Development of Hypersphere World-Universe Model. Narrative. Part VII. WUM – Continuation of Classical Physics

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Abstract

According to Wikipedia, *Classical physics refers to pre-1900 physics, while modern physics refers to post-1900 physics which incorporates elements of quantum mechanics and relativity* . In our opinion, Classical Physics is branch of Physics that should be described by classical notions, which define emergent phenomena. Emergent phenomenon is property that is a result of simple interactions that work cooperatively to create more complex interaction. Physically, simple interactions occur at microscopic level, and collective result can be observed at macroscopic level. WUM introduces classical notions, when the very first ensemble of particles was created and become possible to introduce notion "*Medium of the World*". We emphasize that Classical Physics is principally different from Quantum Physics that describes quantum objects, which have only four-momenta. Classical Physics is dealing with ensembles of quantum objects!

Existence of the Medium is a principal point of WUM. It follows from observations of Intergalactic Plasma, Microwave Background and Far-Infrared Background Radiations. Abandoning of Luminiferous Aether by Special Relativity in 1905 was crucial for Classical Physics. It is a great pity that mainstream physicists at that time did not know (or forgot) theory of Luminiferous Aether developed by J. McCullagh in 1846. The Medium of the World is the Savior of Classical Physics! *Don't throw the baby out with the bathwater*. WUM is a natural continuation of Classical Physics. The main objective of the Model is to unify and simplify existing results in Classical Physics into single coherent picture of a New Cosmology.

Analysis of Hubble Tension

Abstract

The results of measurements of Hubble 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 various teams far exceeds standard uncertainties provided with the values. This discrepancy is called Hubble Tension. In this paper, we discuss Macrostructures of the World and provide an explanation of Hubble Tension in frames of the developed Hypersphere World-Universe Model (WUM).

1. Introduction

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 [1]: *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.*** In the article "Measurements of the Hubble Constant: Tensions in Perspective," she provides an excellent review of the Hubble Constant measurements [2]:

- 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 $H_0 = 69.6 \pm 1.9\ km/sec/Mpc$ for the TRGB and 73.2 ± 1.3 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) consistently yield lower values of $H_0 = 67.4 \pm 0.5$ and $67.6 \pm 1.1\ km\ s^{-1}Mpc^{-1}$, respectively, both adopting the current standard ΛCDM model;
- High values of H_0 were initially obtained from time-delay measurements of strong gravitational lensing with $H_0 = 73^{+1.7}_{-1.8}\ km\ s^{-1}Mpc^{-1}$, apparently consistent with the Cepheid measurements. However, recent detailed consideration of the assumptions in the modeling of the lens mass distribution leads to a much lower value of the Hubble constant, as well as a significantly larger value of the uncertainty $H_0 = 67.4^{+4.1}_{-3.2}\ km\ s^{-1}Mpc^{-1}$, currently consistent with the CMB and TRGB measurements;
- This TRGB calibration was updated and yield value of $H_0 = 69.6 \pm 0.8\ (stat) \pm 1.7\ (sys)\ km\ s^{-1}Mpc^{-1}$. To date, the TRGB is the only method with comparable numbers of galaxies in its calibration relative to Cepheids;
- The updated TRGB calibration applied to a distant sample of Type Ia supernovae from the Carnegie Supernova Project results in the value of Hubble constant of $H_0 = 69.8 \pm 0.6\ (stat) \pm 1.6\ (sys)\ km\ s^{-1}Mpc^{-1}$. No statistically significant difference is found between the value of H_0 based on 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 $10^{17}\ M_\odot$. The neighboring superclusters to LSC are Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster. Distance from the Earth to the Centre of LSC is $250\ Mly$.

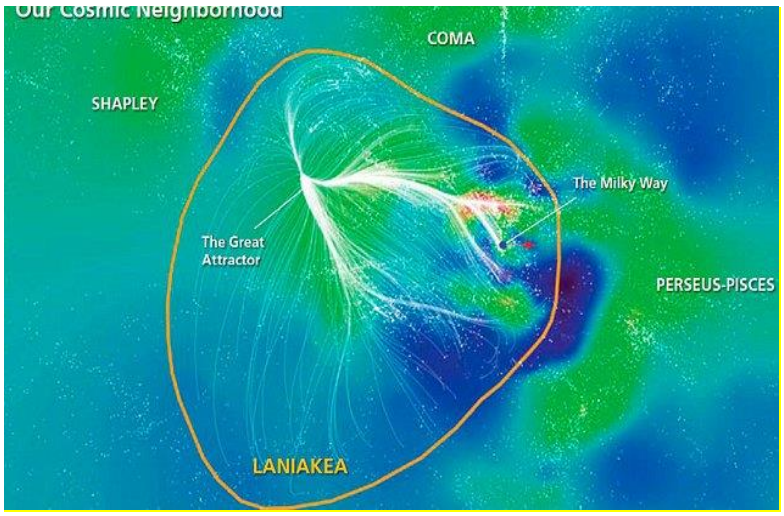


Figure 1. Laniakea Supercluster. Adapted from [3].

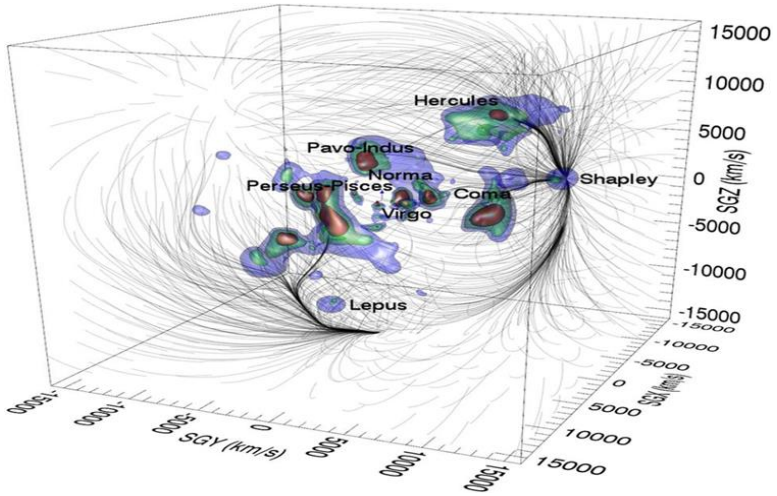


Fig. 2. Structure within a cube extending 16,000 km s−1 (~200 Mpc). Adapted from [3].

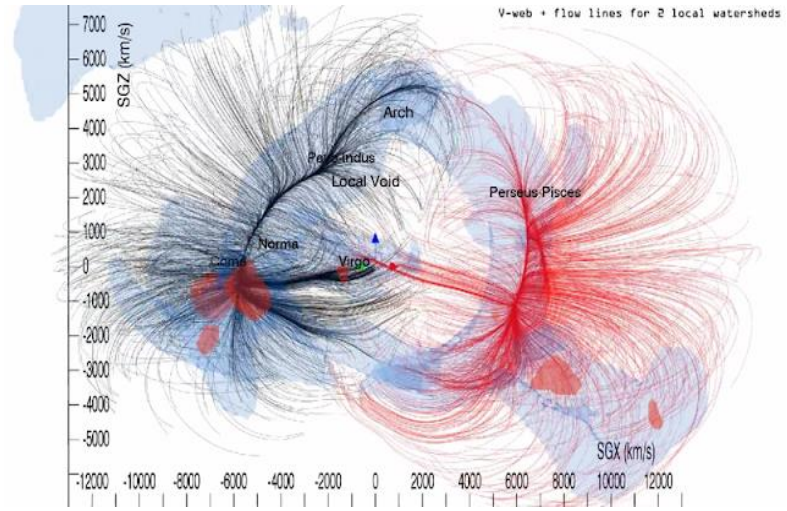


Fig. 3. A representation of structure and flows due to mass within 6,000 km s-1 (80 Mpc). Adapted from [3].

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 ($\gtrsim 10^3$) [4].

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"* [3].

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. 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***" [5].

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****. This new discovery of the Giant Arc adds to an* ***accumulating set of (cautious) challenges to 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.* ***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?"*** [6].

WUM. These latest observations of the World can be explained in frames of the developed WUM only [7];

- "*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 $\sim 10^3$ [4]. 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**).

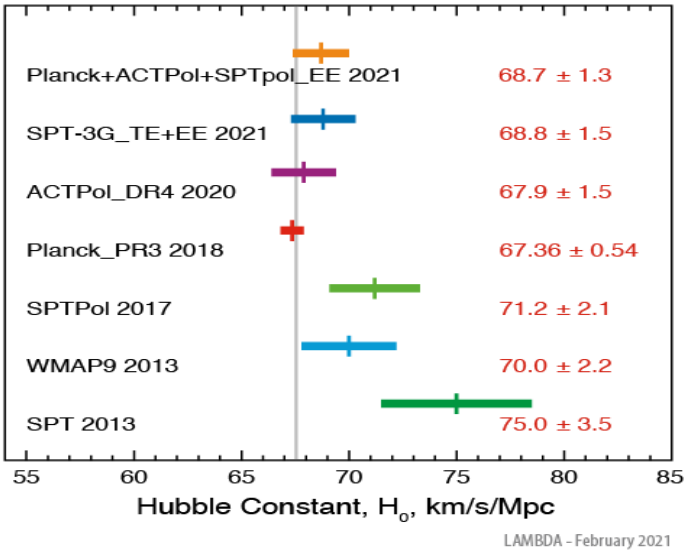
3. Hubble Tension Explanation

The experimental observations of galaxies in the universe show that most of them are disk galaxies [8]. 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 a 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 [9].



The calculated value of Hubble constant in 2013 [10]: $H_0 = 68.733\ km/s\ Mpc$ is in excellent agreement with the most recent measured value in 2021: $H_0 = 68.7 \pm 1.3\ km/s\ Mpc$ using only CMB data [9].

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

- All measurements of Hubble 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 (BBM) 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;
- The value of H should be measured based on Cosmic Microwave Background Radiation only.

This explanation is in good agreement with the experimental results provided by W. L. Freedman who belongs to the camp that believes that the difference could be due to errors in measurement. I belong to the camp that believes that the difference is significant!

The main differences between BBM and WUM are:

- Mainstream scientists, following BBM, measure the values of the Hubble constant based on various characteristics of Macroobjects, the distribution of which in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous;
- WUM suggests that the value of the Hubble constant should be measured based on Cosmic Microwave Background Radiation only, which depends on the characteristics of the Medium of the World. The Medium is Homogeneous and Isotropic. Its parameters do not practically depend on Macroobjects, which can create some fluctuations in the Medium.

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Unidentified Infrared Discrete Emission Bands

Abstract

Unidentified Infrared emission bands (UIBs) are infrared discrete emissions from circumstellar regions, interstellar media (ISM), star-forming regions, and extragalactic objects for which the identity of the emitting materials is unknown. The main infrared features occur around peaks at 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm with the photon's rest energy at the peaks 0.376, 0.200, 0.161, 0.144, 0.111, and 0.098 eV, respectively. The UIB emission phenomenon has been studied for about 45 years. The prevailing hypothesis is that the materials responsible for UIB are polycyclic aromatic hydrocarbon (PAH) molecules. PAHs are thought to be one of the main forms in which carbon exists in space. And yet, not a single member of this group of compounds had been identified in space definitively until now [1]. In frames of Hypersphere World-Universe Model (WUM), we introduced Dark Matter (DM) particles, named DIONs, with the rest energy 0.199 eV and an energy density of 68.8% of the total energy density of the World. DIONs compose Outer shells of DM Supercluster's Cores – the main objects of the World [2]. In this paper, we give an explanation of UIB emission based on the self-annihilation of DM particles DIONs and biDIONs (DIONs pairs) with a rest energy about 0.38 eV that depends on the binding energy. To the best of our knowledge, WUM is the only cosmological model in existence that is consistent with UIB emission phenomenon.

1. Introduction

In the present manuscript, which consider the phenomenon "Unidentified Infrared Discrete Emission Bands", we:

- Review articles published in this area for forty five years by hundreds of scientists who proposed the *prevailing hypothesis that the materials responsible for UIB are polycyclic aromatic hydrocarbon (PAH) molecules. And yet,* ***not a single member of this group of compounds had been identified in space definitively until now*** [1];
- Give a principally different **explanation** of UIB emission based on the self-annihilation of DM particles DIONs and biDIONs that is consistent with the law of the energy conservation;
- Do not pretend on the development of a theory of this phenomenon in frames of WUM.

The history of the Unidentified Infrared Emission Bands (UIBs) can be traced back to at least 1977. In 2016, S. Kwok provided an excellent review of this phenomenon [3]:

A family of unidentified infrared emission (UIE) features at 3.3, 6.2, 7.7, 8.6, and 11.3μm was discovered almost 40 years ago [4]. The 3.3μm feature was first identified as the C–H stretching mode of aromatic compounds by R. F. Knacke in1977 [5]. In 1981, the organic affiliation was extensively discussed by W. W. Duley and D. A. Williams who assigned the 3.3 and 11.3μm features to graphitic (aromatic) materials. Specifically, the 3.3μm feature is identified as due to aromatic C–H stretch, the 6.2 μm feature as aromatic C–C stretch, the 8.6μm feature as the C–H in-plane bending mode, and the 11.3, 12.4 and 13.3μm features as due to solo, duo and trio C–H out-of-plane bending modes, respectively [6].

In 1980s, astronomers went on to hypothesize that the materials responsible for Unidentified Infrared emission (UIR) should be polycyclic aromatic hydrocarbon (PAH) molecules, which are chemical compounds containing only carbon and hydrogen—that is composed of multiple aromatic rings [7], [8], [9]. PAHs are prevalent in Interstellar Media (ISM) of galaxies in both the nearby and distant Universe and make up a dominant emission mechanism in the mid-infrared wavelength range, containing as much as **10% of the total integrated infrared luminosity of galaxies** [Wikipedia. Polycyclic aromatic hydrocarbon].

J. P. Simpson, *et al*. have taken spectra of many positions in the central 25 min of the **Galactic Center**. The spectra exhibit strong UIR/PAH features at 6.2, 7.7, 8.6 and 11.3 microns, in addition to the ionic lines of (Ne II), at 12.8 microns, (S III) 18.7 microns, and (Ar II) 6.98 microns. Compared to the spectrum of the **Orion nebula**, the Galactic Center spectra have **similar PAH features**, but the Orion Nebula also has strong lines of (He III) 15.6 microns, (S IV) 10.5 microns, and (Ar III) 8.99 microns [10].

D. Cesarsky, *et al.* present mid-infrared spectro-imagery and high-resolution spectroscopy of the **Orion bar** and of a region in the **Orion nebula** (see **Figure 1**). Their data shows emission from amorphous silicate grains from the entire H II region and around the isolated star Theta2 Ori A. In their opinion, the observed spectra can be reproduced by a mixture of interstellar silicate and carbon grains heated by the radiation of the hot stars present in the region [11].

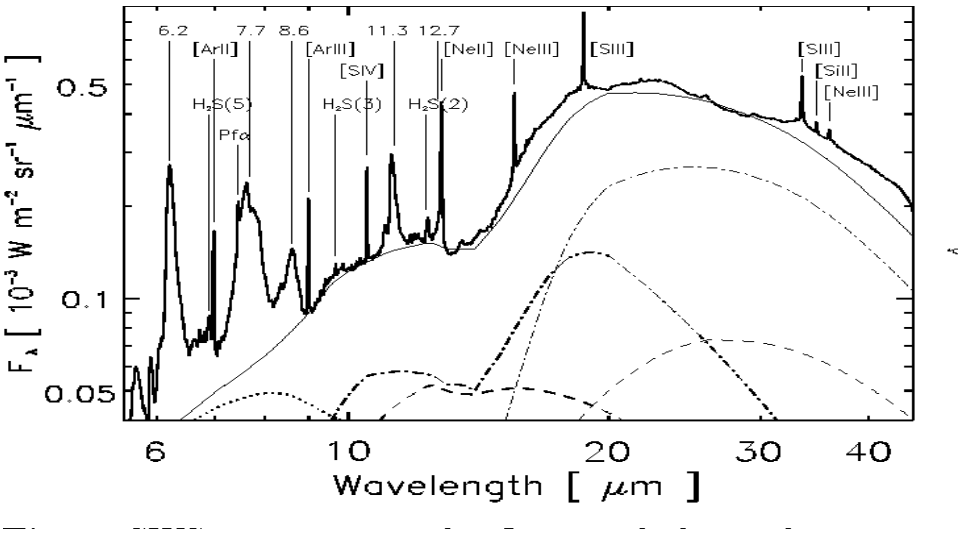

Figure 1. Short Wavelength Spectrometer (SWS) spectrum (full line) in the **Orion nebula**. The identification of the strongest spectral features (6.2, 7.7, 8.6, 11.3, and 12.7 μm) is indicated. Adapted from [11].

In 2008, A. G. G. M. Tielens provided an excellent review of Interstellar PAH Molecules:

Large polycyclic aromatic hydrocarbon (PAH) molecules carry the infrared (IR) emission features that dominate the spectra of most galactic and extragalactic sources. This review surveys the observed mid-IR characteristics of these emission features and summarizes laboratory and theoretical studies of the spectral characteristics of PAHs and the derived intrinsic properties of emitting interstellar PAHs. Dedicated experimental studies have provided critical input for detailed astronomical models that probe the origin and evolution of interstellar PAHs and their role in the universe. The physics and chemistry of PAHs are discussed, emphasizing the contribution of these species to the photoelectric heating and the ionization balance of the interstellar gas and to the formation of small hydrocarbon radicals and carbon chains. Together, these studies demonstrate that PAHs are abundant, ubiquitous, and a dominant force in the interstellar medium of galaxies [12].

In 2013, S. Kwok and Y. Zhang asked the following question: "Why is no PAH molecule detected?" [13]:
Since the UIR features are widely observed throughout the Galaxy and represent up to ***20% of the total energy output of starburst galaxies****, the* ***carrier of these features must be extremely common and abundant****. PAH have very strong absorption in the UV (0.12–0.3 μm). If the abundance of PAH is high enough to emit strongly in the infrared, then it is difficult to understand why the same molecules in the ground electronic*

state will not cause absorption features in the UV. Sensitive searches have been made in the UV with the Hubble Space Telescope and the Very Large Telescope, but no detection was made, putting very low upper limits on the abundance of PAH molecules in the diffuse interstellar medium (ISM). The absence of UV absorption features of the diffuse ISM is in fact a strong argument against a molecular carrier PAH .

S. Kwok and Y. Zhang suggested that the carrier of UIR bands is an amorphous carbonaceous solid with mixed aromatic/aliphatic structures, rather than free-flying polycyclic aromatic hydrocarbon molecules. Through spectral fittings of the astronomical spectra of UIR bands, the authors showed that a significant amount of the energy is emitted by aliphatic component, implying that aliphatic groups are an essential part of the chemical structure [13].

In 2021, D. Bradley made the following conclusion about PAH molecules: *Interstellar spectra recorded using mid-infrared spectroscopy show many emission lines. The spectral lines are usually assigned to polycyclic aromatic hydrocarbons (PAHs). Indeed, PAHs are thought to be one of the main forms in which carbon exists in space. And yet, not a single member of this group of compounds had been identified in space definitively until now* [1].

2. Dark Matter in WUM

Hypersphere World-Universe Model (WUM) is based on **two parameters only** α and Q [20]:

- α is the dimensionless Rydberg constant: $\alpha = (2aR_\infty)^{1/3}$ (that was later named "Fine-structure constant") and a is a basic unit of size $a = 1.7705641 \times 10^{-14}\, m$;
- Q is the dimensionless time-varying quantity 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: $Q = 0.759972 \times 10^{40}$ and is, in fact, the Dirac Large Number;
- A basic unit of time t_0 equals to: $t_0 = a/c = 5.9059662 \times 10^{-23}\, s$ 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 ($E_0 = hc/a$ is a basic unit of energy and h is Planck 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.

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 five 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 [14], [15], [16], [17], [18], [19]. **Self-annihilation of DMPs is the cornerstone of WUM**.

WUM proposes multicomponent DM system consisting of two couples of coannihilating Dark Matter Particles (DMPs): a heavy Dark Matter Fermion (DMF) – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV) that is a dipole of Dirac's monopoles with charge $\mu = e/2\alpha$ (e is the elementary charge); a heavy fermion – DMF2 (9.6 GeV) and a light spin-0 boson – ELOP (340 keV) that is a dipole of preons with electrical charge e/3; self-annihilating fermions – DMF3 (3.7 keV) and DMF4, named DION, (0.2 eV).

WUM postulates that rest energies of DMFs and bosons are proportional to a basic unit of energy E_0 multiplied by different exponents of α and can be expressed with the following formulae [20]:

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

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

We still do not have a direct confirmation of DMPs' rest energies, but we do have various 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 [21].

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.

According to WUM, the total DIONs energy density in the World 68.8% is almost ten times greater than the total baryonic energy density 7.2%. The rest 24% is the energy density of five DM particles above. At such a high DIONs concentration, "DIONs pairs" (biDIONs) can be created. Their concentration may indeed be sufficient to undergo the self-annihilation, and as a result create an emission with 3.3 μm. In the present paper we **discuss the possibility to explain UIB emission features through self-annihilation of DIONs and biDIONs** with the rest energy of about 0.38 eV.

3. Weak Interaction

According to WUM, strength of gravity is characterized by the gravitational parameter [2]:

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

where $G_0 = a^2c^4/8\pi hc$ is an extrapolated value of G at the Beginning of the World ($Q=1$). 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 thirty 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. The weak interaction between DMPs will be efficient in case when their concentration n_W is larger than

$$n_W^{cr} = 2.21346 \times 10^{11}\ m^{-3}$$

The calculated maximum average concentration of DIONs in the largest shell of Superclusters n_{DION}^{SC} is [2]:

$$n_{DION}^{SC} \cong 4.2 \times 10^{15}\ m^{-3}$$

It 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 DM Cores of all Macroobjects. In our view, weak interaction between DM particles DMF3 provides integrity of Fermi Bubbles and Solar Corona [2].

4. Galaxies in WUM

According to WUM, the total energy density of the World ρ_W equals to $\rho_W = 3\rho_0 \times Q^{-1}$ throughout the World's evolution, where a basic unit of energy density ρ_0 is: $\rho_0 = E_0/a^3$. The energy density of the Medium is two-thirds of the total energy density and Macroobjects (Superclusters, Galaxies, and Extrasolar systems)– one-third in all cosmological times. The calculated average energy density of DIONs in the Intergalactic Medium ρ_{DION}^{IGM} is:

$$\rho_{DION}^{IGM} = 0.688 \times 2\rho_0 \times Q^{-1}$$

and the calculated average concentration of them n_{DION}^{IGM} is:

$$n_{DION}^{IGM} = 1.15 \times 10^{10}\ m^{-3}$$

that is much smaller than n_W^{cr}. It means that the weak interaction between DIONs is not efficient, the self-annihilation between them is practically not happening, and hence, UIB emission in the Intergalactic Medium is not observed. This result is in good agreement with the experimental observations (see Section 2).

Milky Way (MW) is the second-largest spiral galaxy in the Local Group (after Andromeda Galaxy), with its estimated visible stellar disk diameter

$$D_{MW} = 185 \pm 15\ kly$$

thickness of thin stellar disk about $2\ kly$ and mass

$$M_{MW} = (1.6 - 3.2) \times 10^{42} kg$$

In our view, MW is a Disk Bubble (DB) whose boundary with the Intergalactic Medium has a surface energy density σ_0 that is a basic unit of surface energy density: $\sigma_0 = E_0/a^2$. The Disk Bubble contains Interstellar Medium (ISM) and (100 – 400) billion Extrasolar systems. According to WUM, mass of MW equals to:

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

We calculate D_{MW} by the following equation:

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

The calculated value of the visible stellar disk diameter is in good agreement with its estimated value obtained by astronomers. Considering the average stellar disk diameter $D_{MW} = 185\ kly$ we can calculate the mass of MW:

$$M_{MW} = 1.92 \times 10^{42}\ kg$$

average energy density:

$$\rho_{MW} = 3.78 \times 10^{-3}\ J\ m^{-3}$$

and average concentration of DIONs in ISM n_{DION}^{ISM} :

$$n_{DION}^{ISM} = 5.45 \times 10^{16}\ m^{-3}$$

that is over five orders of magnitude larger than the critical concentration n_W^{cr} . Density fluctuations of them could happen in ISM and clumps of DIONs will arise with a density that is sufficient for their self-annihilation. Concentration of DIONs in circumstellar regions, star-forming regions, and extragalactic objects is even larger than n_{DION}^{ISM} . At such a high DIONs concentration, "DIONs pairs" (biDIONs) can be created, their concentration n_{biDION}^{ISM} may indeed be sufficient to undergo the weak interaction and self-annihilation ($n_{biDION}^{ISM} \geq n_W^{cr}$), and as a result, UIB emission at 3.3 μm can be observed inside of MW.

Andromeda Galaxy (AG) is a barred spiral galaxy approximately 2.5 Mly from Earth and the nearest large galaxy to MW with about 10^{12} stars. It has an estimated visible stellar disk diameter ~220 kly and mass $(3 \pm 1) \times 10^{42}\ kg$. Parameters of AG are close enough to the parameters of MW. It seems reasonable that the calculations of the galaxy parameters made above for MW are valid for AG also.

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 [22]. Considering the fact that the calculated concentrations of DIONs are about five orders of magnitude larger than the critical concentration, we can suppose that our conclusions for MW are fair for all galaxies in the World.

It is worth noting that in frames of WUM the Interstellar Medium in Galaxies is, in fact, a low viscosity "Liquid" with "Weak bonds" between DM particles DIONs, which are constantly moving concerning each other, and the weak bonds are continually breaking and reforming. This "Liquid" can be named "Aether." In WUM, Galaxies emerged due to the Explosive Volcanic Rotational Fission of Overspinning DM Superclusters' Cores with the biggest Shells composed of DIONs. As the result of this mechanism, the Galaxy Bubbles created, which have look like "Chicken egg" at that time:

- "Yolk" – spinning liquid DM Core of galaxy with high viscosity composed of DMPs (DMF1, DMF2, and DMF3);
- "Albumen" – liquid ISM with low viscosity made of DIONs with dissolved other DMPs;
- "Membrane" – boundary between ISM and Intergalactic Medium with surface energy density σ_0.

"Yolk" contains one-third of the total galaxy Matter, and "Albumen" adds up to two-thirds of the total galaxy Matter. Extrasolar systems emerge due to the Explosive Volcanic Rotational Fission of Overspinning DM galaxy Core and enter ISM. As the result, galaxy Bubble expands in the plane of the spinning Core and becomes a Disk Bubble.

5. Explanation of Unidentified Infrared Emission Bands

It is well-known that electron-positron annihilation is a fundamental process when an electron and a positron collide in free space. The energy-momentum conservation requires that the annihilation takes place with the emission of at least two photons. Annihilation of electron-positron producing more than two photons is less likely. Annihilation of an electron-positron pair accompanied by emission of three photons is discussed by A. Ore and J. L. Powell who calculated the cross section for this process. They found that the ratio of the calculated cross section to that of ordinary two-photon annihilation is 1:370 [23].

The main infrared features of UIBs occur around peaks at 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm with the photon's rest energy at the peaks 0.376, 0.200, 0.161, 0.144, 0.111, and 0.098 eV, respectively. These UIBs are observed in ISM of galaxies in both the nearby and distant World and are, in fact, the "Fingerprints" of all galaxies.

By analogy with the electron-positron annihilation, we suppose that DIONs and biDIONs self-annihilate with the emission of two or three photons. Indeed, the self-annihilation of them follows an energy conservation requirement:

- Two biDIONs with a rest energy about 0.38 eV can produce two photons with the rest energy 0.376 eV (3.3 μm);
- Two DIONs with the rest energy 0.199 eV can produce two photons with the rest energy 0.200 eV (6.2 μm);
- Two DIONs with the rest energy 0.199 eV can produce three photons with the rest energies 0.161 eV (7.7 μm), 0.144 eV (8.6 μm), and 0.111 eV (11.2 μm), or 0.098 eV (12.7 μm);
- Two DIONs with the rest energy 0.199 eV can produce three photons with the rest energies 0.200 eV (6.2 μm), 0.111 eV (11.2 μm), and 0.098 eV (12.7 μm).

The following results speak in favor of this explanation:

- The source of UIBs is prevalent in ISM of all galaxies and make up a dominant emission mechanism in the mid-infrared wavelength range, containing as much as 10% of the total integrated infrared luminosity of galaxies and up to 20% of the total energy output of starburst galaxies;
- All studies of this phenomenon demonstrate that the source of UIBs is extremely common, abundant, ubiquitous, and a dominant force in ISM of galaxies;
- UIBs are the same infrared discrete emissions from various regions of Galaxies: ISM, circumstellar regions, star-forming regions, extragalactic objects, and regions of cold molecular gas, for which the identity of the emitting materials is unknown;
- The spectra of the Galactic Center exhibit strong UIB features at 6.2, 7.7, 8.6 and 11.3 microns;
- The absence of UV absorption features of the diffuse ISM is, in fact, a convincing argument against a group of PAH molecules as the carrier of UIBs. Not a single member of this group of compounds had been identified in space definitively until now.

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. According to Reviewer, *the document so engendered is a gateway to a new testing program, which may lead to falsifiable results.*

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Center of Milky Way Galaxy

Abstract

In 2013, World-Universe Model (WUM) made one of the most important predictions: *"Macroobjects of the World have cores made up of the discussed DM* (Dark Matter) *particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [1]. Prof. R. Genzel and A. Ghez confirmed this prediction: *"The Discovery of a Supermassive* ***Compact Object*** *at the Centre of Our Galaxy"* (Nobel Prize in Physics 2020). On May 12, 2022, astronomers, using the Event Horizon Telescope, released the first image of the accretion disk around the Sagittarius A*(Sgr A*) produced using a world-wide network of radio observatories made in April 2017. These observations were obtained by a global array of millimeter wavelength telescopes and analyzed by an international research team that now numbers over 300 people, which claimed that Sgr A* is a Supermassive Black Hole (SBH). In the present paper we analyze these results in frames of WUM. Based on the totality of all accumulated experimental results for the Center of the Milky Way Galaxy we conclude that Sgr A* is the DM Core of our Galaxy.

1. Introduction

Sagittarius A* (Sgr A*) is a **supermassive black objec**t at the Galactic Center of the Milky Way (MW), which was discovered in 1954 by J. D. Kraus, H-C. Ko, and S. Matt with Ohio State University radio telescope at 250 MHz . It is a **bright and very compact astronomical radio source**. In 1982 R. L. Brown understood that the strongest radio emission from the center of MW appeared to be due to a compact **nonthermal radio object**.

The Sagittarius A* cluster is the cluster of stars in close orbit around Sgr A* (see **Figure 1**). The individual stars are often listed as "S-stars." One of the most studied stars is S2, a relatively bright star that also passes close by Sgr A*[2]. As of 2020, S14 is the record holder of closest approach to Sgr A*, at about 12.6 AU ($1.88 \times 10^{12}\ m$), almost as close as Saturn gets to the Sun. Its orbital period is 12 years, but an extreme eccentricity of 0.985 gives it the close approach and high velocity of about 8% of the speed of light.

In 2005, F. Eisenhauer, *et al.* reported the results (with 75 milli-arcsec resolution) of **near-IR** imaging spectroscopy within the central 30 light days of the Galactic Center, taken with the new adaptive optics assisted, integral field spectrometer SINFONI on the ESO-VLT (see **Figure 1**).

In 2018, S. D. von Fellenberg, *et al.* reported the first detection of the Galactic Centre in the far infrared. Their measurements were obtained with PACS on board the Herschel satellite at 100 μm and 160 μm [3].

In 2019, the observations of several stars orbiting Sgr A*, particularly S2, have been used to determine the mass and upper limits on the radius of the object. Based on mass and increasingly precise radius limits [4], astronomers have found that the enclosed mass of Sgr A* is 4.154 ± 0.014 million solar masses. A calculated Schwarzschild radius of its mass $1.227 \times 10^{10}\ m$ is about two orders of magnitude smaller than the minimum distance of S14 from Sgr A*: $1.88 \times 10^{12}\ m$.

In May 2022, the Event Horizon Telescope Collaboration presented Event Horizon Telescope (EHT) 1.3 mm measurements of the radio source located at the position of the supermassive black object Sgr A*, collected during the 2017 April campaign (see **Figure 2**) [5]. A deciphered image of Sgr A* is depicted in **Figure 3**.

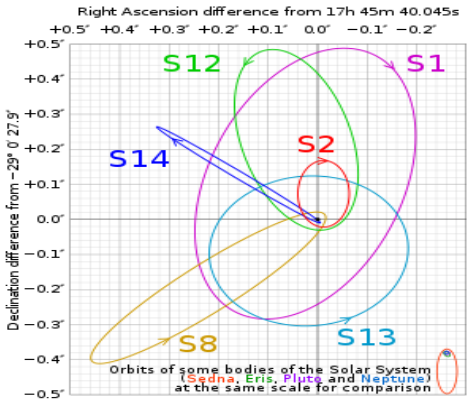

Figure 1. Inferred orbits of 6 stars around SBH **candidate** Sgr A* at MW center [2].

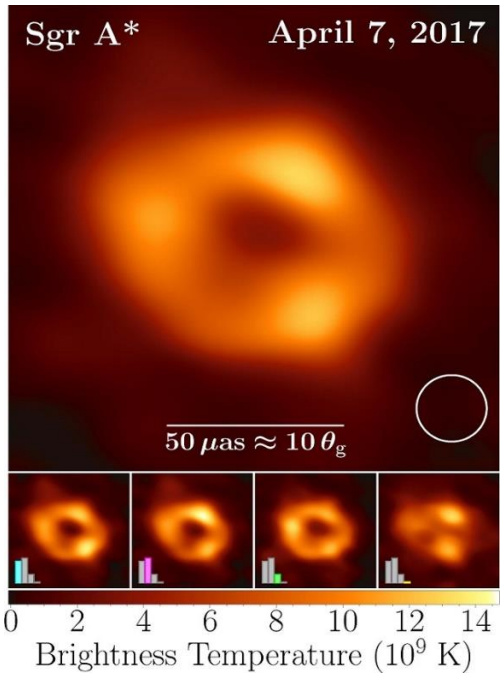

Figure 2. Sagittarius A* imaged by the Event Horizon Telescope in 2017, released in 2022 [5].

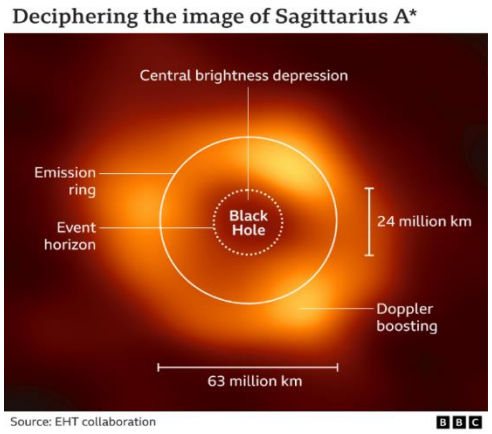

Figure 3. The Milky Way's monster black hole seen for the FIRST time [6].

The observations were conducted with eight facilities at six locations across the globe. Novel calibration methods are employed to account for Sgr A*'s flux variability. The majority of the 1.3 mm emission arises from horizon scales where intrinsic structural source variability is detected on timescales of minutes to hours. The effects of interstellar scattering on the image and its variability are found to be subdominant to intrinsic source structure. The calibrated visibility amplitudes, particularly the locations of the visibility minima, are broadly consistent with a blurred ring with a diameter of $(51.8 \pm 2.3)\ \mu as$ $(6.337 \times 10^{10}\ m)$ [5] as determined in later works in this series (distance to Sgr A* is $26.673\ kly$ [4]).

Contemporaneous multiwavelength monitoring of Sgr A* was performed at 22, 43, and 86 GHz and at near-infrared and X-ray wavelengths. Several X-ray flares from Sgr A* are detected by Chandra, one at low significance jointly with Swift on 2017 April 7 and the other at higher significance jointly with NuSTAR on 2017 April 11. The brighter April 11 flare is not observed simultaneously by the EHT but is followed by a significant increase in millimeter flux variability immediately after the X-ray outburst, indicating a likely connection in the emission physics near the event horizon. The Collaboration compared Sgr A*'s broadband flux during the EHT campaign to its historical spectral energy distribution and find that both the quiescent emission and flare emission are consistent with its long-term behavior.

Astronomers of the Collaboration have made a first comparison of the EHT 2017 Sgr A* data to a state-of-the-art library of ideal time-dependent General Relativistic Magnetohydrodynamics simulations models. The models assume that the mass and distance to Sgr A* are known and that the central object is a SBH described by the Kerr metric. The model parameters are as follows: whether the horizon magnetic field is strong or weak; the SBH spin a^*; and the inclination angle i between the line of sight and the accretion flow orbital angular momentum vector.

None of the fiducial models survive the full gauntlet of 11 constraints. The astronomers set aside both variability constraints and got two fiducial models that pass the remaining nine constraints in all simulation pipelines. These models in the "best-bet region" are strongly magnetized and have positive spin and low inclination, with $(a^*, i) = (0.5, 30°)$ and $(0.94, 10°)$ [5].

Based on the obtained results the Event Horizon Telescope Collaboration claimed that Sgr A* is SBH. Below we will analyze the obtained experimental results in frames of WUM [7].

2. Hypersphere World-Universe Model

2.1. Multi-Component Dark Matter

There are three prominent hypotheses on nonbaryonic Dark Matter (DM), namely Hot Dark Matter (HDM), Warm Dark Matter (WDM), and Cold Dark Matter (CDM). The most widely discussed models are based on the CDM hypothesis, and the corresponding particles are most commonly assumed to be Weakly Interacting Massive Particles (WIMPs). A neutralino with mass in $100 \Leftrightarrow 10{,}000\ GeV/c^2$ range is the leading CDM candidate. It is known that a sterile neutrino with mass in $1 \Leftrightarrow 10\ keV/c^2$ range is a good WDM candidate. The best candidates for the identity of HDM are neutrinos and axions.

In 1952, Y. Nambu (Nobel Prize Laureate in Physics) proposed an empirical mass spectrum of elementary particles with a mass unit close to one quarter of the mass of a pion (about $m_0/2 \cong 35\ MeV/c^2$) [8]. He noticed that meson masses are even multiplies of a mass unit $m_0/2$, baryon (and also unstable lepton) masses are odd multiplies, and mass differences among similar particles are quantized by $m_0 \cong 70\ MeV/c^2$.

In WUM, we introduced a basic energy unit E_0 that equals to:

$$E_0 = hc/a = 70.025267\ MeV$$

where h is Planck constant, c is the electrodynamic constant, and a is the basic size unit. It is interesting that the rest energy of electron E_e equals to:

$$E_e = \alpha \times E_0$$

where dimensionless Rydberg constant α equals to: $\alpha = (2aR_\infty)^{1/3}$; R_∞ is Rydberg constant and Rydberg energy Ry is:

$$Ry = hcR_\infty = \alpha^3 \times E_0/2 = 13.605693\ eV$$

It is worth noting that the constant α was later named "Fine-structure constant."

In 2012, D. Hooper in the article "The Empirical Case For 10 GeV Dark Matter" *summarized and discussed the body of evidence which has accumulated in favor of dark matter in the form of approximately 10 GeV particles. This evidence includes the spectrum and angular distribution of gamma rays from the Galactic Center, the synchrotron emission from the Milky Way's radio filaments, the diffuse synchrotron emission from the Inner Galaxy (the "WMAP Haze") and low-energy signals from the direct detection experiments DAMA/LIBRA, CoGeNT and CRESST-II* [9].

In our view, 10 GeV particles can be DMPs with the following rest energy:

$$E_{Hooper} = \alpha^{-1} \times E_0 = 9.6\ GeV$$

In 2009, A. Bykov, *et al.* investigated *the nature of the extended hard X-ray source XMMU J061804.3+222732 and its surroundings using XMM-Newton, Chandra, and Spitzer observations. A feature at 3.7 keV was found in the X-ray spectrum of Src 3 at the 99% confidence level* [10]. In 2012, A. Moretti, *et al.* measured the diffuse gamma-ray emission at the deepest level and with the best accuracy available at that time. An emission line around 3.7 keV is clearly visible in the obtained spectrum [11].

In frames of WUM, 3.7 keV emission can be a result of a self-annihilation of DMPs with the following rest energy:

$$E_{Moretti} = \alpha^2 \times E_0 = 3.7\ keV$$

In addition to Fermions discussed above, we offer another type of Dark Matter particles – Bosons. The quantum theory of magnetic charge started with a paper by P. Dirac in 1931m in which he showed that if any magnetic monopoles exist in the universe, then electric charge in the universe must be quantized [12]. The electric charge is, in fact, quantized, which is consistent with (but does not prove) the existence of monopoles.

WUM introduces spin-0 boson – DIRAC with the rest energy $E_{DIRAC} = \alpha^0 \times E_0 = 70\ MeV$, that is a dipole of Dirac's monopoles with magnetic charges $\mu = e/2\alpha$ (e is an elementary charge). They possess a substantial magnetic dipole momentum**.** In our view, DIRACs are responsible for the electric charge quantization.

In 1979 H. Harari [13] and M. A. Shupe [14] proposed a heuristic model, treating leptons and quarks as composites of spin $1/2$ fields with charges of 0 and $\pm e/3$. In particle physics, preons are postulated to be "point-like" particles, conceived to be subcomponents of quarks and leptons [15].

In 2009, S. Sukhoruchkin has this to say about "A Role of Hadronic effects in Particle Masses" [16]: *We discuss relations in particle mass spectrum and consider results of analysis of spacing distributions in nuclear spectra which show a distinguished character of intervals related to the electron mass and nucleon mass*

splitting. Systematic appearance of stable nuclear intervals rationally connected with particle mass splitting 170-340-510-1020 keV... was found in levels of different nuclei including low-spin levels observed in (γ, γ) and (n, γ) reactions.

WUM introduces spin-0 boson – ELOP with the rest energy $E_{ELOP} = 2/3\alpha^1 E_0 = 340\ keV$, that is a dipole of preons with electric charges $e_{preon} = e/3$. They possess a substantial electric dipole momentum**.**

In 2003, C. Boehm, P. Fayet, and J. Silk proposed two-component DM system consisting of bosonic and fermionic components for the explanation of emission lines from the bulge of the Milky Way galaxy. They analyzed a way *to reconcile the low and high energy signatures in gamma-ray spectra, even if both of them turn out to be due to Dark Matter annihilations. One would be a heavy fermion for example, like the lightest neutralino (> 100 GeV), and the other one a possibly light spin-0 particle (~ 100 MeV). Both of them would be neutral and also stable* [17].

Based on the discussed ideas and experimental results, in 2013 we proposed a multicomponent DM system consisting of two couples of coannihilating DMPs: a heavy DM fermion – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV); a heavy fermion – DMF2 (9.6 GeV) and a light spin-0 boson – ELOP (340 keV); fermions – DMF3 (3.7 keV) and DMF4 (0.2 eV) named DION in 2019 [18].

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

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

These values fall into ranges estimated in literature. The reason for this multicomponent DM system was to explain

- The diversity of Very High Energy gamma-ray sources in the World;
- The diversity of DM Cores of Macroobjects of the World (superclusters, galaxies, and extrasolar systems), which are Fermion Compact Objects in WUM (see Section 2.2).

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 (cores 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 [19].

In this regard, it is worth recalling about the study of 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 do not know the values of neutrino masses"*. Although we still cannot measure neutrinos' masses directly, no one doubts their existence.

Neutrons serve as another example**.** The mass of a neutron cannot be directly determined by mass spectrometry since **it has no electric charge**. But since the masses of a proton and of a deuteron can be measured with a mass spectrometer, the mass of a neutron can be deduced by subtracting proton mass from deuteron mass, with the difference being the mass of the neutron plus the binding energy of deuterium (expressed as a positive emitted energy). The latter can be directly measured by measuring the energy of a single 0.7822 MeV gamma photon emitted when a deuteron is formed by a proton capturing a neutron (this is exothermic and happens with zero-energy neutrons). The small recoil kinetic energy of the deuteron (about 0.06% of the total energy) must also be accounted for.

The energy of the gamma ray can be measured to high precision by X-ray diffraction techniques, as was first done by Bell and Elliot in 1948. The best modern (1986) values for neutron mass obtained using this technique are provided by Greene, *et al.*: $m_{neutron} = 1.008644904\ Da$ (the Dalton is unified atomic mass unit). The value for the neutron mass in MeV is less accurately known, due to smaller accuracy in the known conversion of Da to MeV/c^2: $m_{neutron} = 939.56563(28)\ MeV/c^2$ [Wikipedia. Neutron].

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

2.2. Macroobjects Shell Model

The existence of Supermassive Objects (SMOs) in galactic centers is now commonly accepted. Many non-traditional models explaining SMOs observed in galaxies and galaxy clusters are widely discussed in literature [20]-[26]. The prospect that DMPs might be observed in Centers of Macroobjects has drawn many new researchers to the field. Indirect effects in cosmic rays and gamma-ray background from the annihilation of DM in the form of heavy stable neutral leptons in Galaxies were considered in pioneer articles [27]-[32].

According to **WUM**, Macroobjects of the World (Superclusters, Galaxies, Extrasolar systems) have Cores 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 the heaviest particles; outer shells are larger and consist of lighter particles. **Weak Interaction** between DMPs provides integrity of all shells. Self-annihilation of DMPs can give rise to any combination of gamma-ray lines [33].

WUM provides a mathematical framework that allows calculating the primary cosmological parameters of the World that are in good agreement with the most recent measurements and observations [34]. **Table 1** describes the parameters of Macroobjects Cores in the present Epoch made up of different fermions: self-annihilating DMF1, DMF2, DMF3, DMF4, and Electron-Positron plasma.

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

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

The calculated parameters of the shells show that [34]:

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

Macroobjects' Cores have the following properties:

- The minimum radius of Core R_{min} made up of any fermion equals to three Schwarzschild radii;
- Core density does not depend on M_{max} and R_{min} and does not change in time while $M_{max} \propto \tau^{3/2}$ and $R_{min} \propto \tau^{1/2}$ (where τ is a cosmological time [35]);
- DM cores of superclusters and galaxies are responsible for the gravitational lensing effect.

In WUM, the calculated maximum stellar mass $M_S \cong 174\ M_\odot$ [1] is in good agreement with the mass of one of the most massive known stars R136a1: $M_S = 222^{+29}_{-28}\ M_\odot$ [36].

K. Mehrgan, *et al.* observed a supergiant elliptical galaxy Holmberg 15A. It has been alleged that the primary component of the galactic core is SBH with a mass of $4 \times 10^{10} M_\odot$ [37].

TON 618 is a very distant and extremely luminous quasar. It possesses one of the most massive SBHs ever found, with a mass of $6.6 \times 10^{10}\ M_\odot$ at the center of TON 618 [38].

How SBHs initially formed is one of the biggest problems in the study of galaxy evolution today. SBHs have been observed as early as 690 million years after the Big Bang [39]. How they could grow so quickly remains unexplained.

C. R. Argüelles, *et al.* propose a novel mechanism for the creation of SBHs from DM without requiring prior star formation or needing to invoke seed black holes with unrealistic accretion rates. The authors investigate a potential existence of stable galactic cores made up of fermionic DM, and surrounded by a diluted DM halo, finding that the centers of these structures could become so concentrated that they could also collapse into SBHs once a critical threshold is reached. They analyzed this mechanism with DM haloes mass up to $5.9 \times 10^{10}\ M_\odot$ [40].

According to **WUM**, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with shells consisting of DMF3 with the calculated maximum mass of $6 \times 10^{10}\ M_\odot$ (see **Table 1**). This value is in good agreement with the experimental values [37] [38] and with the analyzed values by C. R. Argüelles, *et al.* [40].

Laniakea Supercluster (LS) is a galaxy supercluster that is home to the Milky Way and approximately 10^5 other nearby galaxies. It is known as the largest supercluster with estimated binding mass of $10^{17}\ M_\odot$ [41]. The mass-to-light ratio of the LS is about 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [42].

In 1933, Fritz Zwicky investigated the velocity dispersion of Coma cluster and found a surprisingly high mass-to-light ratio (~500). He concluded: "*if this would be confirmed, we would get the surprising result that dark matter is present in much greater amount than luminous matter*" [43]. **These ratios are one of the main arguments in favor of presence of large amounts of Dark Matter in the World.**

In frames of **WUM**, LS emerged 13.77 billion years ago due to Rotational Fission of the Supercluster Overspinning (surface speed at equator exceeding escape velocity) DM Core and self-annihilation of DMPs. The Core was created during Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects existed [33].

B. Carr, F. Kühnel, and L. Visinelli "*consider the observational constraints on stupendously large black holes (SLABs) in the mass range* $M > 10^{11} M_{\odot}$ *. These have attracted little attention hitherto, and we are aware of no published constraints on a SLAB population in the range (*$10^{12} - 10^{18}) M_{\odot}$ *. However, there is already evidence for black holes of up to nearly* $10^{11} M_{\odot}$ *in galactic nuclei* [38], *so it is conceivable that SLABs exist, and they may even have been seeded by primordial black holes"* [44].

According to **WUM**, the calculated maximum mass of supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the estimated value by L. Bliss[41] and discussed values by B. Carr, *et al.* [44]. In the future, these stupendously large compact objects can give rise to new Luminous Superclusters as the result of their DM Cores' rotational fission

It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time, given how far away from each other they are located. In our view, there were many Beginnings for different Luminous Superclusters. . It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters [45].

2.3. Angular Momentum Problem

Angular Momentum Problem is one of the most critical problems in Standard Cosmology (SC) that must be solved. SC does not explain how Galaxies and Extra Solar systems obtained their enormous orbital angular momenta. Any theory of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out.

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

- How did Galaxies and Extra Solar systems obtain their substantial orbital and rotational angular momenta;
- Why are all Macroobjects rotating;
- How did Milky Way (MW) give birth to different Extra Solar systems in different times;
- The beginning of MW galaxy was about 13.77 billion years. The age of MW is about the Age of the World. What is the origin of the MW huge orbital angular momentum? We must discuss the Beginning of MW;
- The oldest star in MW (named Methuselah) is nearly as old as the universe itself. How did it happen?
- The beginning of the Solar System (SS) was 4.57 billion years ago. What is the origin of SS orbital angular momentum? We must discuss the Beginning of SS.

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – **Rotational Fission** of overspinning Prime objects. From the point of view of Fission model, the prime object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellites** [18].

In frames of **WUM**, Prime Objects are DM Cores of Superclusters, which must accumulate tremendous angular momenta before the Birth of the Luminous World. It follows that a long enough time period must elapse. We name this period "Dark Epoch" [18]. 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 Rotational Fission of Superclusters' Cores and self-annihilation of DMPs;
- The main players of the World are Superclusters' Cores, which accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their Rotational

Fission. The experimental observations of galaxies in the universe show that most of them are disk galaxies [56]. These results speak in favor of the developed Rotational Fission mechanism;

- DM Core of MW was born 13.77 billion years ago as the result of the Rotational Fission of Virgo DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the Rotational Fissions of the Milky Way DM Core in different times (4.57 billion years ago for the Solar system);
- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons;
- Gravitational waves can be a product of Rotational Fission of overspinning Macroobjects Cores.

2.4. Milky Way Center

MW is a barred spiral galaxy with an estimated visible diameter of $100 - 200\ kly$. MW is a part of the Local Group of galaxies that form part of the Virgo Supercluster, which is itself a component of LS. It is estimated to contain 100–400 billion stars. The galactic center is an intense radio source known as Sgr A*. In 2008, A. M. Ghez, *et al*. found the enclosed mass of It: $(4.1 \pm 0.6) \times 10^6\ M_\odot$ [46].

Several teams of researchers have attempted to image Sgr A* in the radio spectrum using very-long-baseline interferometry. The current highest-resolution (approximately 30 μas) measurement, made at a wavelength of 1.3 mm, indicated an overall angular size for the source of $50\ \mu as$ [47]. At a distance of $26.673\ kly$ this yields a diameter of $6.337 \times 10^{10}\ m$.

E. A. C. Mills in her "Journey to the Center of the Galaxy: Following the gas to understand past and future activity in galaxy nuclei" wrote [48]: *"The* ***young stars in the central lightyear****, the innermost of whose orbits are famously used to determine parameters of central supermassive black hole, are suggested to have formed in-situ in one of the most extreme environments imaginable: in an incredibly dense gas disk a fraction of a light year from the black hole. Even allowing for recent activity in the past few hundred years which we can detect from the X-ray light of these outbursts reflecting off of clouds a few hundred light years from the black hole…* ***our black hole is no AGN****"* (Active Galactic Nucleus).

On January 5, 2015, NASA reported observing an X-ray flare 400 times brighter than usual, a record-breaker, from Sgr A*. The unusual event may have been caused by the breaking apart of an asteroid falling into SBH or by the entanglement of magnetic field lines within gas flowing into Sgr A*, according to astronomers [49].

On May 2021, NASA published new images of the galactic center, based on surveys from Chandra X-ray Observatory. Astronomers present a catalogue of the detected X-ray sources in the 0.3-7 keV band. NASA has released a stunning new picture of our galaxy's violent, super-energized "**downtown**." The image, a composite of 370 observations made over the past two decades by the orbiting Chandra X-ray observatory, depicts billions of stars in the center of the Milky Way. The author of this investigations D. Wang of the University of Massachusetts Amherst said: "*What we see in the picture is a violent or energetic ecosystem in our galaxy's downtown"* [50].

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

In 2013, we proposed a principally different explanation of supermassive compact objects: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores"* [40].

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

- The calculated value of the radius of the Electron-Positron shell $2.9 \times 10^{10}\ m$ is in excellent agreement with the experimentally measured value of the radio source $3 \times 10^{10}\ m$ [47];

- The calculated value of the mass of the Electron-Positron shell $6.6 \times 10^{36}\ kg$ is in good agreement with the experimentally measured value of the supermassive compact object $8.5 \times 10^{36}\ kg$ [46];
- The additional mass of the DMF3 shell of $1.9 \times 10^{36}\ kg$ is much smaller than the maximum mass of it: $1.2 \times 10^{41}\ kg$;
- X-ray flare 400 times brighter than usual can be explained by the detonation of DMF3 particles (3.7 keV) and their self-annihilation [49];
- The excess of gamma-ray emission with energy about 10 GeV reported by D. Hooper from the Galactic Center [51] can be explained by DMF2 particles (9.6 GeV) self-annihilation;
- DM Fermi Bubbles can be explained based on DMF1, DMF2, and DMF3 particles (see Section 2.5).

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 [54]. H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8\ Byr$ that does not conflict with the Age of the Universe, $13.77 \pm 0.06\ Byr$, based on the microwave background radiation and Hubble constant [55]. It means that this star must have formed between 13.66 and 13.83 Byr, an amount of time that is too short for formation of the second generation of stars according to prevailing theories. In our Model, this discovery can be explained by generation of HD 140283 by overspinning Core of MW 13.77 billion years ago.

In frames of the developed Rotational Fission model, it is easy to explain hyper-runaway stars unbound from the Milky Way with speeds of up to $\sim 700\ km/s$ [56]: they were launched by overspinning DM Core of the Large Magellanic Cloud with the speed higher than the escape velocity.

S. E. Koposov, *et al.* present the discovery of the fastest Main Sequence hyper-velocity star S5-HVS1 with mass of about 2.3 solar mass that is located at a distance of ~ 9 kpc from the Sun. When integrated backwards in time, the orbit of the star points unambiguously to the Galactic Centre, implying that S5-HVS1 was kicked away from Sgr A* with a velocity of ~ 1800 km/s , and travelled for 4.8 Myr to its current location. So far, this is the only hyper-velocity star confidently associated with the Galactic Centre [57]. In frames of the developed Model, this discovery can be explained by Gravitational Burst (GB) of the overspinning Core of the Milky Way 4.8 million years ago, which gave birth to S5-HVS1 with the speed higher than the escape velocity of the Core.

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

2.5. 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 themselves glow in nearly uniform gamma rays over their colossal surfaces. Gamma-ray spectrum at Galactic latitude $\leq 10°$, without showing any sign of cutoff up to around 1 TeV, remains unconstrained [60]. Years after the discovery of FBs, their origin and the nature of the gamma-ray emission remain unresolved.

WUM explains FBs the following way [33]:

- Core of the Milky Way is made up of DMPs: DMF1 (1.3 TeV), DMF2 (9.6 GeV), and DMF3 (3.7 keV). The second component (DMF2) explains the excess GeV emission reported by Dan Hooper from the Galactic

Center [51]. Core rotates with surface speed at equator close to the escape velocity between Gravitational Bursts (GBs), and over the escape velocity at the moments of GBs;

- Bipolar astrophysical jets (which are astronomical phenomena where outflows of matter are emitted as the extended beams along the axis of rotation [51]) of DMPs are ejected from the rotating Core into the Galactic halo along the rotation axis of the Core;
- Due to self-annihilation of DMF1 and DMF2, these beams are gamma-ray jets [52]. The prominent X-ray structures on intermediate scales (hundreds of parsecs) above and below the plane (named the Galactic Centre "*chimneys*" [53]) are the result of the self-annihilation of DMF3 particles;
- FBs are bubbles whose boundary with the Intergalactic Medium has a basic surface energy density $\sigma_0 = hc/a^3$. These bubbles are filled with DMPs: DMF1, DMF2, and DMF3. The calculated diameter D_{FB} of FBs: $D_{FB} = 28.6\ kly$ is in good agreement with the measured size of the FBs 25 kly [68] and 32.6 kly [53]. **FBs made up of DMF3 particles resemble a honeycomb filled with DMF1 and DMF2**;
- With Nikola Tesla's principle at heart – "*There is no energy in matter other than that received from the environment "*– we calculate mass M_{FB} of FBs: $M_{FB} = 3.6 \times 10^{41} kg$. Recall that the mass of Milky Way M_{MW} is about: $M_{MW} = (1.6 - 3.2) \times 10^{42} kg$;
- FBs radiate X-rays due to the self-annihilation of DMF3 (3.7 keV). Gamma rays up to 1 TeV [62] are the result of self-annihilation of DMF1 (1.3 TeV) and DMF2 (9.6 GeV) particles in Dark Matter Objects (DMOs) whose density is sufficient for the self-annihilation of DMPs to occur. On the other hand, DMOs are much smaller than stars in the World, and have a high concentration in FBs to provide nearly uniform gamma ray glow over their colossal surfaces [33];
- The total flux of the gamma radiation from FBs is the sum of the contributions of all individual DMOs, which irradiate gamma quants with different energies and attract new DMF1 and DMF2 particles from FBs. The Core of the Milky Way supplies FBs with new DMPs through the galactic wind, explaining the brightness of FBs remaining fairly constant during the time of observations. In our opinion, FBs are built continuously throughout the lifetime of the Milky Way galaxy.

In our view, **FBs are DMPs' clouds containing uniformly distributed Dark Matter Objects,** in which DMPs self-annihilate and radiate X-rays and gamma rays. DM Fermi Bubbles constitute a principal proof of WUM.

3. Analysis of Event Horizon Telescope Results

The Event Horizon Telescope Collaboration presented the outstanding Event Horizon Telescope 1.3 mm measurements of the radio source located at the position of the supermassive black object Sgr A* [5]. Contemporaneous multiwavelength monitoring of Sgr A* was performed at 22, 43, and 86 GHz and at near-infrared and X-ray wavelengths. Using the Event Horizon Telescope, astronomers released the first image of the accretion disk around the Sgr A*. Based on the obtained results the Event Horizon Telescope Collaboration claimed that Sgr A* is a Supermassive Black Hole.

In our opinion, the results obtained by Collaboration are model-dependent and not sufficient to support this claim. Astronomers should answer some principal questions:

- The age of MW is similar to the Age of the World. The oldest star in MW (named Methuselah) is nearly as old as the World itself. If Sgr A* is a SBH, then how it could grow so quickly?
- What is the origin of the alleged SBH positive spin?
- Their models in the "best-bet region" have low inclination 30° and 10° that contradicts the disk shape of the MW galaxy and bipolar astrophysical jets, which are astronomical phenomena where outflows of matter are emitted as the extended beams along the axis of rotation;

- The MW galaxy (including Sgr A*) is gravitationally bounded with Virgo Supercluster (VS) and has a huge orbital angular momentum calculated based on the distance of 65 million light- years from VS and orbital speed of about 400 km/s [63]. How did MW galaxy obtain this substantial orbital angular momentum?
- What is the mechanism of gamma rays emission from the Galactic Center?
- What is the mechanism of Gamma- and X-rays emissions from the Fermi Bubbles?

In frames of WUM Macroobjects Shell Model, the results obtained by the Event Horizon Telescope Collaboration can be explained in the following way:

- The image is dominated by the bright, thick ring with the diameter of $6.337 \times 10^{10}\ m$. The ring has a comparatively dim Interior that is made up of DM Fermions DMF1 (1.3 TeV) and DMF2 (9.6 GeV), which are responsible for the excess of gamma-ray emission from Sgr A* due to their self-annihilation;
- DMPs are continuously absorbing by the Interior of the Sgr A* . Ordinary Matter is a byproduct of DMPs self-annihilation. It is re-emitted by the Interior continuously into the Shell around it;
- Very powerful gamma quants with energy of at least 1.02 MeV in the vicinity of atomic nuclei of the Shell produce electron-positron pairs with high concentration;
- The bright, thick area with the diameter of $6.337 \times 10^{10}\ m$ consists of Ordinary Matter and Electron-Positron plasma with the radius of $2.9 \times 10^{10}\ m$ that is a compact **nonthermal radio object** responsible for the strongest radio emission from the center of MW;
- The area from the radius of $3.17 \times 10^{10}\ m$ to $1.88 \times 10^{12}\ m$ is filled out with DM Fermions DMF3 (3.7 keV), which are responsible for X-rays from the center of MW due to their self-annihilation. The 400 times brighter than usual X-ray flare reported by NASA is the result of the detonation process inside of this shell, which does not destroy it; instead, Hyper-flare occurred in active region of the shell, analogous to Solar flares;
- The enclosed mass of Supermassive Compact Object of $4.154 \times 10^{6}\ M_{\odot}$ is the mass of the MW DM Core made up of DMF1 and DMF2 with the Ordinary Matter and Electron-Positron Shell and DMF3 shell;
- Sgr A* has gotten the rotational and orbital angular momenta as the result of the rotational fission of the DM Core of the Virgo supercluster;
- The inclination angle between the line of sight and the rotational angular momentum vector of Sgr A* is about 90°.

As a conclusion:

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

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Paradigm Shift for Cosmology and Classical Physics

Abstract

In 1937, Paul Dirac proposed Large Number Hypothesis and Hypothesis of Variable Gravitational Constant, and later added notion of Continuous Creation of Matter in World. Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing different mechanism of Matter creation. In this paper, we show that WUM is natural continuation of Classical Physics and can already serve as basis for Paradigm Shift for Cosmology and Classical Physics. WUM is proposed as an alternative to prevailing Big Bang Model (BBM) that relies on General Relativity.

WUM and BBM are principally different Models:

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

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

Most direct observational evidence of validity of WUM are:

1) Microwave Background Radiation and Intergalactic Plasma speak in favor of existence of **Medium**;

2) Laniakea Supercluster with binding mass $\sim 10^{17}\ M_\odot$ is home to Milky Way (MW) galaxy and $\sim 10^5$ other nearby galaxies, which did not start their movement from Initial Singularity;

3) MW is gravitationally bounded with Virgo Supercluster (VSC) and has **Orbital Angular Momentum** calculated based on distance of 65 Mly from VSC and orbital speed of $\sim 400\ km\ s^{-1}$, which far exceeds rotational angular momentum of MW;

4) Mass-to-light ratio of VSC is ~300 times larger than that of Solar ratio. Similar ratios are obtained for other superclusters. These ratios are main arguments in favor of presence of significant amounts of **Dark Matter** in World.

5) Astronomers discovered the most distant galaxy HD1 that is ~13.5 Bly away. WUM predicts discovery of galaxies with distance ~13.8 Bly .

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

Introduction

Today, a growing feeling of stagnation in Physics is shared by a large number of researchers. In some respects, the situation today is similar to that at the end of 19th century, when the common consensus held that the body of Physics was nearly complete. Discoveries of Special and General Relativity, Quantum Physics and Elementary Particles shook that belief and led to a new renaissance in Physics that lasted for a century. The genius of Einstein, Planck, Bohr, Dirac, Heisenberg, and Schrödinger allowed them to propose fundamentally new theories with very little experimental data to back them up.

During the 20th century, their theories were validated and elaborated with newly acquired experimental results. The pendulum may, however, have swung too far: today, all results must be made fit into the existing

framework. The frameworks get adjusted when necessary, particularly inconvenient results may even get discarded at times. The time may be ripe to propose new fundamental models that will be both simpler than the current state of the art, as well as open up new areas of research.

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, A. Einstein wrote: "*Since the mathematicians have invaded the theory of relativity, I do not understand it myself anymore*".

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

WUM is proposed as an alternative to the prevailing BBM. 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 spacetime (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 Big Bang (BB) and thought to have contained all the energy and spacetime of the universe. From a physical point of view, existence of a mathematical singularity is a drawback of any theory. It means that the theoretical model did not consider some significant physical phenomenon that prevents an occurrence of the singularity.

In our view, there is no way to prevent an occurrence of the initial singularity in BBM. A **Finite World** must have gotten started in a principally different way – a **Fluctuation** in the Eternal Universe with 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 a 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 a 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 (see Section 5.2). The main differences between BBM and WUM are the existence of the Medium of the World (consisting of protons, electrons, photons, neutrinos, and dark matter particles) and the source of the World's energy – the Eternal Universe.

In our view, we should make use of a number of hypotheses unknown and forgotten by mainstream scientific community in order to elaborate a New Cosmology. Below we will describe the Hypotheses belonging to classical physicists such as Newton, Le Sage, McCullagh, Riemann, Heaviside, Tesla, Dirac, and Sakharov and develop them in frames of WUM. Please pay tribute to these great physicists!

The presented Hypotheses are not new, and we do not claim credit for them. In fact, we are developing the existent Hypothesis and proposing new Hypothesis in frames of WUM. The main objective of the Model is to unify and simplify existing results in Classical Physics into a single coherent picture of a New Cosmology. Many results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers [1]-[28] (and references therein) in such cases.

Part I. History of Classical Physics

1. Classical Physics before Special Relativity [12] [13] [24]

1.1. Fundamental Physical Constants [12]

Kinetic Theory of Gases explains macroscopic properties of gases, such as pressure, temperature, viscosity, thermal conductivity, and volume, by considering their molecular composition and motion. In 1859, J. C. Maxwell formulated the Maxwell distribution of molecular velocities, which gave the proportion of molecules having a certain velocity in a specific range. This was the first-ever statistical law in Physics that defines macroscopic properties of gases as **emergent phenomena** (see Section 6.2).

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

Rydberg Constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series. As of 2018, R_∞ is the most accurately measured Fundamental physical constant.

Electron Charge-to-Mass Ratio e/m_e is a Quantity in experimental physics. It bears significance because the electron mass m_e cannot be measured directly. The e/m_e ratio of an electron was successfully calculated by J. J. Thomson in 1897. We define it after Thomson $R_T \equiv e/m_e$.

Planck Constant was suggested by M. Planck as the result of the investigations the problem of black-body radiation. He used Boltzmann's famous equation from Statistical Thermodynamics: $S = k_B \ln W$ that shows the relationship between entropy S and the number of ways the atoms or molecules of a thermodynamic system can be arranged (k_B is the Boltzmann constant). As the result of his analysis, Planck found that the average resonator entropy must be described by a function which depends on the ratios U/ν and U/E at the same time (U is vibrational energy of vibrating resonator). Planck reconciled those two requirements through $E = h\nu$ in which **h represents a factor that converts units of frequency ν into units of energy E.** In 1901, Planck calculated the value of h from experimental data: $h = 6.55 \times 10^{-34}\ J \cdot s$, that is within 1.2% of the currently accepted value. We emphasize that Planck constant, which is generally associated with the behavior of microscopically small systems, was introduced by Planck based on **Statistical Thermodynamics** before Quantum Physics.

Based on the experimentally measured values of the constants R_∞ , R_T , c, h , and the value of permeability of free space: $\mu_0 = 4\pi \times 10^{-7}\ H/m$ we calculate the most important Fundamental constants as follows:

- Basic size unit a :

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

- Dimensionless Rydberg constant α :

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

It is worth noting that the constant α was later named "Fine-structure constant";

- Mass of electron m_e :

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

- Elementary charge e :

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

All these constants, including classical electron radius $a_o = a/2\pi$, were measured and could be calculated before Quantum Physics.

1.2. History of Dark Matter. Early Ideas [24]

The history of 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:

- 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 DM in the form of 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 (MW). His argument was simple yet powerful: if stars in MW 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 MW. 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.

1.3. Nebular Hypothesis [13]

The most widely accepted model of Solar System (SS) formation, known as the Nebular hypothesis, was first proposed in 1734 by E. Swedenborg and later elaborated and expanded upon by I. Kant in 1755. This hypothesis maintains that 4.6 billion years ago, SS formed from the gravitational collapse of a giant molecular

cloud, which was light years across. Most of a mass collected in the Centre, forming the Sun; the rest of a mass flattened into a protoplanetary disc, out of which the planets and other bodies in SS formed.

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

- It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;
- Each planet and moon in SS 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 SS is concentrated in the planets, yet a staggering 99.8 percent of all the mass in SS is in our Sun;
- Jupiter itself has 60 percent of the planetary angular motion. Evolutionary theory cannot account for this. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;
- There is no possible means by which the angular momentum from the Sun could be transferred to the planets. Yet this is what would have to be done if any of the evolutionary theories of SS origin are to be accepted.

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.

Part II. Bing Bang Model

2.1. Special Relativity [Wikipedia]

The principle of relativity dates back to Galileo and was incorporated into Newtonian physics. However, in the late 19th century, the existence of electromagnetic waves led some physicists to suggest that the universe was filled with a substance they called "**Aether**", which, they postulated, would act as the medium through which these waves, or vibrations, propagated. An Aether was thought to be an **absolute reference frame** against which all speeds could be measured and could be considered fixed and motionless relative to Earth or some other fixed reference point. The Aether was supposed to be sufficiently elastic to support electromagnetic waves, while those waves could interact with Matter, yet offering no resistance to bodies passing through it. The results of various experiments, including the Michelson–Morley experiment in 1887, led to the theory of **Special Relativity** (SR) that is a scientific theory regarding the relationship between space and time. In 1905, A. Einstein based a work on SR on two postulates:

- The **laws of physics are invariant** (that is, identical) in all **inertial frames of reference** (that is, frames of reference with no acceleration);
- The **speed of light in vacuum** is the same for all observers, regardless of the motion of the light source or observer.

Lorentz invariance is the essential core of SR. Einstein's solution was to discard the notion of an "Aether" and the absolute state of rest. In relativity, any reference frame moving with uniform motion will observe the same laws of physics. In particular, the speed of light in vacuum is always measured to be c, even when measured by multiple systems that are moving at different (but constant) velocities.

2.2. General Relativity [Wikipedia]

General Relativity (GR) is a geometric theory of gravitation published by A. Einstein in 1915 and is a current description of gravitation in modern physics. It generalizes SR and refines Newton's law of universal gravitation, providing a unified description of gravity as a geometric property of **four-dimensional spacetime**.

The Einstein's field equations are nonlinear and considered difficult to solve. But in 1916, K. Schwarzschild found the first non-trivial exact solution to the Einstein field equations, the Schwarzschild metric. This solution laid the groundwork for the description of the final stages of gravitational collapse, and the objects known today as Black Holes (BHs).

In 1917, Einstein applied his theory to the universe as a whole, initiating the field of relativistic cosmology. He assumed a static universe, adding a new parameter to his original field equations—the cosmological constant—to match that observational presumption. By 1929, however, the work of Hubble and others had shown that our universe is expanding. This is readily described by the expanding cosmological solutions found by Friedmann in 1922, which do not require a cosmological constant. Einstein later declared the cosmological constant the biggest blunder of his life.

2.3. Big Bang Model [7] [15] [16] [24] [26]

The framework for BBM relies on GR and on simplifying assumptions such as homogeneity and isotropy of space. The Lambda Cold Dark Matter (ΛCDM) model is a parametrization of BBM in which the universe contains three major components: first, a Cosmological constant Λ associated with dark energy; second, a postulated Cold Dark Matter; and third, Ordinary matter.

Dark Matter. G. Bertone and D. Hooper provide an excellent review of DM along with BBM:

- 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*";
- 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 DM candidates, including axions, gravitinos, etc., a definition of this term has since evolved to denote only particles that interact through the weak force;
- By the end of the 1980s, the conclusion that most of the mass in the Universe consists of cold and nonbaryonic 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.**

The ΛCDM model is based on **six parameters**: baryon density, dark matter density, dark energy density, scalar spectral index, curvature fluctuation amplitude, and reionization optical depth. The values of these 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 ΛCDM model

can be extended by adding cosmological inflation. It is frequently referred to as the Standard Model of BB cosmology. The Four Pillars of the Standard Cosmology (SC) are as follows:

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

2.3.1. Expansion of the Universe

There is now excellent evidence for Hubble's law which states that the recessional velocity v of a galaxy is proportional to its distance d from us, that is, $v = Hd$ where H is Hubble's constant. Projecting galaxy trajectories backwards in time means that they converge to a cosmological Singularity at $t = 0$ that is an infinite energy density state. This uncovers one of the shortcomings of SC – the Horizon problem: *Why does the universe look the same in all directions when it arises out of causally disconnected regions? This problem is most acute for the very smooth cosmic microwave background radiation.*

This problem was resolved by introduction of Cosmological Inflation, which is a theory of an extremely rapid exponential expansion of space in the early universe. This rapid expansion increased the linear dimensions of the early universe by a factor of at least 10^{26}, and so increased its volume by a factor of at least 10^{78}. The inflationary epoch lasted from 10^{-36} s after the conjectured BB singularity to some time between 10^{-33} and 10^{-32} s after the singularity. Following the inflationary period, the universe continued to expand, but at a slower rate.

"*It's a beautiful theory*, said Peebles. *Many people think it's so beautiful that it's surely right. But the evidence of it is very sparse*". According to Silk, *our best theory of the beginning of the universe, inflation, awaits a definitive and falsifiable probe, in order to satisfy most physicists that it is a trustworthy theory. Our basic problem is that we cannot prove the theory of inflation is correct, but we urgently need to understand whether it actually occurred* .

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:

- *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's 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.*

L. Verde, T. Treu, and A. G. Riess gave a brief summary of the "Workshop at Kavli Institute for Theoretical Physics, July 2019". It is not yet clear whether the discrepancy in the observations is due to systematics, or indeed constitutes a major problem for the Standard model.

2.3.2. Origin of Cosmic Background Radiation

According to BBM, about 380,000 years after BB the temperature of the universe fell to the point where nuclei could combine with electrons to create neutral atoms. As a result, photons no longer interacted frequently with matter, the universe became transparent, and Microwave Background Radiation (MBR) was

created. This cosmic event is usually referred to as Decoupling. The photons that existed at the time of photon decoupling have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time. The photons present at the time of decoupling are the same photons that we see in MBR now. But then, **why is MBR is perfect black-body**?

According to **WUM**, wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They do not have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*". In frames of WUM, the black-body spectrum of MBR is due to thermodynamic equilibrium of photons with the Intergalactic Plasma (IGP), the existence of which is experimentally proved.

2.3.3. Nucleosynthesis of Light Elements

Big Bang Nucleosynthesis (BBN) refers to the production of nuclei other than those of hydrogen during the early phases of the Universe. Primordial nucleosynthesis is believed to have taken place in the interval from roughly 10 seconds to 20 minutes after the BB and is calculated to be responsible for the formation of most of the universe's helium as the isotope helium-4, along with small amounts of deuterium, helium-3, and a very small amount of lithium-7. Essentially all of the elements that are heavier than lithium were created much later, by stellar nucleosynthesis in evolving and exploding stars.

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

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

In frames of **WUM**, Nucleosynthesis of all elements (including light elements) occurs inside of DM Cores of all Macroobjects (MOs) during their evolution. The theory of Stellar Nucleosynthesis is well developed, starting with the publication of a celebrated $B^{2}FH$ review paper. With respect to WUM, this theory should be expanded to include self-annihilation of heavy DM fermions in MO Cores.

2.3.4. Formation of Galaxies and Large-Scale Structures

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

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

As a conclusion: BBM relies on the following assumptions:

- Homogeneity and isotropy of space;
- 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;
- BBM is inconsistent with the Law of conservation of angular momentum (see Section 2.4).

The performed analysis shows that the Four Pillars of SC are model-dependent and not strong enough to support BBM.

2.4. Angular Momentum Problem [13] [18] [20]

Angular momentum problem is one of the most critical problems in BBM that must be solved. Any theory of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out. SC cannot answer the following questions:

- Sun accounts for ~ 0.3% of the total angular momentum of SS while about 60% is attributed to Jupiter;
- SS has an orbital angular momentum that far exceeds rotational angular momentum;
- MW galaxy is gravitationally bounded with Virgo Supercluster and has an orbital momentum, which far exceeds the rotational angular momentum;
- How did MW galaxy and SS obtain their substantial orbital angular momenta?

To the best of our knowledge, the Standard Model does not answer these questions. **WUM is the only cosmological model in existence that is consistent with this Fundamental Law** (see Section 5.2).

2.5. Black Holes [1][16] [23][27]

BH is a **mathematical solution** of Einstein's field equations for gravity in 3+1 dimensional spacetime. The simplest BH solution is the Schwarzschild solution, which describes the gravitational field in the **spherically symmetric, static, vacuum case**. This solution is characterized with a single parameter, which corresponds to the mass of an object that produces the same gravitational field.

The existence of supermassive compact objects in galactic centers is now commonly accepted. It is commonly believed that the central mass is a Supermassive Black Hole (SBH). There exists, however, evidence to the contrary. In 2013, N. Hurley-Walker spotted a previously unknown radio galaxy NGC1534 that is quite close to Earth but is much fainter than it should be if the central BH was accelerating the electrons in the jets: *"The discovery is also intriguing because at some point in its history the central black hole switched off, but the radio jets have persisted. The interesting thing about the object I found is that it's being hosted by a spiral galaxy, like our own"*. It's also possible there was never a BH there at all.

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

In 2022, the Event Horizon Telescope (EHT) Collaboration presented outstanding 1.3 mm measurements of the radio source located at the position of the supermassive black object Sgr A* . Contemporaneous multiwavelength monitoring of Sgr A* was performed at 22, 43, and 86 GHz and at near-infrared and X-ray wavelengths. Using EHT, astronomers released the first image of the accretion disk around the Sgr A*. Based on the obtained results the EHT Collaboration claimed that Sgr A* is a SBH.

In our opinion, the results obtained by Collaboration are model-dependent and not sufficient to support this claim. Astronomers should answer some principal questions:

- The age of MW is similar to the Age of the World. The oldest star in MW (named Methuselah) is nearly as old as the World itself. If Sgr A* is a SBH, then how it could grow so quickly?
- What is the origin of the alleged SBH positive spin?
- Their models in the "best-bet region" have low inclination 30° and 10° that contradicts the disk shape of the MW galaxy and bipolar astrophysical jets, which are astronomical phenomena where outflows of matter are emitted as the extended beams along the axis of rotation;
- The MW galaxy (including Sgr A*) is gravitationally bounded with VS and has a huge orbital angular momentum (see Section 2.4). How did MW galaxy obtain this substantial orbital angular momentum?
- What is the mechanism of gamma rays emission from the Galactic Center?

In frames of **WUM,** the results obtained by the EHT Collaboration can be explained in the following way:

- The image is dominated by the bright, thick ring with the radius of $3.17 \times 10^{10}\ m$. The ring has a comparatively dim Interior that is made up of DM Fermions DMF1 (1.3 TeV) and DMF2 (9.6 GeV), which are responsible for the excess of gamma-ray emission from Sgr A*;
- Dark Matter Particles (DMPs) are continuously absorbing by the Interior of Sgr A* . Ordinary Matter is a byproduct of DMPs self-annihilation. It is re-emitted by the Interior continuously into a Shell around it;
- Very powerful gamma quants with energy of at least 1.02 MeV in the vicinity of atomic nuclei of the Shell produce electron-positron pairs with high concentration;
- The bright, thick area consists of Ordinary Matter and Electron-Positron plasma with the radius of $2.9 \times 10^{10}\ m$ that is a compact **nonthermal radio object** responsible for the strongest radio emission;
- The area from the radius of $3.17 \times 10^{10}\ m$ to $1.88 \times 10^{12}\ m$ is filled out with DM Fermions DMF3 (3.7 keV), which are responsible for X-rays from the center of MW due to their self-annihilation;
- The enclosed mass of Supermassive Compact Object of $4.154 \times 10^{6}\ M_{\odot}$ is the mass of the MW DM Core made up of DMF1 and DMF2 with the Ordinary Matter and Electron-Positron Shell and DMF3 Shell;
- Sgr A* has gotten the rotational and orbital angular momenta as the result of the rotational fission of the DM Core of the Virgo supercluster;
- The inclination angle between the line of sight and the rotational angular momentum vector of Sgr A* is about 90°.

As a conclusion: The totality of all obtained experimental results testify in favor of the existence of the supermassive compact object made up of Dark Matter particles at MW Center.

Part III. Principal Experimental Results

3.1. Electrodynamic constant

In 1857, W. Weber and R. Kohlrausch determined that there was a quantity related to electricity and magnetism, "*the ratio of the absolute electrostatic unit of charge to the absolute electromagnetic unit of charge*" (in modern language, the **electrodynamic constant** $\boldsymbol{c}$ **with the value** $\boldsymbol{c = 1/\sqrt{\mu_0 \varepsilon_0}}$, where μ_0 is the permeability of free space and ε_0 is the permittivity of free space) and determined that it should have units of velocity. They measured this ratio by an experiment which involved charging and discharging a **Leyden jar** and measuring the magnetic force from the discharge current and found a value of $c = 3.107 \times 10^{8}\ m/s$, remarkably close to the speed of light, which had recently been measured at $c_{light} = 3.15 \times 10^{8}\ m/s$ by H. Fizeau in 1849 and at $c_{light} = 2.98 \times 10^{8}\ m/s$ by L. Foucault in 1850. However,

Weber and Kohlrausch did not make the connection to the speed of light. In 1861, J. Maxwell established the connection to the speed of light and concluded that light is a form of electromagnetic radiation.

In the physical sciences, a **wavenumber** k is a **spatial frequency** of a wave. Whereas **temporal frequency** can be thought of as the number of waves per unit time, wavenumber is the number of waves per unit distance. The wavenumber follows from the Helmholtz wave equation, which can be derived from Maxwell's equations (MEs). The Helmholtz equation is a partial differential equation:

$$\nabla^2 E - \omega^2 \mu\varepsilon E = 0$$

For a plane wave of angular frequency ω traveling in the x direction, the solution to the Helmholtz equation is of the form:

$$E(x,t) = E_0 \cos(\omega t - kx)$$

where k is the wavenumber, which is given by:

$$k = \omega\sqrt{\mu\varepsilon}$$

Electromagnetic waves in any bulk material move at the velocity of light v_{light} that is a function of permeability μ and permittivity ε of the material:

$$v_{light} = 1/\sqrt{\mu\varepsilon}$$

In free space, electromagnetic waves move at the velocity c_{light}:

$$c_{light} = 1/\sqrt{\mu_0\varepsilon_0} = c$$

The free-space k_0 can be expressed as a function of frequency f and velocity, or just the wavelength:

$$k_0 = \frac{\omega}{c_{light}} = \frac{2\pi f}{c} = \frac{2\pi}{\lambda}$$

From this equation, we can get a relation $\boldsymbol{c = f\lambda}$, where c is the **electrodynamic constant** (see Section 3.2).

3.2. Speed of Light [Wikipedia]

The first measurement of the speed of light v_{light} was made by H. Fizeau in 1849: $v_{light} = 315000\ km/s$ with +5.1% error. The last measurement of v_{light} with rotating mirror was made by A. Michelson in 1926: $v_{light} = 299796 \pm 4\ km/s$ with +12 ppm error.

Another way to find v_{light} is to independently measure the frequency f and wavelength λ of an electromagnetic wave and calculate it using the relation $\boldsymbol{v_{light} = f\lambda}$. One option is to measure the resonance frequency of a cavity resonator. If the dimensions of the resonance cavity are also known, these can be used to determine the wavelength of the wave. In 1950, L. Essen obtained the following result: $v_{light} = 299792.5 \pm 4\ km/s$ with +0.14 ppm error.

Interferometry is another method to find wavelength of electromagnetic radiation for determining v_{light}. A coherent beam of light (e.g. from a laser), with a known frequency f, is split to follow two paths and then recombined. By adjusting the path length while observing the interference pattern and carefully measuring the change in path length, the wavelength of the light λ can be determined. v_{light} is then calculated using the equation $\boldsymbol{v_{light} = f\lambda}$. In 1972, using the laser interferometer method a group at the US National Bureau of Standards in Boulder, Colorado determined the speed of light to be $v_{light} = 299792456.2 \pm 1.1\,m/s$. This was 100 times less uncertain than the previously accepted value.

In 1983, the 17th meeting of the General Conference on Weights and Measures (CGPM) redefined the metre as: "The metre is the length of the path traveled by light (**in vacuum ?**) during a time interval of 1/299792458

of a second". As a result of this definition, the value of the speed of light **(in vacuum ?**) is exactly 299792458 m/s and has become a defined constant in the SI system of units.

In **WUM**, there are no speed of light in vacuum and massless photons because there is no vacuum in the World. In reality, there is the Medium of the World with IGP and the minimum energy of photons passing through IGP (see Section 5.3.4). We emphasize that c is the **electrodynamic constant** in MEs but not a speed of light in vacuum as it is accepted now. Using the relation $\boldsymbol{v_{light} = f\lambda}$ is, in fact, the way to measure the value of the electrodynamic constant (see Section 3.1).

3.3. Cosmic Microwave Background

In 1965, A. Penzias and R. Wilson discovered Cosmic Microwave Background Radiation (MBR).

3.4. Fast Radio Bursts [7] [8]

In radio astronomy, a Fast Radio Burst (FRB) is a transient radio pulse of length ranging from a fraction of a millisecond to a few milliseconds, caused by some high-energy astrophysical process not yet understood. Astronomers estimate the average FRB releases as much energy in a millisecond as the Sun puts out in 3 days. The first FRB was discovered by D. Lorimer and D. Narkevic in 2007. FRBs have pulse dispersion measurements $> 100\ pc\ cm^{-3}$, much larger than expected for a source inside the MW galaxy and consistent with a propagation through IGP.

The existence of MBR and IGP means that there is no vacuum in the universe as it was claimed by SR in 1905. In **WUM**, we introduce the Medium of the World, which is composed of stable elementary particles: protons, electrons, photons, neutrinos, and DMPs.

Part IV. Hypotheses Revisited by WUM

4.1. Aether [12]

Physical Aether was suggested as early as 18th 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. At that time, it was realized that Aether could not be an elastic matter of an ordinary type that can only transmit longitudinal waves.

Unique properties of Aether were discussed by J, McCullagh in 1846 who proposed a theory of a rotationally elastic medium. 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. Aether with these properties can transmit transverse waves. J. McCullagh has this to say about the Aether: "*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.*"

Luminiferous Aether was abandoned in 1905 by Special Relativity. In later years there have been classical physicists who advocated the existence of Aether:

- N. Tesla declared in 1937 in "Prepared Statement on the 81st birthday observance": *All attempts to explain the workings of the universe without recognizing the existence of the aether and the indispensable function it plays in the phenomena are futile and destined to oblivion* ;
- P. Dirac stated in 1951 in an article in Nature, titled "Is there an Aether?" that *we are rather forced to have an aether* .

WUM is based on Maxwell's equations, and McCullagh's theory is a good fit for description of the Medium. The Model introduces the Medium of the World that is some kind of "Aether" composed of stable elementary particles. The existence of the Medium is a principal point of WUM. It follows from the observations of IGP; MBR; Far-Infrared Background (FIFB) Radiation. According to WUM, inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. The Medium is the absolute frame of reference. The total energy density of the Medium is 2/3 of the total energy density of the World in all cosmological times. All Macroobjects (MOs) are built from the same particles. The energy density of MOs adds up to 1/3 of the total energy density throughout the World's evolution. In our opinion, the **Medium of the World is the Savior of Classical Physics! Don't throw the baby out with the bathwater.**

4.2. Le Sage's Theory of Gravitation [12] [25]

Wikipedia summarizes this unique theory as follows: *"Sage's theory of gravitation is a kinetic theory of gravity originally proposed by Nicolas Fatio de Duillier in 1690 and later by Georges-Louis Le Sage in 1748. The theory proposed a mechanical explanation for Newton's gravitational force in terms of streams of tiny unseen particles (which Le Sage called ultra-mundane corpuscles) impacting all material objects from all directions. According to this model, any two material bodies partially shield each other from the impinging corpuscles, resulting in a net imbalance in the pressure exerted by the impact of corpuscles on the bodies, tending to drive the bodies together".*

Le Sage proposed quantitative estimates for some of the theory's parameters:
- He called the gravitational particles ultramundane corpuscles because he supposed them to originate beyond our known universe. The distribution of the ultramundane flux is isotropic, and the laws of its propagation are very similar to that of light;
- He suggested that the ultramundane corpuscles might move at the speed of light;
- To maintain mass proportionality, ordinary matter consists of cage-like structures, in which their diameter is only the 10^7th part of their mutual distance, so the particles can travel through them nearly unhindered.

L. Spitzer in 1941 calculated, that absorption of radiation between two dusts particles lead to a net attractive force which varies proportional to r^{-2} . The Le Sage mechanism also has been identified as a significant factor in the behavior of dusty plasma. A. M. Ignatov has shown that an attractive force arises between two dust grains suspended in isotropic collisionless plasma due to inelastic collisions between ions of the plasma and the grains of dust. This attractive force is inversely proportional to the square of the distance between dust grains and can counterbalance the Coulomb repulsion between dust grains.

In frames of **WUM**, the time-varying Gravitational parameter $G \propto \tau^{-1}$ is proportional to the energy density of the Medium of the Word $\rho_M \propto \tau^{-1}$ (see Section 5.3.1). It is not constant. That is why, WUM aligns gravity with the Le Sage's theory of gravitation. In WUM, the gravity is a result of simple interactions of DM particles DMF4 with Matter that work cooperatively to create a more complex interaction. The total DMF4 energy

density is about 68.8% of the total energy density of the World (see Section 5.3.8). DM particles DMF4 are responsible for the Le Sage's mechanism of the gravitation.

To summarize:

- Le Sage's theory of gravitation defines Gravity as an emergent phenomenon;
- Gravity is not an interaction but a manifestation of the Medium;
- The proposed mechanism of Gravitation resembles Le Sage's theory.

4.3. Hypersphere Universe [7]

In 1854, G. Riemann proposed a Hypersphere as a model of a finite universe. A hypersphere is the four-dimensional analog of a sphere. A regular three-dimensional Ball has a two-dimensional surface. Similarly, a 4-dimensional Ball (the Nucleus of the World) has a 3-dimensional surface (the Hypersphere).

In 1870, W. Clifford made the statement that matter is nothing, but ripples, hills and bumps of space curved in a higher dimension and the motion of matter is nothing more than variations in that curvature. He speculated that the force of electricity and magnetism is caused by the bending of higher-dimensional space and planned to add gravity to his theory at later date. This is the first time that anyone had speculated that a "force" is nothing but the bending of space itself, preceding A. Einstein by 45 years. Clifford's idea that electromagnetism was caused by vibrations in the fourth dimension also preceded the work of T. Kaluza, who would also attempt to explain electromagnetism with the higher dimension.

WUM follows the idea of the Hypersphere Universe, albeit proposing that the World is evenly stretched as the result of the expansion of the Nucleus of the World along the fourth spatial dimension. The World is filled out with the Medium and MOs consisting of stable elementary particles.

4.4. Gravitoelectromagnetism [11] [27]

Gravitoelectromagnetism (GEM) is a gravitational analog of Electromagnetism. GEM equations differing from Maxwell's equations by some constants were first published by O. Heaviside in 1893 as a separate theory expanding Newton's law. GEM is an approximation to the Einstein's gravity equations in the weak field limit. H. Thirring pointed out this analogy in his "*On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation*" paper published in 1918. It allows us to use formal analogies between the electromagnetism and relativistic gravity. In case of the strong field limit, we should use the Einstein's gravity equations.

In 2021, G. Ludwig in his paper "Galactic rotation curve and dark matter according to gravitomagnetism" wrote: *Most theories used to explain the rotation curve have been restricted to the Newtonian potential framework, disregarding the general relativistic corrections associated with mass currents. In this paper it is shown that the gravitomagnetic field produced by the currents modifies the galactic rotation curve, notably at large distances. The coupling between the Newtonian potential and the gravitomagnetic flux function results in a nonlinear differential equation that relates the rotation velocity to the mass density. The solution of this equation reproduces the galactic rotation curve without recourse to obscure dark matter components.* ***The effects attributed to dark matter can be simply explained by the gravitomagnetic field produced by the mass currents*** [Ludwig, G. O. (2021) Galactic rotation curve and dark matter according to gravitomagnetism. Eur. Phys. J. C **81**, Article number:186. https://doi.org/10.1140/epjc/s10052-021-08967-3].

In accordance with **WUM**, DM is concentrated in the Cores of all MOs. There are no BHs. Instead, there are DM Cores of galaxies. WUM is based on the Gravitomagnetism. The explanation of galactic rotation curve made by G. O. Ludwig is in good agreement with the approach of WUM.

4.5. Dirac Large Number Hypothesis [12]

Dirac Large Number Hypothesis is an observation made by P. Dirac in 1937 relating ratios of size scales in the Universe to that of force scales. The ratios constitute very large, dimensionless numbers, some 40 orders of magnitude in the present cosmological epoch. According to Dirac's hypothesis, the apparent equivalence of these ratios might not to be a mere coincidence but instead could imply a cosmology where the strength of gravity, as represented by the gravitational "constant" G, is inversely proportional to the cosmological time τ: $G \propto \tau^{-1}$.

WUM follows the idea of time-varying G and introduces 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, Dirac Large Number:

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

where $t_0 = a/c$ is the basic time unit. In the present Epoch, $Q = 0.759972 \times 10^{40}$.

4.6. Emergent Gravity, Space and Time [12]

C. Barcelo, *et al.* have this to say about emergent gravity: *One of the more fascinating approaches to "quantum gravity" is the suggestion, typically attributed to Sakharov that gravity itself may not be "fundamental physics". Indeed, it is now a relatively common opinion, that gravity (and in particular the whole notion of spacetime and spacetime geometry) might be no more "fundamental" than is fluid dynamics. The word "fundamental" is here used in a rather technical sense – fluid mechanics is not fundamental because there is a known underlying microphysics that of molecular dynamics, of which fluid mechanics is only the low-energy low-momentum limit*.

WUM: Time and Space are closely connected with Mediums' Impedance and Gravitomagnetic parameter. It follows that neither Time nor Space could be discussed in absence of the Medium. The gravitational parameter G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. Gravity, Space and Time are all emergent phenomena. In this regard, it is worth to recall the Einstein's quote: *When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter.*

Part V. Hypersphere World-Universe Model

5.1. Assumptions [28]

WUM is based on the following primary assumptions:

- The World is a Finite Boundless 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. As the result, the Hypersphere is evenly stretched;
- The Eternal Universe serves as an unlimited source of DM, which is 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.

5.2. Principal Points [9] [10] [19] [21] [22] [28]

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 size unit of 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 Boundless 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 Center 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 evenly stretched so that the radius of the Nucleus is increasing with speed c that is the gravitodynamic constant. The stretching of the Hypersphere World can be understood through the analogy with 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.

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".

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

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

Content of the World. The World consists of the Medium and MOs. Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium is 2/3 of the total energy density and MOs (Superclusters, Galaxies, Extrasolar Systems (ESS), Planets, Moons, *etc.*) –

1/3 in all cosmological times. The relative energy density of DM 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 4.8% in the Medium of the World and 2.4% in MOs (see Section 5.3.8).

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.

We do not know that our 3D space is curved. But we know that it is expanding without center of expansion. We introduce the radius of the curvature in the fourth spatial dimension $R = a \times Q$ to give an explanation providing insight into the curved nature of the World. In WUM, Local Physics is linked with the large-scale structure of the Hypersphere World through the dimensionless quantity Q. The proposed approach to the fourth spatial dimension agrees with Mach's principle: "*Local physical laws are determined by the large-scale structure of the universe* ". Applied to WUM, it follows that all parameters of the World depending on Q are a manifestation of the Worlds' curvature in the fourth spatial dimension.

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** (PCPs) and calculates their values, which are in good agreement with the latest results of their measurements.

The mechanism that can provide Angular Momenta to Macroobjects is **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".

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 an **Explosive Volcanic Rotational Fission** of Overspinning DM Supercluster's Cores and self-annihilation of DMPs.

Macroobjects Shell Model. MOs of the World possess the following properties: their Cores are made up of DMPs; they contain other particles, including DMPs and Ordinary Particles, in shells surrounding the Cores. 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. 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. 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$), which emerged in different places of the World at different Cosmological times. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous.

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

As a conclusion: The described picture of the creation and evolution of the World is, in fact, a Paradigm Shift for Cosmology.

5.3. Predictions and Explained Problems [1]-[7] [14] [17] [23] [28]

> *It doesn't make any difference how beautiful your guess is, it doesn't make any difference how smart you are, who made the guess, or what his name is. If it disagrees with experiment, it is wrong. That is all there is to it.*
>
> Richard Feynman

In 2013, WUM revealed a self-consistent set of time-varying values of PCPs of the World: Gravitation parameter, Hubble's parameter, Temperature of MBR, and concentration of IGP. Based on the inter-connectivity of these parameters WUM performed precise calculations of PCPs values that were only measured experimentally earlier and made verifiable predictions. The remarkable agreement of the calculated values of PCPs with the observational data gives us considerable confidence in the Model.

5.3.1. Newtonian Constant of Gravitation

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

- The cosmic FIRB was announced in 1999 ;
- MBR temperature was measured in 2009 ;
- Nine-Year Wilkinson Microwave Anisotropy Probe Observations were published in 2012 .

At the same time, the most important for the Cosmology, Newtonian constant of gravitation G, proved too difficult to measure. Its measurement precision was the worst among all Fundamental physical constants.

In 2010, CODATA stated the following value of G:

$$G(2010) = 6.67384 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (120\ ppm)$$

with Relative Standard Uncertainty (RSU): $RSU = 1.2 \times 10^{-4} = 120\ ppm$.

In 2013, WUM proposed a principally different way to solve the problem of G measurement precision. WUM revealed a self-consistent set of time-varying values of PCPs. Based on the value of Fermi Coupling constant in 2010:

$$G_F(2010) = 1.166364 \times 10^{-5} GeV^{-2} \ (4.3\ ppm)$$

WUM predicted the value of the gravitational constant G^*_{2014} equals to:

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

and recommended this value to CODATA. To the best of our knowledge, no breakthrough in G measurement methodology has been achieved since. Nevertheless, in 2015 CODATA recommended a more precise value of G(2014):

$$G(2014) = 6.67408 \times 10^{-11} m^3 kg^{-1} s^{-2} \ (47\ ppm)$$

In 2018, the recommendation improved further:

$$G(2018) = 6.67430 \times 10^{-11} m^3 kg^{-1} s^{-2} \ (22\ ppm)$$

Since 2013, the relative standard uncertainty of G measurements reduced from 120 ppm to 22 ppm! It seems that CODATA considered the WUM's recommendation of the predicted value of G and used it for G(2014) and $G(2018)$ without any reference or explanation of their methodology.

Considering a more precise value of Fermi Coupling constant in 2014:

$$G_F(2014) = 1.1663787 \times 10^{-5} GeV^{-2} \ (0.51\ ppm)$$

WUM calculated the predicted value of gravitational constant G^*_{2018} :

$$G^*_{2018} = 6.674536 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

which is x8 more accurate than G^*_{2014} . The predicted value of G^*_{2018} is in excellent agreement with the experimentally measured by Q. Li, *et al.* in 2018 values of G using two independent methods:

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

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

WUM recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of the Newtonian Constant of Gravitation G^*_{2018} .

5.3.2. Hubble's Constant

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 frames of **WUM**, the Hubble tension can be explained the following way:

- All measurements of H are model-dependent;
- Statistics of these measurements is not sufficient to yield reliable conclusions;
- Hubble's law in SC is valid for BBM 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.

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.** The calculated value of Hubble's constant in 2013: $H_0 = 68.733\ km/s\ Mpc$ is in excellent agreement with the most recent measured value in 2021: $H_0 = 68.7 \pm 1.3\ km/s\ Mpc$ using only MBR data.

The main differences between BBM and WUM are:

- Mainstream scientists, following BBM, measure the values of H based on various characteristics of MOs, the distribution of which in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous;
- WUM suggests that the value of H should be measured based on MBR only, which depends on the characteristics of the Medium of the World. The Medium is Homogeneous and Isotropic. Its parameters do not practically depend on MOs, which can create some perturbations in It.

This explanation is in good agreement with the experimental results provided by W. L. Freedman who belongs to the camp that believes that the difference could be due to errors in measurement. **I belong to the camp that believes that the difference is significant!**

5.3.3. Missing Baryon

The Missing Baryon Problem is related to the fact that the observed amount of baryonic matter did not match theoretical predictions. Observations by the Planck spacecraft in 2015 yielded a theoretical value for baryonic matter of 4.85% of the contents of the Universe. However, directly adding up all the known baryonic matter produces a baryonic density less than half of this.

The existence of the Medium of the World is a principal point of WUM. It follows from the observations of MBR and IGP. Detailed analysis of IGP carried out in 2013 showed that the relative energy density of protons in the Medium Ω_p is: $\Omega_p = 2\pi^2\,\alpha/3 = 4.8014655\%$.

In our opinion, direct measurements of the IGP parameters can be done by investigations of Fast Radio Bursts, which are millisecond duration radio signals originating from distant galaxies. These signals are dispersed according to a precise physical law and this dispersion is a key observable quantity which, in tandem with a redshift measurement, can be used for fundamental physical investigations.

The dispersion measure and redshift, carried out in 2016 by E. F. Keane, *et al.*, provide a direct measurement of density of ionized baryons in the intergalactic medium Ω_{IGM}: $\Omega_{IGM} = 4.9 \pm 1.3\%$ that is in excellent agreement with the predicted by WUM value of Ω_p in 2013.

5.3.4. Minimum Energy of Photons

Analysis of IGP shows that the value of the lowest plasma frequency ν_{pl} is:

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

Photons with energy smaller than $E_{ph} = h\nu_{pl}$ cannot propagate in plasma, thus $h\nu_{pl}$ is the smallest amount of energy a photon may possess. Following L. Bonetti, *et al.* we can call this amount of energy the rest energy of photons that equals to

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

The above value, predicted by WUM in 2013, is in good agreement with the value

$$E_{ph} \lesssim 2.2 \times 10^{-14}\ eV$$

obtained by L. Bonetti, *et al.* in 2017. It is more relevant to call E_{ph} the minimum energy of photons which can pass through IGP.

5.3.5. Black-body spectrum of MBR

According to BBM, the photons that existed at the time of photon decoupling have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time. The photons present at the time of decoupling are the same photons that we see in MBR now. But then, **why MBR is a perfect black-body**?

According to **WUM**, wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They don't have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*". In frames of WUM, the black-body spectrum of MBR is due to thermodynamic equilibrium of photons with IGP. We calculate the value of MBR temperature T_{MBR}:

$$T_{MBR} = \frac{E_0}{k_B}\left(\frac{15\alpha}{2\pi^3}\frac{m_e}{m_p}\right)^{1/4} \times Q^{-1/4} = 2.72518\ K$$

The calculated value of T_{MBR} is in excellent agreement with measured value of $2.72548 \pm 0.00057\ K$.

5.3.6. Far-Infrared Background Radiation

The cosmic FIRB which was announced in 1998, is part of the Cosmic Infrared Background with wavelengths near 100 microns that is the peak power wavelength of the black-body radiation at temperature 29 K. In frames of WUM, we calculate the temperature of the peak of FIRB T_{FIRB} :

$$T_{FIRB} = \left(15/4\pi^5\right)^{1/4} E_0/k_B \times Q^{-1/4} = 28.955\ K$$

that is in an excellent agreement with experimentally measured value of $29\ K$.

5.3.7. Center of Milky Way Galaxy

In 2013, WUM made one of the most important predictions: "*Macroobjects of the World have cores made up of the discussed DM (Dark Matter) particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*". Prof. R. Genzel and A. Ghez confirmed this prediction: "The Discovery of a Supermassive Compact Object at the Centre of Our Galaxy" (Nobel Prize in Physics 2020). On May 12, 2022, astronomers, using the Event Horizon Telescope, released the first image of the accretion disk around the Sagittarius A*(Sgr A*) produced using a world-wide network of radio observatories made in April 2017. They claimed that Sgr A* is SBH. We analyzed these results. Based on the totality of all accumulated experimental results for the Center of MW we conclude that **Sgr A* is the DM Core of our Galaxy**.

5.3.8. Rest Energies of DMPs and Neutrinos

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; self-annihilating fermions – DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain

- The diversity of Very High Energy gamma-ray sources in the World;

- The diversity of DM Cores of Macroobjects of the World (superclusters, galaxies, and extrasolar systems), which are Fermion Compact Objects in WUM.

WUM predicts the following **rest energies for neutrinos**: a tauonic neutrino ($4.5 \times 10^{-2}\ eV$); a muonic neutrino ($7.5 \times 10^{-3}\ eV$); and an electronic neutrino ($3.1 \times 10^{-4}\ eV$).

5.3.9. Distribution of Matter

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.

5.3.10. Weak Interaction

WUM introduce **Weak Interaction** between DMPs and Ordinary particles that provides integrity of all Shells in MOs' Cores.

5.3.11. Explained Problems

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

- **Faint young Sun paradox** describes the apparent contradiction between observations of liquid water early in Earth's history and the astrophysical expectation that the Sun's output would be only 70% as intense during that epoch as it is during the modern epoch. In WUM, all MOs of the World were fainter in the past. As their cores absorb new DMPs, the sizes of MOs and thus their luminosity are increasing in time $\propto \tau$. Considering the age of the World $\cong$ 14.2 Byr and the age of SS $\cong$ 4.6 Byr, it is easy to find that the young Sun's output was only 67.6% of what it is today;
- **Matter-Antimatter Asymmetry problem.** Ordinary Matter is a byproduct of DMPs self-annihilation. This problem does not arise (since antimatter does not get created by DMPs self-annihilation);
- **Black-body spectrum of MBR** is due to thermodynamic equilibrium of photons with IGP;
- **Unidentified Infrared Discrete Emission Bands** with peaks 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm explained by self-annihilation of DM particles DMF4 (0.2 eV);
- **Solar Corona, Geocorona and Planetary Coronas** made up of DMPs resemble honeycombs filled with plasma particles (electrons, protons, multicharged ions), which are the result of DMPs self-annihilation;
- **Lightning Initiation problem** and **Terrestrial Gamma-Ray Flashes** are explained by the self-annihilation of DMPs in Geocorona;
- **Ball Lightnings** are 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. WUM predicts a **new phenomenon** – a generation of Ball Lightnings (BLs) according to the proposed model of them. Once we master a creation of BLs in a controlled environment, we can concentrate our efforts on harvesting that energy from a practically infinite Source – the Medium of the World with DMPs.

As a conclusion: Medium of the World, Dark Matter, and Angular Momentum are **Three Pillars of WUM**.

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

Part VI. Classical Physics

6.1. Primary Notions [Wikipedia]

According to Wikipedia, **Classical Physics** *is a group of physics theories that predate modern, more complete, or more widely applicable theories. If a currently accepted theory is considered to be modern, and its introduction represented a major paradigm shift, then the previous theories, or new theories based on the older paradigm, will often be referred to as belonging to the area of "classical physics".*
As such, the definition of a classical theory depends on context. Classical physical concepts are often used when modern theories are unnecessarily complex for a particular situation. Most often classical physics refers to pre-1900 physics, while ***modern physics refers to post-1900 physics which incorporates elements of quantum mechanics and relativity*** .

There is no doubt that we cannot develop any scientific concept about the physical world without establishing a primary idea of **Space** and **Time**. Newton's primary notion of Space and Time is documented in his Principles of Mathematics:

Absolute Space, in its own nature, without regard to anything external, remains always similar and immovable. Relative Space is some movable dimension or measure of the absolute spaces; which our senses

determine, by its position to bodies; and which is vulgarly taken for immovable space… And so instead of absolute places and motions, we use relative ones; and that without any inconvenience in common affairs; but in Philosophical disquisitions, we ought to abstract from our senses, and consider things themselves, distinct from what are only sensible measures of them. For it may be that there is nobody really at rest, to which the places and motions of others may be referred.

Absolute, True, and Mathematical Time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called Duration: Relative, Apparent, and Common Time is some sensible and external (whether accurate or unequable) measure of Duration by the means of motion, which is commonly used instead of True time; such as an Hour, a Day, a Month, a Year… All motions may be accelerated and retarded, but the True, or equably progress, of Absolute time is liable to no change.

Euclidean Space is the fundamental space of geometry, intended to represent **Physical Space**. Originally, it was the **three-dimensional space of Euclidean geometry**.

In mathematical physics, **Minkowski Spacetime** is a combination of three-dimensional **Euclidean Space** and **Time** into a four-dimensional manifold where the spacetime interval between any two events is independent of the inertial frame of reference in which they are recorded. Although initially developed by H. Minkowski for Maxwell's equations of electromagnetism, the mathematical structure of Minkowski spacetime was shown to be implied by the postulates of Special Relativity.

Minkowski spacetime is closely associated with Einstein's theories of **Special Relativity** and **General Relativity** and is the most common mathematical structure on which special relativity is formulated. Because it treats time differently than it treats the 3 spatial dimensions, Minkowski spacetime differs from four-dimensional Euclidean space.

In physics, the **Gravity** is a fundamental interaction which causes mutual attraction between all things with mass or energy. Gravity is by far the weakest of the four fundamental interactions. As a result, it has no significant influence at the level of subatomic particles. However, gravity is the most significant interaction between objects at the **Macroscopic Scale,** and it determines the motion of planets, stars, galaxies, etc.

General Relativity describes Gravity not as a force, but as the curvature of spacetime, caused by the uneven distribution of mass, and causing masses to move along geodesic lines. The most extreme example of this curvature of spacetime is BH, from which nothing—not even light—can escape once past the BH's event horizon. However, for most applications, gravity is well approximated by Newton's law of universal gravitation.

Scientists are currently working to develop a theory of gravity consistent with quantum mechanics, a quantum gravity theory, which would allow gravity to be united in a common mathematical framework (a **theory of everything**) with the other three fundamental interactions of physics.

In physics, the **Principle of Relativity** is the requirement that the equations describing the laws of physics have the same form in all admissible frames of reference (including inertial forces). For example, in the framework of special relativity the Maxwell equations have the same form in all inertial frames of reference. In the framework of general relativity the Einstein field equations have the same form in arbitrary frames of reference.

In modern physical cosmology, the cosmological principle **Universality of Physical Laws** is the notion that the spatial distribution of matter in the universe is homogeneous and isotropic when viewed on a large enough scale, since the forces are expected to act uniformly throughout the universe, and should, therefore, produce no observable irregularities in the large-scale structuring over the course of evolution of the matter field that was initially laid down by BBM.

In physics, a **Conservation Law** states that a particular measurable property of an **isolated physical system** does not change as the system evolves over time. **Exact Conservation Laws** include conservation of mass and energy, conservation of linear momentum and angular momentum, and conservation of electric charge.

One particularly important result concerning conservation laws is **Noether theorem**, which states that there is a one-to-one correspondence between each one of them and a differentiable symmetry of nature:

- Conservation of energy follows from the time-invariance of physical systems;
- Conservation of linear momentum follows from the space-translation invariance (translation along x, y, z directions);
- Conservation of angular momentum arises from the fact that physical systems behave the same way regardless of how they are oriented in space (rotation invariance - rotation about x, y, z axes).

6.2. Paradigm Shift for Classical Physics [28]

Classical Physics is a branch of Physics that should be described by classical notions, which define emergent phenomena. An **Emergent Phenomenon** is a property that is a result of simple interactions that work cooperatively to create a more complex interaction. Physically, simple interactions occur at a microscopic level, and the collective result can be observed at a macroscopic level. WUM introduces classical notions, when the very first ensemble of particles was created at the cosmological time $\tau_M \cong 10^{-18}\ s$ and become possible to introduce the notion "**Medium of the World**". We emphasize that Classical Physics is principally different from Quantum Physics that describes quantum objects, which have only four-momenta. **Classical Physics is dealing with ensembles of quantum objects!**

The World is a **3D Hypersphere of the 4D Nucleus of the World**, which is expanding in Its fourth spatial dimension. As the result, the Hypersphere is evenly stretched. 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 in the fourth spatial dimension 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** τ that is principally different from the **Solar Time** t (which is defined by the parameters of SS: the Rotation of the Earth around its own axis – day and the Sun – year) and **Cosmic Time** of the General Relativity. It is defined by the **Impedance** (Wave Resistance) of the Medium of the World that equals to the Hubble's parameter $H = \tau^{-1}$. Cosmological Time marches on at constant pace since the Beginning of the World until the present Epoch and defines the Age of the World $A_\tau = \tau$. All time-varying parameters of the World can be measured relatively to the Age of the World.

According to WUM:

- The World's energy density is $\rho_W \propto \tau^{-1}$ in all cosmological times;

- The particles relative energy densities are proportional to the dimensionless Rydberg constant α ;
- All time-varying PCPs of the World: Gravitation, Hubble's, Concentration of IGP, Temperature of MBR, etc. have values that reversibly depend on cosmological time τ .

WUM concludes that any theory of evolution of the World should be consistent with the Cosmological Time. In the Classical Physics and our everyday life we use an **alleged Space (3D Euclidean) and Solar Time** $\boldsymbol{t}$.

Time-Varying Gravitational parameter $G \propto \tau^{-1}$ 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.**

WUM states a **Supremacy of Matter**: **Time, Space and Gravitation** have no separate existence from Matter. They are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium of the World respectively. Gravitation, Space and Time are all emergent phenomena. In this regard, it is worth recalling 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*".

It turned out that 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 the potential energy of deformation depends only on the rotation of the volume elements and not on their compression or general distortion.

Principle of Relativity is valid because the Medium of the World is an absolute frame of reference. Then, there is no need to discuss Special Relativity and General Relativity, which abandoned the Aether in 1905.

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. It is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of the total Matter. The distribution of MOs with 1/3 of the total Matter is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous, and therefore, the Cosmological Principal is not viable for the entire World.

Conservation Laws of Energy, Linear Momentum and Angular Momentum are not **Exact Conservation Laws** because the World is not an isolated physical system and is continuously getting Dark Matter from the Eternal Universe.

WUM is based on **Maxwell's Equations** (MEs) that form the foundation of classical Electrodynamics and Gravitomagnetism. The Einstein field equations are nonlinear MEs in the strong field limit. In MEs, there are no notions "Charge" and "Energy" but there are "**Charge Density**" and "**Energy Density**". MEs produce only two physically measurable quantities: **energy density and energy flux density**.

Angular Momenta of MOs are due to the Explosive Volcanic Rotational Fission of Overspinning DM Supercluster's Cores.

As a conclusion:

- The proposed new Primary Notions are, in fact, a Paradigm Shift for Classical Physics.

- Based on the totality of results obtained by WUM, we suggest adopting the existence of Dark Matter and the Medium of the World that is the Savior of the Classical Physics.

Conclusion

WUM is based on two parameters only: dimensionless 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.

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 Paradigm Shift for Cosmology and Classical Physics. The Model should be developed into the well-elaborated theory by the entire physical community.

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Cosmology and Classical Physics. Summary

Abstract

In 1937, Paul Dirac proposed Large Number Hypothesis and Hypothesis of Variable Gravitational Constant, and later added notion of Continuous Creation of Matter in World. Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing different mechanism of Matter creation. In this paper, we show that WUM is natural continuation of Classical Physics. WUM is proposed as an alternative to prevailing Big Bang Model (BBM) that relies on General Relativity.

WUM and BBM are principally different Models:

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

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

Most direct observational evidence of validity of WUM are:

1) Microwave Background Radiation and Intergalactic Plasma speak in favor of existence of **Medium**;

2) Laniakea Supercluster with binding mass $\sim 10^{17}\ M_\odot$ is home to Milky Way (MW) galaxy and $\sim 10^5$ other nearby galaxies, which did not start their movement from Initial Singularity;

3) MW is gravitationally bounded with Virgo Supercluster (VSC) and has **Orbital Angular Momentum** calculated based on distance of 65 Mly from VSC and orbital speed of $\sim 400\ km\ s^{-1}$, which far exceeds rotational angular momentum of MW;

4) Mass-to-light ratio of VSC is ~300 times larger than that of Solar ratio. Similar ratios are obtained for other superclusters. These ratios are main arguments in favor of presence of significant amounts of **Dark Matter** in World.

5) Astronomers discovered the most distant galaxy HD1 that is ~13.5 Bly away. WUM predicts discovery of galaxies with distance ~13.8 Bly .

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

Introduction

WUM is proposed as an alternative to the prevailing BBM. 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 spacetime (with practically infinite speed) in the early universe up to 93 billion light-years in diameter of the observable universe for time $< 10^{-32}\ s$. The size of the whole universe is unknown, and it might be infinite in extent.

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

In our view, there is no way to prevent an occurrence of the initial singularity in BBM. A **Finite World** must have gotten started in a principally different way – a **Fluctuation** in the Eternal Universe with 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 a 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 a 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 (see Section 4.2). The main differences between BBM and WUM are the existence of the Medium of the World (consisting of protons, electrons, photons, neutrinos, and dark matter particles) and the source of World's energy – the Eternal Universe. The main objective of the Model is to unify and simplify existing results in Classical Physics into a single coherent picture of a New Cosmology. Results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers [1]-[27] (and references therein) in such cases.

Part I. History of Classical Physics

1. Classical Physics before Special Relativity [12] [13] [24]

1.1. Fundamental Physical Constants [12]

Kinetic Theory of Gases explains macroscopic properties of gases, such as pressure, temperature, viscosity, thermal conductivity, and volume, by considering their molecular composition and motion. In 1859, J. C. Maxwell formulated the Maxwell distribution of molecular velocities, which gave the proportion of molecules having a certain velocity in a specific range. This was the first-ever statistical law in Physics that defines macroscopic properties of gases as **emergent phenomena** (see Section 5.2).

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

Rydberg Constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series. As of 2018, R_∞ is the most accurately measured Fundamental physical constant.

Electron Charge-to-Mass Ratio e/m_e is a Quantity in experimental physics. It bears significance because the electron mass m_e cannot be measured directly. The e/m_e ratio of an electron was successfully calculated by J. J. Thomson in 1897. We define it after Thomson $R_T \equiv e/m_e$.

Planck Constant (h) was suggested by M. Planck as the result of investigations the problem of black-body radiation. He used Boltzmann's famous equation from Statistical Thermodynamics: $S = k_B \ln W$ that shows the relationship between entropy S and the number of ways the atoms or molecules of a thermodynamic system can be arranged (k_B is the Boltzmann constant). In 1901, Planck calculated the value of h from

experimental data: $h = 6.55 \times 10^{-34}\ J \cdot s$, that is within 1.2% of the currently accepted value. We emphasize that Planck constant, which is generally associated with the behavior of microscopically small systems, was introduced by Planck based on **Statistical Thermodynamics** before Quantum Physics.

Based on the experimentally measured values of the constants R_∞, R_T, c, h, and the value of permeability of free space: $\mu_0 = 4\pi \times 10^{-7}\ H/m$ we calculate the most important Fundamental constants: **Basic size unit** a, including **Classical electron radius** $a_o = a/2\pi$; **Dimensionless Rydberg constant** α that was later named "Fine-structure constant"; **Mass of electron** m_e; **Elementary charge** e. All these constants were measured and could be calculated before Quantum Physics.

1.2. History of Dark Matter. Early Ideas [24]

The history of 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:

- 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;
- 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 DM in the form of 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*;
- In 1904, Lord Kelvin was among the first to attempt a dynamical estimate of the amount of dark matter in the Milky Way (MW). His argument was simple yet powerful: if stars in MW 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;
- H. Poincare was impressed by Lord Kelvin's idea of applying the "theory of gases" to the stellar system of MW. 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.

1.3. Nebular Hypothesis [13]

The most widely accepted model of Solar System (SS) formation, known as the Nebular hypothesis, was first proposed in 1734 by E. Swedenborg and later elaborated and expanded upon by I. Kant in 1755. This hypothesis maintains that 4.6 billion years ago, SS formed from the gravitational collapse of a giant molecular cloud, which was light years across. Most of a mass collected in the Centre, forming the Sun; the rest of a mass flattened into a protoplanetary disc, out of which the planets and other bodies in SS formed.

The Nebular hypothesis is not without its critics. V. Ferrell outlined the following counter-arguments:

- It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;
- Each planet and moon in SS has unique structures and properties. How could each one be different if all of them came from the same nebula;
- A full 98% of all the angular momentum in SS is concentrated in the planets. Jupiter itself has 60% 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 Sun could be transferred to planets. Yet this is what would have to be done if any of the evolutionary theories of SS origin are to be accepted.

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

Part II. Bing Bang Model

2.1. Framework for Big Bang Model [7] [15] [16] [24] [26]

The framework for BBM relies on General Relativity and on simplifying assumptions such as homogeneity and isotropy of space. The Lambda Cold Dark Matter (ΛCDM) model is a parametrization of BBM in which the universe contains three major components: first, a Cosmological constant Λ associated with dark energy; second, a postulated Cold Dark Matter; and third, Ordinary matter.

Dark Matter. G. Bertone and D. Hooper provide an excellent review of DM along with BBM:
- In 1984, G. Blumenthal, *et al.* 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* ;
- By the end of the 1980s, the conclusion that most of the mass in the Universe consists of cold and nonbaryonic particles had become widely accepted, **Cold dark matter in the form of some unknown species of elementary particle had become the leading paradigm.**

The ΛCDM model is based on six parameters, the values of which are mostly not predicted by current theory. The Four Pillars of BBM are as follows:

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

2.2. Expansion of Universe

There is now excellent evidence for the expansion of universe. Projecting galaxy trajectories backwards in time means that they converge to a Cosmological Singularity at $t = 0$ that is an infinite energy density state. This uncovers one of the shortcomings of BBM – the Horizon problem: *Why does the universe look the same in all directions when it arises out of causally disconnected regions? This problem is most acute for the very smooth cosmic microwave background radiation.*

This problem was resolved by Cosmological Inflation, which is a theory of an extremely rapid expansion of space in the early universe up to 93 billion light-years in diameter for time $< 10^{-32}\ s$.

"*It's a beautiful theory*, said Peebles. *Many people think it's so beautiful that it's surely right. But the evidence of it is very sparse*". According to Silk, *our best theory of the beginning of the universe, inflation, awaits a definitive and falsifiable probe, in order to satisfy most physicists that it is a trustworthy theory. Our basic problem is that we cannot prove the theory of inflation is correct, but we urgently need to understand whether it actually occurred* .

2.3. Origin of Cosmic Background Radiation

According to BBM, about 380,000 years after BB a temperature of the universe fell to the point where nuclei could combine with electrons to create neutral atoms. As a result, photons no longer interacted frequently with matter, the universe became transparent, and Microwave Background Radiation (MBR) was created. The photons that existed at that time have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time. These photons are the same photons that we see in MBR now. But then, **why is MBR is perfect black-body**?

According to **WUM**, wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They do not have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*". In frames of WUM, the black-body spectrum of MBR is due to thermodynamic equilibrium of photons with the Intergalactic Plasma (IGP), the existence of which is experimentally proved.

2.4. Nucleosynthesis of Light Elements

Big Bang Nucleosynthesis refers to a production of nuclei other than those of hydrogen during early phases of universe. Primordial nucleosynthesis is calculated to be responsible for a formation of most of the universe's helium-4, along with small amounts of deuterium, helium-3, and lithium-7. All of the elements that are heavier than lithium were created much later, by stellar nucleosynthesis in evolving and exploding stars.

During the 1970s, there were major efforts to find processes that could produce deuterium. The standard explanation now used for the abundance of deuterium is that the universe does not consist mostly of baryons, but that **non-baryonic dark matter** makes up most of the mass of the universe.

In case of lithium, astronomers observe a **cosmological lithium discrepancy** in the universe: older stars seem to have less lithium than they should, and some younger stars have much more. M. Anders, *et al.* report on the results of the first measurement of the $^{2}H(\alpha,\gamma)^{6}Li$ cross section at BB energies. Their results have firmly **ruled out BBN lithium production** as a possible explanation for the reported ^{6}Li detections.

In frames of **WUM**, Nucleosynthesis of all elements (including light elements) occurs inside of DM Cores of all Macroobjects(MOs) during their evolution (see Section 4.2)

2.5. Formation of Galaxies and Large-Scale Structures

The formation and evolution of galaxies can be explained only in terms of gravitation within an inflation + dark matter + dark energy scenario. At about 10,000 years after BB, the temperature had fallen to such an extent that the energy density of the universe began to be dominated by massive particles, rather than the light and other radiation which had predominated earlier. This change in the form of the main matter density meant that the gravitational forces between the massive particles could begin to take effect, so that any small perturbations in their density would grow. This brings into focus one of shortcomings of BBM – a **density fluctuation problem**: *The perturbations which gravitationally collapsed to form galaxies must have been primordial in origin; from whence did they arise?*

As a conclusion: The performed analysis shows that the Four Pillars are model-dependent and not strong enough to support BBM.

2.6. Angular Momentum Problem [13] [18] [20]

Angular momentum problem is one of the most critical problems in BBM that must be solved. Any theory

of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out. BBM cannot answer the following questions:

- Sun accounts for ~ 0.3% of the total angular momentum of SS while about 60% is attributed to Jupiter;
- SS has an orbital angular momentum that far exceeds rotational angular momentum;
- MW galaxy is gravitationally bounded with VSC and has an orbital momentum, which far exceeds the rotational angular momentum;
- How did MW galaxy and SS obtain their substantial orbital angular momenta?

To the best of our knowledge, BBM does not answer these questions. **WUM is the only cosmological model in existence that is consistent with this Fundamental Law** (see Section 4.2).

2.7. Black Holes [1][16] [23][27]

Black Hole (BH) is a **mathematical solution** of Einstein's field equations. The existence of supermassive compact objects in galactic centers is now commonly accepted. It is commonly believed that the central mass is a Supermassive Black Hole (SBH). In 2022, the Event Horizon Telescope (EHT) Collaboration presented outstanding 1.3 mm measurements of the radio source located at the position of the supermassive black object Sgr A* . Using EHT, astronomers released the first image of the accretion disk around the Sgr A*. Based on the obtained results the EHT Collaboration claimed that Sgr A* is SBH.

In our opinion, the results obtained by EHT Collaboration are model-dependent and not sufficient to support this claim. Astronomers should answer some principal questions:

- The age of MW is similar to the Age of the World. The oldest star in MW (named Methuselah) is nearly as old as the World itself. If Sgr A* is a SBH, then how it could grow so quickly?
- The MW galaxy (including Sgr A*) is gravitationally bounded with VSC and has a huge orbital angular momentum (see Section 2.4). How did MW galaxy obtain this substantial orbital angular momentum?
- What is the mechanism of gamma rays emission from the Galactic Center.

As a conclusion: The totality of all obtained experimental results testify in favor of the existence of the **Supermassive Compact Object** made up of DMPs at MW Center.

Part III. Hypotheses Revisited by WUM

3.1. Aether [12]

Aether was suggested by I. Newton. Following the work of T. Young and A-J. Fresnel it was believed that light propagates as a transverse wave within an elastic medium called Luminiferous Aether. It was realized that Aether could not be an elastic matter of an ordinary type that can transmit longitudinal waves. Unique properties of Aether were discussed by J, McCullagh in 1846 who proposed a theory of a rotationally elastic medium with a potential energy of deformation that depends on a rotation of volume elements and not on their compression or general distortion. This theory produces equations analogous to Maxwell's equations. Aether with these properties can transmit transverse waves. Luminiferous Aether was abandoned in 1905 by SR. In later years there have been classical physicists who advocated the existence of Aether:

- N. Tesla declared in 1937 in "Prepared Statement on the 81st birthday observance": *All attempts to explain the workings of the universe without recognizing the existence of the aether and the indispensable function it plays in the phenomena are futile and destined to oblivion* ;
- P. Dirac stated in 1951 in an article in Nature, titled "Is there an Aether?" that *we are rather forced to have an aether* .

WUM is based on Maxwell's equations, and McCullagh's theory is a good fit for description of the Medium. The existence of the Medium is a principal point of WUM. It follows from the observations of IGP and MBR. Inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. The Medium is the absolute frame of reference. The total energy density of the Medium is 2/3 of the total energy density of the World in all cosmological times. All MOs are built from the same particles. The energy density of MOs adds up to 1/3 of the total energy density throughout the World's evolution. In our opinion, the Medium of the World is the Savior of Classical Physics! Don't throw the baby out with the bathwater.

3.2. Le Sage's Theory of Gravitation [12] [25]

Wikipedia summarizes this unique theory as follows: *"Sage's theory of gravitation is a kinetic theory of gravity originally proposed by Nicolas Fatio de Duillier in 1690 and later by Georges-Louis Le Sage in 1748. The theory proposed a mechanical explanation for Newton's gravitational force in terms of streams of tiny unseen particles impacting all material objects from all directions. According to this model, any two material bodies partially shield each other from the impinging corpuscles, resulting in a net imbalance in the pressure exerted by the impact of corpuscles on the bodies, tending to drive the bodies together".*

Le Sage proposed quantitative estimates for some of the theory's parameters:

- He called the gravitational particles ultramundane corpuscles because he supposed them to originate beyond our known universe. The distribution of the ultramundane flux is isotropic, and the laws of its propagation are very similar to that of light;
- He suggested that the ultramundane corpuscles might move at the speed of light;
- To maintain mass proportionality, ordinary matter consists of cage-like structures, in which their diameter is only the 10^7th part of their mutual distance, so the particles can travel through them nearly unhindered.

In frames of **WUM**, the time-varying Gravitational parameter $G \propto \tau^{-1}$ is proportional to the energy density of the Medium of the Word $\rho_M \propto \tau^{-1}$ (see Section 3.6). It is not constant. That is why, WUM aligns gravity with the Le Sage's theory of gravitation. In WUM, the gravity is a result of simple interactions of DM particles DMF4 with Matter that work cooperatively to create a more complex interaction. The total DMF4 energy density is about 68.8% of the total energy density of the World (see Section 4.2). DM particles DMF4 are responsible for the Le Sage's mechanism of the gravitation.

To summarize:

- Le Sage's theory of gravitation defines Gravity as an emergent phenomenon;
- Gravity is not an interaction but a manifestation of the Medium;
- The proposed mechanism of Gravitation resembles Le Sage's theory.

3.3. Hypersphere Universe [7]

In 1854, G. Riemann proposed a Hypersphere as a model of a finite universe. A hypersphere is the four-dimensional analog of a sphere. A regular three-dimensional Ball has a two-dimensional surface. Similarly, a 4-dimensional Ball (the Nucleus of the World) has a 3-dimensional surface (the Hypersphere).

In 1870, W. Clifford made the statement that matter is nothing, but ripples, hills and bumps of space curved in a higher dimension and the motion of matter is nothing more than variations in that curvature. He speculated that the force of electricity and magnetism is caused by the bending of higher-dimensional space and planned to add gravity to his theory at later date. This is the first time that anyone had speculated that a "force" is nothing but the bending of space itself, preceding A. Einstein by 45 years. Clifford's idea that

electromagnetism was caused by vibrations in the fourth dimension also preceded the work of T. Kaluza, who would also attempt to explain electromagnetism with the higher dimension.

WUM follows the idea of the Hypersphere Universe, albeit proposing that the World is evenly stretched as the result of the expansion of the Nucleus of the World along the fourth spatial dimension. The World is filled out with the Medium and MOs consisting of stable elementary particles.

3.4. Gravitoelectromagnetism [11] [27]

Gravitoelectromagnetism (GEM) is a gravitational analog of Electromagnetism. GEM equations differing from Maxwell's equations by some constants were first published by O. Heaviside in 1893 as a separate theory expanding Newton's law. GEM is an approximation to the Einstein's gravity equations in the weak field limit. H. Thirring pointed out this analogy in his "*On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation*" paper published in 1918. It allows us to use formal analogies between the electromagnetism and relativistic gravity.

In 2021, G. Ludwig in his paper "Galactic rotation curve and dark matter according to gravitomagnetism" wrote: *Most theories used to explain the rotation curve have been restricted to the Newtonian potential framework, disregarding the general relativistic corrections associated with mass currents. In this paper it is shown that the gravitomagnetic field produced by the currents modifies the galactic rotation curve, notably at large distances. The coupling between the Newtonian potential and the gravitomagnetic flux function results in a nonlinear differential equation that relates the rotation velocity to the mass density. The solution of this equation reproduces the galactic rotation curve without recourse to obscure dark matter components.* ***The effects attributed to dark matter can be simply explained by the gravitomagnetic field produced by the mass currents*** [Ludwig, G. O. (2021) Galactic rotation curve and dark matter according to gravitomagnetism. Eur. Phys. J. C **81**, Article number:186. https://doi.org/10.1140/epjc/s10052-021-08967-3].

In accordance with **WUM**, DM is concentrated in the Cores of all MOs. There are no BHs. Instead, there are DM Cores of galaxies. WUM is based on Gravitomagnetism. The explanation of galactic rotation curve made by G. O. Ludwig is in good agreement with the approach of WUM.

3.5. Dirac Large Number Hypothesis [12]

Dirac Large Number Hypothesis is an observation made by P. Dirac in 1937 relating ratios of size scales in the Universe to that of force scales. The ratios constitute very large, dimensionless numbers, some 40 orders of magnitude in the present cosmological epoch. According to Dirac's hypothesis, the apparent equivalence of these ratios might not to be a mere coincidence but instead could imply a cosmology where the strength of gravity is inversely proportional to the cosmological time τ: $G \propto \tau^{-1}$.

WUM follows the idea of time-varying G and introduces 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, Dirac Large Number:

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

where $t_0 = a/c$ is the basic time unit. In the present Epoch, $Q = 0.759972 \times 10^{40}$.

3.6. Emergent Gravity, Space and Time [12]

Barcelo, *et al.* have this to say about emergent gravity: *One of the more fascinating approaches to "quantum gravity" is the suggestion, typically attributed to Sakharov that gravity itself may not be "fundamental*

physics". Indeed, it is now a relatively common opinion, that gravity (and in particular the whole notion of spacetime and spacetime geometry) might be no more "fundamental" than is fluid dynamics. The word "fundamental" is here used in a rather technical sense – fluid mechanics is not fundamental because there is a known underlying microphysics that of molecular dynamics, of which fluid mechanics is only the low-energy low-momentum limit .

WUM: Time and Space are closely connected with Mediums' Impedance and Gravitomagnetic parameter. It follows that neither Time nor Space could be discussed in absence of the Medium. The gravitational parameter G that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. Gravity, Space and Time are all emergent phenomena.

Part IV. Hypersphere World-Universe Model

4.1. Assumptions

WUM is based on the following primary assumptions:

- The World is a Finite Boundless 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 . As the result, the Hypersphere is evenly stretched;
- The Eternal Universe serves as an unlimited source of DM, which is 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.

4.2. Principal Points [9] [10] [19] [21] [22]

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 size unit of a . The World is a Finite Boundless 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 Center 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 so that Its radius is increasing with speed c that is the gravitodynamic constant. Its surface, the 3D Hypersphere, is evenly stretched. The stretching of It 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.

Creation of Matter. The surface of the Nucleus is created in a process analogous to sublimation. Continuous creation of matter is a result of this process. Sublimation is a well-known endothermic process that happens

when surfaces are intrinsically more energetically favorable than a 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. 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 a surface energy), we can imagine that 3D Hypersphere World has a "Surface Energy" of 4D Nucleus. A grows of the surface of 4D Nucleus means an increase of the World's "Surface Energy".

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

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

Content of the World. The World consists of the Medium and MOs. Total energy density of the World equals to the critical energy density throughout the World's evolution. The energy density of the Medium is 2/3 of the total energy density and MOs (Superclusters, Galaxies, Extrasolar Systems, Planets, Moons, *etc.*) – 1/3 in all cosmological times. The relative energy density of DM 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 4.8% in the Medium of the World and 2.4% in MOs.

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

Rotational Fission of overspinning (surface speed at equator exceeding escape velocity) Prime Objects is the mechanism that can provide Angular Momenta to MOs. 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".
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 an **Explosive Rotational Fission** of Overspinning DM Supercluster's Cores and self-annihilation of DMPs.

Macroobjects Shell Model. MOs of the World possess the following properties: their Cores are made up of DMPs; they contain other particles, including DMPs and Ordinary Particles, in shells surrounding the Cores. 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. Superclusters are 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. 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters

($\gtrsim 10^3$), which emerged in different places of the World at different Cosmological times. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous.

Macroobjects Evolution. 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.

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. MOs' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation in their DM cores. **Nucleosynthesis** of all elements occurs inside of MOs during their evolution.

4.3. Predictions and Explained Problems [1]-[7] [14] [17] [23]

In 2013, WUM revealed a self-consistent set of time-varying values of PCPs of the World: Gravitation parameter, Hubble's parameter, Temperature of MBR, and concentration of IGP. Based on the inter-connectivity of these parameters WUM performed precise calculations of PCPs values that were only measured experimentally earlier and made verifiable predictions. The remarkable agreement of the calculated values of PCPs with the observational data gives us considerable confidence in the Model.

4.3.1. Newtonian Constant of Gravitation

The very first manuscript "World-Universe Model" (WUM) was uploaded on viXra in March 2013. At that time, the most important for Cosmology, Newtonian constant of gravitation G, proved too difficult to measure. Its measurement precision was the worst among all Fundamental physical constants.

In 2010, CODATA stated the following value of G:

$$G(2010) = 6.67384 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (120\ ppm)$$

with Relative Standard Uncertainty (RSU): $RSU = 1.2 \times 10^{-4} = 120\ ppm$.

In 2013, WUM proposed a principally different way to solve the problem of G measurement precision based on the value of Fermi Coupling constant in 2010:

$$G_F(2010) = 1.166364 \times 10^{-5} GeV^{-2} \ \ (4.3\ ppm)$$

WUM predicted the value of the gravitational constant G^*_{2014} equals to:

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

and recommended this value to CODATA. To the best of our knowledge, no breakthrough in G measurement methodology has been achieved since. Nevertheless, in 2015 CODATA recommended a value of G(2014):

$$G(2014) = 6.67408 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (47\ ppm)$$

In 2018, the recommendation improved further:

$$G(2018) = 6.67430 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (22\ ppm)$$

It seems that CODATA considered the WUM's recommendation of the predicted value of G and used it for G(2014) and $G(2018)$ without any reference or explanation of their methodology.

Considering a more precise value of Fermi Coupling constant in 2014:

$$G_F(2014) = 1.1663787 \times 10^{-5} GeV^{-2} \ (0.51\ ppm)$$

WUM calculated the predicted value of gravitational constant G^*_{2018} :

$$G^*_{2018} = 6.674536 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

that is in excellent agreement with the experimentally measured by Q. Li, *et al.* in 2018 value of $G(Li)$:

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

WUM recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of the Newtonian Constant of Gravitation G^*_{2018} .

4.3.2. Hubble's Constant

The results of measurements of the Hubble's constant H_0 , 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 frames of **WUM**, the Hubble tension can be explained the following way:

- All measurements of H are model-dependent;
- Statistics of these measurements is not sufficient to yield reliable conclusions;
- There are observations of various characteristics of Galaxies that belong to different Superclusters, the distribution of which in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous.

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 MBR** that depends on characteristics of the Medium of the World. The Medium is Homogeneous and Isotropic. Its parameters do not practically depend on MOs, which can create some perturbations in It. The calculated value of Hubble's constant in 2013: $H_0 = 68.733\ km/s\ Mpc$ is in excellent agreement with the measured value in 2021: $H_0 = 68.7 \pm 1.3\ km/s\ Mpc$ using only MBR data.

4.3.3. Missing Baryon

The Missing Baryon Problem is related to the fact that the observed amount of baryonic matter did not match theoretical predictions for baryonic matter of 4.85% of the contents of Universe. However, directly adding up all the known baryonic matter produces a baryonic density less than half of this.

An existence of the Medium is a principal point of **WUM**. It follows from observations of MBR and IGP. Detailed analysis of IGP carried out in 2013 showed that the relative energy density of protons in the Medium Ω_p is: $\Omega_p = 2\pi^2\,\alpha/3$. In our opinion, direct measurements of IGP parameters can be done by investigations of Fast Radio Bursts, which are millisecond duration radio signals originating from distant galaxies. These signals are dispersed according to a precise physical law and this dispersion is a key observable quantity which, in tandem with a redshift measurement, can be used for fundamental physical investigations.

The dispersion measure and redshift, carried out in 2016 by E. F. Keane, *et al.*, provide a direct measurement of density of ionized baryons in the intergalactic medium Ω_{IGM} : $\Omega_{IGM} = 4.9 \pm 1.3\%$ that is in excellent agreement with the predicted by WUM in 2013 value of $\Omega_p = 4.8014655\%$.

4.3.4. Minimum Energy of Photons

Analysis of IGP shows that the value of the lowest plasma frequency ν_{pl} is:

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

Photons with energy smaller than $E_{ph} = h\nu_{pl}$ cannot propagate in plasma, thus $h\nu_{pl}$ is the minimum energy of photons which can pass through IGP:

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

The above value, predicted by WUM in 2013, is in good agreement with the value obtained by L. Bonetti, *et al.* in 2017: $E_{ph} \lesssim 2.2 \times 10^{-14}\ eV$.

4.3.5. Black-Body Spectrum of MBR

In frames of WUM, the black-body spectrum of MBR is due to thermodynamic equilibrium of photons with IGP. We calculate the value of MBR temperature T_{MBR}:

$$T_{MBR} = \left(\frac{15\alpha}{2\pi^3}\frac{m_e}{m_p}\right)^{1/4} E_0/k_B \times Q^{-1/4} = 2.72518\ K$$

that is in excellent agreement with the measured value of $2.72548 \pm 0.00057\ K$.

4.3.5. Far-Infrared Background Radiation

The cosmic FIRB which was announced in 1998, is part of the Cosmic Infrared Background with wavelengths near 100 microns that is the peak power wavelength of the black-body radiation at temperature 29 K. In frames of WUM, we calculate the temperature of the peak of FIRB T_{FIRB} :

$$T_{FIRB} = \left(15/4\pi^5\right)^{1/4} E_0/k_B \times Q^{-1/4} = 28.955\ K$$

that is in an excellent agreement with experimentally measured value of $29\ K$.

4.3.6. Center of Milky Way Galaxy

In 2013, WUM made one of the most important predictions: "*Macroobjects of the World have cores made up of the discussed DM (Dark Matter) particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*". In 2020, R. Genzel and A. Ghez confirmed this prediction by: "The Discovery of a **Supermassive Compact Object** at the Centre of Our Galaxy".

4.3.7. Rest Energies of DMPs

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; self-annihilating fermions – DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain:

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

4.3.8. Explained Problems

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 explained by the Explosive Volcanic Rotational Fission of Overspinning DM Supercluster's Cores;
- **Hubble Tension** explained by observations of Galaxies, which belong to different Superclusters. The value of H should be measured based on Cosmic Microwave Background Radiation only;
- **Missing Baryon problem,** related to the fact that the observed amount of baryonic matter did not match theoretical predictions, solved by the calculation of the concentration of IGP;
- **Fermi Bubbles** – two large structures in gamma-rays and X-rays above and below Galactic center – are stable clouds of DMPs (DMF1, DMF2, and DMF3) containing uniformly distributed Dark Matter Objects, in which DMPs self-annihilate and radiate X-rays and gamma rays;
- **Galaxies are ellipticals and spirals** due to an Explosive Rotational Fission of their Overspinning DM Cores;
- **Coronal Heating Problem** relates to a question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. According to WUM, the origin of the Solar corona plasma is not the coronal heating. Plasma particles (electrons, protons, multicharged ions) are so far apart that plasma temperature in the usual sense is not very meaningful. The plasma is the result of a self-annihilation of DMPs. The Solar corona made up of DMPs resembles a honeycomb filled with plasma;
- **Cores of Sun and Earth** rotating faster than their surfaces despite high viscosity of the internal medium. WUM explains the phenomenon through absorption of DMPs by Cores. DMPs supply not only additional mass ($\propto \tau^{3/2}$), but also additional angular momentum ($\propto \tau^2$). Cores irradiate products of self-annihilation, which carry away excessive angular momentum. Solar wind is the result of this mechanism;
- **Diversity and Internal Heating of Gravitationally-Rounded Objects** in SS is explained by DM Reactors inside of MOs fueled by DMPs. All chemical elements, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation in their different DM cores;
- **Faint young Sun paradox** describes the apparent contradiction between observations of liquid water early in Earth's history and the astrophysical expectation that the Sun's output would be only 70% as intense during that epoch as it is during the modern epoch. In WUM, all MOs of the World were fainter in the past. As their DM cores absorb new DMPs, size of MOs R_{MO} and their luminosity L_{MO} are increasing in time $R_{MO} \propto \tau^{1/2}$ and $L_{MO} \propto \tau$ respectively. Considering the age of the World $\cong$ 14.2 Byr and the age of SS $\cong$ 4.6 Byr, it is easy to find that the young Sun's output was only 67.6% of what it is today;
- **Matter-Antimatter Asymmetry problem.** Ordinary Matter is a byproduct of DMPs self-annihilation. This problem does not arise, since antimatter does not get created by DMPs self-annihilation;
- **Black-Body spectrum of MBR** is due to thermodynamic equilibrium of photons with IGP;
- **Unidentified Infrared Discrete Emission Bands** with peaks 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm explained by self-annihilation of DM particles DMF4 (0.2 eV);
- **Solar Corona, Geocorona and Planetary Coronas** made up of DMPs resemble honeycombs filled with plasma particles (electrons, protons, multicharged ions), which are the result of DMPs self-annihilation;
- **Lightning Initiation problem** and **Terrestrial Gamma-Ray Flashes** are explained by the self-annihilation of DMPs in Geocorona;
- **Ball Lightnings** are 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. WUM predicts a **new phenomenon** – a generation of Ball Lightnings (BLs) according to the proposed model of them. Once we master a creation of BLs in a controlled environment, we can concentrate our efforts on harvesting that energy from a practically infinite Source – the Medium of the World with DMPs.

Part V. Classical Physics

5.1. Primary Notions [Wikipedia]

According to Wikipedia, **Classical Physics** *is a group of physics theories that predate modern, more complete, or more widely applicable theories. Classical physics refers to pre-1900 physics, while modern physics refers to post-1900 physics which incorporates elements of quantum mechanics and relativity .*

There is no doubt that we cannot develop any scientific concept about the physical world without establishing a primary idea of **Space** and **Time**. Newton's primary notion of Space and Time is documented in his "Principles of Mathematics". **Euclidean Space** is the fundamental space of geometry, intended to represent Physical Space. Originally, it was three-dimensional space of Euclidean geometry.

In mathematical physics, **Minkowski Spacetime** is a combination of 3D Euclidean Space and Time into a four-dimensional manifold where a spacetime interval between any two events is independent of the inertial frame of reference in which they are recorded. Minkowski spacetime is closely associated with Einstein's theories of **Special Relativity** (SR) and **General Relativity** (GR). Because it treats time differently than it treats spatial dimensions, the Minkowski spacetime differs from four-dimensional Euclidean space.

Gravity is a fundamental interaction which causes mutual attraction between all things with mass or energy. Gravity is by far the weakest of the four fundamental interactions. As a result, it has no significant influence at the level of subatomic particles. However, gravity is the most significant interaction between objects at the Macroscopic Scale. GR describes Gravity not as a force, but as the curvature of spacetime, caused by the uneven distribution of mass, and causing masses to move along geodesic lines. However, for most applications, gravity is well approximated by Newton's law of gravitation.

Principle of Relativity is the requirement that the equations describing the laws of physics have the same form in all admissible frames of reference (including inertial forces). For example, in the framework of SR the Maxwell's equations have the same form in all inertial frames of reference. In the framework of GR the Einstein's field equations have the same form in arbitrary frames of reference.

Universality of Physical Laws is the notion that the spatial distribution of matter in the universe is homogeneous and isotropic when viewed on a large enough scale, since the forces are expected to act uniformly throughout the universe, and should, therefore, produce no observable irregularities in the large-scale structuring over the course of evolution of the matter field that was initially laid down by BBM.

Conservation Law states that a particular measurable property of an **isolated physical system** does not change as a system evolves over time. **Exact Conservation Laws** include conservation of energy, conservation of linear momentum and angular momentum, and conservation of electric charge. One particularly important result concerning conservation laws is **Noether theorem**, which states that there is a one-to-one correspondence between each one of them and a differentiable symmetry of nature:

- Conservation of energy follows from the time-invariance of physical systems;
- Conservation of linear momentum follows from the space-translation invariance (translation along x, y, z directions);
- Conservation of angular momentum arises from the fact that physical systems behave the same way regardless of how they are oriented in space (rotation invariance - rotation about x, y, z axes).

5.2. Classical Physics in WUM

Classical Physics is a branch of Physics that should be described by classical notions, which define emergent phenomena. An **Emergent Phenomenon** is a property that is a result of simple interactions that work cooperatively to create a more complex interaction. Physically, simple interactions occur at a microscopic level, and the collective result can be observed at a macroscopic level. WUM introduces classical notions, when the very first ensemble of particles was created at the cosmological time $\tau_M \cong 10^{-18}\ s$ and become possible to introduce the notion "**Medium of the World**". We emphasize that Classical Physics is principally different from Quantum Physics that describes quantum objects, which have only four-momenta. **Classical Physics is dealing with ensembles of quantum objects!**

World is **3D Hypersphere of 4D Nucleus of the World**, which is expanding in Its fourth spatial dimension. As the result, the Hypersphere is evenly stretched. All points of the Hypersphere are equivalent: there are no preferred centers or boundaries of the World. The 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. **3D Finite Boundless World** has a **Spatial Measure** – Radius of the curvature in the fourth spatial dimension 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** τ that is principally different from a **Solar Time** t (which is defined by the parameters of SS) and **Cosmic Time** of GR. It is defined by the **Impedance** (Wave Resistance) of the Medium of the World that equals to the Hubble's parameter $H = \tau^{-1}$. Cosmological Time marches on at constant pace since the Beginning of the World until the present Epoch and defines the Age of the World $A_\tau = \tau$. In Classical Physics and our everyday life we use an **alleged Space (3D Euclidean) and Solar Time** $\boldsymbol{t}$. Time-Varying Gravitational parameter $G \propto \tau^{-1}$ that is proportional to the Mediums' energy density can be introduced only for the Medium filled with Matter. The **Gravitation** is a result of simple interactions of DMPs with Matter that work cooperatively to create a more complex interaction. DMPs are responsible for Le Sage's mechanism of the gravitation. **Gravity is not an interaction but a manifestation of the Medium.**

Supremacy of Matter: Time, Space and Gravitation have no separate existence from Matter. They are closely connected with the Impedance, Gravitomagnetic parameter, and Energy density of the Medium of the World respectively. Gravitation, Space and Time are all emergent phenomena. In this regard, it is worth recalling 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*". It turned out that abandoning of the Luminiferous Aether in 1905 was crucial for 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.

Principle of Relativity is valid because the Medium of the World is an absolute frame of reference. Then, there is no need to discuss SR and GR.

Universality of Physical Laws is valid at the cosmological times $\tau \geq \tau_M$ because they are determined by the Medium of the World. It is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of the total Matter. Its parameters do not practically depend on MOs, which can create some perturbations in It. The distribution of MOs with 1/3 of the total Matter is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous, and therefore, the Cosmological Principal is not viable for the entire World. **Conservation Laws** of Energy, Linear Momentum and Angular Momentum are not **Exact Conservation Laws** because the World is not an isolated physical system and is continuously getting DM from the Universe.

WUM is based on **Maxwell's Equations** (MEs) that form a foundation of Classical Electrodynamics and Gravitomagnetism. The Einstein's field equations are nonlinear MEs in the strong field limit. In MEs, there are no notions "Charge" and "Energy" but there are "Charge Density" and "Energy Density". MEs produce only two physically measurable quantities: energy density and energy flux density.

Conclusion

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

We do not know that our 3D space is curved. But we know that it is expanding without center of expansion. We introduce the radius of the curvature in the fourth spatial dimension $R = a \times Q$ to give an explanation providing insight into the curved nature of the World. In WUM, Local Physics is linked with the large-scale structure of the Hypersphere World through the dimensionless quantity Q. The proposed approach to the fourth spatial dimension agrees with Mach's principle: "*Local physical laws are determined by the large-scale structure of the universe*". Applied to WUM, it follows that all parameters of the World depending on Q are a manifestation of the Worlds' curvature in the fourth spatial dimension.

WUM does not attempt to explain all available cosmological data, as that is an impossible feat for any one article. Nor does WUM pretend to have built an all-encompassing theory that can be accepted as is. The Model needs significant further elaboration. The Model should be developed into the well-elaborated theory by the entire physical community.

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JWST Discoveries – Confirmation of World-Universe Model Predictions

Abstract

In 1937, P. Dirac proposed Large Number Hypothesis and Hypothesis of Variable Gravitational Constant[1], and later added notion of Continuous Creation of Matter in World [2]. Developed Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing different mechanism of Matter creation. Most direct observational evidences of validity of WUM are: 1) Microwave Background Radiation and Intergalactic Plasma speak in favor of existence of **Medium**; 2) Laniakea Supercluster with binding mass $\sim 10^{17}\ M_{\odot}$ is home to Milky Way (MW) galaxy and $\sim 10^{5}$ other nearby galaxies, which did not start their movement from Initial Singularity (see **Figure 1**); 3) MW is gravitationally bounded with Virgo Supercluster (VSC) and has **Orbital Angular Momentum** calculated based on distance of 65 Mly from VSC and orbital speed of $\sim 400\ km\ s^{-1}$, which far exceeds rotational angular momentum of MW; 4) Mass-to-light ratio of VSC is ~ 300 times larger than that of Solar ratio. Similar ratios are obtained for other superclusters (see **Figure 2**). These ratios are main arguments in favor of presence of tremendous amounts of **Dark Matter** (DM) in World.

JWST discoveries confirm the most important predictions of WUM in 2018: 1) **Absolute Age** of World is 14.22 Gyr; 2) **Dark Epoch** (spanning for Laniakea Supercluster (LSC) from the Beginning of World for 0.45 Gyr) when only DM Macroobjects (MOs) form and evolve; 3) **Luminous Epoch** (ever since, 13.77 Gyr for LSC) when Luminous MOs (superclusters, galaxies, extrasolar systems, etc.) emerge; 4) Transition from Dark Epoch to Luminous Epoch is due to **Explosive Rotational Fission** of Overspinning (surface speed at equator exceeding escape velocity) DM Supercluster's Cores and self-annihilation of DM Particles (DMPs); 5) MOs of World form from top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs; 6) 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters, which emerged in different places of World at different Cosmological times.

1. Introduction

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.

In 1937, Paul Dirac in the paper "A new basis for cosmology" said [1]:

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

In Summary, he concluded:

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

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) [2]:

- *One might assume that nucleons are created uniformly throughout space, and thus mainly in intergalactic space. We may call this* ***additive creation****.*
- *One might assume that new matter is created where it already exists, in proportion to the amount existing there. Presumably the new matter consists of the same kind of atoms as those already existing. We may call this* ***multiplicative creation****.*

The developed Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing a different mechanism of matter creation (see Section 2.2). WUM was developed for the last 20 years and is, in fact, a Paradigm Shift for Cosmology. The main objective of the Model is to unify and simplify existing results in Classical Physics into a single coherent picture of a New Cosmology. Results obtained in WUM are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced paper " *Review Article. Cosmology and Classical Physics*" [4] (and references therein) in such cases.

2. Hypersphere World-Universe Model

2.1. Assumptions

WUM is based on the following primary assumptions:

- The World is a Finite Boundless 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. As the result, the Hypersphere is evenly stretched;
- The Eternal Universe serves as an unlimited source of Dark Matter (DM), which is continuously created in the Nucleus of the World. Ordinary Matter is a byproduct of DM Particles (DMPs) self-annihilation.

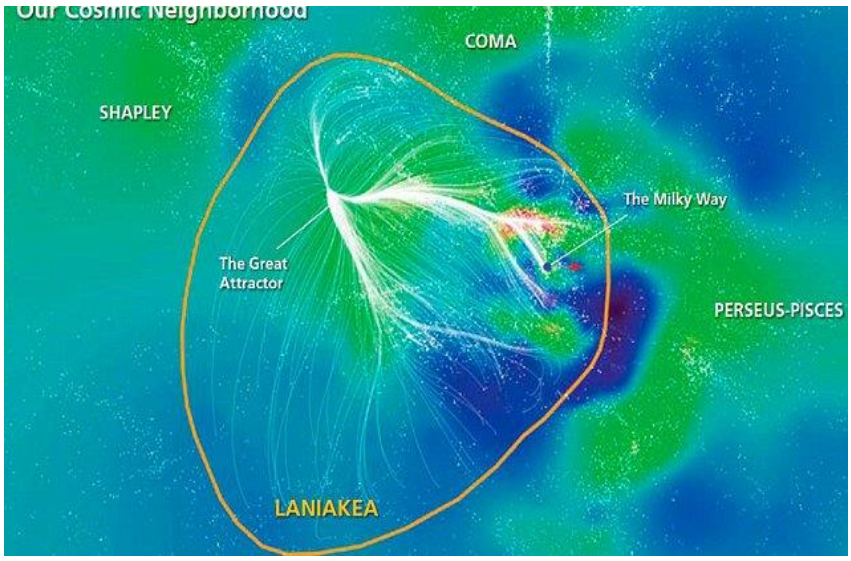

Figure 1. Laniakea Supercluster. Adapted from [3].

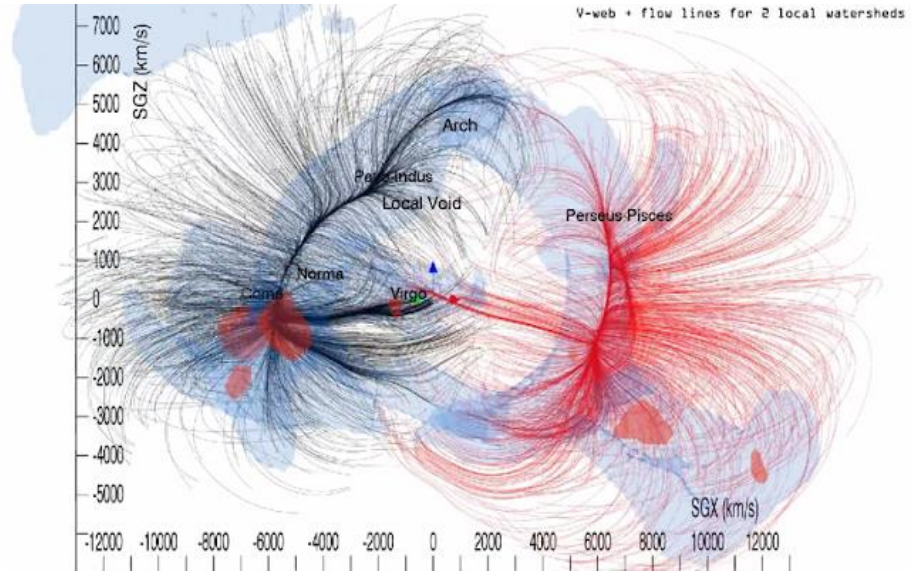

Figure 2. A representation of structure and flows due to mass within 6,000 km s−1 (~80 Mpc). Surfaces of red and blue respectively represent outer contours of clusters and filaments as defined by the local eigenvalues of the velocity shear tensor determined from the Wiener Filter analysis. Flow threads originating in our basin of attraction that terminate near 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 [3].

2.2. Principal Points

WUM is based on the following Principal Points:

Beginning. 14.22 Gyr ago, the World was started by a Fluctuation in the Eternal Universe, and the Nucleus of the World, which is a 4D ball, was born. An extrapolated Nucleus radius at the Beginning was equal to the basic size unit of a. The World is a Finite Boundless 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 Center 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 so that Its radius is increasing with speed c that is the gravitodynamic constant. Its surface, the 3D Hypersphere, is evenly stretched. The stretching of It 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.

Creation of Matter. WUM follows the idea of the continuous creation of matter by the **additive mechanism**, albeit introducing a different mechanism of matter creation. The surface of the Nucleus is created in a process analogous to sublimation. Continuous creation of matter is a result of this process. Sublimation is a well-known endothermic process that happens when surfaces are intrinsically more energetically favorable than a 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. 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 a surface energy), we can imagine that 3D Hypersphere World has a "Surface Energy" of 4D Nucleus. A grows of the surface of 4D Nucleus means an increase of the World's "Surface Energy".

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

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

Content of World. The World consists of the Medium and Macroobjects (MOs). Total energy density of the World equals to the critical energy density (calculated with the Hubble's law) throughout the World's evolution. The energy density of the Medium is 2/3 of the total energy density and MOs (Superclusters, Galaxies, Extrasolar Systems, Planets, Moons, *etc.*) – 1/3 in all cosmological times. The relative energy density of DM Fermions DMF4 is $\cong 68.8\%$; five DMPs (DMF1, DMF2, DMF3, DIRACs, and ELOPs) is $\cong 4.8 \times 5 = 24\%$, and Ordinary particles (protons, electrons, photons, and neutrinos) is $\cong 4.8\%$ in the Medium of the World and $\cong 4.8/2 = 2.4\%$ in MOs (see Section 2.3.2).

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

Macroobjects Formation. Superclusters are 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. 3D Finite Boundless World presents a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$), which emerged in different places of the World at different Cosmological times. The distribution of Macroobjects in the World is spatially Inhomogeneous and Anisotropic and temporally Non-simultaneous.

Macroobjects Evolution. 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.

Dark Matter Reactors. MOs' cores are essentially DM Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation in their DM cores. **Nucleosynthesis** of all elements occurs inside of MOs during their evolution.

2.3. Main Pillars

2.3.1. Medium

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 Medium is an active agent in all physical phenomena in the World. The existence of the Medium

is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation (MBR); Far-Infrared Background Radiation. Inter-galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. MBR is part of the Medium; it then follows that the Medium is the absolute frame of reference. Relative to MBR rest frame, MW galaxy and the Sun are moving with the speed of 552 and 370 $km\ s^{-1}$, respectively.

WUM is the classical model, therefore classical notions can be introduced only when the very first ensemble of particles was created at a 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 time unit: $t_0 = a/c = 5.9059662 \times 10^{-23}\ s$; a is a basic size unit: $a = 1.7705641 \times 10^{-14}\ m$; 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.

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: $\mu_g = R^{-1}$ (R is the size of the World). 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 a proposed **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.

Inter-Connectivity of Primary Cosmological Parameters (PCPs). The constancy of the universe fundamental constants, including Newtonian constant of gravitation G, 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 PCPs 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: $Q = 0.759972 \times 10^{40}$ and is, in fact, the Dirac Large Number. 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.

The Model develops a mathematical framework that allows for direct calculation of the following parameters through Q:

- The predicted value of G in 2013 [5], [6]:

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

  is in excellent agreement with the experimentally measured by Qing Li, *et al.* in 2018 values [7]:

  $$G(1) = 6.674184 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.64\ ppm)$$
  $$G(2) = 6.67484 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.61\ ppm)$$

- The predicted value of H_0 in 2013 [5], [6]:

  $$H_0 = 68.733\ km/s\ Mpc$$

  is in excellent agreement with the most recent measured value in 2021[8]:

$$H_0 = 68.7 \pm 1.3 \ km/s\ Mpc$$

using only Cosmic Microwave Background data;

- 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 MOs must hold true in cold World conditions**;
- The Age of the World: $A_\tau = t_0 \times Q = 14.22\ Gyr$ is determined by the parameters of the Medium only.

As the conclusion:

- It turned out that an abandoning of the Luminiferous Aether in 1905 was crucial for Classical Physics;
- The Medium of the World is the Savior of Classical Physics! **Don't throw the baby out with the bathwater**.

2.3.2. Multicomponent Dark Matter

WUM proposes multicomponent DM system consisting of two couples of co-annihilating DMPs: a heavy Dark Matter Fermion (DMF) – DMF1 (1.3 TeV) and a light spin-0 boson – DIRAC (70 MeV) that is a dipole of Dirac's monopoles with charge $\mu = e/2\alpha$ (e is the elementary charge); a heavy fermion – DMF2 (9.6 GeV) and a light spin-0 boson – ELOP (340 keV) that is a dipole of preons with electrical charge e/3; self-annihilating fermions DMF3 (3.7 keV) and DMF4 (0.2 eV). The reason for this multicomponent DM system was to explain:

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

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

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

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

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

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

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

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

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

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

In this regard, it is worth recalling a story about neutrinos: "*The neutrino was postulated first by W. Pauli in 1930 to explain how beta decay could conserve energy, momentum, and angular momentum (spin). But we still don't know the values of neutrino masses*". Although we still cannot measure neutrinos' masses directly, no one doubts their existence.

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

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

2.3.3. Macroobject Shell Model

In WUM, Macrostructures of the World (Superclusters, Galaxies, Extrasolar systems) have Nuclei made up of DMFs, which are surrounded by Shells composed of DM and Baryonic Matter. The shells envelope one another, like a Russian doll. The lighter a particle, the greater the radius and the mass of its shell. Innermost shells are the smallest and are made up of heaviest particles; outer shells are larger and consist of lighter particles. The proposed 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 very high viscosity and function as solid-state objects.

The calculated parameters of the shells show that:

- 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.

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}

According to WUM, Cores of Galaxies are DM Compact Objects made up of DMF1 and/or DMF2 with shell of DMF3 with the calculated maximum mass of $6 \times 10^{10}\ M_{\odot}$ (see **Table 1**). This value is in good agreement with the experimentally obtained value of the most massive "black hole" ever found, with a mass of $6.6 \times 10^{10}\ M_{\odot}$ at the center of TON 618 [10]. It is worth noting that there are no black holes in WUM.

"*The Discovery of a* ***Supermassive Compact Object*** *at the Centre of Our Galaxy*" (Nobel Prize in Physics 2020) made by R. Genzel and A. Ghez is a confirmation of one of the most important predictions of WUM in 2013: "*Macroobjects of the World have cores made up of the discussed DM particles. Other particles, including DM and baryonic matter, form shells surrounding the cores*" [5].

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

- Their Nuclei are made up of DMFs and contain other particles, including DM and Baryonic matter, in shells surrounding the Nuclei;
- DMPs are continuously absorbed by Cores of all MOs. Ordinary Matter (about 7.2% of the total Matter) is a byproduct of DMPs self-annihilation. It is re-emitted by Cores of MOs continuously;
- 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. 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.

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 [11]. In frames of WUM, this discovery can be explained by Gravitational Burst of the overspinning Core of MW 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, amount of time that is too short for formation of gas giants according to prevailing theories [12]. In frames of the developed Rotational Fission(RFS) model, this discovery can be explained by Gravitational Burst of the overspinning Core of MW two million years ago, which gave birth to CI Tau system with all planets generated at the same time.

To summarize:

- 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 RFS of overspinning DM Macroobject Cores.

2.3.4. Angular Momentum

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

- 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: $L_{rot}^{SS} = 3.2 \times 10^{43} J\,s$;
- MW galaxy is gravitationally bounded with Virgo Supercluster and has an orbital angular momentum L_{orb}^{MW} calculated based on the distance of $65\ Mly$ from VSC 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 : $L_{rot}^{MW} \approx 1 \times 10^{67}\ J\,s$.

In our opinion, there is only one mechanism that can supply angular momenta to MOs – **Rotational Fission** of Overspinning Prime Objects. From the point of view of Fission model, the Prime Object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite**.

In frames of WUM, Prime Objects are DM Cores of Superclusters, which must accumulate tremendous rotational angular momenta before the Birth of the Luminous World. It means that it must be some long enough time in the history of the World, which we named "Dark Epoch".

To be consistent with the Law of Conservation of Angular Momentum, in 2018 we developed a New Cosmology [14]:

- WUM introduces Dark Epoch (spanning for LSC from the Beginning for 0.45 Gyr) when only DM MOs existed, and Luminous Epoch (ever since for 13.77 Gyr for LSC) when Luminous MOs emerged due to the RFS of Overspinning DM Superclusters' Cores and self-annihilation of DMPs;
- Proposed **Weak Interaction** of DMPs with Matter provides the integrity of DM Cores, which are **3D fluid balls with a very high viscosity** and act as solid-state objects;
- The principal objects of the World are overspinning DM Cores of Superclusters, which accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their RFS. The experimental observations of galaxies in the universe showed that most of them are disk galaxies. 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;
- Macroobjects' cores are essentially DM Reactors fueled by DMPs. All chemical elements, gases, water vapors, compositions, radiations are produced by MOs themselves as the result of DMPs self-annihilation;
- DM Core of MW was born 13.77 billion years ago as the result of the **Explosive RFS** of VSC DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the repeating Explosive 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.

3. Macrostructures

Laniakea Supercluster is a galaxy supercluster that is home to MW and approximately 10^5 other nearby galaxies (see **Figure 1**). It is known as one of the largest superclusters with estimated binding mass

$10^{17}\ M_{\odot}$. Neighboring superclusters are Shapley Supercluster, Hercules Supercluster, Coma Supercluster, and Perseus-Pisces Supercluster (see **Figure 2**). The mass-to-light ratio of Virgo Supercluster is ~ 300 times larger than that of the Solar ratio. Similar ratios are obtained for other superclusters [15]. 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*" [16].

We emphasize that $\sim 10^5$ nearby galaxies are moving around Centre of LSC. They belong to It. All these galaxies did not start their movement from the "Initial Singularity". The neighboring superclusters have the same structures (see **Figure 2**). It means that the World is, in fact, a Patchwork Quilt of different Luminous Superclusters ($\gtrsim 10^3$).

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

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"* [18].

WUM. A calculated maximum mass of supercluster DM Core of 2.1×10^{19} solar mass (see **Table 1**) is in good agreement with the values discussed by B. Carr, *et al.* [18]. 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 $\gtrsim 10^3$. It is unlikely that all of them gave birth to Luminous Superclusters at the same cosmological time being far away from each other. In our view, there were many "Beginnings" for different Luminous Superclusters (even at a time that was more than 13.77 Gyr ago and less than 14.22 Gyr). .

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*" [3].

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***" [19].

In 2021 at the "*Giant Arc at the 238th virtual meeting of the American Astronomical Society*", A. Lopez reported about the discovery of "*a giant, almost symmetrical arc of galaxies – the Giant Arc – spanning 3.3 billion light years at a distance of more than 9.2 billion light years away that is* ***difficult to explain in current models of the Universe****. The Giant Arc is twice the size of the striking Sloan Great Wall of galaxies and clusters" that is seen in the nearby Universe. This new discovery of the Giant Arc adds to an* ***accumulating set of (cautious) challenges to the Cosmological Principle****"* [20].

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

- *"Galaxies* **do not** *congregate in clusters and along filaments".* On the contrary, Cosmic Web that is "*networks of structure that are interconnected with no clear boundaries"* is the result of the Rotational Fission of DM Cores of neighbor Superclusters;
- *"Generation of angular momentum across these scales"* provide DM Cores of Superclusters through the Rotational Fission mechanism;
- *"Spinning cylindrical tendrils of matter hundreds of millions of light-years across"* are the result of spiral jets of galaxies generated by DM Cores of Superclusters with internal rotation;
- The Giant Arc is the result of the intersection of the Galaxies' jets generated by the neighbor DM Cores of Superclusters;
- Cosmological principal is valid for the Homogeneous and Isotropic Medium of the World consisting of elementary particles with 2/3 of total Matter. The distribution of Macroobjects with 1/3 of total Matter is Inhomogeneous and Anisotropic, and therefore, the Cosmological Principal is not viable;
- The main conjecture of 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 (see **Figure 1** and **Figure 2**).

4. JWST Discoveries

According to NASA, "*Most galaxies are between 10 billion and 13.6 billion years old. Our universe is about 13.8 billion years old, so most galaxies formed when the universe was quite young! The newest galaxy we know of formed only about 500 million years ago. In 2016, astronomers used NASA's Hubble Space Telescope to measure a galaxy called GN-z11 that is 13.4 billion light-years away* [21].

H. Yan, *et al.* introduced a New JWST Program and discussed the very first observations [22]:

On July 13, 2022, NASA released to the whole world the data obtained by the James Webb Space Telescope (JWST) Early Release Observations (ERO). These are the first set of science-grade data from this long-awaited facility, marking the beginning of a new era in astronomy. Many critical questions unanswered in the past several decades now see the hope of being addressed. JWST will push the redshift boundary far beyond what has been reached by the Hubble Space Telescope (HST), and in so doing it will lead to the understanding of how the first luminous objects - first stars and first galaxies - were formed in the early universe. The red wavelength cut-off at 1.6 micron limits HST to redshift around 11, which is when the age of the universe was only ~420 million years.

The NIRCam instrument, the most sensitive camera onboard JWST, extends to 5 micron and will allow for the detection of early objects only several tens of million years after the Big Bang should they exist.
Here we report the result from our search of candidate galaxies at redshift larger than 11 using these ERO data. We have a total of 88 such candidates spreading over the two fields, some of which could be at redshifts as high as 20. ***Neither the high number of such objects found nor the high redshifts they reside at are expected from the previously favored predictions****.*

J. Achenbach outlined the following situation with the measurements of early galaxy formation by JWST [23]:

- *The first scientific results have emerged in recent weeks, and what the telescope has seen in deepest space is a little puzzling. Some of those distant galaxies are* ***strikingly massive****. A general assumption had*

been that early galaxies — which formed not long after the first stars ignited — would be relatively small and misshapen. Instead, some of them are ***big, bright, and nicely structured*** *;*

- *"The models just don't predict this," Garth Illingworth, an astronomer at the University of California at Santa Cruz, said of the massive early galaxies. "How do you do this in the universe at such an early time? How do you form so many stars so quickly?";*
- *What has surprised astronomer Dan Coe of the Space Telescope Science Institute are the number of nicely shaped,* ***disklike galaxies****. But* ***dust*** *can be throwing off the calculations. Dust can absorb blue light and redden the object. It could be that some of these very distant, highly red-shifted galaxies are just very dusty, and not actually as far away (and as "young") as they appear. That would realign the observations with what astronomers expected.*

It is a question of time. Massive mature disk galaxies cannot possibly form so soon according to the big bang theory. The presence of such galaxies so early on is then a refutation of the big bang theory. Massive mature spiral galaxies take billions of years to form, and so should not be there at all at the 'beginning'.

R. P. Naidu, *et al.* present a search for luminous $z > 10$ galaxies [24]. They infer that the most secure candidates are two systems: GLASS-z13 ($z \approx 13$, light-travel distance of 13.4572 Gyr) and GLASS-z11 ($z \approx 11$, light-travel distance of 13.4 Gyr), which have already built up $\sim 10^9$ solar masses in stars over the $300-400$ Myr after Big Bang.

Ivo Labbe, *et al.* have identified galaxies with stellar masses as high as $M^* \sim 10^{11}\ M_\odot$ out to redshifts z~6, approximately one billion years after the Big Bang [25]. They find seven galaxies with $M^* > 10^{10}\ M_\odot$ and 7<z<11 in the survey area, including two galaxies with $M^* \sim 10^{11}\ M_\odot$. **The stellar mass density in massive galaxies is much higher than anticipated from previous studies: a factor of 10-30 at z~8 and more than three orders of magnitude at z~10.**

C. T. Donnan, *et al.* provide details of the 55 high-redshift galaxy candidates, 44 of which are new [26]. Their sample contains 6 galaxies at $z \geq 12$, one of which appears to set a new redshift record as an apparently robust galaxy candidate at $z = 16.7$ (light-travel distance of 13.5512 Gyr). They also measure a stellar mass $log_{10}(M^*/M_\odot) = 9.0 \pm 0.4$.

J. A. Zavala, *et al.* report a galaxy, CEERSDSFG-1, for which a photometric redshift fit to the JWST data alone predicts a redshift of $z_{phot} \sim 18$ [27]. However, they show it is a dusty star-forming galaxy (DSFG) at z ≈ 5 based on deep millimeter interferometric observations. Astronomers also present a detection at 850 μm around the position of candidate galaxy CEERS-93316 ($z \approx 16.7$). While the **authors cannot conclusively show this detection is astrophysical or associated with this object,** they illustrate that if it is associated, the available photometry are consistent with a DSFG at z ≈ 5. This provides evidence that DSFGs may contaminate searches for ultra-high-redshift galaxy candidates from JWST observations.

A. Ferrara, A. Pallottini, P. Dayal revealed an unexpected abundance of super-early (z>10), massive ($M^* \sim 10^9\ M_\odot$) galaxies at the bright-end of the ultraviolet luminosity function [28]. They present a minimal physical model that explains the observed galaxy abundance at z=10−14. The model also predicts that **galaxies at z>11 should contain negligible amounts of dust**. The authors speculate that dust could have been efficiently ejected during the very first phases of galaxy build-up.

Y. Ono, *et al.* present morphologies of 25 galaxy candidates at z~9−17 [29]. They obtain effective radii $r_e \sim 200 - 300\ pc$ with the exponential-like profiles for galaxies at z~12−17 . One bright galaxy at z~12, GL-z12-1, has an extremely compact size with $r_e = 61 \pm 11\ pc$. Comparing with numerical

simulations, authors find that such a compact galaxy naturally forms at z≳10, and that **frequent mergers at the early epoch produce more extended galaxies**.

F. Ziparo, *et al.* report about the recent JWST discovery of a population of super-early (redshift z>10), relatively massive (stellar mass $M_* = (10^8 - 10^9)\ M_\odot$) and evolved (metallicity $Z \approx 0.1\ Z_\odot$) galaxies, which nevertheless show blue ($\beta \cong -2.6$) spectra, and very small dust attenuation ($A_V \leq 0.02$), challenges our interpretation of these systems [30].

The summary of the JWST discoveries in the Early World:

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

5. Analysis of JWST Discoveries

The problem of old galaxies formation is a long-standing problem. The age of the Universe is $13.77 \pm 0.06\ Gyr$, based on data on the cosmic microwave background [31]. Astronomers believe that our own Milky Way (MW) galaxy is approximately 13.6 Gyr old. MW is one of the two largest spiral galaxies in the Local Group (the other being the Andromeda Galaxy) with mass $1.15 \times 10^{12} M_\odot$. Massive mature disk galaxies like MW cannot form so soon for 0.17 Gyr only.

Moreover, the oldest known star HD140283 (Methuselah star) is a subgiant star about 190 light years away from the Earth for which a reliable age has been determined. Its total space motion relative to the Sun is 361.3 km/s [32]. In 2013, H. E. Bond, *et al.* found its age to be $14.46 \pm 0.8\ Gyr$ that does not conflict with the age of the Universe. It means that this star must have formed between 13.66 Gyr and 13.83 Gyr , amount of time that is too short for formation of second generation of stars according to prevailing theories [33]. While it currently has a higher estimated age, it is usually a fellow methuselah SMSS J031300.36−670839.3 that it cited as the oldest star with an accurately determined age 13.6 Gyr [34].

WUM explains these discoveries the following way [35]:

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

$\cong 10^{-18}s$. At time $\tau \gg 10^{-18}s$ density fluctuations could happen in the Medium of the World filled with DMF1, DMF2, DIRACs, ELOPs, DMF3, and DMF4. The heaviest Dark Matter particles DMF1 could collect into a cloud with distances between particles smaller than the range of the introduced by WUM weak interaction R_W [35]. As the result, 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. The process described above is the formation of the DM Cores of Superclusters [35];

- DMPs supply not only additional mass ($\propto \tau^{3/2}$) to Cores, but also additional angular momentum ($\propto \tau^2$) fueling the overspinning of DM Supercluster's Cores until reaching a critical point of their stability when surface speed at equator exceeds escape velocity and DM Galaxy's Cores are ejected (as the result of the **Explosive Rotational Fission**). DM Galaxy's Cores obtain their orbital and rotational angular momenta from rotational angular momentum of DM Superclusters' Cores;
- According to WUM, Early-galaxies formed in near present configuration. There are no protogalaxies in the World. That is why JWST did not see their images;
- Macroobjects form from the top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs;
- The oldest known stars in MW (HD140283 and SMSS J031300.36−670839.3) are the result of the Rotational Fission of the overspinning DM Core of the MW galaxy 13.77 Gyr and 13.6 Gyr ago, which was ejected 13.77 Gyr ago by the overspinning DM Core of the Virgo supercluster;
- The total space motion of HD140283 relative to the Sun with speed 361.3 km/s is due to the Rotational Fission of the overspinning DM Core of MW;
- Oldest galaxies with high-redshifts up to z=26 (light-travel distance of 13.63 Gyr) will be confirmed. It depends on the physical parameters of JWST;
- Most of galaxies (including early galaxies) are disklike galaxies due to the Rotational Fission of the overspinning DM Supercluster's Cores;
- The presence of very dusty highly red-shifted galaxies should be proved by discussing a mechanism of dust creation. According to Herschel Space Observatory, *dust is formed in stars and is then blown off in a slow wind or a massive star explosion. The dust is then 'recycled' in the clouds of gas between stars and some of it is consumed when the next generation of stars begins to form. Dust formed in stellar wind or by Supernova Shockwave* [36]. The dust could have been efficiently ejected during the very first phases of galaxy build-up as A. Ferrara, A. Pallottini, P. Dayal speculated;
- Massive mature disk galaxies with mass up to $M^* \sim 10^{11}\, M_\odot$ cannot form so soon because it takes billions of years to form them, and so should not be there at all at the 'beginning';
- Compact Disc Galaxies emerged as the result of the Rotational Fission of the overspinning DM Core of Superclusters. Each of them have one DM Core. There are no frequent mergers at the early epoch.

6. Conclusion

WUM does not attempt to explain all available cosmological and astrophysical 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. We intend to give full details as to the formation of Galaxies by WUM in our next paper.

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Fundamental Physical Constants
Primary Physical Parameters

Abstract

Every four years the Committee on Data for Science and Technology (CODATA) supplies a self-consistent set of values of the basic constants and conversion factors of physics recommended for international use. In 2013, the World-Universe Model (WUM) proposed a principally different depiction of the World as an alternative to the picture of the Big Bang Model. This article: 1) Gives the short history of Classical Physics before Special Relativity; 2) Calculates Fundamental Physical Constants based on experimentally measured Rydberg constant, Electrodynamic constant, Electron Charge-to-Mass Ratio, and Planck constant; 3) Discusses Electrodynamic constant and Speed of Light; 4) Considers Dimensionless Fundamental Parameters (Dirac Large Number Q and Dimensionless Rydberg Constant α); 5) Calculates Newtonian Constant of Gravitation based on the Inter-connectivity of Primary Physical Parameters; 6) Makes a detailed analysis of the Self-consistency of Fundamental Physical Constants and Primary Physical Parameters through the prism of WUM.

The performed analysis suggests: 1) Discontinuing using the notion "Vacuum" and its characteristics (Speed of Light in Vacuum, Characteristic Impedance of Vacuum, Vacuum Magnetic Permeability, Vacuum Electric Permittivity); 2) Accepting the exact numerical values of Electrodynamic constant, Planck constant, Elementary charge, and Dimensionless Rydberg Constant α. WUM recommends the predicted value of Newtonian Constant of Gravitation in 2018 to be considered in CODATA Recommend Values of the Fundamental Physical Constants 2022.

1. Introduction

> *It does not make any difference how beautiful your guess is, it does not make any difference how smart you are, who made the guess, or what his name is. If it disagrees with experiment, it is wrong. That is all there is to it.*
>
> Richard Feynman

The very first manuscript "World-Universe Model" (WUM) was uploaded on viXra in March 2013 [1]. At that time great results in Cosmology were achieved:

- The cosmic Far-Infrared Background Radiation was announced in 1999 [2];
- Temperature of the Microwave Background Radiation was measured in 2009 [3];
- Wilkinson Microwave Anisotropy Probe Observations were published in 2012 [4].

At the same time, the most important for the Cosmology, Newtonian constant of gravitation, proved too difficult to measure [5]. Its measurement precision was the worst among all Fundamental physical constants.

In 2013, we proposed a principally different Model that is, in fact, a Paradigm Shift for Cosmology. WUM is developed around two Primary Physical Parameters in various rational exponents which define all macro and micro features of the World: Dimensionless Rydberg 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.

2. Classical Physics Before Special Relativity

In this Section we describe principal milestones in Classical Physics. Based on the analysis of the measured physical constants we conclude that the most important Fundamental constants could be calculated before Special Relativity [6].

Physical Aether was suggested as early as 17th century, by Isaac Newton. Following the work of Thomas Young (1804) and Augustin-Jean Fresnel (1816), it was believed that light propagates as a transverse wave within an elastic medium called Luminiferous Aether. At that time, it was realized that Aether could not be an elastic matter of an ordinary type that can only transmit longitudinal waves.

Unique properties of Aether were discussed by James McCullagh in 1846 who proposed a theory of a rotationally elastic medium, i.e., a medium in which every particle resists absolute rotation. This theory produces equations analogous to Maxwell's electromagnetic equations [7]. Aether with these properties can transmit transverse waves.

We emphasize that Aether was abandoned in 1905 by Special Relativity. The Friedmann equations were first derived in 1922 from Einstein's field equations for the Friedmann–Lemaitre–Robertson–Walker metric and a **perfect fluid** with a given mass density ρ and pressure p, which is a **medium** of the universe.

In later years there have been classical physicists who advocated the existence of Aether:

- Nikola Tesla declared in 1937 in "Prepared Statement on the 81st birthday observance": "*All attempts to explain the workings of the universe without recognizing the existence of the aether and the indispensable function it plays in the phenomena are futile and destined to oblivion"* [8];
- Paul Dirac said in 1951 in the article in Nature, titled "Is there an Aether?" that "*we are rather forced to have an aether"* [9].

There are no Luminiferous Aether and Vacuum in **WUM**. The Model introduces the **Medium of the World**, which is composed of stable elementary particles: protons, electrons, photons, neutrinos, and Dark Matter Particles (DMPs). The existence of the Medium is a principal point of WUM. It follows from the observations of Intergalactic Plasma; Cosmic Microwave Background Radiation; Far-Infrared Background Radiation. According to WUM, Inter-Galactic voids discussed by astronomers are, in fact, examples of the Medium in its purest. The Medium is the absolute frame of reference [6].

Maxwell's equations were published by J. C. Maxwell in 1861 [10]. He calculated the velocity of electromagnetic waves from the value of an electrodynamic constant c measured by Weber and Kohlrausch in 1857 [11] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [12]. This observation made him suggest that **light is an electromagnetic phenomenon** [13].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** (see Section 5) but **not the speed of light in vacuum** (see Section 6). 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 stable elementary particles.

Rydberg constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series [14].

Electron Charge-to-Mass Ratio e/m_e is a Quantity in experimental physics. It bears significance because the electron mass m_e cannot be measured directly. The e/m_e ratio of an electron was successfully measured by J. J. Thomson in 1897 [15]. We name it after Thomson: $R_T \equiv e/m_e$.

Planck Constant h was suggested by M. Planck in 1901 as the result of investigating the problem of black-body radiation. He used Boltzmann's equation from **Statistical Thermodynamics**: $S = k_B \ln W$ that

shows the relationship between entropy S and the number of ways the atoms or molecules of a thermodynamic system can be arranged (k_B is the Boltzmann constant) [16].

3. Fundamental Physical Constants

Based on the experimentally measured values of the constants R_∞, R_T, c, h, and the magnetic constant (permeability of free space): $\mu_0 = 4\pi \times 10^{-7}\ H/m$ we calculate the **most important constants** as follows:

- Basic size unit a :

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

- Dimensionless Rydberg constant α :

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

- Electron rest energy E_e :

$$E_e = \alpha hc/a$$

- Elementary charge e :

$$e^2 = 2\alpha h/\mu_0 c$$

All these Fundamental constants, including classical electron radius $a_o = a/2\pi$, were measured and could be calculated before Quantum Physics. It is worth noting that the constant α was later named "Sommerfeld's constant" and later "Fine-structure constant."

4. Basic Units

In WUM we introduce the following Basic Units:

- Size a
- Time $t_0 = a/c$
- Energy $E_0 = hc/a$

We often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units of time t_0, size a, and energy E_0. For example, $c = a/t_0$ and $h = E_0 \times t_0$.

5. Electrodynamic constant

In 1857, W. Weber and R. Kohlrausch determined that there was a quantity related to electricity and magnetism, "*the ratio of the absolute electrostatic unit of charge to the absolute electromagnetic unit of charge*" (in modern language, the **electrodynamic constant c with the value of $c = 1/\sqrt{\mu_0 \varepsilon_0}$**, where μ_0 is the permeability of free space and ε_0 is the permittivity of free space) and determined that it should have units of velocity. They measured this ratio by an experiment which involved charging and discharging the Leyden jar and measuring the magnetic force from the discharge current and found the value of $c = 3.107 \times 10^8\ m/s$ [10] remarkably close to the speed of light, which had recently been measured at $v_{light} = 3.15 \times 10^8\ m/s$ by H. Fizeau in 1849 [11] and at $v_{light} = 2.98 \times 10^8\ m/s$ by L. Foucault in 1850 [17]. However, Weber and Kohlrausch did not make the connection to the speed of light. In 1861, J. Maxwell established the connection to the speed of light and concluded that light is a form of electromagnetic radiation [9].

6. Speed of Light

The first measurement of the speed of light v_{light} was made by H. Fizeau in 1849: $v_{light} = 315000\ km/s$

with +5.1% error [18]. The last measurement of v_{light} with rotating mirror was made by A. Michelson in 1926: $v_{light} = 299796 \pm 4\ km/s$ with +12 ppm error [18].

Another way to find v_{light} is to independently measure the frequency f and wavelength λ of an electromagnetic wave and calculate it using the relation $\boldsymbol{v_{light} = f\lambda}$. One way is to measure the resonance frequency of a cavity resonator. If the dimensions of the resonance cavity are also known, these can be used to find a wavelength of the wave. In 1947, L. Essen obtained the following result: $v_{light} = 299792.5 \pm 1\ km/s$ with +0.14 ppm error [18].

Interferometry is another method to find a wavelength of the electromagnetic radiation for determining v_{light}. A coherent beam of light (e.g. from a laser), with a known frequency f, is split to follow two paths and then recombined. By adjusting the path length while observing the interference pattern and carefully measuring the change in path length, the wavelength of the light λ can be found. The v_{light} is then calculated using the equation $v_{light} = f\lambda$. In 1972, using the laser interferometer method a group at the US National Bureau of Standards determined the speed of light to be $v_{light} = 299792456.2 \pm 1.1\ m/s$. This was 100 times less uncertain than the previously accepted value [18].

In 1983, the 17th meeting of the General Conference on Weights and Measures redefined the metre as: "*The metre is the length of the path traveled by light (**in vacuum ?**) during a time interval of 1/299792458 of a second*". As a result of this definition, the value of the speed of light (**in vacuum ?**) is exactly 299792458 m/s and has become a defined constant in the SI system of units [18].

Let us clarify a notion "Vacuum." A **Vacuum is a space devoid of matter**. An approximation to such vacuum is a region with a gaseous pressure much less than atmospheric pressure. **Physicists often discuss ideal test results that would occur in a perfect vacuum**, which they sometimes simply call "vacuum" or free space.

By definition, an ***Outer space*** *is the expanse that exists beyond Earth and its atmosphere and between celestial bodies.* ***Outer space is not completely empty****—it is a* ***near perfect vacuum*** *containing a low density of particles, predominantly a plasma of hydrogen and helium, as well as electromagnetic radiation, magnetic fields, neutrinos, dust, and cosmic rays. The baseline temperature of outer space is 2.7255 kelvins. The plasma between galaxies is thought to account for about half of the baryonic (ordinary) matter in the universe, having a number density of less than one hydrogen atom per cubic metre* [Wikipedia. Outer Space].

We absolutely agree with this definition. Moreover in frames of WUM, we calculate the density of the Intergalactic plasma: $n_p = n_e = 0.25480\ m^{-3}$ and the temperature of the Microwave Background Radiation: $T_{MBR} = 2.72518\ K$ [19], which are in good agreement with the results above.

The existence of the Intergalactic plasma was proved by the observations of Fast Radio Bursts, which are millisecond duration radio signals originating from distant galaxies. These signals are dispersed according to a precise physical law and this dispersion is a key observable quantity which, in tandem with a redshift measurement, can be used for fundamental physical investigations.

In **WUM**, the Outer space is the Medium of the World, which is composed of stable elementary particles: protons, electrons, photons, neutrinos, and DMPs. There is no Dark Energy in WUM. The experimental proves are: the Intergalactic plasma (protons, electrons), the Microwave Background Radiation (photons), the Cosmic Neutrino Background (neutrinos), and Mass-to-light ratios of Superclusters which are $(300 - 500)$ times larger than that of Solar ratio (DMPs).

According to Maxwell's equations, electromagnetic waves in any bulk material move at the velocity v_{EM} that is a function of permeability μ_M and permittivity ε_M of the material:

$$v_{EM} = 1/\sqrt{\mu_M \varepsilon_M}$$

where $\mu_M = \mu_r\mu_0$ and $\varepsilon_M = \varepsilon_r\varepsilon_0$, and μ_r and ε_r are the relative permeability and permittivity of the material, respectively. Then, the velocity of electromagnetic waves is:

$$v_{EM} = c/\sqrt{\mu_r\varepsilon_r}$$

In case of vacuum: $\mu_r = \varepsilon_r = 1$ and $v_{EM} = c$. In case of Outer space $\mu_r > 1$ and $v_{EM} < c$ (see Section 9). It follows that there is no miracle in the maximum value of the velocity v_{EM} that equals to the value of the Electrodynamic constant c ! In any bulk material including the Outer space $v_{EM} < c$.

In WUM, there are no speed of light in vacuum and massless photons because there is no vacuum in the World. In reality, there is the Medium of the World with the Intergalactic plasma and the minimum energy of photons passing through the Intergalactic plasma. We emphasize that c is the electrodynamic constant in Maxwell's equations but not a speed of light in vacuum as it is accepted now. Using the relation $v_{light} = f\lambda$ is, in fact, the way to measure the value of the electrodynamic constant [20].

In our opinion, in 1983 the 17th meeting of the General Conference on Weights and Measures redefined not only the metre, but as a result, the value of the electromagnetic constant that has become a defined constant in the SI system of units.

7. Dimensionless Fundamental Parameters

Arthur Eddington was the first physicist to recognize the significance of universal dimensionless constants, now considered among the most critical components of major physical theories.

7.1. Dirac Large Number Q

Inter-Connectivity of Primary Physical Parameters. The constancy of the universe fundamental constants, including Newtonian constant of gravitation, is now commonly accepted, although has never been firmly proven 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 it is done in some other areas of physics. WUM holds that there indeed exist relations between all physical parameters which depend on dimensionless time-varying quantity Q, which is a measure of the Size R and Age A_τ of the World and is, in fact, Dirac Large Number:

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

In the present Epoch, $Q = 0.759972 \times 10^{40}$ [21].

According to WUM, the following parameters of the World depend on Q [21]:

- Newtonian parameter of gravitation G

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

- Hubble's parameter H

$$H = \frac{c}{a} \times Q^{-1}$$

- Age of the World A_τ

$$A_\tau = \frac{a}{c} \times Q$$

- The Worlds' radius of curvature in the fourth spatial dimension R

$$R = a \times Q$$

- Critical energy density ρ_{cr}

$$\rho_{cr} = 3\frac{hc}{a^4} \times Q^{-1}$$

- Concentration of intergalactic plasma (IGP) n_{IGP}

$$n_{IGP} = \frac{2\pi^2}{a^3}\frac{m_e}{m_p} \times Q^{-1}$$

- Minimum energy of photons E_{ph}

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

- Temperature of the Microwave Background Radiation (MBR) T_{MBR}

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

- Temperature of the Far-Infrared Background Radiation (FIRB) peak T_{FIRB}

$$T_{FIRB} = \frac{E_0}{k_B}(\frac{15}{4\pi^5})^{1/4} \times Q^{-1/4}$$

- Fermi coupling parameter G_F

$$\frac{G_F}{(\hbar c)^3} = \sqrt{30}(2\alpha\frac{m_e}{m_p})^{1/4}\frac{m_p}{m_e}\frac{1}{E_0^2} \times Q^{-1/4}$$

- Electronic neutrino mass m_{ν_e}

$$m_{\nu_e} = \frac{1}{24}m_0 \times Q^{-1/4}$$

- Muonic neutrino mass m_{ν_μ}

$$m_{\nu_\mu} = m_0 \times Q^{-1/4}$$

- Tauonic neutrino mass m_{ν_τ}

$$m_{\nu_\tau} = 6m_0 \times Q^{-1/4}$$

where $\hbar$ is Dirac constant: $\hbar = h/2\pi$, $m_0 = h/ac$, m_p is a mass of a proton, m_e is a mass of an electron.

7.2. Dimensionless Rydberg Constant α

The mystery about α is actually a double mystery: The first mystery – the origin of its numerical value $\alpha \approx 1/137$ – has been recognized and discussed for decades. The second mystery – the range of its domain – is generally unrecognized.

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In Section 3, we calculate Dimensionless Rydberg Constant α :

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

Rydberg constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series [14].

In WUM, the following parameters of the World depend on α :

- Rydberg constant R_∞

$$R_\infty = \alpha^3 \times \frac{1}{2a}$$

- Rydberg unit of energy Ry

$$Ry = \alpha^3 \times \frac{E_0}{2}$$

- Electron rest energy E_e :

$$E_e = \alpha \times E_0$$

- Elementary charge e :

$$e^2 = \alpha \times \frac{2h}{\mu_0 c}$$

WUM postulates that rest energies of Dark Matter Fermions (DMFs) and bosons are proportional to E_0 multiplied by different exponents of α and can be expressed with the following formulae [1]:

DMF1 (fermion)

$$E_{DMF1} = \alpha^{-2} \times E_0$$

DMF2 (fermion)

$$E_{DMF2} = \alpha^{-1} \times E_0$$

DIRAC (boson)

$$E_{DIRAC} = \alpha^0 \times E_0$$

ELOP (boson)

$$E_{ELOP} = \alpha^1 \times \frac{2E_0}{3}$$

DMF3 (fermion)

$$E_{DMF3} = \alpha^2 \times E_0$$

DMF4 (fermion)

$$E_{DMF4} = \alpha^4 \times E_0$$

According to WUM, a proton energy density in the Medium of the World ρ_p , equals to [21]:

$$\rho_p = \alpha \times \frac{2\pi^2 \rho_{cr}}{3}$$

the total DMF4 relative energy density ρ_{DMF4} , in terms of proton energy density ρ_p , equals to [21]:

$$\rho_{DMF4} = \frac{45}{\pi}\rho_p$$

Our Model holds that the energy density of all types of self-annihilating DMPs is proportional to ρ_p . In all, there are 5 different types of self-annihilating DMPs: DMF1, DMF2, DIRAC, ELOP, and DMF3. Then the total energy density of DM ρ_{DM} is:

$$\rho_{DM} = 5\rho_p$$

The total baryonic energy density ρ_B is:

$$\rho_B = 1.5\rho_p$$

The sum of electron and MBR energy densities ρ_{eMBR} equals to:

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

We take energy density of neutrinos ρ_ν to equal:

$$\rho_\nu = \rho_{MBR} = 2\frac{m_e}{m_p}\rho_p$$

For FIRB radiation energy density ρ_{FIRB} we take

$$\rho_{FIRB} = \frac{1}{5\pi}\frac{m_e}{m_p}\rho_p \approx 0.032\rho_{MBR}$$

which corresponds to the value of $0.034\ \rho_{MBR}$ calculated by E. L. Wright [22]. Then the energy density of the World ρ_W in Luminous Epoch equals to the theoretical critical energy density ρ_{cr}

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

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

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

which is in excellent agreement with the commonly adopted value of 137.035999. It follows that there is a direct correlation between constants α and m_e/m_p expressed by the obtained equation. As shown, m_e/m_p is not an independent constant but is instead derived from α [23]:

$$\frac{m_e}{m_p} = \frac{15/\pi\alpha - 450 - 65\pi}{55\pi + 2}$$

Summary:

- The World's energy density is inversely proportional to the dimensionless time-varying parameter Q in all cosmological times;
- The particles relative energy densities are proportional to constant α in Luminous Epoch;
- The α plays a central role in WUM;
- Constant α and quantity Q should be named "Universe Constant" and "World Parameter."

As a conclusion,

There exist a number of competing cosmological models. In our opinion, the most probable model is the one that built on the minimum number of parameters. WUM is based on **two parameters** only: dimensionless Rydberg constant α and dimensionless quantity Q, which increases in time $Q \propto \tau$, and is, in fact, a measure of the Size and Age of the World. In WUM we often use well-known physical parameters, keeping in mind that all of them can be expressed through the Basic Units. Taking the relative values of physical parameters in terms of the Basic Units we can express all dimensionless parameters of the World through two Fundamental Parameters α and Q in various rational exponents, as well as small integer numbers and π .

8. Newtonian Constant of Gravitation

In 2010, CODATA stated the following value of G:

$$G(2010) = 6.67384 \times 10^{-11} m^3 kg^{-1} s^{-2}\ \ (120\ ppm)$$

with Relative Standard Uncertainty (RSU): $RSU = 1.2 \times 10^{-4} = 120\ ppm$.

In 2013, WUM proposed a principally different way to solve the problem of G measurement precision. WUM revealed a self-consistent set of time-varying values of Primary Physical Parameters (PPPs). Based on the value of Fermi Coupling constant in 2010:

$$G_F(2010) = 1.166364 \times 10^{-5} GeV^{-2}\ \ (4.3\ ppm)$$

WUM predicted the value of the gravitational constant G^*_{2014} equals to [24]:

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

and recommended this value to CODATA.

To resolve the problem T. Quinn, C. Speake, and J. Luo organized the Royal Society meeting titled "The Newtonian constant of gravitation, a constant too difficult to measure?" in London on Feb. 2014 [25].

According to J. Luo:

"*The Newtonian gravitational constant G holds an important place in physics. Though there have been about 300 measurements of G since the first laboratory measurement by Cavendish over 200 years ago, its measurement precision is the worst among all the fundamental physics constants*".

T. Quinn in the paper "*Outcome of the Royal Society meeting on G held at Chicheley Hall on 27 and 28 February 2014 to discuss 'The Newtonian constant of gravitation, a constant too difficult to measure?'*" concluded [26]:

At the end of the meeting, a broad consensus was reached on the following main points.

(1) The problem of arriving at a reliable value for G in the face of the wide dispersion of recent results (some 450 ppm, more than ten times the sigma of the individual results) is unlikely to be resolved by one or two additional results obtained, as in the past, by teams working independently

(2) There is nevertheless an urgent need to resolve this situation, unprecedented in the determination of one of the fundamental constants of physics. Although at present there is no pressing problem in theoretical physics that requires an accurate value of G, accurate values of the fundamental constants are an essential part of the foundations of physics. In almost all areas of the physical sciences, determinations of fundamental constants are at the frontiers of science. This is so in experimental gravitational physics where one of the characteristics of the work is the need to measure extremely small forces. The science and techniques used in the determination of G are those also used in tests of the equivalence principle, in tests of the inverse square law and in the search for other non-Newtonian forces. Quite apart from the results of such measurements, whether they are null experiments or ones leading to a value of a constant, the training of young scientists who participate has always been an important product of high metrology. The wide disagreement among recent measured values of G must cast some doubt on our abilities in this crucial area of small-force measurement and in other areas where similar techniques are used. This is an unsatisfactory situation.

(3) There are a number of key parameters some or all of which have to be measured with the highest accuracy in determinations of G. These include mass, density, length, time, electric current, voltage, capacitance, and angle. In some experiments, there may be others. Measurements of these must be traceable to verified national and international standards with evaluated uncertainties with respect to the SI. The experiments themselves must be conducted in laboratories having the highest quality of temperature and environmental control. All of this strongly points to a national metrology institute, or a laboratory closely associated with a national metrology institute, as being the most appropriate place for future experiments to take place.

(4) Thus, instead of simply calling for new determinations of G, it is suggested that an international advisory board be created, made up largely of those who have already conducted a G experiment, to advise on the choice of method or methods, on the design of the experiment, on its construction and finally on the interpretation of the data and calculation of the results. This would be in contrast to the present situation in which outside criticism and comments can be brought to bear only when the experiment is finished and published when it is too late to affect the outcome. It is only by proceeding in this way that one might hope to obtain results that are demonstrably reliable.

To the best of our knowledge, no breakthrough in *G* measurement methodology has been achieved since.

Nevertheless, in 2015 CODATA recommended a more precise value of G(2014):

$$G(2014) = 6.67408 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (47\ ppm)$$

In 2018, the recommendation improved further:

$$G(2018) = 6.67430 \times 10^{-11} m^3 kg^{-1} s^{-2} \ \ (22\ ppm)$$

Since 2013, the relative standard uncertainty of G measurements reduced from 120 ppm to 22 ppm! It seems that CODATA considered the WUM's recommendation of the predicted value of G and used it for G(2014) and $G(2018)$ without any reference or explanation of their approach.

Considering a more precise value of Fermi Coupling constant in 2014:

$$G_F(2014) = 1.1663787 \times 10^{-5} GeV^{-2} \ \ (0.51\ ppm)$$

WUM calculated a predicted value of gravitational constant G^*_{2018} :

$$G^*_{2018} = \ 6.674536 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

which is x8 more accurate than G^*_{2014} . The predicted value of G^*_{2018} is in excellent agreement with the experimentally measured by Q. Li, *et al.* in 2018 values of G using two independent methods [27]:

$$G(1) = 6.674184 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.64\ ppm)$$
$$G(2) = 6.67484 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.61\ ppm)$$

WUM recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of G^*_{2018} .

9. Self-Consistency of Fundamental Physical Constants

Every four years CODATA supplies a self-consistent set of values of the basic constants and conversion factors of physics recommended for international use.

Table 1, borrowed from CODATA Recommended Values of the Fundamental Physical Constants, 2010, 2014, and 2018 summarizes the results of measurements of Universal, Electromagnetic, and Atomic and Nuclear constants. Observe that the most of Fundamental Physical Constants have more precise values with each adjustment. However, there are a few results that prompt some questions.

9.1. Characteristic Impedance of Vacuum, Vacuum Electric Permittivity, Vacuum Magnetic Permeability, Speed of Light in Vacuum

In 2010 and 2014 these constants had exact values that equal to the theoretical values in free space. Whereas, in 2018 Characteristic Impedance of Vacuum Z_V , Vacuum Electric Permittivity ε_V , Vacuum Magnetic Permeability μ_V have different numerical values with $RSU = 1.5 \times 10^{-10}$. Z_V and ε_V were calculated based on the value of μ_V according to the following equations: $Z_V = \mu_V c$ and $\varepsilon_V = (\mu_V c_V^2)^{-1}$ with the exact value of speed of light in vacuum c_V (see **Table 1**).

Observe that the value of μ_V (2018) is larger than μ_V (2014). It means that there is a relative permeability of the Medium of the World μ_r and the magnetic permeability of the Medium μ_M equals to:

$$\mu_M = \mu_r \mu_0$$

The calculated value of μ_r is:

$$\mu_r = 1.00000000054$$

According to WUM, there is a relative electric permittivity of the Medium of the World ε_r and the electric permittivity of the Medium ε_M equals to:

$$\varepsilon_M = \varepsilon_r \varepsilon_0$$

Then, the speed of light in the Medium v_M can be calculated by the following equation:

$$v_M = (\mu_M \varepsilon_M)^{-1/2} = (\mu_r \mu_0 \varepsilon_r \varepsilon_0)^{-1/2} = c/(\mu_r \varepsilon_r)^{-1/2} < c$$

Table 1. Summary of the results of measurements of the Fundamental Physical Constants relevant to the 2010, 2014, and 2018 adjustments.

Fundamental Physical Constant	**Numerical Value. Relative Standard Uncertainty, 2010**	**Numerical Value. Relative Standard Uncertainty, 2014**	**Numerical Value. Relative Standard Uncertainty, 2018**
Characteristic Impedance of Vacuum Z_0 , Ω	376.730 313 461 exact	376.730 313 461 exact	376.730 313 668 1.5×10^{-10}
Newtonian Constant of Gravitation G, $\times 10^{-11}\ m^3 kg^{-1} s^{-2}$	6.673 84 1.2×10^{-4}	6.674 08 4.7×10^{-5}	6.674 30 2.2×10^{-5}
Planck constant h, $\times 10^{-34}\ J\ Hz^{-1}$	6.626 069 57 4.4×10^{-8}	6.626 070 040 1.2×10^{-8}	6.626 070 15 exact
Speed of Light in Vacuum $c, m\ s^{-1}$	299 792 458 exact	299 792 458 exact	299 792 458 exact
Vacuum Electric Permittivity ε_0 , $\times 10^{-12}\ F\ m^{-1}$	8.854 187 8176 exact	8.854 187 8176 exact	8.854 187 8128 1.5×10^{-10}
Vacuum Magnetic Permeability μ_0 , $\times 10^{-6}\ N\ A^{-2}$	1.256 637 061 44 exact	1.256 637 061 44 exact	1.256 637 062 12 1.5×10^{-10}
Elementary charge C, $\times 10^{-19}$	1.602 176 565 2.2×10^{-8}	1.602 176 6208 6.1×10^{-9}	1.602 176 634 exact
Electron Charge to Mass Quotient $-e/m_e$, $\times 10^{11}\ C\ kg^{-1}$	−1.758 820 088 2.2×10^{-8}	−1.758 820 024 6.2×10^{-9}	−1.758 820 01076 3.0×10^{-10}
Fermi Coupling Constant $G_F/(\hbar c)^3$, $\times 10^{-5}\ GeV^{-2}$	1.166 364 4.3×10^{-6}	1.166 3787 5.1×10^{-7}	1.166 3787 5.1×10^{-7}
Fine-Structure Constant α , $\times 10^{-3}$	7.297 352 5698 3.2×10^{-10}	7.297 352 5664 2.3×10^{-10}	7.297 352 5693 1.5×10^{-10}
Hartree Energy E_h , $\times 10^{-18}\ J$	4.359 744 34 4.4×10^{-8}	4.359 744 650 1.2×10^{-8}	4.359 744 722 2071 1.9×10^{-12}
Rydberg Constant R_∞ , m^{-1}	10 973 731.568 539 5.0×10^{-12}	10 973 731.568 508 5.9×10^{-12}	10 973 731.568 160 1.9×10^{-12}

We emphasize that $\mu_0 = 4\pi \times 10^{-7}\ H/m$ is the magnetic constant (permeability of free space) in Maxwell's equations and c is the electrodynamic constant but not the speed of light in vacuum c_V.

In our opinion, the value of the electric permittivity of the Medium ε_M must be experimentally measured but not calculated as it is have done by CODATA for "Vacuum Electric Permittivity" ε_V.

The existence of the Medium of the World is a principal point of WUM. It consists of Intergalactic plasma, Microwave background radiation, cosmic Far-Infrared background, Dark Matter particles including magnetic dipoles DIRACs and electric dipoles ELOPs. Cosmic Maxwell's equations should consider the macroscopically averaged electric dipole and magnetic dipole moment densities of the Medium in the presence of applied fields [28] as it has be done by H. Harmuth and K. Lukin [29] [30].

Detailed analysis of the measurements of the electrodynamic constant and speed of light, held in [20], shows that using the relation $v_{light} = f\lambda$ is, in fact, the way to measure the value of the electrodynamic constant c. In our view, the exact value of "speed of light in vacuum" (in CODATA) is nothing but the value of the electrodynamic constant.

9.2. Elementary Charge. Rydberg Constant. Hartree Energy. Electron Charge to Mass Quotient. Electron Mass

The relation used by CODATA to find elementary charge is:

$$e^2 = 2\alpha h/\mu_0 c$$

As of 2018, the elementary charge e, Planck constant h, and "speed of light in vacuum" (electrodynamic constant) c have the exact numerical values. The magnetic constant: $\mu_0 = const$. It means that the "Fine-Structure Constant" (Dimensionless Rydberg constant): $\alpha = const$. Following WUM:

$$\alpha^3 = 2aR_\infty = (R_\infty R_T)\left[8(\mu_0 h/c)^3\,(R_\infty R_T)\right]^{1/5}$$

Consequently, a product of R_∞ and R_T is:

$$(R_\infty R_T) = const$$

Hartree Energy E_h can be calculated by the following equation:

$$E_h = hcR_\infty$$

Electron mass m_e is:

$$m_e = e/R_T$$

The RSU of the numerical value of the Rydberg constant R_∞ is: $RSU = 1.9 \times 10^{-12}$. It means that the RSU of the numerical values of R_T, E_h, m_e must be the same as R_∞. In our view, it is worth accepting the exact values of all Fundamental Constants: Z_0, μ_0, ε_0, α, h, c, e, m_e, a, R_T, E_h, R_∞. We should concentrate our efforts on the measurements of time-varying Primary Physical Parameters.

10. Conclusion

The detailed analysis of the self-consistency of Fundamental physical constants based on the developed World-Universe Model shows that it is the right time to:

- Discontinue using the notion "Vacuum" and its characteristics;
- Correct the numerical values and relative standard uncertainty of Fundamental Physical Constants;
- Recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of the Newtonian Constant of Gravitation G^*_{2018}.

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Decisive Role of Gravitational Parameter G in Cosmology

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

Galileo Galilei

Abstract

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 Hypersphere World-Universe Model (WUM) follows these ideas, albeit introducing a different mechanism of Matter creation. In this paper we show that Gravitational parameter G that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly.

1. Introduction

About 21 years ago, I developed an interest in Cosmology. For 11 years, I have been elaborating a model I dubbed World-Universe Model (WUM), and then in 2013, I uploaded the first papers on viXra [1], [2], which were, in fact, the beginning of a New Paradigm in Cosmology. From 2015, I published a serious of articles on WUM in the Journal of High Energy Physics, Gravitation and Cosmology (Editor-in-Chief Prof. Dr. C. Corda – an expert in the fields of mathematics, theoretical physics, astrophysics, and cosmology). The manuscript "Review Article: Cosmology and Classical Physics" [3] is a synthesis of my approach to Cosmology and the article "JWST Discoveries—Confirmation of World-Universe Model Predictions" [4] is a quintessence of WUM. The present paper is a continue of the previous manuscript "Fundamental Physical Constants and Primary Physical Parameters" [5]. It concentrates on the detailed analysis of Primary Physical Parameters and emphasizes the decisive role of experimentally measured Gravitational parameter G in Cosmology.

2. Principal Points of WUM

2.1. Fundamental Physical Constants

Maxwell's equations were published by J. C. Maxwell in 1861 [6]. He calculated the velocity of electromagnetic waves from the value of an **electrodynamic constant** c measured by Weber and Kohlrausch in 1857 [7] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [8]. This observation made him suggest that **light is an electromagnetic phenomenon** [9].

We emphasize that c in Maxwell's equations **is the electrodynamic constant** but **not the speed of light in vacuum.** 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 stable elementary particles.

Rydberg constant R_∞ is a physical constant relating to atomic spectra. The constant first arose in 1888 as an empirical fitting parameter in the Rydberg formula for the hydrogen spectral series [10].

Electron Charge-to-Mass Ratio e/m_e is a Quantity in experimental physics. It bears significance because the electron mass m_e cannot be measured directly. The e/m_e ratio of an electron was successfully measured by J. J. Thomson in 1897 [11]. We name it after Thomson: $R_T \equiv e/m_e$.

Planck Constant h was suggested by M. Planck in 1901 as the result of investigating the problem of black-body radiation. He used Boltzmann's equation from **Statistical Thermodynamics**: $S = k_B \ln W$ that shows the relationship between entropy S and the number of ways the atoms or molecules of a thermodynamic system can be arranged (k_B is the Boltzmann constant) [12].

Based on the **experimentally measured** values of the constants R_∞ , R_T , c , h , and the magnetic constant: $\mu_0 = 4\pi \times 10^{-7}\ H/m$ we make measurable the **most important constants** as follows [5]:

- Basic size unit a :

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

- Dimensionless Rydberg constant α :

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

- Electron rest energy E_e :

$$E_e = \alpha hc/a$$

- Elementary charge e :

$$e^2 = 2\alpha h/\mu_0 c$$

All these Fundamental constants, including classical electron radius $a_o = a/2\pi$, could be calculated based on the experimentally measured constants before Quantum Physics! It is worth noting that the constant α was later named “Sommerfeld’s constant” and later “Fine-structure constant.”

2.2. Basic Units

In WUM we introduce the following Basic Units:

- Size a
- Time $t_0 = a/c$
- Frequency $\nu_0 = c/a$
- Energy $E_0 = hc/a$
- Surface Energy Density $\sigma_0 = hc/a^3$
- Energy Density $\rho_0 = hc/a^4$

2.3. 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; Far-Infrared Background Radiation. There is no empty space (vacuum) in WUM. 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 [13].

2.4. Principal Role of Maxwell's Equations

Maxwell's Equations (MEs) form the foundation of classical electrodynamics. Gravitoelectromagnetism (GEM) is a gravitational analog of Electromagnetism. GEM equations differing from MEs by some constants were first published by O. Heaviside in 1893 as a separate theory expanding Newton's law. GEM is an approximation to the Einstein's gravity equations in the weak field limit. H. Thirring pointed out this analogy in his "*On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation*" paper published in 1918 [14]. It allows us to use formal analogies between the electromagnetism and relativistic gravity. MEs produce only two physically measurable quantities: energy density and energy flux density [15].

The value of MEs is even greater because J. Swain showed that "*linearized general relativity admits a formulation in terms of gravitoelectric and gravitomagnetic fields that closely parallels the description of the electromagnetic field by Maxwell's equations"* [16]. We emphasize that **GEM considers not only interactions between masses but also between mass currents**, which produce gravitomagnetic field.

In 2021, G. Ludwig in his paper "Galactic rotation curve and dark matter according to gravitomagnetism" wrote: *Most theories used to explain the rotation curve have been restricted to the Newtonian potential framework, disregarding the general relativistic corrections associated with mass currents. In this paper it is shown that the gravitomagnetic field produced by the currents modifies the galactic rotation curve, notably at large distances. The coupling between the Newtonian potential and the gravitomagnetic flux function results in a nonlinear differential equation that relates the rotation velocity to the mass density. The solution of this equation reproduces the galactic rotation curve without recourse to obscure dark matter components.* ***The effects attributed to dark matter can be simply explained by the gravitomagnetic field produced by the mass currents*** [17]

WUM is based on Gravitomagnetism. The explanation of the galactic rotation curve made by G. O. Ludwig is in good agreement with the approach of WUM.

3. Primary Cosmological Parameters

There are only two directly measured Cosmological Parameters: the Gravitational parameter G and the Temperature of the Cosmic Microwave Background Radiation T_{MBR}. To the best of our knowledge, Q. Li, *et al.* in 2018 experimentally measured the most accurate values of G using two independent methods [18]:

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

$$G(2) = 6.674484 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.61\ ppm)$$

with Relative Standard Uncertainty (RSU): $RSU = 1.16 \times 10^{-5} = 11.6\ ppm$.

D. J. Fixsen in 2009 measured the value of T_{MBR} with $RSU = 3 \times 10^{-5} = 30\ ppm$ [19]:

$$T_{MBR} = 2.725181\ K\ (30\ ppm)$$

It means that the most accurate parameter is G, and all other Cosmological Parameters could be, in principal, calculated based on the value of G with the same accuracy.

3.1. Inter-Connectivity of Primary Cosmological Parameters

The constancy of the universe fundamental constants, including Newtonian constant of gravitation, is now commonly accepted, although has never been firmly established as a fact. All conclusions on the

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: $Q = 0.7599440 \times 10^{40}$ and is, in fact, the Dirac Large Number (see Section 3.4). **WUM is based on two parameters only**: α and Q.

3.2. Energy Density of the World

Imagine that the World is a Hubble Bubble with a radius $R = c\tau$ (where c is a gravitodynamic constant and τ is a cosmological time) and an energy density of a spherical surface σ_0. With Nikola Tesla's principle at heart – *There is no energy in matter other than that received from the environment* – we calculate an energy of the World E_W:

$$E_w = 4\pi R^2 \sigma_0$$

and average energy density ρ_W:

$$\rho_W = \frac{3\sigma_0}{R} = \frac{3hc}{a^3 R} = \frac{3hc}{a^4}\frac{a}{R} = 3\rho_0 \times Q^{-1}$$

that is inversely proportional to R.

3.3. Critical Energy Density

The principal idea of WUM is that ρ_W equals to the critical energy density ρ_{cr}:

$$\rho_W = \rho_{cr}$$

which can be found by considering a sphere of radius R_M and enclosed mass M that can be calculated by multiplication of critical mass density by the volume of the sphere. When the World has the critical density, the Hubble velocity $H \times R_M$ ($H = c/R$ is the Hubble's parameter) equals to the escape velocity:

$$2G \times \frac{4\pi}{3} R_M^3 \times \frac{\rho_{cr}}{R_M c^2} = (H \times R_M)^2$$

which gives an equation for ρ_{cr} [20]:

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

This equation can be rewritten as:

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

where $\mu_g = \frac{4\pi G}{c^2}$ is the gravitomagnetic parameter and $\rho_M = \frac{2}{3}\rho_{cr}$ is the energy density of the Medium. Considering that $H \propto R^{-1}$, it is easy to see that the gravitational parameter $G \propto R^{-1}$. We emphasize that the values of the main cosmological parameters G and H depend on the value of ρ_M which is the characteristic of the **Medium** that is Homogeneous and Isotropic.

3.4. Gravitational Parameter G and Dirac Large Number Q

Considering equations in Sections 3.2 and 3.3, we can find the equation for G:

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

The average value of Gravitational parameter G_{av} of the experimentally measured values [18]:

$$G_{av} = \frac{G(1) + G(2)}{2} = 6.674334 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

allows us to calculate the value of Q based on the value of G_{av}:

$$Q = \frac{a^2 c^4}{8\pi hc} \times G_{av}^{-1} = 0.7599440 \times 10^{40}$$

3.5. Intergalactic Plasma

In our Model, the World consists of stable elementary particles with lifetimes longer than the age of the World. Protons with mass m_p and electrons with mass m_e have identical concentrations in the World: $n_p = n_e$. Intergalactic plasma (IGP) consisting of protons and electrons has plasma frequency ω_{pl}:

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

Since the formula calculating the potential energy of interaction of protons and electrons contains the same parameter k_{pe}:

$$k_{pe} = m_p \omega_{pl}^2 = m_e \omega_e^2 = m_e (2\pi \nu_0 \times Q^{-1/2})^2$$

where we assume that ω_e is proportional to $Q^{-1/2}$, then ω_{pl}^2 is proportional to Q^{-1}. Energy densities of protons and electrons are then proportional to Q^{-1}, similar to the critical energy density $\rho_{cr} \propto Q^{-1}$. We substitute $\omega_{pl}^2 = \frac{m_e}{m_p}(2\pi\nu_0 \times Q^{-1/2})^2$ into the first equation and calculate concentrations n_p and n_e:

$$n_p = n_e = \frac{2\pi^2}{a^3} \frac{m_e}{m_p} \times Q^{-1} = 0.254810\ m^{-3}$$

A. Mirizzi, *et al.* found that the mean diffuse intergalactic plasma density is bounded by $n_e \lesssim 0.27\ m^{-3}$ [21] corresponding to the WMAP measurement of the baryon density [22]. The calculated Mediums' plasma density is in good agreement with the estimated value [21].

$\rho_p = n_p E_p$ is the energy density of protons in the Medium. The relative energy density of protons in the Medium Ω_p is then the ratio of ρ_p / ρ_{cr}:

$$\Omega_p = \frac{2\pi^2 \alpha}{3} = 0.048014655$$

According to WUM, the relative energy density of baryons in Macroobjects Ω_{MO} is:

$$\Omega_{MO} = \frac{1}{2}\Omega_p = \frac{\pi^2 \alpha}{3} = 0.024007318$$

The calculated values of Ω_p and Ω_{MO} are in good agreement with their 2015 estimations [23], [24].

In our opinion, measurements of IGP parameters can be done by investigations of the Fast Radio Bursts,

which are millisecond duration radio signals originating from distant galaxies. These signals are dispersed according to a precise physical law and this dispersion is a key observable quantity which, in tandem with a redshift measurement, can be used for fundamental physical investigations [25].

The dispersion measure and redshift, conducted by E. F. Keane, *et al.*, provide the measurement of the cosmic density of ionized baryons in the intergalactic medium Ω_{IGM} [25]:

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

that is in excellent agreement with the predicted by WUM value of $\Omega_p = 0.048014655$. Using the equation for n_e, we calculated the value of photons' time delay [26]:

$$\Delta t_{ph}^{cal} = 2.189 \times (\frac{\nu}{1GHz})^{-2}$$

which is in good agreement with experimentally measured value [25]:

$$\Delta t_{ph}^{exp} = 2.438 \times (\frac{\nu}{1GHz})^{-2}$$

To summaries: the values of the Intergalactic plasma parameters predicted by WUM in 2013 [1] are confirmed by experiments conducted in 2016 [25].

3.6. Minimum Energy of Photons

Analysis of Intergalactic plasma shows that the value of the lowest plasma frequency ν_{pl} is [1]:

$$\nu_{pl} = \nu_0(\frac{m_e}{m_p})^{1/2} \times Q^{-1/2} = 4.53228\ Hz$$

Photons with energy smaller than $E_{ph} = h\nu_{pl}$ cannot propagate in plasma, thus $h\nu_{pl}$ is the smallest amount of energy a photon may possess:

$$E_{ph} = (\frac{m_e}{m_p})^{1/2} E_0 \times Q^{-1/2} = 1.87433 \times 10^{-14}\ eV$$

The above value, predicted by WUM in 2013, is in good agreement with the value:

$$E_{ph} \lesssim 2.2 \times 10^{-14}\ eV$$

obtained by L. Bonetti, *et al.* in 2017 [27]. Following L. Bonetti, *et al.* we can call this amount of energy the rest energy of photons. In our opinion, it is more relevant to call E_{ph} the minimum energy of photons which can pass through the Intergalactic plasma.

3.7. Origin of Cosmic Microwave Background Radiation

According to the standard Big Bang Model, the photons that existed at the time of photon decoupling (380,000 years after the Big Bang) have been propagating ever since, though growing fainter and less energetic, since the expansion of space causes their wavelength to increase over time.

WUM: Wavelength is a classical notion. Photons, which are quantum objects, have only four-momenta. They do not have wavelengths. By definition, "*Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment*".

According to WUM, the black body spectrum of Microwave Background Radiation (MBR) is due to thermodynamic equilibrium of photons with IGP consisting of protons and electrons. It explains why MBR is a perfect blackbody.

$\rho_e = n_e E_e$ is the energy density of electrons in the Medium. We assume that the energy density of MBR ρ_{MBR} equals to twice the value of ρ_e (due to two polarizations of photons):

$$\rho_{MBR} = 2\rho_e = 4\pi^2 \alpha \frac{m_e}{m_p} \rho_0 \times Q^{-1} = \frac{8\pi^5}{15} \frac{k_B^4}{(hc)^3} T_{MBR}^4$$

where T_{MBR} is MBR temperature. We can now calculate the value of T_{MBR}:

$$T_{MBR} = \frac{E_0}{k_B} \left(\frac{15\alpha}{2\pi^3} \frac{m_e}{m_p}\right)^{1/4} \times Q^{-1/4} = 2.725245\ K$$

Thus calculated value of T_{MBR} is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [19].

At the Beginning of the World, the extrapolated value of T_{MBR0} at $Q = 1$ is:

$$T_{MBR0} = 2.1927 \text{ MeV} = 2.5445 \times 10^{10} \text{ K}$$

Note that T_{MBR0} is considerably smaller than values commonly discussed in literature.

Let us proceed to calculate the value of T_{MBR} at different Ages of the World A_τ (see **Table 1**).

Table 1. The value of T_{MBR} at different Ages of the World.

Age	T_{MBR}
1 s	70,5377 K
10^8 s ≅ 3.2 yr	705.377 K
10^{16} s ≅ 0.32 Byr	7.05377 K
1.4×10^{16} s ≅ 0.45 Byr (Luminous Epoch)	6.47747 K
3×10^{17} s ≅ 9.6 Byr (birth of Solar system)	3.01403 K
4.49×10^{17} s ≅ 14.22 Byr (present)	2.725245 K

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

3.8. Primary Parameters

According to WUM, the following parameters of the World depend on Q [5]:

- Newtonian parameter of gravitation G

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

- Hubble's parameter H

$$H = \frac{c}{a} \times Q^{-1}$$

- Age of the World A_τ

$$A_\tau = \frac{a}{c} \times Q$$

- The Worlds' size R

$$R = a \times Q$$

- Critical energy density ρ_{cr}

$$\rho_{cr} = 3\frac{hc}{a^4} \times Q^{-1}$$

- Concentration of intergalactic plasma n_{IGP}

$$n_{IGP} = \frac{2\pi^2}{a^3}\frac{m_e}{m_p} \times Q^{-1}$$

- Minimum energy of photons E_{ph}

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

- Temperature of the Microwave Background Radiation (MBR) T_{MBR}

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

- Temperature of the Far-Infrared Background Radiation (FIRB) peak T_{FIRB}

$$T_{FIRB} = \frac{E_0}{k_B}(\frac{15}{4\pi^5})^{1/4} \times Q^{-1/4}$$

3.9. Hubble's Parameter and Age of the World

The most important parameters in Cosmology are the Hubble's Parameter H_0 and Age of the World A_τ which we can calculate by the following equations:

$$H_0 = \frac{8\pi hc}{a^3 c^3} \times G_{av} = 68.75084\ km\ s^{-1} Mpc^{-1}$$

$$A_\tau = \frac{a^3 c^3}{8\pi hc} \times G_{av}^{-1} = 4.4882037 \times 10^{17} s = 14.22226\ By$$

We emphasize that the Hubble's parameter H_0 and absolute Age of the World A_τ are determined by the experimentally measured value of G_{av} !

4. Age of Universe

In physical cosmology, the age of the universe is the time elapsed since the Big Bang. We do not know the exact age of the universe, but we believe that it is around 13.8 billion years. Astronomers estimate the age of the universe in different ways:

- NASA's Wilkinson Microwave Anisotropy Probe (WMAP) project's nine-year data released in 2012 estimated the age of the universe to be (13.772±0.059) billion years. This measurement is made by using the location of the first acoustic peak in the microwave background power spectrum to determine the size of the decoupling surface (size of the universe at the time of recombination). The light travel time to this surface (depending on the geometry used) yields a reliable age for the universe. **Assuming the validity of the models** used to determine this age, the residual accuracy yields a margin of error near one percent [28];
- In 2015, P. A. R. Ade, *et al.* presented results based on full-mission Planck observations of temperature and polarization anisotropies of the CMB. **These data are consistent with the six-parameter inflationary LCDM cosmology**. From the Planck temperature and lensing data, for this cosmology they estimated the

age of the universe to be (13.813±0.038) billion years [23], slightly higher but within the uncertainties of the earlier number derived from the WMAP data [28];

- The age of the universe based on the best fit to Planck 2018 data alone is 13.787±0.020 billion years. This number was obtained from the final full-mission Planck measurements of CMB anisotropies, combining information from the temperature and polarization maps and the lensing reconstruction (in contrast to other methods which typically involve Hubble's law and the age of the oldest stars in globular clusters). In authors opinion, *It is possible to use different methods for determining the same parameter (in this case, the age of the universe) and arrive at different answers with no overlap in the "errors"* [29];
- The oldest known star HD 140283 (Methuselah star) is a subgiant star about 190 light years away from the Earth for which a reliable age has been determined. H. E. Bond, *et al.* found its age to be 14.46 +/- 0.8 Gyr [30] that does not conflict with the age of the Universe, 13.77 +/- 0.06 Gyr, based on the microwave background and Hubble constant [28]. 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. While it currently has a higher estimated age, it is usually a fellow methuselah SMSS J031300.36−670839.3 that it cited as the oldest star with an accurately determined age 13.6 *Gyr* [31];
- Most galaxies are between 10 billion and 13.6 billion years old. Our universe is about 13.8 billion years old, so most galaxies formed when the universe was quite young! Astronomers believe that our own Milky Way galaxy is approximately 13.6 billion years old [32];
- The most distant galaxy in 2016 we know of was a galaxy called GN-z11 that is 13.4 billion light-years away. Because it is that far away, Hubble sees the light from the young galaxy as it was when the Universe was just 400 million years old [32]. In 2022, astronomers confirmed that the galaxy GLASS-z12 (previously known as GLASS-z13) is one of the earliest and most distant galaxies ever discovered. It is 13.6 billion years away [33];
- CEERS-93316 is a candidate high-redshift galaxy, with an estimated redshift of approximately z = 16.4. If confirmed, it would be one of the earliest and most distant known galaxies observed. CEERS-93316 would have a light-travel distance (lookback time) of 13.7 billion years [34].

We emphasize that now with JWST we are looking for the earliest and most distant galaxies, and at the same time, **we live in one of the earliest galaxies – Milky Way**! According to Standard Cosmology, massive mature disk galaxies with mass up to $M^*{\sim}10^{11}M_{\odot}$ cannot form for the amount of time (100-400) million years because it takes billions of years to form them, and so should not be there at all.

WUM explains these discoveries the following way [4]:

- **It is a question of time!** The Beginning of the World was **14.22 Gyr** ago! WUM introduces **Dark Epoch** (spanning for Laniakea Supercluster from the Beginning of the World for **0.45 Gyr**) when only DM Macroobjects existed, and **Luminous Epoch** (ever since, **13.77 Gyr**). Transition from Dark Epoch to Luminous Epoch is due to an **Explosive Volcanic Rotational Fission** of Overspinning DM Supercluster's Cores and self-annihilation of DMPs. Ordinary Matter is a byproduct of DMPs self- annihilation;
- Different Superclusters have different transition time from Dark Epoch to Luminous Epoch. It means that "Age of universe" (the beginning of Luminous Epoch for the whole universe) is not fixed. We stress that in WUM, the Beginning of the World (Dark Epoch) is fixed. **14.22 Gyr is the absolute Age of the World**;
- Most of galaxies (including early galaxies) are disklike galaxies due to the Rotational Fission of the overspinning DM Supercluster's Cores. DM Galaxy's Cores obtain their orbital and rotational angular momenta from rotational angular momentum of DM Superclusters' Cores;
- Early-galaxies formed in near present configuration. There are no protogalaxies in the World and frequent mergers of them at the early epoch. That is why JWST did not see their images;

- The oldest known stars in MW (HD140283 and SMSS J031300.36−670839.3) are the result of the Rotational Fission of the overspinning DM Core of the MW galaxy 13.77 Gyr and 13.6 Gyr ago, which was ejected 13.77 Gyr ago by the overspinning DM Core of the Virgo supercluster;
- Macroobjects form from the top (Superclusters) down to Galaxies and Extrasolar systems in parallel around different Cores made up of different DMPs.

5. Conclusion

Thanks to the revealed by WUM Inter-Connectivity of Primary Cosmological Parameters, we show that Gravitational parameter G that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly. We recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the measured value of the Gravitational parameter G_{av} and introduce the dimensionless Quantity Q for the calculations of all Cosmological parameters.

WUM does not attempt to explain all available cosmological and astrophysical 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.

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