Physical Constants and Parameters in World-Universe Cosmology

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Abstract

World-Universe Cosmology (WUC) is grounded on 1) **Cosmic Medium** – carrier of all interactions in Classical Physics; 2) **Universe-Created Matter** – continuously generated; 3) **Angular Momentum** – inherited from the Eternal Universe. All physical laws are determined by the dimensionless quantity $\boldsymbol{Q}$, a dynamic version of **Dirac's Large Number,** and shaped by the Cosmic Medium, consistent with **Mach's Principle**: *"Local physical laws are determined by the large-scale structure of the universe."* The main goal of the present paper is to demonstrate how **Physical Constants and Major Cosmological Parameters** arise in WUC.

1. Introduction. Classical Physics before Quantum Physics[1]

Kinetic Theory of Gases explains macroscopic properties of gases, such as pressure, viscosity, temperature, 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**.

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

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

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

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

2. Fundamental Physical Constants [2]

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

- Basic size unit a :

$$a = 0.5\left[(2\,\mu_0 h/c)^3\, R_\infty R_T^6\right]^{1/5} = 1.7705641 \times 10^{-14}\, m$$

- Dimensionless Rydberg constant α :

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

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

- Electron rest energy E_e :

$$E_e = \alpha hc/a$$

- Elementary charge e :

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

All these constants were measured and could be calculated before Quantum Physics.

3. Inter-Connectivity of Primary Cosmological Parameters [3]

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

WUC holds that there indeed exist relations between all Cosmological parameters that depend on dimensionless time-varying quantity Q that is a measure of the Size R and Age A_τ of the World according to the equation:

$$Q = R/a = A_\tau/t_0$$

where t_0 is the basic time unit: $t_0 = a/c$. Q in the modern epoch equals to:

$$Q = 0.759972 \times 10^{40}.$$

According to WUC, the following parameters of the World depend on Q :

- Newtonian parameter of gravitation G : $G = \frac{a^2c^4}{8\pi hc} \times Q^{-1}$
- Hubble's parameter H : $H = \frac{c}{a} \times Q^{-1}$
- Age of the World A_τ : $A_\tau = \frac{a}{c} \times Q$
- The Worlds' Radius R : $R = a \times Q$
- Critical energy density ρ_{cr} : $\rho_{cr} = 3\frac{hc}{a^4} \times Q^{-1}$
- Concentration of Intergalactic plasma n_{IGP} : $n_{IGP} = \frac{2\pi^2}{a^3}\frac{m_e}{m_p} \times Q^{-1}$
- Minimum energy of photons E_{ph} : $E_{ph} = (\frac{m_e}{m_p})^{1/2} E_0 \times Q^{-1/2}$
- Temperature of MBR T_{MBR} : $T_{MBR} = \frac{E_0}{k_B}(\frac{15\alpha}{2\pi^3}\frac{m_e}{m_p})^{1/4} \times Q^{-1/4}$
- Temperature of Far-Infrared Background Radiation peak T_{FIRB} :

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

In frames of WUC, all these Cosmological parameters are a manifestation of the Worlds' curvature in the fourth spatial dimension. They can be calculated based on experimentally measured value of G_{av}.

4. Directly Measured Cosmological Parameters

There are only two directly measured Cosmological parameters: the Gravitational parameter G and the Temperature of the Cosmic Microwave Background Radiation (MBR) T_{MBR}. Q. Li, *et al.* experimentally measured the most accurate values of G using two independent methods [4]

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

$$G(2) = 6.674484 \times 10^{-11} m^3 kg^{-1} s^{-2}\ (11.61\ ppm)$$

which are in excellent agreement with the value of $G = 6.67420 \times 10^{-11} m^3 kg^{-1} s^{-2}$ predicted by WUC in 2013. In 2009, D. J. Fixsen measured the value of MBR temperature T_{MBR} [5]:

$$T_{MBR} = 2.725181\ K\ (30\ ppm)$$

It means that the most accurate parameter is G, and all other Cosmological parameters could be, in principle, calculated based on the value of G with the same accuracy. Thanks to the revealed by WUC Inter-Connectivity of Cosmological parameters, we show that G that can be measured directly makes measurable all Cosmological parameters, which cannot be measured directly.

5. Gravitational Parameter G and Dirac Large Number Q

Considering equations in Section 3, we have the following equation for G:

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

An average value of Gravitational parameter G_{av} of experimentally measured values by Q. Li, *et al.*

$$G_{av} = \frac{G(1) + G(2)}{2} = 6.674334 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

allows us to calculate the value of Q_{av} based on the value of G_{av}:

$$Q_{av} = \frac{a^2 c^4}{8\pi hc} \times G_{av}^{-1} = 0.759944 \times 10^{40}$$

Below, we will use this value of Q_{av} for a calculation of all Cosmological parameters.

Leveraging Inter-Connectivity of primary cosmological parameters revealed by WUC, we demonstrate that the gravitational parameter G_{av}, which can be measured directly, enables the determination of all other cosmological parameters that are not directly measurable. Using G_{av}, we calculate the radius of the curvature R as follows:

$$G_{av} \rightarrow Q_{av} \rightarrow R = a \times Q_{av} = 1.3459 \times 10^{26}\ m\,.$$

6. Hubble's Parameter and Age of the World

The most important parameters in Cosmology are the Hubble's parameter H_0 and the Age of the World A_τ, which we can calculate by the following equations:

$$H_0 = \frac{8\pi hc}{a^3 c^3} \times G_{av} = 68.733\ km\ s^{-1} Mpc^{-1}$$

$$A_\tau = \frac{1}{H_0} = \frac{a^3 c^3}{8\pi hc} \times G_{av}^{-1} = 14.226\ Byr$$

We emphasize that the Hubble's parameter H_0 and absolute Age of the World A_τ are determined by the experimentally measured value of G_{av} !

According to WUC, the value of H should be measured based on MBR only. The calculated value of the Hubble's parameter in 2013: $H_0 = 68.733\ km\ s^{-1} Mpc^{-1}$ is in excellent agreement with the most recent measured value in 2021: $H_0 = 68.7 \pm 1.3\ km\ s^{-1} Mpc^{-1}$ using only MBR data.

7. Temperature T_{MBR} and Electron-to-Proton Mass Ratio m_e/m_p

Considering equation in Section 3 for T_{MBR} :

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

we have the following equation for m_e/m_p :

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

8. There is no Cosmic Medium – There is Nothing [6]

In 1937, N. Tesla declared, "*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.*" **The concept of the Cosmic Medium (CM) plays a fundamental role in WUC**.

WUC, being a classical model, introduces classical notions only from the moment the first ensemble of particles emerged, at a cosmological time $\tau \gtrsim 10^{-18}\ s$, which defined by the value of $Q \gtrsim \alpha^{-2} \cong 18{,}780$. Time, Space, and Gravitation are intrinsically linked to the Impedance (characterized by the Hubble parameter $H = \tau^{-1}$), the Gravitomagnetic parameter, and the energy density of CM, respectively. Consequently, Time, Space, and Gravitation cannot be discussed independently of CM.

Gravity, under WUC, is not an interaction but rather a manifestation of CM. This perspective aligns with Le Sage's theory of gravitation, which, in WUC, is based on Universe-Created Particles (UCPs), referred to as XIONs. The energy density of CM constitutes two-thirds of the total energy density of Observable World (OW). All physical laws are determined by CM, which is both homogeneous and isotropic. Indeed, CM emerges as the cornerstone of Classical Physics – a savior of its principles. Let us not discard this profound concept with the tide of modernity: **we must not throw the baby out with the bathwater**!

The physical parameters in WUC corresponding to the characteristics of CM are depicted in **Table 1.** Analysis of this table shows that all major physical parameters determine by characteristics of CM.

Conclusion

WUC is consistent with all fundamental concepts of the Observable World. The model successfully describes primary cosmological parameters and their relationships, allowing for precise calculations of values that were previously determined only through experimentation. Moreover, its verifiable predictions and remarkable agreement with observational data reinforce confidence in its validity. Rather than claiming to explain all cosmological data or presenting a fully developed theory, it serves as a foundation for a New Cosmology—one originally envisioned by P. Dirac in 1937. While further refinement by the global physics community is essential, WUC's insights, combined with the groundbreaking discoveries of JWST and Dirac's proposals over the past 88 years, underscore the need for a fundamental transformation in Astronomy, Cosmology, and Classical Physics.

Table 1. Physical parameters in WUC corresponding to the characteristics of Cosmic Medium.

Characteristic of CM	Physical parameter
4D Nucleus extrapolated radius, a	Basic size unit, a
Impedance, $Z = \tau^{-1}$	Cosmological time, $\tau = Z^{-1}$
Magnetic parameter, $\mu = R^{-1}$	Radius of the Nucleus, $R = \mu^{-1}$
Impedance-to-Magnetic parameter ratio	Electrodynamic constant, $c = Z/\mu$
Impedance, $Z = \tau^{-1}$	Hubble parameter, $H = Z$
Impedance, $Z = \tau^{-1}$	Age of the World, $A_\tau = Z^{-1} = \tau$
Hypersphere	Finite volume of the World, $V_W = 2\pi^2 R^3$
3D Hubble's Bubble	Volume of the Observable World, $V_{OW} = \frac{4}{3}\pi R^3$
Surface energy density σ_0	Basic energy unit, $E_0 = \sigma_0 a^2$
Surface energy density σ_0	Total energy of Observable World, $E_{OW} = 4\pi R^2 \sigma_0$
Angular momentum flux density $j_h = \sigma_0 = h/a^2 t_0$	Planck constant, $h = \sigma_0 a^2 t_0 = E_0 t_0$, $t_0 = a/c$
Radius of the Nucleus-to-Basic size unit ratio	Dirac's Large Number, $Q = R/a$
Energy density $\rho_{CM} = \frac{2hc}{a^4} \times Q^{-1}$	Gravitational parameter, $G = \frac{\rho_{CM}}{4\pi} \times P^2$, $P = \frac{a^3}{2h/c}$
Electron-Proton Intergalactic plasma	Constant $\alpha = E_e/E_0$
Temperature of microwave background radiation	Electron-to-Proton mass ratio, m_e/m_p
UCPs continuously created by the Eternal Universe	UCPs rest energy, $\alpha^n \times E_0$, $n = -2 \rightarrow 6$

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