through the Rotational Fission mechanism;
- “Spinning cylindrical tendrils of matter hundreds of millions of light-years across” are the result of spiral jets of galaxies generated by DM Cores of Superclusters with internal rotation;
- The Giant Arc is the result of the intersection of the Galaxies’ jets generated by the neighbor DM Cores of Superclusters;
- The calculated maximum mass of the supercluster DM Core of 2.1×10^{19} solar mass (see **Table 2**) is in good agreement with the values discussed by L. Bliss [43] and B. Carr, F. Kühnel and L. Visinelli [49]. 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 $\sim 10^3$ [22]. 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 at different Cosmological times;
- 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 **Fig. 1** and **Fig. 2**). Big Bang never happened.

Dark Matter Cosmology

Medium of the World

WUM introduces the Medium of the World, which consists of stable elementary particles with

lifetimes longer than the age of the World: protons, electrons, photons, neutrinos, and Dark Matter Particles (DMPs). The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation. Inter-galactic 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 the MBR rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 $km s^{-1}$, respectively [7].

The energy density of the Medium is 2/3 of the total energy density of the World. Superclusters, Galaxies, Extrasolar systems, planets, moons, *etc.* are made of the same particles. The energy density of Macroobjects adds up to 1/3 of the total energy density of the World throughout the World's evolution [7]. **Cosmological**

principal is valid for the Homogeneous and Isotropic Medium. The distribution of Macroobjects is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable for the entire World.

WUM is the classical model, therefore classical notions can be introduced only when the very first ensemble of particles was created at the cosmological time τ_M equals to: $\tau_M = \alpha^{-2} \times t_0 \cong 10^{-18}s$ [15]. The cosmological principal **Universality of Physical Laws** is valid at the cosmological times $\tau \geq \tau_M$ because Physical Laws are determined by the Medium of the World.

In frames of WUM, Time and Space are closely connected with the Mediums' impedance (wave resistance) Z_g that equals to the Hubble's parameter H : $Z_g = H = \tau^{-1}$ and the gravitomagnetic parameter μ_g , which equals to: $\mu_g = R^{-1}$. It follows that neither Time nor Space could be discussed in absence of the Medium.

According to WUM, the World is the 3D Hypersphere of the 4D Nucleus, which is expanding in Its fourth spatial dimension. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World. A Hypersphere is an example of a 3-Manifold which locally behaves like regular Euclidean 3D space: just as a sphere looks like a plane to small enough observers. The 3D Finite Boundless World has a **Spatial Measure** – Radius of the curvature of the 4D Nucleus R . All spatial parameters of the World can be measured relatively to R . Any cosmological model of the Infinite Universe has no Spatial Measure.

WUM introduces a Cosmological Time that is principally different from the Solar Time which is defined by the parameters of the Solar System and Cosmic Time of the General Relativity. It is defined by the Impedance of the Medium of the World that equals to the Hubble's parameter. Cosmological Time τ marches on at constant pace since the Beginning of the World until the present Epoch and is, in fact, a **Timing Measure** that defines the Age of the World $A_\tau = \tau$. All timing parameters of the World can be measured relatively to the Age of the World. WUM concludes that any theory of evolution of the World should be consistent with the Cosmological Time [19]. In our everyday life we use the alleged Space (3D Euclidean) and Solar Time.

The gravitational parameter G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. The Gravitation is a result of simple interactions of DMPs with Matter (by the introduced new Weak Interaction) that work cooperatively to create a more complex interaction. DMPs are responsible for the Le Sage's mechanism of the gravitation [6].

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

Creation of Matter

WUM follows the idea of the continuous creation of matter by the additive mechanism discussed by P. Dirac in 1974 [50]. To provide the creation of Matter by the Universe uniformly throughout the World, we consider the following Concept of the World proposed by G. Riemann in 1854 [51]: **3D Finite World is a Hypersphere** of 4D Nucleus. In our view, the World was started by a Fluctuation in Eternal Universe, and 4D Nucleus of the World with a radius of a was born. The Nucleus is expanding in Its fourth spatial dimension and Its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with the speed c (gravitodynamic constant) for a cosmological time τ from the Beginning and equals to $R = c\tau$.

The surface of the Nucleus is created in a process analogous to sublimation. Continuous creation of matter is the result of this process. Sublimation is a well-known endothermic process that happens when surfaces are intrinsically more energetically favorable than the bulk of a material, and hence there is a driving force for surfaces to be created. DM is created by the Universe in the 4D Nucleus of the World. DMPs carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a Matter-Antimatter Asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has 2D spherical surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus.

The proposed 4D process is responsible for the Expansion, Creation of Matter, and Arrow of Time. It constitutes the main **Hypothesis of WUM**. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created [15]. It is important to emphasize that:

- Creation of Matter is a direct consequence of expansion;
- Creation of DM occurs homogeneously in all points of the 3D Finite Boundless Hypersphere World.

Angular Momentum Problem

Angular momentum problem is one of the most critical problem in Standard Cosmology that must be solved. Standard Cosmology does not explain how Galaxies and Extrasolar systems obtained their enormous **orbital angular momenta** [13]:

- Solar System (SS) has an orbital momentum L_{orb}^{SS} calculated based on the distance of 26.4 kly from the galactic Centre and orbital speed of about 220 km/s : $L_{orb}^{SS} = 1.1 \times 10^{56} J s$, which far exceeds the rotational angular momentum: $L_{rot}^{SS} = 3.2 \times 10^{43} J s$;
- Milky Way (MW) galaxy is gravitationally bounded with the Virgo Supercluster and has an orbital angular momentum L_{orb}^{MW} calculated based on the distance of 65 million light-years from Virgo Supercluster and orbital speed of about 400 km/s [52]: $L_{orb}^{MW} = 2.5 \times 10^{71} J s$, which far exceeds the total rotational angular momentum of MW [13]: $L_{rot}^{MW} \approx 1 \times 10^{67} J s$.

In our opinion, there is only one mechanism that can supply angular momenta to Macroobjects – **Rotational Fission** of overspinning (surface speed at equator exceeding escape velocity) Prime Objects. From the point of view of Fission model, the Prime Object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite**.

In frames of WUM, Prime Objects are DM Cores of Superclusters, which must accumulate tremendous rotational angular momenta before the Birth of the Luminous World. This process must take a long enough time in the history of the World, which we named “Dark Epoch” [13].

Dark Epoch

Dark Epoch started at the Beginning of the World and lasted for 0.45 Gyr 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 . 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 Gyr).

The process described above is the formation of the DM Core of Superclusters [13]. 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 4.5). We estimate the number of Supercluster Cores at the end of Dark Epoch to be around $\sim 10^3$ [22]. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other.

Rotational Fission

According to WUM, a rotational angular momentum of overspinning object before rotational fission is [13]:

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

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 Milky Way. At least 100 galaxy groups and clusters are located within its diameter of 110 million light-years. Considering parameters of DMF4 shell (see **Table 2**), we calculate the rotational angular momentum L_{rot}^{VSC} of VS Core before rotational fission:

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

Milky Way (MW) is gravitationally bounded with VS [61]. Let us compare L_{rot}^{VSC} with an orbital momentum of MW L_{orb}^{MW} calculated based on the distance of 65 million light years from VS Core and orbital speed of about 400 km/s [52]:

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

It means that as the result of rotational fission of VS Core, approximately $\sim 10^6$ galaxies like Milky Way 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 [53], the actual number of created galaxies could be much larger.

Analogous calculations for MW Core based on parameters of DMF3 shell (see **Table 2**) produce the following value of rotational angular momentum L_{rot}^{MWC} [13]:

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

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

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

As the result of rotational fission of MW Core 13.77 Gyr ago, approximately $\sim 10^4$ Extrasolar systems like Solar System 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 [54]), 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.

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 [55]. H. E. Bond, *et al.* found its age to be 14.46 +/- 0.8 Gyr that does not conflict with the age of the Universe, 13.77 +/- 0.06 Gyr, based on the microwave background and Hubble constant [55]. It means that this star must have formed between 13.66 and 13.83 Gyr, amount of time that is too short for formation of second generation of stars according to prevailing theories. In our Model this discovery can be explained by generation of HD 140283 by overspinning Core of the MW 13.77 Gyr 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 ~ 700 km/s [56]: they were launched by overspinning Core of the Large Magellan Cloud with the speed higher than the escape velocity [13].

Luminous Epoch

Luminous Epoch spans from 0.45 Gyr up to the present Epoch (during 13.77 Gyr). According to WUM, Cores of all Macroobjects (MOs) of the World (Superclusters, Galaxies, Extrasolar systems) possess the following properties [13]:

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

- Size, mass, composition, L_{orb} and L_{rot} of satellite cores depend on local density fluctuations at the edge of OC and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation.

WUM refers to OC detonation process as Gravitational Burst (GB), analogous to Gamma Ray Burst [8]. In frames of WUM, the repeating GBs can be explained the following way:

- As the result of GB, the OC loses a small fraction of its mass and a large part of its rotational angular momentum;
- After GB, the Core absorbs new DMPs. Its mass increases $\propto \tau^{3/2}$, and its angular momentum L_{rot} increases much faster $\propto \tau^2$, until it detonates again at the next critical point of its stability;
- Afterglow of GBs is a result of processes developing in the Nuclei and shells after detonation;
- In case of Extrasolar systems, a star wind is the afterglow of star detonation: star Core absorbs new DMPs, increases its mass $\propto \tau^{3/2}$ and gets rid of extra L_{rot} by star wind particles;
- Solar wind is the afterglow of Solar Core detonation 4.57 Gyr ago. It creates the bubble of the heliosphere continuously;
- In case of Galaxies, a galactic wind is the afterglow of repeating galactic Core detonations. In Milky Way it continuously creates two Dark Matter Fermi Bubbles (see Section 4.7).

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass about 2.3 solar masses 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 the current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [57]. In frames of the developed Model this discovery can be explained by Gravitational Burst of the overspinning Core of the Milky Way 4.8 million years ago, which gave birth to S5-HVS1 with the speed higher than the escape velocity of the Core.

C. J. Clarke, *et al.* observed CI Tau, a young 2-million-year-old star. CI Tau is located about 500 light years away in a highly-productive stellar 'nursery' region of the galaxy. They discovered that the Extrasolar System contains four gas giant planets that are only 2 million years old [58], amount of time that is too short for formation of gas giants according to prevailing theories. In frames of the developed Rotational Fission model, this discovery can be explained by Gravitational Burst of the overspinning Core of the Milky Way two million years ago, which gave birth to CI Tau system with all planets generated at the same time [13].

To summarize:

- The rotational fission of macroobject DM Cores is the most probable process that can generate satellite cores with large 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.

Dark Matter Fermi Bubbles

In 2010, the discovery of two Fermi Bubbles (FBs) emitting gamma- and X-rays was announced. FBs extend for about 25 kly above and below the center of the galaxy [59]. The outlines of the bubbles are quite sharp, and the Bubbles glow in nearly uniform gamma rays over their colossal surfaces.

Gamma-ray spectrum remains unconstrained up to around 1 TeV [60]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

In **WUM**, Fermi Bubbles are DMPs' clouds containing uniformly distributed Dark Matter Objects (DMOs), in which DMPs self-annihilate and radiate X-rays and gamma rays. FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2. Weak interaction between DMF3 particles provides integrity of FBs. Gamma rays up to 1 TeV are the result of the self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) in DMOs, which are macroobjects whose density is sufficient for the self-annihilation of DMPs to occur. On the other hand, DMOs are much smaller than stars in the World, and have a high concentration in FBs to provide nearly uniform gamma ray glow over their colossal surfaces. The Core of MW supplies FBs with new DMPs through the galactic wind, explaining the brightness of FBs remaining constant during the time of observations. In our opinion, FBs are built continuously throughout the lifetime of MW (13.77 Byr) [15].

Dark Matter Cores of Macroobjects

The following facts support the existence of DM Cores of Macroobjects [13]:

- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope;
- J. Zhang, *et al.* concluded that the Earth's inner core is rotating faster than its surface by about 0.3 – 0.5 degrees per year;
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere.

A fact that Macroobject Cores rotate faster than surrounding envelopes, despite high viscosity of the internal medium, is intriguing. WUM explains this phenomenon through absorption of DMPs by Cores. Dark Matter particles supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^2$). Cores irradiate products of DMPs self-annihilation, which carry away excessive angular momentum. The Solar wind is the result of this mechanism for the Sun and Upper mantle with Crust – for the Earth and other planets and moons. Radiuses of DM cores of the different Macroobjects of Solar System (SS) are presented in **Table 3**.

Table 3. The radius of the DM core of the different Macroobjects in the Solar system [20].

Macroobject	Sun	Saturn	Earth	Mars	Moon	Mimas
Radius, km ($\times 10^3$)	487	34.9	3.52	1.83	0.381	< 0.2

Sun's Dark Matter Core

Internal Structure. According to the standard Solar model, the Sun has:

- Core that extends from the center to about 20–25% of the solar radius, contains 34% of the Sun's mass. It produces all of Sun's energy;
- Radiative zone from the Core to about 70% of the solar radius, in which convection does not occur and energy transfer occurs by means of radiation;
- Core and Radiative zone contain practically all Sun's mass [61].

The large power output of the Sun is mainly due to the huge size and density of its Core, with only a

fairly small amount of power being generated per cubic meter. Theoretical models of the Sun's interior indicate a maximum power density of approximately 276.5 W/m^3 at the center of the Core [62], which is about the same power density inside a compost pile [63] and closer approximates reptile metabolism than a thermonuclear bomb. In our view, Core and Radiative zone are the parts of the Sun's DM Core.

Evolution of the Sun. By 1950s, stellar astrophysicists had worked out the physical principles governing the structure and evolution of stars [64]. According to these principles, the Sun's luminosity had to change over time, with the young Sun being about 30% less luminous than today [65], [66], [67], [68]. The long-term evolution of the bolometric solar luminosity $L(\tau)$ as a function of cosmological time τ can be approximated by a simple linear law: $L(\tau) \propto \tau$ [64].

One of the consequences of **WUM** holds that all stars were fainter in the past. As their cores absorb new DMPs, size of MO cores R_{MO} and their luminosity L_{MO} are increasing in time: $R_{MO} \propto \tau^{1/2}$ and $L_{MO} \propto R_{MO}^2 \propto \tau$, respectively. Taking the age of the World: $A_W \cong 14.2 \text{ Byr}$ and the age of SS: $A_{SS} \cong 4.6 \text{ Byr}$, it is easy to find that the young Suns' output was 67% of what it is today. Literature commonly refers to the value of 70% [64]. This result supports the developed model of the structure and evolution of the Sun [21].

Solar Corona. Geocorona. Planetary Coronas

Solar Corona is an aura of plasma that surrounds the Sun and extends at least $8 \times 10^6 \text{ km}$ into outer space (compare with the Sun's radius $7 \times 10^5 \text{ km}$). Spectroscopy measurements indicate strong ionization and plasma temperature in excess of 10^6 K [69]. The corona emits radiation mainly in the X-rays, observable only from space. The plasma is transparent to its own radiation and to solar radiation passing through it, therefore we say that it is optically-thin. The gas, in fact, is very rarefied, and the photon mean free-path by far overcomes all other length-scales, including the typical sizes of the coronal features.

J. T. Schmelz made the following comment on the composition of Solar corona: *Along with temperature and density, the elemental abundance is a basic parameter required by astronomers to understand and model any physical system. The abundances of the solar corona are known to differ from those of the solar photosphere* [70].

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

- The corona emits radiation mainly in X-rays due to the self-annihilation of DMF3 particles;
- The plasma is transparent to its own radiation and to the radiation coming from below;
- The elemental composition of the Solar corona and the Solar photosphere are known to differ;
- During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted [71] (one photon had an energy as high as 467.7 GeV [15]). In our view, it is the result of enormous density fluctuations of DMPs in the Solar corona and their self-annihilation.

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 the coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. The plasma is the result of self-annihilation of DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV) particles. The Solar corona made up of DMPs resembles a honeycomb filled with plasma [13].

Geocorona is a luminous part of an outermost region of the Earth's atmosphere [14] that extends to at least 640,000 km from the Earth [72]. It is seen primarily via Far-Ultra-Violet light from the Sun that is scattered by neutral hydrogen [73]. X-rays (in the range of energies 0.08 – 10 keV) from Earth's Geocorona were first detected by Chandra X-ray Observatory [74].

Planetary Coronas. X-rays from Planets and some observed moons (Europa, Io, Io Plasma Torus, Titan) were also observed by Chandra [74]. According to NASA:

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

In **WUM**, the Geocorona and Planetary Coronas possess features like those of the Solar Corona.

Dark Matter Reactors

Internal Heating. The analysis of Sun's heat for planets in SS yields the effective temperature of Earth of 255 K [75]. The actual mean surface temperature of Earth is 288 K [76]. The higher actual temperature of Earth is due to energy generated internally by the planet itself. According to the standard model, the Earth's internal heat is produced mostly through radioactive decay. The major heat-producing isotopes within Earth are K-40, U-238, and Th-232. The mean global heat loss from Earth is 44.2 TW [77]. The Earth's Uranium has been thought to be produced in one or more supernovae over 6 Gyr ago [78].

Radiogenic decay can be estimated from the flux of geoneutrinos that are emitted during radioactive decay. The KamLAND Collaboration combined precise measurements of the geoneutrino flux with existing measurements from the Borexino detector, Italy. They found that decay of U-238 and Th-232 together contribute about 20 TW to the total heat flux from the Earth to space. The neutrinos emitted from the decay of K-40 contribute 4 TW. Based on the observations the KamLAND Collaboration made a conclusion that *heat from radioactive decay contributes about half of Earth's total heat flux* [79].

Plutonium-244 with half-life of 80 million years is not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Plutonium-244 present

in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [80].

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 [13]. They arrive in the Crust of Earth due to convection currents in the mantle carrying heat and isotopes from the interior to the planet's surface [81].

Jupiter radiates more heat than it receives from the Sun [82]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 degrees C [83]) have been difficult to explain, due to lack of a known heat source [12]. **Saturn** radiates 2.5 times more energy than it receives from the Sun [84]; **Uranus** – 1.1 times [85]; **Neptune** – 2.6 times [86].

S. Kamata, *et al.* report that “*many icy Solar System bodies possess subsurface oceans. To maintain an ocean, Pluto needs to retain heat inside*”. Kamata, *et al.* show that “*the presence of a thin layer of gas hydrates at the base of the ice shell can explain both the long-term survival of the ocean and the maintenance of shell thickness contrasts. Gas hydrates act as a thermal insulator, preventing the ocean from completely freezing while keeping the ice shell cold and immobile. The most likely guest gas is methane*” [87].

According to **WUM**, the internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate through the entire objects' envelope, get absorbed into the cores, and continuously support DMF1 self-annihilation. Objects' cores are essentially Dark Matter Reactors fueled by DMF1 [13].

In WUM, Macroobjects' cores are essentially DM Reactors fueled by DMPs. Chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded Macroobjects in the Solar system is explained by the differences in their DM cores (mass, size, density, composition). The DM Reactors at their cores (including Earth) are very efficient and provide enough energy for the internal heating and all their geological processes like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc. [22].

Conclusion

Dark Matter is abundant:

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

Dark Matter is omnipresent:

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

WUM is based on two dimensionless parameters only: Rydberg constant α and time-varying quantity Q . In WUM we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units of time t_0 , size a , and energy E_0 . 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 [1].

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

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Hubble Tension

Abstract

The results of measurements of the Hubble's constant H_0 , which characterizes the expansion rate of the universe, shows that the values of H_0 vary significantly depending on Methodology. The disagreement in the values of H_0 obtained by the various teams far exceeds the standard uncertainties provided with the values. This discrepancy is called the Hubble Tension. In this paper, we discuss Macrostructures of the World (Superclusters and Galaxies); explain their Origin and Evolution in frames of the developed Hypersphere World-Universe Model (WUM), which is, in fact, the Paradigm Shift in Cosmology [1]; and provide the explanation of the Hubble Tension. The main difference between WUM and Big Bang Model (BBM) is: Instead of the Infinite Homogeneous and Isotropic Universe around the Initial Singularity in BBM, in WUM, the 3D Finite Boundless World (the Hypersphere) presents a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$), which emerged in various places of the World at different Cosmological times. In WUM, the Medium of the World is Homogeneous and Isotropic. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous.

1. Introduction

E. Conover in the paper "Debate over the universe's expansion rate may unravel physics. Is it a crisis?" outlined the following situation with the measurements of an expansion rate of the universe [2]:

- *Scientists with the Planck experiment have estimated that the universe is expanding at a rate of 67.4 km/s Mpc with an experimental error of 0.5 km/s Mpc;*
- *But supernova measurements have settled on a larger expansion rate of 74.0 km/s Mpc, with an error of 1.4 km/s Mpc. That leaves an inexplicable gap between the two estimates. Now "the community has started to take this [problem] extremely seriously," says cosmologist Daniel Scolnic of Duke University, who works on the supernova project led by Riess, called SH0ES;*
- *It is unlikely that an experimental error in the Planck measurement could explain the discrepancy. That prospect is "not a possible route out of our current crisis," said cosmologist Lloyd Knox of the University of California, Davis;*
- *So, worries have centered on the possibility that the supernova measurements contain unaccounted for systematic errors - biases that push the SH0ES estimate to larger value.*

L. Verde, T. Treu, and A. G. Riess gave a brief summary of the "Workshop at Kavli Institute for Theoretical Physics, July 2019" [3].

Table 1 summarizes the results of measurements of the Hubble's constant H_0 in 2019-2020 [4]. Observe that the values of H_0 vary significantly depending on Methodology. The disagreement in the values of H_0 obtained by the various teams far exceeds the standard uncertainties provided with the values. The average values of H_0 vary from 67.4 to 76.8 $km\ s^{-1}Mpc^{-1}$. This discrepancy is called the Hubble tension [5]. A. Mann gave a summary of the situation with the measurements of H_0 in "One Number Shows Something Is Fundamentally Wrong with Our Conception of the Universe" paper [6]. It is not clear whether the discrepancy in the observations is due to systematics, or indeed constitutes a major problem for the Standard model.

Table 1. Measurements of the Hubble constant H_0 . Adapted from [4].

Date Published	H_0 $km\ s^{-1}Mpc^{-1}$	Observer	Remarks/Methodology
2020-12-16	72.1 ± 2.0	Hubble Space Telescope and Gaia EDR3	Combining earlier work on red giant stars, using the tip of the red-giant branch (TRGB) distance indicator, with parallax measurements of Omega Centauri from Gaia EDR3.
2020-12-15	73.2 ± 1.3	Hubble Space Telescope and Gaia EDR3	Combination of HST photometry and Gaia EDR3 parallaxes for Milky Way Cepheids, reducing the uncertainty in calibration of Cepheid luminosities to 1.0%. Overall uncertainty in the value for H_0 is 1.8%, which is expected to be reduced to 1.3% with a larger sample of type Ia supernovae in galaxies that are known Cepheid hosts.
2020-12-04	73.5 ± 5.3	E. J. Baxter, B. D. Sherwin	Gravitational lensing in the CMB is used to estimate H_0 without referring to the sound horizon scale, providing an alternative method to analyze the Planck data.
2020-11-25	$71.8^{+3.9}_{-3.3}$	P. Denzel, <i>et al.</i>	Eight quadruply lensed galaxy systems are used to determine H_0 to a precision of 5%, in agreement with both "early" and "late" universe estimates. Independent of distance ladders and the cosmic microwave background.
2020-11-07	67.4 ± 1.0	T. Sedgwick, <i>et al.</i>	Derived from 88 $0.02 < z < 0.05$ Type Ia supernovae used as standard candle distance indicators. The H_0 estimate is corrected for the effects of peculiar velocities in the supernova environments, as estimated from the galaxy density field. The result assumes $\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$ and a sound horizon of 149.3 Mpc, a value taken from Anderson et al. (2014).
2020-09-29	$67.6^{+4.3}_{-4.2}$	S. Mukherjee, <i>et al.</i>	Gravitational waves, assuming that the transient ZTF19abnrh found by the Zwicky Transient Facility is the optical counterpart to GW190521. Independent of distance ladders and the cosmic microwave background.
2020-06-18	$75.8^{+5.2}_{-4.9}$	T. de Jaeger, <i>et al.</i>	Use Type II supernovae as standardisable candles to obtain an independent measurement of H_0
2020-02-26	$73.9^{+3.0}_{-3.0}$	Megamaser Cosmology Project	Geometric distance measurements to Megamaser-hosting galaxies. Independent of distance ladders and the cosmic microwave background.
2019-10-14	$74.2^{+2.7}_{-3.0}$	STRIDES	Modelling the mass distribution & time delay of the lensed quasar DES J0408-5354.
2019-09-12	$76.8^{+2.6}_{-2.6}$	SHARP HOLiCOW	Modelling three galactically lensed objects and their lenses using ground-based adaptive optics and the Hubble Space Telescope
2019-08-20	$70.3^{+1.36}_{-1.35}$	K. Dutta, <i>et al.</i>	This is obtained analyzing low-redshift cosmological data within Λ CDM model. The datasets used are Type-Ia Supernova, Baryon Acoustic Oscillations, Time-Delay measurements using Strong-Lensing, measurements using Cosmic Chronometers and growth measurements from large scale structure observations.
2019-08-15	$73.5^{+1.4}_{-1.4}$	M. J. Reid, D. W. Pesce, A. G. Riess	Measuring the distance to Messier 106 using its supermassive black hole, combined with measurements of eclipsing binaries in the Large Magellanic Cloud.
2019-07-16	$69.8^{+1.9}_{-1.9}$	Hubble Space Telescope	Distances to red giant stars are calculated using the tip of the red-giant branch (TRGB) distance indicator.
2019-07-10	$73.3^{+1.7}_{-1.7}$	HOLiCOW collaboration	Updated observations of multiply imaged quasars, now using six quasars, independent of the cosmic distance ladder and independent of the cosmic microwave background measurements.
2019-07-08	$70.3^{+5.3}_{-5.0}$	LIGO and Virgo detectors	Uses radio counterpart of GW170817, combined with earlier gravitational wave and electromagnetic data.
2019-03-28	$68.0^{+4.2}_{-4.1}$	Fermi-LAT	Gamma ray attenuation due to extragalactic light. Independent of the cosmic distance ladder and the cosmic microwave background.
2019-03-18	$74.03^{+1.42}_{-1.42}$	Hubble Space Telescope	Precision HST photometry of Cepheids in the Large Magellanic Cloud (LMC) reduce the uncertainty in the distance to the LMC from 2.5% to 1.3%. The revision increases the tension with CMB measurements to the 4.4σ level ($P=99.999\%$ for Gaussian errors), raising the discrepancy beyond a plausible level of chance. Continuation of a collaboration known as Supernovae, for the Equation of State of Dark Energy (SHoES).
2019-02-08	$67.78^{+0.91}_{-0.87}$	Joseph Ryan, <i>et al.</i>	Quasar angular size and baryon acoustic oscillations, assuming a flat LambdaCDM model. Alternative models result in different (generally lower) values for the Hubble constant.

W. L. Freedman in the paper “New analysis by UChicago astronomer finds agreement with standard model in ongoing Hubble tension” outlined the following situation with the measurements of an expansion rate of the universe [7]:

- Our universe is expanding, but our two main ways to measure how fast this expansion is happening have resulted in different answers. For the past decade, astrophysicists have been gradually dividing into two camps: one that believes that the difference is significant, and another that thinks it could be due to errors in measurement;
- One way to measure the Hubble constant is by looking at very faint light left over from the Big Bang, called the cosmic microwave background. Scientists can feed these observations into their ‘standard model’ of the early universe and run it forward in time to predict what the Hubble constant should be today; they get an answer of 67.4 kilometers per second per megaparsec;
- The other method is to look at stars and galaxies in the nearby universe and measure their distances and how fast they are moving away from us. Freedman has been a leading expert on this method for many decades; in 2001, her team made one of the landmark measurements using the Hubble Space Telescope to image stars called Cepheids. The value they found was 72;
- The value of the Hubble constant Freedman’s team gets from the red giants is 69.8 km/s/Mpc—virtually the same as the value derived from the cosmic microwave background experiment.

In the article “Measurements of the Hubble Constant: Tensions in Perspective”, W. L. Freedman provides an excellent review of the Hubble Constant measurements [8]:

- As apparent fissures in the standard model have been emerging, there are also indications that there may be cracks that need attention in the local distance scale as well. For example, the Tip of the Red Giant Branch (TRGB) method and the Cepheid distance scale result in differing values of $H_0 = 69.6 \pm 1.9 \text{ km/sec/Mpc}$ (Freedman et al. 2019, 2020) for the TRGB and 73.2 ± 1.3 (Riess et al. 2021) for the Cepheids;
- In contrast, (early-time) estimates of H_0 based on measurements of fluctuations in the temperature and polarization of the cosmic microwave background (CMB) from Planck and ACT+WMAP (Planck Collaboration et al. 2020; Aiola et al. 2020) consistently yield lower values of $H_0 = 67.4 \pm 0.5$ and $67.6 \pm 1.1 \text{ km s}^{-1}\text{Mpc}^{-1}$, respectively, both adopting the current standard Λ CDM model;
- High values of H_0 were initially obtained from time-delay measurements of strong gravitational lensing (Suyu et al. 2017; Wong et al. 2020), with $H_0 = 73^{+1.7}_{-1.8} \text{ km s}^{-1}\text{Mpc}^{-1}$, apparently consistent with the Cepheid measurements. However, recent detailed consideration of the assumptions in the modeling of the lens mass distribution (Birrer et al. 2020; Birrer & Treu 2020) leads to a much lower value of the Hubble constant, as well as a significantly larger value of the uncertainty $H_0 = 67.4^{+4.1}_{-3.2} \text{ km s}^{-1}\text{Mpc}^{-1}$, currently consistent with the CMB and TRGB measurements;
- This TRGB calibration was updated slightly in (Freedman et al, 2020), yielding a value of $H_0 = 69.6 \pm 0.8 \text{ (stat)} \pm 1.7 \text{ (sys)} \text{ km s}^{-1}\text{Mpc}^{-1}$. To date, the TRGB is the only method with comparable numbers of galaxies in its calibration relative to Cepheids; the H_0 calibration of Riess et al. (2016, 2019), is based on the Cepheid distances to 19 galaxies. Ten of the galaxies in the (Freedman et al, 2019) and (Freedman et al, 2020) TRGB sample also have independent Cepheid distances, an order of magnitude greater number than for Miras (Huang et al. 2020) or the maser technique (Pesce et al. 2020), in both cases for which only a single galaxy is available for comparison with Cepheids;

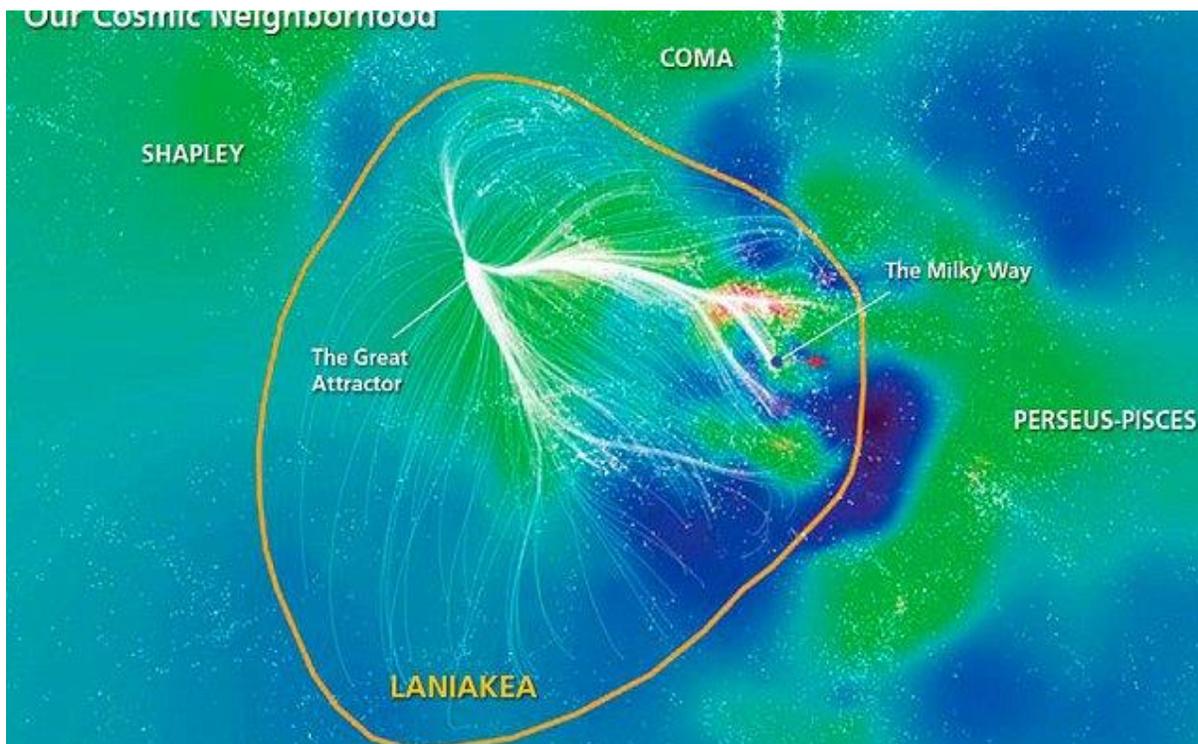
- The updated TRGB calibration applied to a distant sample of Type Ia supernovae from the Carnegie Supernova Project results in a value of the Hubble constant of $H_0 = 69.8 \pm 0.6 (stat) \pm 1.6 (sys) \text{ km s}^{-1} \text{ Mpc}^{-1}$. No statistically significant difference is found between the value of H_0 based on the TRGB and that determined from measurements of the cosmic microwave background.

2. Macrostructures of the World

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to Milky Way (MW) and approximately 100,000 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated binding mass $10^{17} M_{\odot}$ [9]. The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. Distance from the Earth to the Centre of LSC is 250 *Mly*, Redshift – 0.0708 (center).

The mass-to-light ratio of the Virgo Supercluster is about three hundred times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [10]. 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*” [11]. These ratios are one of the **main arguments in favor of presence of substantial amounts of Dark Matter in the World**.

Figure 1. Laniakea Supercluster. Adapted from [12].



We emphasize that about 100,000 nearby galaxies are moving around Centre of Laniakea Supercluster. They belong to LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structure (see **Figure 2** and **Figure 3**). It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$) [13].

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” [12].

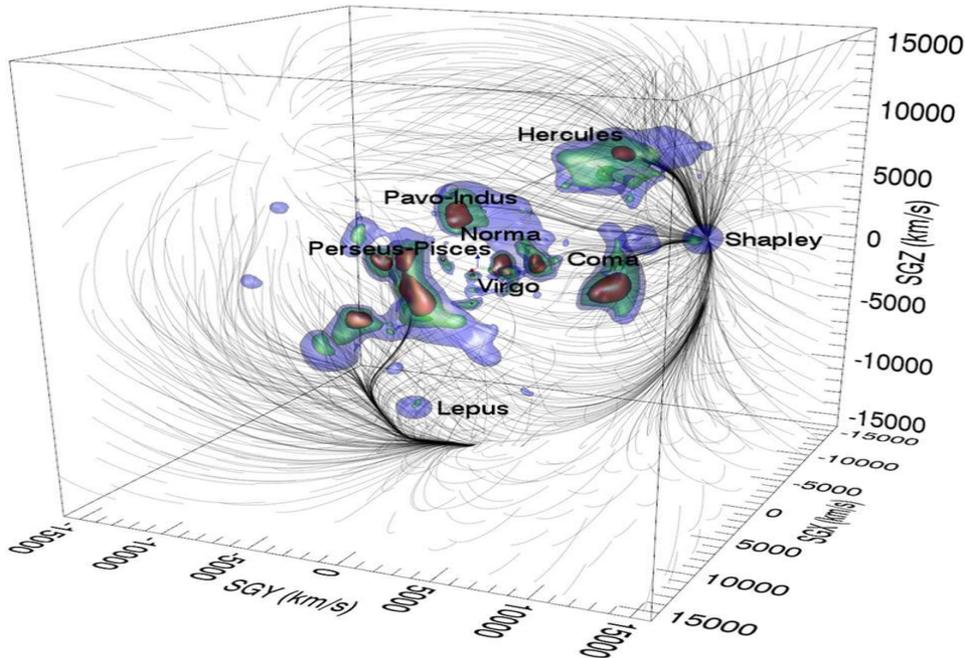


Fig. 2. Structure within a cube extending 16,000 km s⁻¹ (~200 Mpc) on the cardinal axes from our position at the origin. Densities on a grid within the volume are determined from a Wiener Filter reconstruction based on the observed velocity field. Three isodensity contours are shown. The density map is detailed near the center of the box where observational constraints are dense and accurate but tapers to the mean density as constraints weaken. Nevertheless, velocity flows illustrated by the black threads are defined on large scales. Ultimately all flows appear to drain toward Shapley although flows through the Perseus-Pisces filament take a circuitous route through the poorly studied Lepus region. Adapted from [12].

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**” [14].

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

of (cautious) challenges to the Cosmological Principle. The discovery of the Giant Arc adds to the number of structures on scales larger than those thought to be “smooth,” and therefore pushes the boundary size for the Cosmological Principle. The growing number of large-scale structures over the size limit of what is considered theoretically viable is becoming harder to ignore. According to cosmologists, the current theoretical limit is calculated to be 1.2 billion light years, which makes the Giant Arc almost three times larger. Can the standard model of cosmology account for these huge structures in the Universe as just rare flukes or is there more to it than that?” [15].

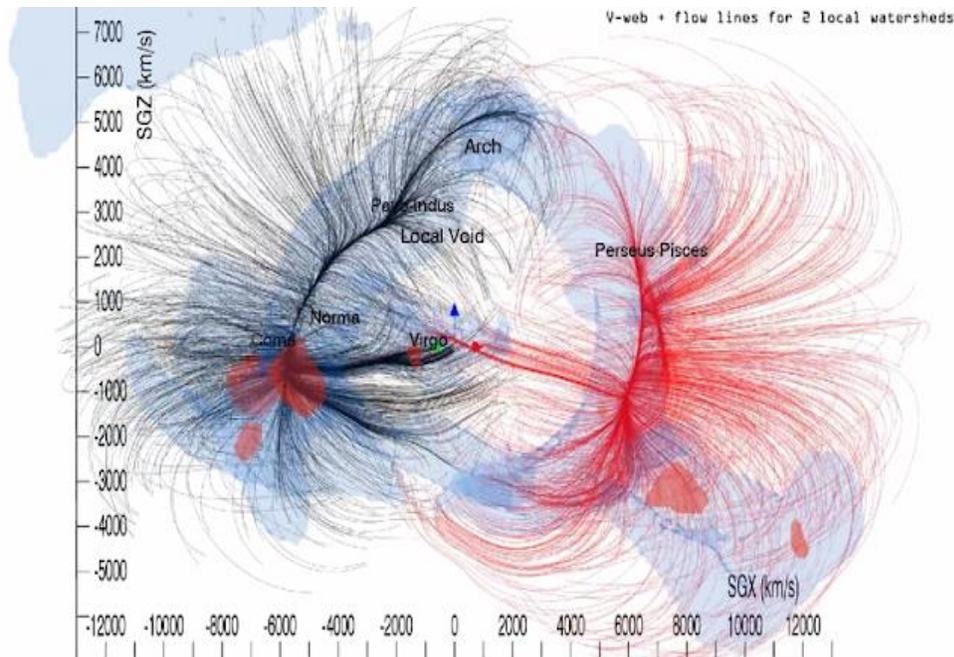


Fig. 3. A representation of structure and flows due to mass within $6,000 \text{ km s}^{-1}$ ($\sim 80 \text{ Mpc}$). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near the Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near the Perseus Cluster are in red. The Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [12].

WUM. These latest observations of the World can be explained in frames of the developed WUM only [16];

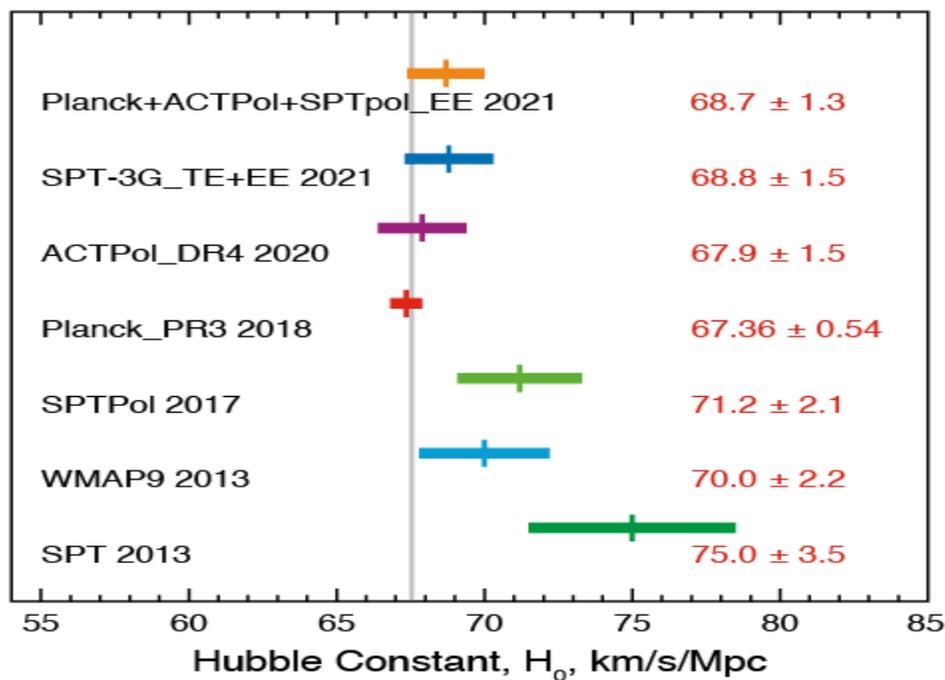
- “Galaxies **do not** congregate in clusters and along filaments.” On the contrary, Cosmic Web that is “networks of structure that are interconnected with no clear boundaries” is the result of the Explosive Volcanic Rotational Fission of Dark Matter (DM) Cores of neighboring Superclusters;
- “Generation of angular momentum across these scales” provide DM Cores of Superclusters through the Explosive Volcanic Rotational Fission;
- “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 neighboring DM Cores of Superclusters;

- 13.77 Gyr ago, when the Laniakea Supercluster emerged, the estimated number of DM Supercluster Cores in the World was around $\sim 10^3$ [13]. 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 at different Cosmological times;
- 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 (Figure 1, Figure 2, Figure 3). Big Bang never happened.

3. Hubble Tension Explanation

The experimental observations of galaxies in the universe show that most of them are disk galaxies [17]. It is well-known that when observing spiral galaxies, the side spinning toward us have a slight blueshift relative to the side spinning away from us. Therefore, there is a meaning of a redshift of a Center of galaxy only. The redshift of the Centre of LSC is 0.0708. But it does not mean that LSC is moving away from MW. On the contrary, MW is moving away from the Centre of LSC. In LSC, some galaxies are moving toward MW, and the other are moving away (see Figure 1). Then redshift depends on the position and movement of a particular galaxy in LSC against MW. More complicated situation with redshift is when galaxies belong to neighboring superclusters, which emerged at different cosmological times.

According to WUM, the value of the Hubble parameter H depends on the cosmological time: $H = \tau^{-1}$. It means that the value of H should be measured based on Cosmic Microwave Background (CMB) radiation only. Figure 4 illustrates recent H_0 determinations using only CMB data. Adapted from [18].



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The calculated value of Hubble's constant in 2013 [19]: $H_0 = 68.733 \text{ km/s Mpc}$ is in excellent agreement with the most recent measured value in 2021: $H_0 = 68.7 \pm 1.3 \text{ km/s Mpc}$ using only CMB data [18].

In frames of WUM, the Hubble Tension can be explained the following way:

- All measurements of Hubble's constant are model-dependent;
- Statistics of these measurements is not sufficient to yield reliable conclusions;
- Hubble's law in Standard Cosmology is valid for the Big Bang model only when all galaxies start their movement from a single point named "Initial Singularity" that is not the case in WUM;
- There are observations of Galaxies, which belong to different Superclusters;
- The value of H depends on the cosmological time $H = \tau^{-1}$ and is higher for the earlier Epoch of the World. It means that the value of H should be measured for each Galaxy separately depending on a distance to it and corresponding cosmological time. We must not calculate average values of H depending on Methodology as it is done in **Table 1**;
- The value of H should be measured based on Cosmic Microwave Background Radiation only.

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Paradigm Shift in Cosmology. Principal Role of Medium & Dark Matter & Angular Momentum

Abstract

The main objective of a paper is to discuss the most important Concepts for any Cosmological model: Space, Time, and Gravitation; Cosmological principle (homogeneous and isotropic universe); Universality of physical laws; Law of the conservation of angular momentum; Expansion of universe; Content of the World; Formation of galaxies and large-scale structures; Speed of light in vacuum; Origin of cosmic microwave background radiation. The performed analysis shows that Big Bang Model (BBM) fails to account for these Concepts and should be obsolete.

Hypersphere World-Universe Model (WUM) is, in fact, a Paradigm Shift in Cosmology [1]. WUM and BBM are principally different Models: 1) Instead of the Initial Singularity with the infinite energy density and the extremely rapid expansion of the space (Inflation) in BBM; in WUM, there was a Fluctuation (4D Nucleus of the World with an extrapolated radius equals to a basic unit of size a) in the Eternal Universe with a finite extrapolated energy density (four orders of magnitude less than the nuclear density) and a finite expansion of the Nucleus in Its fourth spatial dimension with speed c that is the gravitodynamic constant; 2) Instead of a practically Infinite Homogeneous and Isotropic Universe around the Initial Singularity in BBM; in WUM, the 3D Finite Boundless World (the Hypersphere of the 4D Nucleus) presents a Patchwork Quilt of different Luminous Superclusters ($\approx 10^3$), which emerged in different places of the World at different Cosmological times. The Medium of the World is Homogeneous and Isotropic. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous. The Absolute Age of the entire World (determined by the parameters of the Medium) is 14.22 Gyr. The Medium of the World, Dark Matter, and Angular Momentum are the main Three Pillars of WUM.

1. Introduction

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 one hundred years. Between 1907 and 1912, Albert Einstein wrote: *"Since the mathematicians have invaded the theory of relativity, I do not understand it myself anymore"*.

I absolutely agree with John von Neumann who said: *"The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct, which, with addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work."*

In frames of BBM, the Beginning of the Universe is connected with Initial Singularity (infinite energy density) and Cosmological Inflation, which is a theory of an extremely rapid exponential expansion of space (with practically infinite speed) in the early universe up to 93 billion light-years in diameter of the observable universe. The size of the whole universe is unknown, and it might be infinite in extent. The Initial Singularity is a gravitational singularity predicted by General Relativity to have existed before the Big Bang and thought to have contained all the energy and spacetime of the

Universe. From a physical point of view, existence of a mathematical singularity is a drawback of any theory. It means that the theoretical model did not consider some significant physical phenomenon, which prevents an occurrence of the singularity.

In our view, there is no way to prevent an occurrence of the initial singularity in BBM. The World must have gotten started in a principally separate way – a Fluctuation in the Eternal Universe with a finite size and energy density. The size of this Fluctuation can increase with a finite speed. Then, there is no need to introduce the cosmological inflation. However, a question about the mechanism of Continuous Creation of Matter in the World arises. This mechanism was the main challenge of WUM during its development for 20 years.

2. Big Bang Model

The framework for BBM relies on the **General Relativity** and on simplifying assumptions such as homogeneity and isotropy of space. The Lambda Cold Dark Matter (Λ CDM) model is a parametrization of BBM in which the universe contains three major components: a Cosmological constant Λ associated with dark energy; the postulated Cold Dark Matter (CDM); and Ordinary matter. The Λ CDM model is based on six parameters: baryon density, dark matter density, dark energy density, scalar spectral index, curvature fluctuation amplitude, and reionization optical depth. The values of these six parameters are mostly not predicted by current theory; other possible parameters are fixed at “natural” values e.g. total density equals to 1.00; neutrino masses are small enough to be negligible. The Λ CDM model can be extended by adding cosmological inflation. It is frequently referred to as the Standard Model of Big Bang cosmology. The Four Pillars of the Standard Cosmology are as follows [2], [3]:

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

The performed analysis, which we made in [4], shows that the Four Pillars of the Standard Cosmology are model-dependent and not strong enough to support BBM.

3. Analysis of Big Bang Model

In 1905, A. Einstein based a work on **Special Relativity** on two postulates:

- The laws of physics are invariant (i.e., identical) in all inertial systems (i.e., non-accelerating frames of reference);
- The speed of light in a vacuum is the same for all observers, regardless of the motion of the light source.

General Relativity is the geometric theory of gravitation published by A. Einstein in 1915 and is the current description of gravitation in modern physics. General Relativity generalizes Special Relativity and refines Newton's law of universal gravitation, providing a unified description of gravity as a geometric property of space and time or **four-dimensional spacetime**.

In 1983, P. S. Wesson suggested that a fifth dimension might be associated with rest mass m via $x^4 = Gm/c^2 \propto t$, where G is the gravitational constant and c is the speed of light in a vacuum [5]. *The chief effect of this new coordinate on four-dimensional physics was that particle rest mass, usually assumed to be constant, varied with time*. Moreover, J. M. Overduin and P. S. Wesson postulated that *"Metrics which do not depend on x^4 can give rise only to induced matter composed of (massless) photons; while those which depend on x^4 give back equations of state for fluids composed of massive particles"*[6]. **WUM** supplies the fluid that J. M. Overduin and P. S. Wesson have predicted [7]: it is, in fact, the Medium of the World (see Section 4).

As the conclusion:

- **BBM** relies on simplifying assumptions such as **homogeneity and isotropy of space** and **laws of physics are invariant** in all inertial systems;
- The **speed of light in a vacuum** is the same for all observers;
- **Massless photons**;
- The existence of **Cold Dark Matter** is a principal point of **BBM**.

4. Medium of the World

Physical Aether was suggested as early as the 17th century, by I. Newton. Following the work of T. Young (1804) and A. J. Fresnel (1816), it was believed that light propagates as a transverse wave within an elastic medium called Luminiferous Aether, which was abandoned in 1905. In later years there have been classical physicists who advocated the existence of Aether [8]:

- N. Tesla declared in 1937: *All attempts to explain the workings of the universe without recognizing the existence of the Aether and the **indispensable function it plays in the phenomena** are futile and destined to oblivion* [9];
- P. Dirac stated in 1951 in an article "Is there an Aether?" that *we are rather forced to have an Aether* [10].

WUM introduces the Medium of the World, which consists of stable elementary particles with lifetimes longer than the age of the World: protons, electrons, photons, neutrinos, and Dark Matter Particles (DMPs). The existence of the Medium is a principal point of **WUM**. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation; Far-Infrared Background Radiation. Inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. Cosmic Microwave Background Radiation is part of the Medium; it then follows that the **Medium is the absolute frame of reference**. Relative to the Cosmic Microwave Background rest frame, the Milky Way galaxy and the Sun are moving with the speed of 552 and 370 $km\ s^{-1}$, respectively [11].

The energy density of the Medium is 2/3 of the total energy density of the World. Superclusters, Galaxies, Extrasolar systems, planets, moons, *etc.* are made of the same particles. The energy density of Macroobjects adds up to 1/3 of the total energy density of the World throughout the World's evolution [11]. **Cosmological principal is valid for the Homogeneous and Isotropic Medium**. The distribution of Macroobjects is Inhomogeneous and Anisotropic, and therefore, the **Cosmological Principal is not viable for the entire World**.

Intergalactic plasma consisting of protons and electrons is an important part of the Medium. It explains:

- **Missing Baryon problem** related to the fact that the observed amount of baryonic matter did not match theoretical predictions;
- **Black-body spectrum of the Cosmic Microwave Background Radiation** is due to thermodynamic equilibrium of photons with Intergalactic Plasma;
- The predicted by WUM in 2013 value of the **Minimum energy of photons** which can pass through the Intergalactic plasma is in good agreement with the value obtained by L. Bonetti, *et al.* in 2017 [12].

WUM is the classical model, therefore classical notions can be introduced only when the very first ensemble of particles was created at the cosmological time τ_M equals to: $\tau_M = \alpha^{-2} \times t_0 \cong 10^{-18} s$, where α is the dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ (that was later named “Fine-structure constant”); t_0 is a basic unit of time: $t_0 = a/c = 5.9059662 \times 10^{-23} s$; a is a basic unit of size $a = 1.7705641 \times 10^{-14} m$; and c is a gravitodynamic constant. It is worth noting that the **speed of light in vacuum**, commonly denoted as c , is not related to the World in our Model, because there is no vacuum in it. Instead, there is the Medium of the World consisting of elementary particles. In WUM, the cosmological principal **Universality of physical laws** is valid at the cosmological times $\tau \geq \tau_M$ because they are determined by the Medium of the World.

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

WUM holds that there indeed exist relations between all Primary Cosmological Parameters that depend on dimensionless time-varying quantity Q that is a measure of the Size R and Age A_τ of the World [11]:

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

which in present epoch equals to: $Q = 0.759972 \times 10^{40}$ and is, in fact, the Dirac Large Number.

The Model develops a mathematical framework that allows for direct calculation of the following parameters through Q : Newtonian parameter of gravitation; Age of the World; Size of the World; Hubble’s parameter; Critical energy density; Concentration of Intergalactic Plasma; Minimum Energy of Photons; Temperature of the Microwave Background Radiation; Temperature of the Far-Infrared Background Radiation peak; Fermi coupling parameter; Electronic neutrino rest energy; Muonic neutrino rest energy; Tauonic neutrino rest energy. In frames of WUM, we calculate the values of these Primary Cosmological Parameters, which are in good agreement with the latest results of their measurements [11].

WUM is **based on two parameters only** α and Q : the World’s energy density is proportional to Q^{-1} in all cosmological times and particles relative energy densities are proportional to α .

In frames of WUM, **Time and Space** are closely connected with the Mediums' impedance (wave resistance) Z_g that equals to the Hubble's parameter H : $Z_g = H = \tau^{-1}$ and the gravitomagnetic parameter μ_g , which equals to: $\mu_g = R^{-1}$. It follows that neither Time nor Space could be discussed in absence of the Medium. The **gravitational parameter** G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. The Gravitation is a result of simple interactions of DMPs with Matter (by the introduced new **Weak Interaction**) that work cooperatively to create a more complex interaction. DMPs are responsible for Le Sage's mechanism of the gravitation. Gravity is not an interaction but a manifestation of the Medium. **Gravity, Space and Time** are all emergent phenomena. In this regard, it is worth recalling A. Einstein quote: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*" [11].

It turned out that the abandoning of the Luminiferous Aether in 1905 was crucial for the Classical Physics. It is a great pity that the mainstream physicists at that time did not know (or forgot) a theory developed by J. McCullagh in 1846. He proposed a **Theory of a rotationally elastic medium**, i.e. a medium in which every particle resists absolute rotation [13]. The potential energy of deformation in such a medium depends only on the rotation of the volume elements and not on their compression or general distortion. This theory produces equations analogous to Maxwell's equations. J. McCullagh has this to say about the Medium: "*The constitution of the aether, if it ever would be discovered, will be found to be quite different from anything that we are in the habit of conceiving, though at the same time very simple and very beautiful. An elastic medium composed of points acting on each other in the way supposed by Poisson and others will not answer.*" WUM is based on Maxwell's equations, and McCullagh's theory is a good fit for description of the Medium. **As the conclusion**, the Medium is the Savior of the Classical Physics!

5. Dark Matter

5.1. Early Ideas

The history of the Dark Matter (DM) can be traced back to at least the middle of the 19th century. G. Bertone and D. Hooper provide an excellent review of this history [14]. 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 in the 19th century also discussed dark matter 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.*

5.2. Recent Developments

Our article “Astrophysics: Macroobject Shell Model” focuses on more recent developments [15]:

- In 1977-1980, indirect effects in cosmic rays and gamma-ray background from the annihilation of Cold DM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [16]-[21];
- In the wake of the failures of hot DM, it was quickly becoming appreciated that cold DM could do a much better job of accounting for the observed patterns of large-scale structure. In 1984, G. Blumenthal, S. Faber, J. Primack, and M. Rees wrote: “*We have shown that a universe with ~ 10 times as much cold dark matter as baryonic matter provides a remarkably good fit to the observed universe. This model predicts roughly the observed mass range of galaxies, the dissipational nature of galaxy collapse, and the observed Faber-Jackson and Tully-Fisher relations. It also gives dissipationless galactic halos and clusters. In addition, it may also provide natural explanations for galaxy-environment correlations and for the differences in angular momenta between ellipticals and spiral galaxies*” [14];
- By the end of the 1980s, the conclusion that most of the mass in the Universe consists of cold and non-baryonic particles had become widely accepted, among many astrophysicists and particle physicists alike. Cold dark matter in the form of some unknown species of elementary particle had become the leading paradigm [14];
- Two-component DM systems consisting of bosonic and fermionic components are 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) [22];

5.3. Dark Matter in WUM

WUM proposes multicomponent DM system consisting of two couples of coannihilating DMPs: a heavy Dark Matter Fermion (DMF) – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV) that

is a dipole of Dirac's monopoles with charge $\mu = e/2\alpha$ (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 $e/3$; a self-annihilating fermion – DMF3 (3.7 keV), and a fermion DMF4 (0.2 eV).

WUM postulates that rest energies of DMFs and bosons are proportional to a basic unit of energy $E_0 = hc/a$ multiplied by different exponents of α and can be expressed with the following formulae [23]:

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

where h is Planck constant; α is the dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ (that was later named “Fine-structure constant”); a is a basic unit of size $a = 1.7705641 \times 10^{-14} \text{ m}$; and c is the **gravitodynamic constant** that is the ratio of the absolute gravitomagnetic unit of charge E_0 to the absolute gravitostatic unit of charge E_0/c . It is worth noting that the **speed of light in vacuum**, commonly denoted as c , is not related to the World in our Model, because there is no vacuum in it. Instead, there is the Medium of the World consisting of elementary particles. Also note that the rest energy of electron E_e equals to: $E_e = \alpha E_0$ and the Rydberg unit of energy is: $Ry = hcR_\infty = 0.5 \alpha^3 E_0 = 13.605693 \text{ eV}$.

We still do not have a direct confirmation of DMPs' rest energies, but we do have a number of indirect observations. The signatures of DMPs self-annihilation with expected rest energies of 1.3 TeV; 9.6 GeV; 70 MeV; 340 keV; 3.7 keV are found in spectra of the diffuse gamma-ray background and the emissions of various Macroobjects in the World. We connect observed gamma-ray spectra with the structure of Macroobjects (nuclei and shells composition). Self-annihilation of those DMPs can give rise to any combination of gamma-ray lines. Thus, the diversity of Very High Energy gamma-ray sources in the World has a clear explanation in WUM.

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.

5.4. 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. Introduced principally new Weak Interaction of DMPs with Matter provides integrity of all shells. **Table 1** describes the parameters of Macroobjects' Cores, which are 3D fluid balls with a high viscosity and act as solid-state objects [23].

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 [9]:

- Nuclei made up of DMF1 and/or DMF2 compose Cores of stars in Extrasolar Systems;
- Shells of DMF3 and/or Electron-Positron plasma around Nuclei made up of DMF1 and/or DMF2 make up Cores of Galaxies;
- Nuclei made up of DMF1 and/or DMF2 surrounded by shells of DMF3 and DMF4 compose Cores of Superclusters.

In our view, Macroobjects of the World possess the following properties:

- Nuclei are made up of DMPs. Surrounding shells contain DM and Baryonic matter;
- Nuclei and shells are growing in time proportionally to square root of cosmological time $\propto \tau^{1/2}$ until one of them reaches the critical point of its local stability, at which it detonates. The energy released during detonation is produced by the self-annihilation of DMPs. The detonation process does not destroy the Macroobject; instead, Hyper-flares occur in active areas of the shells, analogous to Solar flares;
- All other DMPs in different shells can start self-annihilation process as the result of the first detonation;
- Different emission lines in spectra of bursts are connected to the Macroobjects' structure which depends on the composition of Nuclei and surrounding shells made up of DMPs. Consequently, the diversity of Very High Energy Bursts has a clear explanation;
- Afterglow is a result of processes developing in Nuclei and shells after detonation.

5.5. Macrostructures

Laniakea Supercluster (LSC) is a galaxy supercluster that is home to Milky Way (MW) and approximately 100,000 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated binding mass $10^{17} M_{\odot}$ [25]. The neighboring superclusters to LSC are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. Distance from the Earth to the Centre of LSC is 250 Mly. The mass-to-light ratio of the Virgo Supercluster is about three hundred times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [26]. 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*" [27]. These ratios are one of the **main arguments in favor of presence of significant amounts of Dark Matter in the World.**

We emphasize that about 100,000 nearby galaxies are moving around Centre of Laniakea Supercluster. They belong to LSC. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structure (see **Figure 2**). It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\geq 10^3$) [24].

Figure 1. Laniakea Supercluster. Adapted from [28].

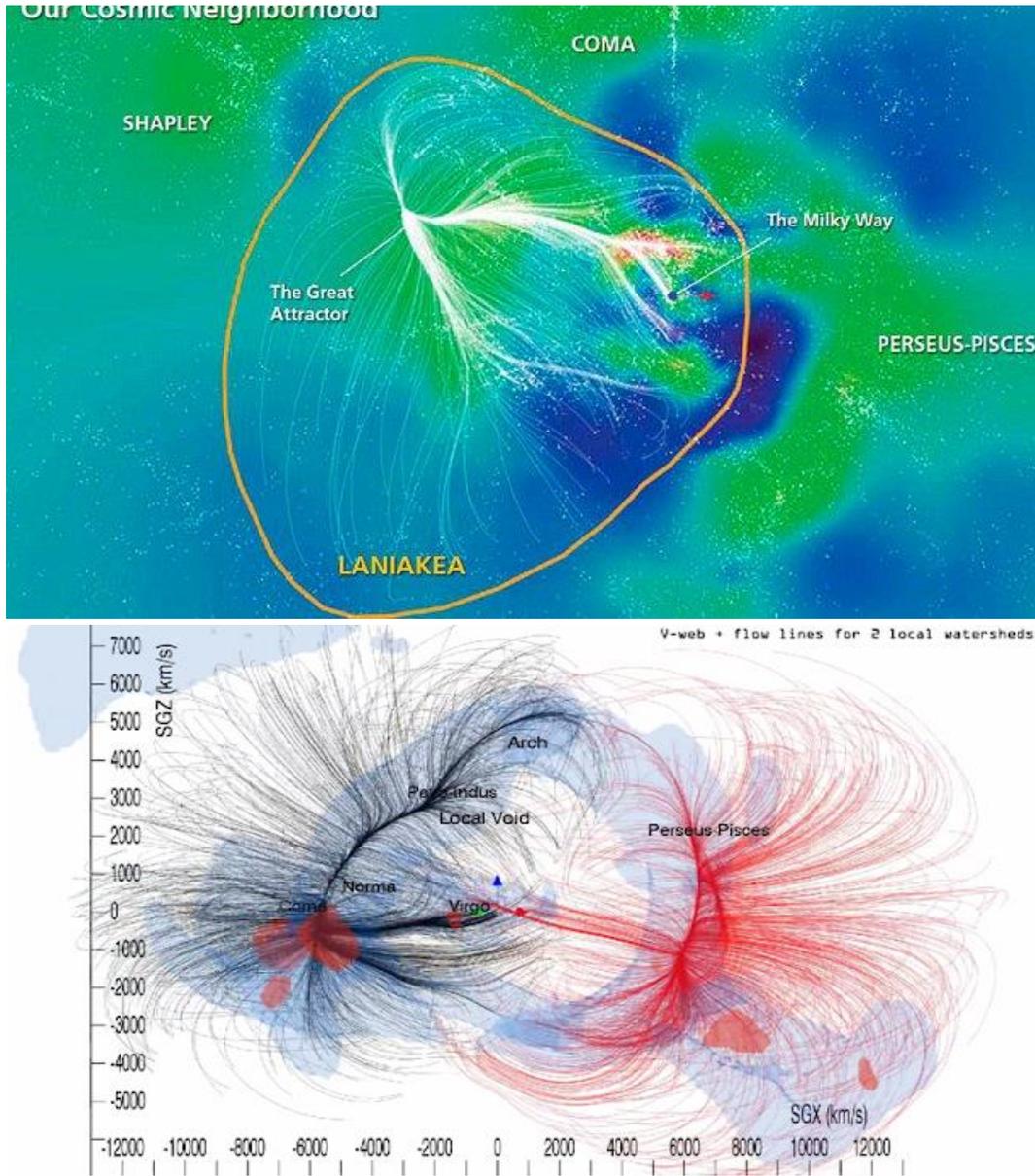


Fig. 2. A representation of structure and flows due to mass within $6,000 \text{ km s}^{-1}$ ($\sim 80 \text{ Mpc}$). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near the Norma Cluster are in black and adjacent flow threads that terminate at the relative attractor near the Perseus Cluster are in red. The Arch and extended Antlia Wall structures bridge between the two attraction basins. Adapted from [28].

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” [28].

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**” [29].

In June 2021, at the “Giant Arc at the 238th virtual meeting of the American Astronomical Society”, A. Lopez reported about the discovery of “a giant, almost symmetrical arc of galaxies – the Giant Arc – spanning 3.3 billion light years at a distance of more than 9.2 billion light years away that is **difficult to explain in current models of the Universe**. The Giant Arc, which is approximately 1/15th the radius of the observable universe, is twice the size of the striking Sloan Great Wall of galaxies and clusters that is seen in the nearby Universe. This new discovery of the Giant Arc adds to an **accumulating set of (cautious) challenges to the Cosmological Principle**. The discovery of the Giant Arc adds to the number of structures on scales larger than those thought to be “smooth,” and therefore pushes the boundary size for the Cosmological Principle. The growing number of large-scale structures over the size limit of what is considered theoretically viable is becoming harder to ignore. According to cosmologists, the current theoretical limit is calculated to be 1.2 billion light years, which makes the Giant Arc almost three times larger. **Can the standard model of cosmology account for these huge structures in the Universe as just rare flukes or is there more to it than that?**” [30].

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” [31].

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 [25] and B. Carr, F. Kühnel and L. Visinelli [31]. 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 $\sim 10^3$ [24]. 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 at different Cosmological times;
- 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 **Fig. 1** and **Fig. 2**). Big Bang never happened.

5.6. Dark Matter Fermi Bubbles

In 2010, the discovery of two Fermi Bubbles (FBs) emitting gamma- and X-rays was announced. FBs extend for about 25 kly above and below the center of the galaxy [32]. The outlines of the bubbles are quite sharp, and the Bubbles glow in nearly uniform gamma rays over their colossal surfaces. Gamma-ray spectrum remains unconstrained up to around 1 TeV [33]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

In **WUM**, FBs are DMPs' clouds containing uniformly distributed Dark Matter Objects (DMOs), in which DMPs self-annihilate and radiate X-rays and gamma rays. FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2. Weak interaction between DMF3 particles provides integrity of FBs. Gamma rays up to 1 TeV are the result of the self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) in DMOs, which are macroobjects whose density is sufficient for the self-annihilation of DMPs to occur. On the other hand, DMOs are much smaller than stars in the World, and have a high concentration in FBs to provide nearly uniform gamma ray glow over their colossal surfaces. The Core of MW supplies FBs with new DMPs through the galactic wind, explaining the brightness of FBs remaining constant during the time of observations. In our opinion, FBs are built continuously throughout the lifetime of MW (13.77 Byr) [11].

5.7. Dark Matter Reactors

Sun's DM Core. According to the standard Solar model, the Sun has:

- Core that extends from the center to 20–25% of the solar radius. It produces all of Sun's energy;
- Radiative zone from the Core to about 70% of the solar radius, in which convection does not occur and energy transfer occurs by means of radiation;
- E. Fossat, *et al.* found that Solar Core rotates 3.8 ± 0.1 faster than the surrounding envelope [34];
- Core and Radiative zone contain practically all Sun's mass [35].

The large power output of the Sun is mainly due to the huge size and density of its Core, with only a fairly small amount of power being generated per cubic meter. Theoretical models of the Sun's

interior indicate a maximum power density of approximately 276.5 W/m^3 at the center of the Core [36], which is about the same power density inside a compost pile [37] and closer approximates reptile metabolism than a thermonuclear bomb. In our view, Core and Radiative zone are the parts of the Sun's DM Core.

Evolution of the Sun. By 1950s, stellar astrophysicists had worked out the physical principles governing the structure and evolution of stars [38]. According to these principles, the Sun's luminosity had to change over time, with the young Sun being about 30% less luminous than today [39], [40], [41]. The long-term evolution of bolometric solar luminosity $L(\tau)$ as a function of cosmological time τ can be approximated by a linear law: $L(\tau) \propto \tau$ [38].

One of the consequences of **WUM** holds that all stars were fainter in the past. As their cores absorb new DMPs, size of MO cores R_{MO} and their luminosity L_{MO} are increasing in time: $R_{MO} \propto \tau^{1/2}$ and $L_{MO}(\tau) \propto R_{MO}^2 \propto \tau$, respectively. Taking the age of the World: $A_W \cong 14.22 \text{ Byr}$ and the age of SS: $A_{SS} \cong 4.57 \text{ Byr}$, it is easy to find that the young Suns' output was 67% of what it is today. Literature commonly refers to the value of 70% [38].

Earth's Internal Heating. The analysis of Sun's heat for planets in Solar System (SS) yields the effective temperature of Earth of 255 K [42]. The actual mean surface temperature of Earth is 288 K [43]. The higher actual temperature of Earth is due to energy generated internally by the planet itself. According to the standard model, the Earth's internal heat is produced mostly through radioactive decay. The major heat-producing isotopes within Earth are K-40, U-238, and Th-232. The mean global heat loss from Earth is 44.2 TW [44]. The Earth's Uranium has been thought to be produced in one or more supernovae over 6 Gyr ago [45].

Radiogenic decay can be estimated from the flux of geoneutrinos that are emitted during radioactive decay. The KamLAND Collaboration found that decay of K-40, U-238 and Th-232 together contribute about 24 TW to the total heat flux from the Earth to space. Based on the observations they made a conclusion that *heat from radioactive decay contributes about half of Earth's total heat flux* [46].

Plutonium-244 with half-life of 80 million years is not produced by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Plutonium-244 present in the Earth's crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [47].

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 [11]. They arrive in the Crust of Earth due to convection currents in the mantle carrying heat and isotopes from the interior to the planet's surface [48].

Planet's Internal Heating. Jupiter radiates more heat than it receives from the Sun [49]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 degrees C [50]) have been difficult to explain. Saturn radiates 2.5 times more energy than it receives from the Sun [51]; Uranus – 1.1 times [52]; Neptune – 2.6 times [53].

S. Kamata, *et al.* report that "*many icy Solar System bodies possess subsurface oceans. To maintain an ocean, Pluto needs to retain heat inside.*" Kamata, *et al.* show that "*the presence of a thin layer of gas hydrates at the base of the ice shell can explain both the long-term survival of the ocean and the*

maintenance of shell thickness contrasts. Gas hydrates act as a thermal insulator, preventing the ocean from completely freezing while keeping the ice shell cold and immobile. The most likely guest gas is methane' [54].

According to **WUM**, the internal heating of all gravitationally-rounded objects of the Solar system is due to DMPs self-annihilation in their cores made up of DMF1 (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the objects. New DMF1 freely penetrate through the entire objects' envelope, get absorbed into the cores, and continuously support DMF1 self-annihilation [11].

In WUM, Macroobjects' cores are essentially DM Reactors fueled by DMPs. Chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded Macroobjects in the Solar system is explained by the differences in their DM cores (mass, size, density, composition). The DM Reactors at their cores (including Earth) are very efficient and provide enough energy for the internal heating and all their geological processes like volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements [24].

6. Angular Momentum

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

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – Rotational Fission of overspinning (surface speed at equator exceeding escape velocity) Prime Objects. From the point of view of Fission model, the prime object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the rotational momentum of the prime object should exceed the orbital momentum of its satellite. In frames of WUM, prime objects are DM Cores of Superclusters, which must accumulate tremendous 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” [55].

To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Overspinning DM Superclusters' Cores and self-annihilation of DMPs;
- Proposed Weak Interaction between DMPs provides the integrity of DM Cores, which are 3D fluid balls with a high viscosity and function as solid-state objects;
- The main 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 Explosive Volcanic Rotational Fission. The experimental observations of

galaxies in the universe showed that most of them are disk galaxies: about 60% are ellipticals and about 20% are spirals [56]. These results speak in favor of the developed Rotational Fission mechanism;

- Size, mass, density, composition, orbital angular momentum, and rotational angular momentum of satellite cores depend on local density fluctuations at the edge of the overspinning prime DM cores and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation;
- DM Core of MW was born 13.77 billion years ago as the result of the Rotational Fission of the Virgo Supercluster DM Core;
- DM Cores of Extrasolar systems (including planets and moons) are the result of the repeating Rotational Fissions of MW DM Core in various times (4.57 billion years ago for the Solar System);
- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons.
- Gravitational waves can be a product of Rotational Fission of overspinning DM Macroobject Cores.

7. Hypersphere World-Universe Model

7.1. Assumptions

WUM is based on three primary assumptions:

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

7.2. Principal Points

WUM is based on the following Principal Points:

The Beginning. The World was started by a Fluctuation in the Eternal Universe, and the Nucleus of the World, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic unit of size a . The extrapolated energy density of the World at the Beginning was four orders of magnitude smaller than the nuclear energy density. The World is a finite 3D Hypersphere that is the surface of the 4D Nucleus. All points of the Hypersphere are equivalent; there are no preferred centers or boundaries of the World. The **Initial Centre of the World** coincides with the center of the 4D Nucleus and located in the fourth spatial dimension of the Nucleus. **The 3D World is curved in the fourth spatial dimension!**

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

is the gravitodynamic constant. The expansion of the Hypersphere World can be understood through the analogy with an expanding 3D balloon: imagine an ant residing on a seemingly two-dimensional surface of a balloon. As the balloon is blown up, its radius increases, and its surface grows. The distance between any two points on the surface increases. The ant sees her world expands but does not observe a preferred center.

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

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 [1].

Creation of Matter. The surface of the Nucleus is created in a process analogous to sublimation. Continuous creation of matter is the result of this process. Sublimation is a well-known endothermic process that happens when surfaces are intrinsically more energetically favorable than the bulk of a material, and hence there is a driving force for surfaces to be created. DM is created by the Universe in the 4D Nucleus of the World. DMPs carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a Matter-Antimatter Asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation). By analogy with 3D ball, which has 2D spherical surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus. The grows of the surface of the 4D Nucleus means the increase of the World's "Surface Energy" [57].

The proposed 4D process is responsible for the Expansion, Creation of Matter, and Arrow of Time. It constitutes the main **Hypothesis of WUM**. In our view, the arrow of the Cosmological Time does not depend on any physical phenomenon in the Medium of the World. It is the result of the Worlds' expansion due to the driving force for surfaces to be created. It is important to emphasize that [57]:

- Creation of Matter is a direct consequence of expansion;
- Creation of DM occurs homogeneously in all points of the 3D Finite Boundless Hypersphere World.

Content of the World. The World consists of the Medium and Macroobjects. Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium is $2/3$ of the total energy density and Macroobjects (Superclusters, Galaxies, Extrasolar systems, Planets, Moons, *etc.*) – $1/3$ in all cosmological times. The relative energy density of DMF4 particles is about 68.8%, self-annihilating DMPs (DMF1, DMF2, DMF3, DIRACs, and ELOPs) – about 24%, and Ordinary particles (protons, electrons, photons, and neutrinos) – about 4.8% in the Medium of the World and 2.4% in Macroobjects.

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

proportional to Q^{-1} in all cosmological times. Particles relative energy densities are proportional to α .

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

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

WUM introduces **Dark Epoch** (spanning from the Beginning of the World for 0.45 billion years) and **Luminous Epoch** (ever since, 13.77 billion years). Transition from Dark Epoch to Luminous Epoch is due to the **Explosive Volcanic Rotational Fission** of Overspinning DM Supercluster's Cores and self-annihilation of DMPs.

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

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

Nucleosynthesis of all elements occurs inside of Macroobjects during their evolution.

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

Dark Matter Reactors. Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation in their DM cores.

8. Conclusion

WUM solves a number of physical problems in contemporary Cosmology and Astrophysics through DMPs and their interactions: **Angular Momentum problem** in birth and subsequent evolution of Galaxies and Extrasolar systems; **Missing Baryon problem** related to the fact that the observed amount of baryonic matter did not match theoretical predictions; **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center; **Coronal Heating problem** – temperature of Sun's corona exceeding that of photosphere by millions of degrees; **Cores of Sun and Earth** rotating faster than their surfaces; **Diversity of Gravitationally-Rounded Objects** in Solar System and their **Internal Heating**; **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. WUM reveals **Inter-Connectivity of Primary Cosmological Parameters** and calculates their values, which are in good agreement with the latest results of their measurements.

In 2013, WUM predicted the values of the following Cosmological parameters: Gravitational, Hubble's, Intergalactic plasma concentration, and Photons minimum energy, which were experimentally confirmed in 2015-2021. "*The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy*" (Nobel Prize in Physics 2020) made by Prof. R. Genzel and A. Ghez is a confirmation of one of the most important predictions of WUM in 2013: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [58].

In WUM, **Ball Lightnings** (BLs) are the 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. The introduced **Super-weak interaction** between DM cores and all particles around them provide integrity of BLs. The core of BL irradiates quanta with different energies and attracts new DMPs from Geocorona due to super-weak interaction. It explains the observed result that the brightness of BLs remains fairly constant during their lifetime. It is important to emphasize that the initial energy required for BL creation is insufficient for its sustenance of up to 1200 seconds. Additional energy, therefore, must be consumed by BL once it had been formed. Once we master the creation of BLs in a controlled environment, we can concentrate our efforts on harvesting that energy [59].

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 – Hypersphere World-Universe Model. Astronomers should plan new purposeful experiments based on the results of these analyses.

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

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