Scientific Research Publishing

Journal of High Energy Physics, Gravitation and Cosmology, 2023, 9, 1187-1207
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Basic Notions of Classical Physics

Vladimir S. Netchitailo

Freelancer, Livermore, USA
Email: netchitailov@gmail.com

How to cite this paper: Netchitailo, V.S. (2023) Basic Notions of Classical Physics. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, 1187-1207.
https://doi.org/10.4236/jhepgc.2023.94084

Received: July 30, 2023
Accepted: October 23, 2023
Published: October 26, 2023

Abstract

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. The developed Hypersphere World-Universe Model (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 four-momenta only. **Classical Physics is dealing with ensembles of quantum objects!** The present paper discusses the Basic Notions of Classical Physics considering a principally different cosmological model WUM, which is, in fact, a Paradigm Shift for Cosmology. WUM is a natural continuation of Classical Physics, and it can already serve as a basis for a New Cosmology proposed by Paul Dirac in 1937.

Keywords

World-Universe Model, Space and Time, Aether, Dark Matter, Gravity, Gravitomagnetism, Fundamental Physical Constants, Creation of Matter, Primary Notions

1. Introduction

According to Wikipedia [1]:

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.

According to **WUM** [2]:

Classical Physics is dealing with ensembles of quantum objects! How Classical Physics can incorporate elements of quantum mechanics in Modern Physics? To be clear, we would like to provide a couple examples:

- 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. The **temperature** of the ideal gas (that is a classical notion) is proportional to the **average kinetic energy of its particles** [3]. The "temperature" knows nothing about movement of each particle, and particles have kinetic energies only. They have no idea about the "temperature";
- In 1965, A. Penzias and R. Wilson discovered Cosmic Microwave Background Radiation (MBR). According to Big Bang (BB) Model, about 380,000 years after BB 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 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 a perfect black-body? What is the mechanism of photons wavelength increasing over time and growing fainter and less energetic?
- According to WUM, wavelength is a classical notion (see Section 2.4). Photons, which are quantum objects, have four-momenta only. They do not have wavelengths. By definition, **Black-body radiation is 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, the existence of which is experimentally proved.

2. Classical Physics before Special Relativity [2]

2.1. Space and Time

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 a 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, a 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 **WUM**, the World is a 3D Hypersphere of 4D Nucleus of the World, which is expanding in Its fourth spatial dimension. As a 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 the 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 Absolute Cosmological Time τ measured from the Beginning of the World (14.22 Byr ago) like Absolute Temperature measured from the absolute zero in Kelvins. It is principally different from the Solar Time *t*, which is defined by the parameters of the Solar System, 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 (see Section 2.3). Cosmological time equals to: $\tau = H^{-1}$. It 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.

In Classical Physics and our everyday life we use an alleged Space (3D Euclidean) and Solar Time *t*. Time is not a physical dimension and is absolutely different entity than Space. Time is a Factor of the World.

In 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 (see Section 2.3).

2.2. Aether

According to *Timeline of luminiferous aether*, Wikipedia [4]:

17th century: R. Boyle was a proponent of an aether hypothesis. According to Boyle, an aether consists of subtle particles, one sort of which explains the absence of vacuum and the mechanical interactions between bodies, and the other sort of which explains phenomena such as magnetism (and possibly gravity) that are, otherwise, inexplicable on the basis of purely mechanical interactions of macroscopic bodies;

1690—C. Huygens's Treatise on Light hypothesized that light is a wave propagating through an aether;

1704—Isaac Newton publishes Opticks, in which he proposes a particle theory of light. This had trouble explaining diffraction, so he adds a "fudge factor", claiming that an "Aethereal Medium" is responsible for this effect, and going further to suggest it might be responsible for other physical effects such as heat;

1727—James Bradley measures stellar aberration for the first time, proving (again) that light has a finite speed as well as that the Earth is moving;

1818—Augustin Fresnel introduces the wave theory of light, which proposes light is a transverse wave travelling in an aether, thereby explaining how polarization can exist. It is important to note that both Newton's particle theory and Fresnel's wave theory both assume an aether exists, albeit for different reasons. From this point on, no one even seems to question its existence;

1904—Hendrik Lorentz publishes a new theory of moving bodies, without discarding the stationary (electromagnetic) ether concept;

1905—Henri Poincaré shows that Lorentz's theory fulfills the principle of relativity and publishes the Lorentz transformations. His model was still based on Lorentz's ether, but he argues that this aether is perfectly undetectable;

1905—Albert Einstein publishes an observationally equivalent theory, but complete with a derivation from principles alone (leaving the ether aside). Einstein also emphasized that this concept implies the relativity of space and time. He later labelled it Special Relativity.

Following the work of T. Young (1804) and A.-J. Fresnel (1818), 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. 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.

It turned out that abandoning the Luminiferous Aether 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. 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 article in Nature "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 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 Inter-Galactic Plasma, MBR, 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. Then, there is no need in frames of reference of Special Relativity. 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. **Medium of the World is the Savior of Classical Physics! Don't throw the baby out with the bathwater.**

2.3. Dark Matter

The history of Dark Matter (DM) can be traced back to at least the end of the 18th century. In a paper for the Philosophical Transactions of the Royal Society of London, read on 27 November 1783 [5], J. Michell was the first to propose the existence of "dark stars". Michell suggested that there might be many "dark stars" in the universe and proposed that astronomers could detect "dark stars" by looking for star systems which behaved gravitationally like two stars, but where only one star could be seen. Michell argued that this would show the presence of a "dark star". It was an extraordinarily accurate prediction of binary systems, in which a "dark star" and a normal star orbit around their center of mass. In the Milky Way (MW) galaxy there are a dozen such binary systems emitting X-rays [6].

In WUM, **DM Cores of all MOs are, in fact, "Dark Stars"**.

G. Bertone and D. Hooper provide an excellent review of this history [7]:

- 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 sim-

ple 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.

WUM proposes DM system consisting of two couples of co-annihilating DMPs: a heavy Dark Matter Fermion (DMF)—DMF1 (1.3 TeV) and a light spin-0 boson—DIRAC (70 MeV) that is a dipole of Dirac's monopoles with charge $\mu = e/2\alpha$ (e is elementary charge and α is dimensionless Rydberg constant, see Section 2.5); a heavy fermion—DMF2 (9.6 GeV) and a light spin-0 boson—ELOP (340 keV) that is a dipole of preons with electrical charge e/3; DMF3 (3.7 keV), DMF4 (0.2 eV), and boson XION (10.6 μeV) [8].

The reason for this multicomponent DM system was to explain:

- The diversity of Very High Energy gamma-ray sources in the World;
- The diversity of DM Cores of MOs (Superclusters, Galaxies, Extrasolar Systems), which are Fermion Compact Objects and DM Reactors in WUM [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 MOs in the World. We connect observed gamma-ray spectra with the structure of MOs (nuclei and shells composition). Self-annihilation of those DMPs can give rise to any combination of gamma-ray lines. Thus, the diversity of Very High Energy gamma-ray sources in the World has a clear explanation [9].

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.

2.4. Gravity

In 1684, Newton sent a manuscript to Edmond Halley titled "De motu corporum in gyrum" (On the motion of bodies in an orbit), which provided a physical justification for Kepler's laws of planetary motion. Halley was impressed by the manuscript and urged Newton to expand on it, and a few years later Newton published a groundbreaking book called "Philosophiæ Naturalis Principia Mathematica" (Mathematical Principles of Natural Philosophy). In this book, New-

ton described gravitation as a universal force, and claimed that "the forces which keep the planets in their orbs must [be] reciprocally as the squares of their distances from the centers about which they revolve" [10].

Le Sage's Theory of Gravitation. Wikipedia summarizes this theory as follows [11]:

"*Le 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 a speed of light;
- To maintain mass proportionality, ordinary matter consists of cage-like structures, in which their diameter is only the 10^{7}th part of their mutual distance, so the particles can travel through them nearly unhindered. In order to achieve exact mass proportionality as in Newton's theory (which implies no shielding or saturation effects and an infinitely porous structure of matter), the ultramundane flux must be infinitely intense.

Le Sage's theory is the very first theory which defines the Gravity as an emergent phenomenon.

In **WUM**, the time-varying Gravitational parameter $G \propto \tau^{-1}$ is proportional to the energy density of the Medium $\rho_M \propto \tau^{-1}$. It is not a constant. That is why WUM aligns gravity with Le Sage's theory of gravitation.

WUM gives for Le Sage's theory the following parameters [12]:

- XIONs (10.6 μeV) are "ultramundane corpuscles";
- XIONs are ultra-relativistic DM particles;
- Proposed Weak interaction between XIONs and Matter provides mass proportionality.
- Energy density of XIONs in the World about 64% of the total energy density provides high intensity of their flux;
- Gravitational mass m_g is a classical notion that defines Gravity—the emergent phenomenon. m_g is an analog of temperature T that defines macroscopic properties of gases. We emphasize that an inertial mass m_i, which is a coefficient of proportionality between a force F and an acceleration a: $F = m_i a$,

has nothing to do with m_g.

According to Wikipedia: *Although inertial mass, passive gravitational mass and active gravitational mass are conceptually distinct, no experiment has ever unambiguously demonstrated any difference between them. In classical mechanics, Newton's third law implies that active and passive gravitational mass must always be identical (or at least proportional), but the classical theory offers no compelling reason why the gravitational mass has to equal the inertial mass. That it does is merely an empirical fact.*

Albert Einstein developed his general theory of relativity starting with the ***assumption*** *that the inertial and passive gravitational masses are the same. This is known as the equivalence principle* [13].

Gravity is not an interaction but a manifestation of the Medium.

3. WUM—Continuation of Classical Physics

3.1. Emergent Gravity, Space and Time [2]

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 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: In our model, the Medium of the World is not fundamental and has macroscopic parameters like in fluid mechanics: impedance, gravitomagnetic parameter, energy density, etc. 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. 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.*

3.2. Decisive Role of Gravitational Parameter *G* in Cosmology [8]

Maxwell's Equations (MEs) form the foundation of classical Electrodynamics. Gravitomagnetism (GM) is a gravitational analog of Electromagnetism (EM). GM equations differing from MEs by some constants were first published by O. Heaviside in 1893 as separate theory expanding Newton's law. GM is an approximation to Einstein's gravity equations in the weak field limit. H. Thirring pointed out this analogy in his "*On the formal analogy between the basic electromagnetic equations and Einstein's gravity equations in first approximation*"

paper published in 1918. It allows us to use this analogy between EM and relativistic gravity. MEs produce only two physically measurable quantities: energy density and energy flux density.

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*". We emphasize that **GM 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.***

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

It is worth noting that in WUM, parameter G is proportional to the energy density of the Medium of the World ρ_M that is inversely proportional to the cosmological time: $\rho_M \propto \tau^{-1}$. Therefore, parameter $G \propto \tau^{-1}$, as it was discussed by P. Dirac in 1937. Introduced by WUM, Cosmological time marches on at constant pace since the Beginning of the World (14.22 Byr ago) until the present Epoch and defines the Age of the World: $A_\tau = \tau$. The Hubble's parameter H, which is, in fact, Wave Resistance of the Medium, equals to: $H = \tau^{-1}$ and should be measured using MBR data only.

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

3.3. Gravitomagnetism [14]

Maxwell's equations (MEs) vary with the unit system used. Although the general shape remains the same, various definitions are changed, and different constants appear in different places. We start our discussion with MEs in SI units. We will not rewrite well-known equations, but only provide the relationships between physical quantities used in MEs for EM and GM in Table 1 and Table 2.

Table 1. Electromagnetism (EM).

Charge	Impedance of Electromagnetic Field	Magnetic Flux
q, C	$Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = \mu_0 c, \Omega$	ϕ_q, Wb
Electric Current	Magnetic Constant	Electric Potential
I_q, A	$\mu_0, \mathrm{H \cdot m^{-1}}$	U_q, V
Magnetic Field Intensity	Electric Constant	Electric Field
$H_q, \mathrm{A \cdot m^{-1}}$	$\varepsilon_0 = \left(\mu_0 c^2\right)^{-1}, \phi \cdot \mathrm{m^{-1}}$	$E_q, \mathrm{V \cdot m^{-1}}$
Electric Flux Density	Electrodynamic Constant	Magnetic Flux Density
$D_q, \mathrm{C \cdot m^{-2}}$	$c, \mathrm{m \cdot s^{-1}}$	$B_q, \mathrm{Wb \cdot m^{-2}}$

Table 2. Gravitomagnetism (GM).

Mass	Impedance of Gravitational Field	Gravitomagnetic Flux
m, kg	$Z_g = \sqrt{\frac{\mu_g}{\varepsilon_g}} = \mu_g c$	$\phi_m, \mathrm{m^2 \cdot s^{-1}}$
Mass Current	Gravitomagnetic Parameter	Gravitoelectric potential
$I_m, \mathrm{kg \cdot s^{-1}}$	$\mu_g = 4\pi G/c^2$	$U_m, \mathrm{m^2 \cdot s^{-2}}$
Gravitomagnetic Field Intensity	Gravitoelectric Parameter	Gravitoelectric Field
$H_m, \mathrm{kg \cdot m^{-1} \cdot s^{-1}}$	$\varepsilon_g = \left(\mu_g c^2\right)^{-1}$	$E_m, \mathrm{m \cdot s^{-2}}$
Gravitoelectric Flux Density	Gravitodynamic Constant	Gravitomagnetic Flux Density
$D_m, \mathrm{kg \cdot m^{-2}}$	$c, \mathrm{m \cdot s^{-1}}$	$B_m, \mathrm{s^{-1}}$

In MEs, an electrodynamic constant c is defined as the ratio of the absolute electrodynamic unit of charge to the absolute electrostatic unit of charge [15]. It is easy to see that the dimension of products (Charge × Magnetic Flux) and (Mass × Gravitomagnetic Flux) equals that of the Plank constant h.

From these **tables** it becomes clear that the dimensions of all physical quantities depend on the choice of the charge and mass dimensions (Coulomb & kilogram in SI units). In other unit systems the dimensions are different. For instance, in Gaussian units (CGSE):

- $\left[q_e\right] = \mathrm{cm^{3/2} \cdot g^{1/2} \cdot s^{-1}}$
- $\left[Z_e\right] = \mathrm{cm^{-1} \cdot s}$

In CGSM:

- $\left[q_m\right] = \mathrm{cm^{1/2} \cdot g^{1/2}}$
- $\left[Z_m\right] = \mathrm{cm \cdot s^{-1}}$

We seem to possess a substantial degree of freedom when it comes to choos-

ing the dimension of charge. For an arbitrary dimension-transposing parameter P, we can:

- Multiply the charge and mass and all physical quantities on the left side of Table 1 and Table 2 by an arbitrary parameter P;
- Divide impedances by P^2;
- Divide magnetic fluxes and all physical quantities on the right side of Table 1 and Table 2 by P.

Following such a transformation, all physically measurable parameters such as energy density and energy flux density remain the same and have the same mechanical dimensions.

By definition, one Coulomb equals to one tenth of the absolute electrodynamic unit of charge. It follows that in SI we use electrodynamic unit of charge e in the electrostatic Coulomb law instead of the electrostatic unit e/c. This seems a bit odd.

Likewise, when describing Newtonian law of gravitation, we use m—the gravitational mass, instead of the gravitodynamic charge mc^2. The gravitostatic charge is then mc. Similarly to the electromagnetic field, the gravitodynamic constant c is the ratio of the absolute gravitodynamic unit of charge E_0 to the absolute gravitostatic unit of charge E_0/c (see Section 3.4). 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.

But there is a principal physical difference between EM and GM:

- In EM, the magnetic constant μ_0 and electric constant ε_0 are the permeability and permittivity of free space, correspondingly;
- In GM, the gravitomagnetic parameter μ_g depends on the gravitational parameter G:

$$\mu_g = \frac{4\pi G}{c^2}$$

which is not a constant and cannot be introduced without the Medium of the World.

In frames of WUM, the gravitomagnetic parameter μ_g can be calculated based on the value of the energy density of the Medium of the World ρ_M:

$$\mu_g = \frac{4\pi G}{c^2} = \frac{\rho_M}{c^2} \times P^2$$

where a dimension-transposing parameter P equals to (h is Planck constant):

$$P = \frac{a^3}{2h/c}$$

The gravitational parameter G equals to:

$$G = \frac{\rho_M}{4\pi} \times P^2$$

Then the Newton's law of universal gravitation can be rewritten in a following

way:

$$F = G\frac{m \times M}{r^2} = \frac{\rho_M}{4\pi}\frac{\frac{a^3}{2L_{Cm}} \times \frac{a^3}{2L_{CM}}}{r^2}$$

where we introduced the measurable parameter of the Medium ρ_M instead of the phenomenological coefficient G; and gravitodynamic charges $m \times P = \frac{a^3}{2L_{Cm}}$ and $M \times P = \frac{a^3}{2L_{CM}}$ instead of macroobject masses m and M (L_{Cm} and L_{CM} are Compton length of mass m and M respectively). The gravitodynamic charges have a dimension of "Area", which is equivalent to "Energy", with the constant that equals to the basic unit of surface energy density $\sigma_0 = hc/a^3$ (see Section 3.5).

Using a substantial degree of freedom when it comes to choosing the dimension of "mass", we can:

- Multiply the mass and all physical quantities on the left side of Table 2 by the parameter $P = \frac{a^3}{2h/c}$;
- Divide impedance by P;
- All physical quantities on the right side of Table 2 leave them as they are.

Following this approach, we find the gravitomagnetic parameter of the Medium μ_M

$$\mu_M = \frac{4\pi G}{Pc^2} = \frac{1}{R}$$

and the impedance of the Medium Z_M:

$$Z_M = \mu_M c = H$$

where H is the Hubble's parameter:

$$H = \frac{c}{R} = \frac{1}{\tau}.$$

As a result of this transformation:

- All parameters of the gravitomagnetic field have dimensions of "Length" and "Time"; "Mass" dimension has disappeared;
- All physical parameters of the World measured in terms of the basic unit of size a and the basic unit of time $t_0 = a/c$ become scalars (see Section 3.5);
- Absolute Size and Age of the World equal to a dimensionless time-varying quantity Q:

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

- The gravitodynamic charge has a dimension of "Area" which is equivalent to "Energy";
- The impedance of the Medium Z_M equals to the Hubble's parameter

$Z_M = H$.

It follows that measuring the value of Hubble's parameter **anywhere** in the World (using MBR data only) and taking its inverse value allows us to calculate the absolute Age of the World. The Hubble's parameter is then the most important characteristic of the World, as it defines the Worlds' Age. While in our Model Hubble's parameter H has a clear physical meaning, the gravitational parameter G

$$G = \frac{a^3 c^3}{8\pi hc} H$$

is a phenomenological coefficient in Newton's law of universal gravitation.

The second important characteristic of the Medium of the World is the gravitomagnetic parameter $\mu_M = R^{-1}$. Taking its inverse value, we can find the radius of the 4D Nucleus characterizing the curved nature of the World.

We emphasize that parameters Z_M and μ_M are principally different physical characteristics of the Medium that are connected through the gravitodynamic constant c: $Z_M = \mu_M c$. It means that "Time" is not a physical dimension and is an absolutely different entity than "Space". Time is a Factor of the World.

3.4. Energy in Matter [16]

From the point of view of pure kinematics, particles are completely characterized by their energy and momentum, *i.e.* their four-momentum $\left(\frac{E}{c}, \boldsymbol{p}\right)$ [17] that satisfies the following equation:

$$\left(\frac{E}{c}\right)^2 - \boldsymbol{p}^2 = Inv = (mc)^2$$

In WUM, the invariant is, in fact, a gravitostatic charge mc squared, and E is the gravitodynamic charge. When the gravitostatic charge of particles equals to momentum p_{DB}, gravitomagnetic flux ϕ_{DB} is (see Section 3.3):

$$\phi_{DB} = \frac{h}{p_{DB}} = \lambda_{DB}$$

known as de Broglie wavelength. The notion of "Wavelength" is thus a macroscopic notion, namely, gravitomagnetic flux of particles characterized by four-momentum only. It means that there is no Wave-Particle duality in WUM. Wavelength is an emergent phenomenon [18].

We can rewrite the first equation as follows:

$$\left(\frac{E}{c}\right)^2 = \boldsymbol{p}^2 + (mc)^2$$

where mc is, in fact, the momentum of the particle in the fourth spatial dimension. In case of the motionless particle ($\boldsymbol{p} = 0$) in the absolute reference frame (3D Medium), the total gravitostatic charge $\frac{E}{c}$ equals to:

$$\frac{E}{c} = mc$$

Then, the gravitodynamic charge of the motionless particle E equals to:

$$E = \frac{E}{c} \times c = mc^2$$

that is named "rest energy". It means that particles have rest energies due to the expansion of the Nucleus of the World in the fourth spatial dimension with the speed c that is the gravitodynamic constant in WUM. In this regard, it is worth recalling the Nicola Tesla quote: "*There is no energy in matter other than that received from the environment. All this energy* (*sometimes viewed as* "*Zero Point Energy*") *comes from the environment giving life to matter, forming a* "*closed circuit*" *through one way or the other* (*being* "*accessed*" *more efficiently or less based on the methodology*). *It is omnipresent, day or night, and is* "*re-emitted*" *by every star in our universe naturally including our sun*" [19].

3.5. Fundamental Physical Constants [2]

Maxwell's equations were published by Maxwell in 1861. He calculated the velocity of electromagnetic waves from the value of an 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.

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.

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. 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 a 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).

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:

- Basic size unit a:

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

- Dimensionless Rydberg constant α:

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

- 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".

In WUM we introduce the following Basic Units:

- Size a
- Time $t_0 = a/c$
- Energy $E_0 = hc/a$
- Surface Energy Density $\sigma_0 = hc/a^3$
- Energy Density $\rho_0 = hc/a^4$

3.6. Dirac Large Number Hypothesis [2]

In 1937, Paul Dirac in the paper "A new basis for cosmology" said [20]:

> "*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*".

WUM follows the idea of time-varying G and introduces a dimensionless time-varying quantity Q, that is, in fact, the Dirac Large Number, which in present epoch equals to: $Q = 0.7599440 \times 10^{40}$. G can be calculated from the value of the parameter Q [8]:

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

WUM holds that there indeed exist simple mathematical relations between all Primary Cosmological Parameters (PCPs) that depend on Q [21]:

- Newtonian parameter of gravitation G;
- Age of the World A_τ;
- The Worlds' radius of curvature in the fourth spatial dimension R;
- Hubble's parameter H;
- Critical energy density ρ_{cr};
- Concentration of Intergalactic Plasma n_{IGP};
- Minimum Energy of Photons E_{ph};
- Temperature of the Microwave Background Radiation T_{MBR};
- Temperature of the Far-Infrared Background Radiation peak T_{FIRB}.

In frames of WUM, we calculate the values of these PCPs, which are in good agreement with the latest results of their measurements.

3.7. Creation of Matter [2]

In 1964, F. Hoyle and J. V. Narlikar offered an explanation for the appearance of new matter by postulating the existence of what they dubbed the "*Creation field*" [22].

In 1974, P. Dirac discussed continuous creation of matter by additive (uniformly throughout space) and multiplicative mechanism (proportional to the amount of existing matter) [23].

WUM. The 3D World, which is a Hypersphere of 4D Nucleus, was started by a fluctuation in the Eternal Universe. 4D Nucleus is expanding in the fourth spatial dimension, and its surface, the Hypersphere, is likewise expanding. The radius of the Nucleus R is increasing with speed c (gravitodynamic constant) for the absolute cosmological time τ from the Beginning and equals to $R = c\tau$.

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

DM is created by the Universe in the 4D Nucleus of the World. DMPs carry new DM into the 3D Hypersphere World. Ordinary Matter is a byproduct of DMPs self-annihilation. Consequently, a matter-antimatter asymmetry problem discussed in literature does not arise (since antimatter does not get created by DMPs self-annihilation).

By analogy with 3D ball, which has two-dimensional sphere surface (that has surface energy), we can imagine that the 3D Hypersphere World has a "Surface Energy" of the 4D Nucleus.

The proposed process is 4D process responsible for the expansion, creation of Matter and Arrow of Time. It is a 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 Hypersphere World.

3.8. Primary Notions [2]

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 Einstein's field equations have the same form in arbitrary frames of reference.

In **WUM**, this Principle 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. We can use the well-known equations considering time-varying physical parameters.

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 BB model.

In **WUM**, this Principal is valid at the cosmological times $\tau \geq \tau_M$ because Physical Laws are determined by the Medium of the World, which is Homogeneous and Isotropic and consist 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 Principal is not viable for the entire World.

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).

In **WUM**, Conservation Laws are not Exact Conservation Laws because the World is not an isolated physical system and is continuously getting DM from the Eternal Universe. WUM is based on **Maxwell's Equations** (MEs) that form the foundation of classical Electrodynamics and Gravitomagnetism. Einstein's field equations are nonlinear MEs, which should be used in the strong field limit. In MEs, there are no notions of elementary "Charge" and "Energy" but there are "**Charge Density**" and "**Energy Density**". MEs produce only two physically measurable quantities: energy density and energy flux density.

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

4. Conclusions

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. 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 a well-elaborated theory by the entire physical community. Considering the JWST discoveries, successes of WUM, and 86 years of Dirac's ideas, it is high time to make a Paradigm Shift for Cosmology and Classical Physics.

Acknowledgements

I am always grateful to Academician Alexander Prokhorov and Prof. Alexander Manenkov, whose influence on my scientific life has been decisive. I am eternally grateful to my Scientific Father Paul Dirac who was a genius and foresaw the Future of Physics in a New Cosmology. I am forever grateful to Nicola Tesla who was a genius. I am much obliged to Prof. Christian Corda for publishing my manuscripts in JHEPGC. I greatly appreciate valuable suggestions of Robert Kuhn that helped me to improve the understanding of the Model. Special thanks to my son Ilya Netchitailo who edited this work.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Classical Physics (2023) Wikipedia. https://en.wikipedia.org/wiki/Classical_physics

[2] Netchitailo, V. (2022) Review Article: Cosmology and Classical Physics. *Journal of High Energy Physics, Gravitation and Cosmology*, **8**, 1037-1072. https://doi.org/10.4236/jhepgc.2022.84074

[3] Kinetic Theory of Gases (2023) Wikipedia. https://en.wikipedia.org/wiki/Kinetic_theory_of_gases#Temperature_and_kinetic_energy

[4] Timeline of Luminiferous Aether (2023) Wikipedia. https://en.wikipedia.org/wiki/Timeline_of_luminiferous_aether

[5] Michell, J. (1784) On the Means of Discovering the Distance, Magnitude, & c. of the Fixed Stars, in Consequence of the Diminution of the Velocity of Their Light in Case Such a Diminution Should Be Found to Take Place in Any of Them, and Such Data Should Be Procured from Observations, as Would Be Farther Necessary for That Purpose. *Philosophical Transactions*, **74**, 35-57. https://doi.org/10.1098/rstl.1784.0008

[6] Cygnus X-1: A Stellar Mass Black Hole (2011) Chandra. https://www.nasa.gov/mission_pages/chandra/multimedia/cygnusx1.html

[7] Bertone, G. and Tait, T.M.P. (2018) A New Era in the Quest for Dark Matter. https://doi.org/10.1038/s41586-018-0542-z

[8] Netchitailo, V. (2023) Decisive Role of Gravitational Parameter G in Cosmology. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, 611-625. https://doi.org/10.4236/jhepgc.2023.93051

[9] Netchitailo, V. (2015) 5D World-Universe Model. Multicomponent Dark Matter. *Journal of High Energy Physics, Gravitation and Cosmology*, **1**, 55-71. https://doi.org/10.4236/jhepgc.2015.12006

[10] Gravity (2023) Wikipedia. https://en.wikipedia.org/wiki/Gravity

[11] Le Sage's Theory of Gravitation (2023) Wikipedia. https://en.wikipedia.org/wiki/Le_Sage%27s_theory_of_gravitation

[12] Netchitailo, V.S. (2023) Dark Matter Particles. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, 1004-1020. https://vixra.org/abs/2306.0127 https://doi.org/10.4236/jhepgc.2023.94074

[13] Inertial vs. Gravitational Mass (2023) Wikipedia. https://en.wikipedia.org/wiki/Mass#Inertial_vs._gravitational_mass

[14] Netchitailo, V. (2016) 5D World-Universe Model. Gravitation. *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 328-343. https://doi.org/10.4236/jhepgc.2016.23031

[15] Assis, A.K.T. (2000) The Meaning of the Constant c in Weber's Electrodynamics. https://www.ifi.unicamp.br/~assis/Proc-Galileo-Back-Italy-II-p23-36(2000).pdf

[16] Netchitailo, V.S. (2021) Paradigm Shift in Cosmology. https://vixra.org/abs/2107.0020

[17] Byckling, E. and Kajantie, K. (1971) Particle Kinematics: (Chapters I-VI, X). University of Jyvaskyla, Jyvaskyla, 243 p. https://inspirehep.net/literature/1251349

[18] Netchitailo, V. (2016) Overview of Hypersphere World-Universe Model. *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 593-632. https://doi.org/10.4236/jhepgc.2016.24052

[19] PESWiki (2005) Tesla's Dynamic Theory of Gravity.

https://file:///C:/Users/Vladimir/Downloads/pdfcoffee.com_teslax27s-dynamic-theory-of-gravity-pdf-free.pdf

[20] Dirac, P.A.M. (1938) A New Basis for Cosmology. *Proceedings of the Royal Society of London A*, **165**, 199-208. https://doi.org/10.1098/rspa.1938.0053

[21] Netchitailo, V. (2017) Mathematical Overview of Hypersphere World-Universe Model. *Journal of High Energy Physics, Gravitation and Cosmology*, **3**, 415-437. https://doi.org/10.4236/jhepgc.2017.33033

[22] Hoyle, F. and Narlikar, J. (1964) A New Theory of Gravitation. *Proceedings of the Royal Society of London A*, **282**, 178-190. https://doi.org/10.1098/rspa.1964.0227

[23] Dirac, P.A.M. (1974) Cosmological Models and the Large Numbers Hypothesis. *Proceedings of the Royal Society of London A*, **338**, 439-446. https://doi.org/10.1098/rspa.1974.0095