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

Albert Einstein

5D WORLD – UNIVERSE MODEL

SPACE–TIME–ENERGY

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ABSTRACT

In 1983, Paul S. Wesson developed 5D Space-Time-Mass theory that associates the fifth dimension with rest mass. The gravitational constant serves as the dimension-transposing parameter.

This paper puts the World-Universe Model (WUM) onto the theoretical basis developed by Prof. Wesson, with the following modifications: the fifth dimension is associated with the total energy of the Medium of the World, and the gravitomagnetic parameter of the Medium serves as the dimension-transposing parameter.

The Medium of the World composed of massive particles (protons, electrons, photons, neutrinos, and dark matter particles) is the manifestation of the 5D Space-Time-Energy WUM.

1. INTRODUCTION

World – Universe Model (WUM) utilizes the following principles:

Variable gravitational parameter. This hypothesis was proposed by Paul Dirac in 1937 [1].

Continuous creation of matter. This idea was proposed by Paul Dirac in 1974 [2].

According to WUM, the World is a 3-sphere that is the surface of a 4-ball Nucleus of the World. The 4-ball is expanding in the 4-dimensional Universe, and its surface the 3-sphere is likewise expanding. The total surface energy of the 4-ball is increasing as it expands, thus creating new matter in our 3-sphere World.

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*".

Existence of the Medium of the World stated by Nikola Tesla: "*All attempts to explain the workings of the universe without recognizing the existence of the ether and the indispensable function it plays in the phenomena are futile and destined to oblivion*". Unique properties of the Medium were discussed by James McCullagh in 1839. He 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 [3].

In WUM, the World consists of the Medium (protons, electrons, photons, neutrinos, and dark matter particles) and Macroobjects (Galaxy clusters, Galaxies, Star clusters, Extrasolar systems, planets, etc.) made of these particles. There are no empty space and dark energy in the WUM.

Mach's principle. A very general statement of Mach's principle is "*Local physical laws are determined by the large-scale structure of the universe*".

Fifth dimension. In 1983, Paul S. Wesson suggested that a fifth dimension might be associated with rest mass via $x^4 = Gm/c^2 \propto t$.

WUM follows this idea, albeit associating the fifth dimension with the parameters of the Medium of the World: the gravitomagnetic parameter and the total energy.

Principal role of Maxwell's Equations (ME) that form the foundation of classical electrodynamics. The value of ME 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*" [4]. Hans 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 [5]. It allows us to use formal analogies between the electromagnetism and relativistic gravity. It is worth to note that *the equations for Gravitoelectromagnetism were first published in 1893, before general relativity, by Oliver Heaviside as a separate theory expanding Newton's law* [Wikipedia, Gravitomagnetism].

Fundamental parameters and units. In accordance with ME for electromagnetism and gravitoelectromagnetism there are two measurable physical characteristics: energy density and energy flux density. For all particles under consideration we used four-momentum to conduct statistical analysis of particles' ensembles, obtaining the energy density as the final result.

Two Fundamental Parameters in various rational exponents define all macro and micro features of the World: Fine-structure constant α and dimensionless quantity Q. While α is constant, Q increases in time, and is in fact a measure of the Size and the Age of the World [6, 7].

WUM is proposed as an alternative to the prevailing Big Bang Model of standard physical cosmology. The main difference is the source of the World's energy. The Model was developed in [6–14]. A number of results obtained there are quoted in the current work without a full justification; an interested reader is encouraged to view the referenced papers in such cases.

In the present work we focus on the physical meaning of the fifth coordinate and provide an overview of WUM in a new light. In Section 2 we present the historical overview of five-dimensional spacetime theories. A paper "*Kaluza-Klein Gravity*" by J. M. Overduin and P. S. Wesson provides an excellent review of such theories. In Section 3 we propose a new physical meaning of the fifth coordinate and give a short summary of WUM in a new light.

2. Brief Historical Overview

J. M. Overduin and P. S. Wesson have this to say about five-dimensional space-time theories [15]:

"Kaluza's achievement was to show that five-dimensional general relativity contains both Einstein's four-dimensional theory of gravity and Maxwell's theory of electromagnetism. He however imposed a somewhat artificial restriction (the cylinder condition) on the coordinates, essentially barring the fifth one a priori from making a direct appearance in the laws of physics. Kaluza unified not only gravity and electromagnetism, but also matter and geometry, for the (massless) *photon appeared in four dimensions as a manifestation of empty five-dimensional spacetime.*

The world of everyday experience is three-dimensional. Nevertheless, the temptation to tinker with the dimensionality of nature has proved irresistible to physicists over the years. The main reason for this is that phenomena which require very different explanations in three-dimensional space can often be shown to be manifestations of simpler theories in higher-dimensional manifolds. But how can this idea be reconciled with the observed three-dimensionality of space? If there are additional coordinates, why does physics appear to be independent of them?

It is useful to keep in mind that the new coordinates need not necessarily be lengthlike (in the sense of being measured in meters, say), or even spacelike (in regard to their metric signature). A concrete example which violates both of these expectations was introduced in 1909 by Minkowski, who showed that the successes of Maxwell's unified electromagnetic theory and Einstein's special relativity could be understood geometrically if time, along with space, were considered part of a four-dimensional spacetime manifold via $x^0 = ict$. *Many of the abovementioned arguments against more than three dimensions were circumvented by the fact that the fourth coordinate did not mark distance. And the*

reason that physics had appeared three-dimensional for so long was because of the large size of the dimension-transposing parameter c, which meant that the effects of "mixing" space and time coordinates (i.e., length contraction, time dilation) appeared only at very high speeds.

In Minkowski's time, there had already been experimental phenomena (namely, electromagnetic ones) whose invariance with respect to Lorentz transformations could be interpreted as four-dimensional coordinate invariance. No such observations pointed to a fifth dimension. Physics was to take place — for as-yet unknown reasons — on a four-dimensional hypersurface in a five-dimensional universe (Kaluza's "cylinder condition"). No mechanism is suggested to explain why physics depends on the first four coordinates, but not on the extra ones. This dependence (on the new coordinates) *presumably appears in regimes that have not yet been well-probed by experiment — much as the relevance of Minkowski's fourth dimension to mechanics was not apparent at non-relativistic speeds.*

An alternative is to take Minkowski's example more literally and entertain the idea that extra dimensions, like time, might not necessarily be lengthlike. In this case the explanation for the near-cylindricity of nature is to be found in the physical interpretation of the extra coordinates; i.e., in the values of the dimension-transposing parameters (like c) needed to give them units of length. The first such proposal of which we are aware is the 1983 "space-time-mass" theory of Wesson [16], who suggested that a fifth dimension might be associated with rest mass via $x^4 = Gm/c^2 \propto t$*. The chief effect of this new coordinate on four-dimensional physics was that particle rest mass, usually assumed to be constant, varied with time. The variation was, however, small and quite consistent with experiment.*

Variable gravity theories are, of course, not new ($G \propto t^{-1}$). *What is new in the models just described — and what is important about noncompactified Kaluza-Klein theory in principle — is not so much the particular physical interpretation one attaches to the new coordinates, but the bare fact that physics is allowed to depend on them at all. It is clearly of interest to study the higher-dimensional Einstein equations with a general dependence on the extra coordinates; i.e., without any preconceived notions as to their physical meaning. It allows us to interpret four-dimensional matter as a manifestation of five-dimensional geometry. This has been termed the "induced-matter interpretation" of Kaluza-Klein theory". Metrics which do not depend on* x^4 *can give rise only to induced matter composed of* (massless) *photons; while those which depend on* x^4 *give back equations of state for fluids composed of massive particles.*

"*Space-Time-Matter (STM) as a theory of 4D matter from 5D geometry was launched in 1992 and developed by a focused group of researches. Unlike Klein and many others since, we avoid overly restrictive assumptions about the physical dimension, scale or topology of the extra coordinates. Dimensional reduction then leaves us with Einstein's field equations as usual, along with extra terms arising solely from the geometry of the higher-dimensional manifold. We identify these extra terms with matter and energy in the four-dimensional world*" [17].

3. COSMOLOGY

Let's proceed to discuss the origin, evolution, and parameters of the World speculated by the WUM in a new light of the Space-Time-Matter theory developed by Paul S. Wesson.

3.1. THE BEGINNING AND EXPANSION

About 14.223 billion years ago the World was started by a fluctuation in the 4-dimensional Universe, and the Nucleus of the World, which is a 4-ball, was born. The antipode length (the furthest distance between any two points) of the World's Nucleus at the Beginning was equal to

$$a = 2\pi a_0 \tag{3.1.1}$$

where a_0 is the classical electron radius. According to WUM, the Age of the World A_τ can be calculated based on the average value of the Gravitational parameter G [8]:

$$A_\tau = \frac{(ac)^3}{8\pi hc} \times G^{-1} = 14.223\ By \tag{3.1.2}$$

where c is the gravitoelectrodynamic constant and h is Planck constant.

The Nucleus has since been expanding through the Universe so that the antipode length R is increasing with speed c for cosmological time τ and equals to

$$R = c\tau = \frac{a^3c^4}{8\pi hc} \times G^{-1} \tag{3.1.3}$$

The corresponding diameter of the Nucleus D_N is:

$$D_N = 2R/\pi \tag{3.1.4}$$

The 4-ball is the interior of a 3-sphere which is the World in our Model. The 3-dimensional cubic hyperarea of a 3-sphere V_W is:

$$V_W = \frac{\pi^2}{4} D_N^3 = \frac{2}{\pi} R^3 \tag{3.1.5}$$

The extrapolated energy density of the World at the Beginning is much smaller than the nuclear energy density [6, 7].

3.2. THE CREATION OF MATTER

Recall the well-known Friedmann equation for the critical energy density of the World ρ_{cr} :

$$\rho_{cr} = \frac{3H^2c^2}{8\pi G} \tag{3.2.1}$$

where H is Hubble's parameter:

$$H = \frac{c}{R} = \frac{1}{\tau} \tag{3.2.2}$$

Equation 3.2.1 can be rewritten as

$$\frac{4\pi G}{c^2} \times \frac{2}{3}\rho_{cr} = \mu_g \times \rho_M = H^2 = \frac{1}{\tau^2} = \frac{c^2}{R^2} \quad 3.2.3$$

where μ_g is the gravitomagnetic parameter and $\rho_M = \frac{2}{3}\rho_{cr}$ is the energy density of the Medium. According to WUM, G is proportional to R^{-1} and is decreasing in time as $G \propto \tau^{-1}$ [6, 7]. It means that ρ_{cr} and ρ_M are also proportional to R^{-1} and are decreasing in time as $\rho_M = \frac{2}{3}\rho_{cr} \propto \tau^{-1}$. In frames of WUM the critical energy density equals to [6, 7]:

$$\rho_{cr} = 3\rho_0 \frac{a}{R} = 3\rho_0 \times Q^{-1} \quad 3.2.4$$

where ρ_0 is the basic unit of energy density

$$\rho_0 = \frac{hc}{a^4} \quad 3.2.5$$

We introduced the dimensionless quantity Q that equals to [8]:

$$Q = \frac{R}{a} = \frac{a^2c^4}{8\pi hc} \times G^{-1} = \frac{D_N}{4a_0} = 0.759960 \times 10^{40} \quad 3.2.6$$

Amount of the additional surface energy of the 4-ball Nucleus provided by the Universe dE_W is proportional to the increase of the hyperarea of the 3-sphere dV_W:

$$dV_W = \frac{6}{\pi}R^2 dR \quad 3.2.7$$

and the energy density of the Medium ρ_M which is the surface energy density of the Nucleus.

The total amount of the surface energy at cosmological time τ is thus

$$E_W = \frac{12}{\pi}\rho_0 a \int_0^R r dr = \frac{6}{\pi}\rho_0 a R^2 = \frac{6}{\pi}\sigma_0 R^2 \quad 3.2.8$$

where constant σ_0 equals to

$$\sigma_0 = \rho_0 a \quad 3.2.9$$

The energy density of the World ρ_W is inversely proportional to the Nucleus antipode length R:

$$\rho_W = \frac{6\pi^3\sigma_0 R^2}{2\pi^3 R^3} = 3\frac{\sigma_0}{R} = \rho_{cr} \quad 3.2.10$$

and equals to ρ_{cr} necessary for the flat World at any cosmological time τ. It is important to note that:

- In our calculations we used the measurable Fundamental unit – energy density;
- All physical parameters under consideration depend on Nucleus diameter D_N which is in fact the fifth coordinate in our Model. The quantity Q is the dimensionless value of it. The physical meaning of this coordinate is discussed in the next section.

3.3. Physical Meaning of the Fifth Coordinate

According to P. S. Wesson: *"a fifth dimension might be associated with rest mass via* $x^4 = Gm/c^2 \propto t$. *The chief effect of this new coordinate on four-dimensional physics was that particle rest mass, usually assumed to be constant, varied with time".*

In our opinion the fifth dimension is associated with the parameters of the Medium of the World:

- The gravitomagnetic parameter $\mu_g = 4\pi G/c^2 \propto \tau^{-1}$;
- The energy density $\rho_M \propto \tau^{-1}$;
- The 3-dimensional cubic hyperarea of a 3-sphere $V_W = \frac{\pi^2}{4} D_N^3 = \frac{2}{\pi} R^3 \propto \tau^3$

via:

$$x^4 = \frac{\mu_g}{c^2} \times \rho_M \times V_W = \frac{\mu_g E_M}{c^2} = \frac{V_W}{R^2} = \frac{2}{\pi} R = \frac{2}{\pi} Qa = D_N \propto \tau \qquad 3.3.1$$

where $E_M = \rho_M V_W$ is the total surface energy of the 4-ball Nucleus.

The proposed approach to the fifth dimension is in agreement 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 fifth dimension of the World (see Section 3.4 and Appendix A for the list of such parameters). The Medium of the World composed of massive particles (protons, electrons, photons, neutrinos, and dark matter particles) is the manifestation of the metric depending on x^4 (see Section 2). Rest masses of protons, electrons, and Dark Matter particles don't vary with time.

3.4. Experimental Evidence of the Fifth Coordinate

The physical laws we observe appear to be independent of the fifth coordinate due to the very small value of the dimension-transposing parameter μ_g. Then direct observation of the fifth dimension would appear to be a hopeless goal.

One way to prove the existence of the fifth dimension is direct measurement of truly large-scale parameters of the World: Gravitational, Hubble's, Temperature of the Microwave background radiation, and the Far-infrared background radiation peak. Conducted at various points of time, these measurements would give us varying results, providing insight into the 5D nature of the Universe. Unfortunately, the accuracy of the measurements is quite poor. Measurement errors far outweigh any possible 5D effects, rendering this technique useless in practice. To be useful, the measurements would have to be separated by billions of years.

Let's consider an effect that has indeed been observed for billions of years, albeit indirectly. Take the so-called "Faint young Sun" paradox. According to WUM, all stars were fainter in the past. As their cores absorb new matter, the size of macroobjects R_{MO} and their luminosity L_{MO} are increasing in time $R_{MO} \propto Q^{1/2} \propto \tau^{1/2}$ and $L_{MO} \propto Q \propto \tau$ respectively [6, 7]. Taking the age of the World $\cong 14.2$ Byr and the age of solar system $\cong 4.6$ Byr, it is easy to find that the young Sun's

output was 67% of what it is today. Literature commonly refers to the value of 70% [18]. This result supports the notion of physical parameters being indeed dependent on the fifth coordinate.

3.5. MEDIUM OF THE WORLD

J. M. Overduin and P. S. Wesson postulated that "*Metrics which do not depend on x^4 can give rise only to induced matter composed of* (massless) *photons; while those which depend on x^4 give back equations of state for fluids composed of massive particles".*

The World – Universe Model supplies the fluid that J. M. Overduin and P. S. Wesson have predicted: it is, in fact, the Medium of the World [6, 7]. According to WUM, empty space does not exist; instead, the World is filled with Medium that consists of massive particles: protons, electrons, photons, neutrinos, and dark matter particles. The inter-galactic voids discussed by astronomers are in fact examples of the Medium in its purest.

Consequently, the Medium of the World as described by WUM can serve as further evidence in favor of the fifth-dimensional view of the World.

4. CONCLUSION

5D Space-Time-Energy World – Universe Model is the first unified model of the World that successfully describes all of the primary parameters and their relationships, ranging in scale from cosmological structures to elementary particles. The Model allows for precise calculation of values that were only measured experimentally earlier, and makes verifiable predictions.

While the Model needs significant further elaboration, it can already serve as a basis for a new physics proposed by Paul Dirac in 1937 and Paul Wesson in 1983.

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Appendix A

Q in various rational exponents defines all time varying parameters of the World as follows [7, 8]:

- Total surface energy of the Nucleus

$$E_W = \frac{6}{\pi} E_0 \times Q^2$$

- Age of the World

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

- Planck mass

$$M_P = 2\frac{E_0}{c^2} \times Q^{1/2}$$

- Newtonian parameter of gravitation

$$G = \frac{ac^4}{8\pi E_0} \times Q^{-1}$$

- Hubble's parameter

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

- Critical energy density

$$\rho_{cr} = 3\frac{E_0}{a^3} \times Q^{-1}$$

- Temperature of the microwave background radiation

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

- Temperature of the far-infrared background radiation peak

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

- Fermi coupling parameter

$$\frac{G_F}{(\hbar c)^3} = \left(1800\alpha\frac{m_e}{m_p}\right)^{1/4}\frac{m_p}{m_e}\frac{1}{E_0^2} \times Q^{-1/4}$$

- Coupling parameters of the Fundamental interactions:
  Gravitational

$$\alpha_G = Q^{-1}$$

  Weak

$$\alpha_W = Q^{-1/4}$$

  Super Weak and Extremely Weak proposed by WUM:

$$\alpha_{SW} = Q^{-1/2}$$

$$\alpha_{EW} = Q^{-3/4}$$

  Strong and Electromagnetic

$$\alpha_s = \alpha_{EM} = 1$$

where E_0 is the basic unit of energy

$$E_0 = \frac{hc}{a}$$

and m_p is the mass of a proton, m_e is the mass of an electron, k_B is Boltzmann constant, α is the fine-structure constant, $\hbar$ is Dirac constant.

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