World-Universe Model – Alternative to Big Bang Model. Essay

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Abstract

This essay provides comparison of the Hypersphere World-Universe Model (WUM) with the prevailing Big Bang Model (BBM) of Standard Cosmology. The performed analysis of BBM shows that Four Pillars of the Standard Cosmology are model-dependent and not strong enough to support the model. The **angular momentum problem** is one of the most critical problem in BBM. Standard Cosmology cannot explain how Galaxies and Extra Solar systems obtained their substantial orbital and rotational angular momenta, and why the orbital momentum of Jupiter is considerably larger than the rotational momentum of the Sun. WUM is the only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum. To be consistent with this Fundamental Law, WUM discusses in detail the Beginning of the World. The Model introduces Dark Epoch (spanning from the Beginning of the World for 0.4 billion years) when only Dark Matter Particles (DMPs) existed, and Luminous Epoch (ever since for 13.8 billion years). Big Bang discussed in Standard Cosmology is, in our view, transition from Dark Epoch to Luminous Epoch due to Rotational Fission of Overspinning Dark Matter (DM) Supercluster's Cores. WUM envisions Matter carried from the Universe into the World from the fourth spatial dimension by DMPs. Ordinary Matter is a byproduct of DM annihilation. 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 – how do they obtain it; Fermi Bubbles – two large structures in gamma-rays and X-rays above and below Galactic center; Diversity of Gravitationally-Rounded Objects in Solar system; some problems in Solar and Geophysics [1]. WUM reveals Inter-Connectivity of Primary Cosmological Parameters and calculates their values, which are in good agreement with the latest results of their measurements.

Keywords

"Big Bang Model"; "Four Pillars of Standard Cosmology"; "Angular Momentum Problem"; "Black Holes"; "Hypersphere World-Universe Model"; "Multicomponent Dark Matter"; "Law of Conservation of Angular Momentum"; "Medium of the World"; "Dark Matter Core"; "Macroobject Shell Model"; "Inter-Connectivity of Primary Cosmological Parameters"; "The Beginning of the World"; "Dark Epoch"; "Rotational Fission"; "Luminous Epoch"; "Intergalactic Plasma"; "Microwave Background Radiation"; "Far-Infrared Background Radiation"; "Emergent Phenomena".

1. Introduction

We can't solve problems by using the same kind of thinking we used when we created them.

Albert Einstein

Hypersphere World-Universe Model (WUM) is proposed as an alternative to the prevailing Big Bang Model of Standard Cosmology. WUM is a classical model, and is described by classical notions, which define emergent phenomena. By definition, an emergent phenomenon is a property that is a result of simple interactions that work cooperatively to create a more complex interaction. Physically, simple interactions occur at a microscopic level, and the collective result can be observed at a macroscopic level. WUM introduces classical notions once the very first ensemble of particles has been created at the cosmological time $\cong 10^{-18}\ s$ (state of the World at cosmological times $< 10^{-18}\ s$ is best described by Quantum Physics).

WUM is based on **two parameters**: dimensionless Rydberg constant $\alpha = (2aR_\infty)^{1/3}$, where R_∞ is Rydberg constant, a is the basic unit of size (classical electron radius equals to: $a_o = a/2\pi$); and a dimensionless time-varying parameter $Q,$ which is a measure of the Size R and Age A_τ of the World $Q = R/a = A_\tau/t_0$, where $t_0 = a/c$ is the basic unit of time and c is the gravitodynamic constant. In the present Epoch, $Q = 0.759972 \times 10^{40}$. It is worth to note that the constant α was later named "Sommerfeld's constant," and subsequently "Fine-structure constant" [1].

The Big Bang Model (BBM) offers a comprehensive explanation for a broad range of observed phenomena. The framework for the 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 the BBM in which the universe contains three major components: first, a Cosmological constant Λ associated with dark energy; second, the postulated Cold Dark Matter (CDM); and third, Ordinary matter.

The ΛCDM model is based on **six parameters**: baryon density Ω_B , dark matter density Ω_{DM} , dark energy density Ω_Λ , 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 Big Bang (BB) cosmology which is the classical model too.

The Four Pillars of the Standard Cosmology are as follows [2]:

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

BBM and WUM are principally different models. Comparison of the main parameters of the models is presented in **Table 1**.

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

Parameter	Big Bang Model	World-Universe Model
Structure of the World	3+1 Spacetime	3D Hypersphere of 4D Nucleus of the World. Time is a Factor of the World
The Beginning	Singularity	4D Nucleus of the World with an extrapolated radius a as the result of a fluctuation in the Universe
Expansion	Inflation – extremely rapid exponential expansion of space	The radius of the Nucleus of the World is increasing with speed c
Content	Dark Energy, Cold Dark Matter, Ordinary matter	Multicomponent Dark Matter (DM), Ordinary matter
Origin of Matter	Singularity	DM comes from the Universe to the Nucleus along the fourth spatial dimension. Ordinary Matter is a byproduct of DM annihilation
Cosmic Microwave Background	Photons wavelength is increasing over time	Thermodynamic equilibrium of photons with Intergalactic plasma
Nucleosynthesis of light elements	Big Bang Nucleosynthesis	Nucleosynthesis of all elements (including light elements) occurs inside of DM Cores of Macroobjects
Primary Cosmological Parameters	Independent	Inter-connected
Galactic Center	Black Hole	DM Core of Galaxy
Law of Conservation of angular momentum	Inconsistent	Consistent

Angular momentum problem is one of the most critical problem in the Standard Cosmology that must be solved. Any theory of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out. To the best of our knowledge, the Hypersphere World-Universe Model is the only cosmological model in existence that is consistent with this Fundamental Law [1].

2. Analysis of the Big Bang Model

2.1. Expansion of the Universe

The fact that galaxies are receding from us in all directions was first discovered by Hubble. 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 the cosmological Singularity at t=0 that is an infinite energy density state. This uncovers one of the shortcomings of the Standard Cosmology – the Horizon problem [3]: *Why does the universe look the same in all directions when it arises out of causally disconnected regions? This problem is most acute for the very smooth cosmic microwave background radiation.*

This problem was resolved by the cosmological Inflation, which is a theory of an extremely rapid 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*" [4].

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* [5].

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 [6]:

- *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;*
- *So, worries have centered on the possibility that the supernova measurements contain unaccounted for systematic errors - biases that push the SH0ES estimate to larger value.*

L. Verde, T. Treu, and A. G. Riess gave a brief summary of the "Workshop at Kavli Institute for Theoretical Physics, July 2019" [7]. 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.

2.2. Origin of the Cosmic Background Radiation

According to BBM, about 380,000 years after the Big Bang the temperature of the universe fell to the point where nuclei could combine with electrons to create neutral atoms. As a result, photons no longer interacted frequently with matter, the universe became transparent, and the Cosmic Microwave Background (CMB) radiation was created. This cosmic event is usually referred to as Decoupling. The photons 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 the CMB radiation now. But then, **why the CMB 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 CMB is due to thermodynamic equilibrium of photons with the Intergalactic plasma [1], the existence of which is experimentally proved [8].

2.3. Nucleosynthesis of the 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 Big Bang 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, but those revealed ways of producing isotopes other than 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 [9].

According to modern cosmological theory, lithium was one of the three elements synthesized in the Big Bang. 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 Big Bang energies. The experiment was performed deep underground at the LUNA 400 kV accelerator in Gran Sasso, Italy. A BBN lithium abundance ratio of $^{6}Li/^{7}Li=(1.5 \pm 0.3) \times 10^{-5}$ is obtained, firmly **ruling out BBN lithium production** as a possible explanation for the reported ^{6}Li detections[10].

In frames of WUM, Nucleosynthesis of all elements (including light elements) occurs inside of DM Cores of all Macroobjects during their evolution. The theory of Stellar Nucleosynthesis is well developed, starting with the publication of a celebrated B^2FH review paper [11]. With respect to WUM, this theory should be expanded to include annihilation of heavy Dark Matter fermions in Macroobjects Cores [1].

2.4. 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 [12]. The standard Hot Big Bang model provides a framework for understanding galaxy formation. At about 10,000 years after the Big Bang, 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 effects, so that any small perturbations in their density would grow.

This brings into focus one of the shortcomings of the Standard Cosmology – the **density fluctuation problem** [3]: *The perturbations which gravitationally collapsed to form galaxies must have been primordial in origin; from whence did they arise?*

There is another problem in the Standard Cosmology – **angular momentum problem** [1]:

- The Sun, for example, only accounts for about 0.3% of the total angular momentum of the Solar System (SS) while about 60% is attributed to Jupiter. Evolutionary theory cannot account for this. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;
- SS has an orbital momentum L_{orb}^{SS} calculated based on the distance of 26.4 kly from the galactic center and orbital speed of about 220 km/s : $L_{orb}^{SS} = 1.1 \times 10^{56} J\ s$, which far exceeds rotational angular momentum: $L_{rot}^{SS} = 3.2 \times 10^{43} J\ s$;
- Milky Way (MW) galaxy is gravitationally bounded with Local Supercluster (LS) and has an orbital momentum L_{orb}^{MW} calculated based on the distance of 65 million light-years from LS 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 [14]: $L_{rot}^{MW} \approx 1 \times 10^{67}\ J\ s$;
- How did MW galaxy and SS obtain their substantial orbital angular momenta?

To the best of our knowledge, the Standard Model doesn't answer these questions. The Hypersphere World-Universe model is the only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum [1].

As a conclusion, the performed analysis shows that the Four Pillars of the Standard Cosmology are model-dependent and not strong enough to support the Big Bang model.

2.5. Black Holes

Black hole is a **mathematical solution** of Einstein's field equations for gravity in 3+1 dimensional spacetime. The simplest black hole 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** [15].

The existence of supermassive objects in galactic centers is now commonly accepted. It is commonly believed that the central mass is a supermassive Black Hole (BH). There exists, however, evidence to the contrary. In late 2013, ICRAR astronomer Dr. N. Hurley-Walker spotted a previously unknown radio galaxy NGC1534 that is quite close to Earth at 248 million light-years 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. This is a very rare occurrence—this is only* ***the fifth of this type*** *to be discovered, and by far the faintest. We can only see it at low frequencies, which tells us that the electrons in the jets are not getting new energy from the black hole, so it must have been switched off for some time. 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 [16].

Recently a population of large, very low surface brightness, spheroidal galaxies was identified in the Coma cluster. The apparent survival of these Ultra Diffuse Galaxies (UDGs) in a rich cluster suggests that they have very high masses. P. van Dokkum, *et al*. present the stellar kinematics of Dragonfly 44, one of the largest Coma UDGs, whose mass about equals that of the Milky Way. However, the galaxy emits only 1% of the light emitted by the Milky Way. Astronomers reported that this galaxy might be made almost entirely of dark matter. The existence of **nearly-dark objects** with this mass is unexpected, as galaxy formation is thought to be maximally-efficient in this regime [17].

Candidate stellar-mass BHs in globular clusters of the Milky Way were reported in the following publications:

- R. Narayan, J. E. McClintock, and I Yi present a new model for BH soft X-ray transients A0620-00, V404 Cyg, and X-ray Nova Mus 1991 with mass 4.4; 9 and 7 solar mass respectively [18];
- K. Gebhardt, R. M. Rich, and L. Ho present the detection of a 20,000 solar mass BH in the Stellar Cluster G1, which is one of the most massive stellar clusters in M31. In their opinion, Globular clusters in our Galaxy should be searched for central BHs [19];
- L. Chomiuk, *et al*. report the discovery of a candidate stellar-mass BH in the globular cluster M62, which they term M62-VLA1. The radio, X-ray, and optical properties of M62-VLA1 are very similar to those for V404 Cyg, one of the best-studied quiescent stellar-mass BHs [20];
- B. Giesers, *et al.* performed multiple epoch observations of NGC 3201 with the aim of constraining the binary fraction. The obtained data show strong evidence that the target star is in a binary system with a **non-luminous object** having a minimum mass of (4.36 ± 0.41) solar mass. This object should be degenerate, since it is invisible, and the minimum mass is significantly higher than the Chandrasekhar limit [21];
- J. Liu, *et al*. report radial velocity measurements of a Galactic star, LB-1 and find that the motion of it requires the presence of a **dark companion** with mass of $68^{+11}_{-13}M_{\odot}$. In authors opinion, *forming such massive ones in a high-metallicity environment would be extremely challenging to current stellar evolution theories* [22].

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 [23].

R. K. Leane and T. R. Slatyer in the paper "Revival of the Dark Matter Hypothesis for the Galactic Center Gamma-Ray Excess" examine the impact of unmodeled source populations on identifying the true origin of the galactic center GeV excess (GCE). The authors discover striking behavior consistent with a mismodeling effect in the real Fermi data, finding that large artificial injected dark matter signals are completely misattributed to point sources. Consequently, they conclude that dark matter may provide a dominant contribution to the GCE after all [24].

As a conclusion, we have the observational evidences for the existence of **non-luminous objects** in centers of galaxies (for example, by the orbits of stars in the center of our galaxy), globular clusters, binary systems, and commonly accept them as BHs. But they might be "Dark Stars" composed of fermion Dark Matter Particles. A mechanism whereby Dark Matter (DM) in protostellar halos plays a role in the formation of the first stars is discussed by K. Freese, *et al.* Heat from neutralino DM annihilation is shown to overwhelm any cooling mechanism, consequently impeding the star formation process. A "dark star'' powered by DM annihilation instead of nuclear fusion may result. Dark stars are in hydrostatic and thermal equilibrium, but with an unusual power source [25].

In frames of WUM, supermassive objects in galactic centers are Macroobjects with Cores made up of DM fermions [1].

3. Hypersphere World-Universe Model

The Hypersphere World-Universe model is the only cosmological model in existence that [1]:

- Is consistent with the Law of conservation of angular momentum, and answers the following questions: why is the orbital momentum of Jupiter larger than rotational momentum of Sun, and how did Milky Way galaxy and Solar system obtain their substantial orbital angular momentum?
- Reveals the Inter-connectivity of primary cosmological parameters of the World (Age, Size, Hubble's parameter, Newtonian parameter of gravitation, Critical energy density, Concentration of Intergalactic Plasma, Temperature of the Microwave Background Radiation, Temperature of the Far-Infrared Background Radiation Peak) and calculates their values, which are in good agreement with experimental results;
- Considers Fermi Bubbles (FBs) built up from Dark Matter Particles (DMPs), and explains X-rays and gamma-rays radiated by FBs as a result of DMPs annihilation;
- Solves Coronal heating problem that relates to the question of why the temperature of the Solar corona is millions of degrees higher than that of the photosphere. In WUM, the Solar corona is made up of DMPs, and the plasma is the result of their annihilation. The Solar corona resembles a honeycomb filled with plasma. The Geocorona and Planetary Coronas possess features similar to these of the Solar Corona;
- Explains the diversity of Very High Energy gamma-ray sources in the World in frames of the proposed Macroobject (MO) Shell Model, which describes Cores of MOs as Nuclei made up of annihilating Dark Matter Fermions (DMFs) surrounded by shells containing other DMPs;
- Explains the diversity of gravitationally-rounded objects (planets and moons in Solar system) and their internal heat through annihilation of DMFs in their Cores.

WUM envisions the following picture of creation and evolution of the World [1]:

- Overspinning (surface speed at equator exceeding escape velocity) DM Cores of Superclusters initiate creation of all World's Macrostructures;
- The outer shells of Supercluster's Cores are composed of DMF4 with mass of 0.2 eV and total energy density of 68.8% of the overall energy density of the World;
- Proposed Weak Interaction between DMPs provides the integrity of Dark Matter (DM) Cores of all MOs;
- DMF4 outer shells of Supercluster's Cores are growing to the critical mass during Dark Epoch lasting from the Beginning of the World (14.2 billion years ago) for 0.4 billion years;
- Luminous Galaxies and Extrasolar Systems arise due to Rotational Fission of Overspinning Supercluster's Cores and annihilation of DMPs;

- Macrostructures of the World form from Superclusters down to Galaxies, Extrasolar systems, planets, and moons. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing in the Luminous Epoch;
- Luminous Epoch spans from 0.4 billion years up to the present Epoch for 13.8 billion years. The Big Bang discussed in the standard cosmological model is, in our view, the transition from Dark Epoch to Luminous Epoch.

In frames of 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 [1].

WUM confirms the Supremacy of Matter postulated by Albert Einstein: "*When forced to summarize the theory of relativity in one sentence: time and space and gravitation have no separate existence from matter*".

WUM is based on two parameters only: dimensionless Rydberg constant α and dimensionless 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. For example, $c = a/t_0$ and $h = E_0 \times t_0$. 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 [1].

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.

The Hypersphere World–Universe Model successfully describes primary cosmological parameters and their relationships, ranging in scale from cosmological structures to elementary particles. WUM predicted in 2013 the values of cosmological parameters (Gravitational; Concentration of Intergalactic Plasma; Relative energy density of baryons in the Medium of the World; Minimum energy of photons), which were confirmed experimentally in 2015 – 2018. The Model allows for precise calculation of values of Hubble's Parameter, Temperature of Microwave Background Radiation, Temperature of Far-Infrared Background Radiation Peak that were only measured experimentally earlier and makes verifiable predictions [26].

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