

Quantitative Predictions of the World–Universe Model Confirmed by Subsequent Observations

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Abstract

A concise record of successful predictions is often more persuasive than hundreds of pages of theoretical development because it directly addresses the central question every physicist asks: *What did the model predict before the observational data became available?* In this paper, we present several quantitative predictions made by the World–Universe Model (WUM) in 2013 [1,2] that were subsequently confirmed by observations and measurements. These prior predictions constitute one of the strongest arguments for the long-term scientific significance of WUM.

The paper presents a self-consistent set of (Q)-dependent, time-varying values for the primary cosmological parameters of the World, including the Newtonian gravitational parameter (G), the Hubble parameter (H_0), the concentration of intergalactic plasma, the minimum photon energy, the temperature of the Microwave Background Radiation (MBR), and the peak temperature of the Far-Infrared Background Radiation (FIRB). The obtained set of values was recommended for consideration in the 2014 adjustment of the CODATA Recommended Values of the Fundamental Physical Constants.

1. Introduction

In 2013, the World–Universe Model (WUM) revealed a self-consistent set of time-varying Primary Cosmological Parameters of the World, including the Newtonian gravitational parameter, Hubble parameter, age of the World, Microwave Background Radiation (MBR) temperature, peak temperature of the Far-Infrared Background Radiation (FIRB), concentration of intergalactic plasma, and minimum photon energy.

The interconnectivity of these parameters enabled WUM to address the Missing Baryon Problem through a calculation of the concentration of intergalactic plasma. Based on this framework, WUM predicted in 2013 the values of several cosmological parameters, including the Newtonian gravitational parameter, Hubble parameter, concentration of intergalactic plasma, and minimum photon energy. These predictions were subsequently confirmed by measurements and observations conducted between 2016 and 2021.

In addition, WUM provided direct calculations of the Microwave Background Radiation temperature and the peak temperature of the Far-Infrared Background Radiation—quantities that had previously been determined only through experimental measurements. The agreement between these calculations and the observed values, together with the successful predictions summarized in this paper, demonstrates the predictive capability of the World–Universe Model and motivates further investigation of its cosmological framework [1,2].

2. Newtonian Constant of Gravitation Tension

In 2013, the Newtonian constant of gravitation (G), one of the most important constants in cosmology and fundamental physics, remained exceptionally difficult to measure accurately. Among all fundamental physical

constants, its measurement precision was the poorest. To address this problem, WUM proposed a fundamentally different approach to determining (G) and, in the process, generated a series of quantitative predictions for primary cosmological parameters.

Table 1, reproduced from the CODATA Recommended Values of the Fundamental Physical Constants 2010 [3], summarizes the principal measurements of the Newtonian gravitational constant available at that time.

Table 1. Summary of measurements of the Newtonian gravitational constant (G) relevant to the 2010 CODATA adjustment.

| Source | Identification | Method | 10^{11} G $\text{m}^3 \text{kg}^{-1} \text{s}^{-2}$ | Rel. stand. uncertainty |
|--|----------------|---|--|----------------------------|
| Luther and Towler (1982) | NIST-82 | Fiber torsion balance, dynamic mode | 6.672 48(43) | 6.4×10^{-5} |
| Karagioz and Izmailov (1996) | TR&D-96 | Fiber torsion balance, dynamic mode | 6.672 9(5) | 7.5×10^{-5} |
| Bagley and Luther (1997) | LANL-97 | Fiber torsion balance, dynamic mode | 6.673 98(70) | 1.0×10^{-4} |
| Gundlach and Merkowitz (2000, 2002) | UWash-00 | Fiber torsion balance, dynamic compensation | 6.674 255(92) | 1.4×10^{-5} |
| Quinn <i>et al.</i> (2001) | BIPM-01 | Strip torsion balance, compensation mode, static deflection | 6.675 59(27) | 4.0×10^{-5} |
| Kleinevoß (2002); Kleinvoß <i>et al.</i> (2002) | UWup-02 | Suspended body, displacement | 6.674 22(98) | 1.5×10^{-4} |
| Armstrong and Fitzgerald (2003) | MSL-03 | Strip torsion balance, compensation mode | 6.673 87(27) | 4.0×10^{-5} |
| Hu <i>et al.</i> (2005) | HUST-05 | Fiber torsion balance, dynamic mode | 6.672 28(87) | 1.3×10^{-4} |
| Schlamming <i>et al.</i> (2006) | UZur-06 | Stationary body, weight change | 6.674 25(12) | 1.9×10^{-5} |
| Luo <i>et al.</i> (2009); Tu <i>et al.</i> (2010) | HUST-09 | Fiber torsion balance, dynamic mode | 6.673 49(18) | 2.7×10^{-5} |
| Parks and Faller (2010) | JILA-10 | Suspended body, displacement | 6.672 34(14) | 2.1×10^{-5} |

NIST: National Institute of Standards and Technology, Gaithersburg, MD, USA; TR&D: Tribotech Research and Development Company, Moscow, Russian Federation; LANL: Los Alamos National Laboratory, Los Alamos, New Mexico, USA; UWash: University of Washington, Seattle, Washington, USA; BIPM: International Bureau of Weights and Measures, S`evres, France; UWup: University of Wuppertal, Wuppertal, Germany; MSL: Measurement Standards Laboratory, Lower Hutt, New Zealand; HUST: Huazhong University of Science and Technology, Wuhan, PRC; UZur: University of Zurich, Zurich, Switzerland; JILA: JILA, University of Colorado and National Institute of Standards and Technology, Boulder, Colorado, USA

Inspection of the data reveals that the measured values of (G) differ significantly depending on the experimental method employed. The discrepancies between measurements substantially exceed the reported standard uncertainties. A detailed analysis indicates that the measurements naturally cluster into three distinct groups. Within each group, the results are mutually consistent; however, measurements belonging to different groups are statistically incompatible.

The measurement results can be separated into the following three groups.

The first group consists of six measurements with an average value

$$G_1 = 6.67401 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

and a relative standard uncertainty of 28.5 ppm (part per million).

The second group consists of four measurements with an average value

$$G_2 = 6.67250 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

and a relative standard uncertainty of 24 ppm.

The third group consists of one measurement with a value

$$G_3 = 6.67539 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

and a relative standard uncertainty of 40 ppm.

The relative uncertainties within these groups are significantly smaller than the uncertainty associated with the complete data set. Specifically, the relative standard uncertainties of (G_1), (G_2), and (G_3) are approximately four, five, and three times smaller, respectively, than the relative uncertainty of 120 ppm assigned to the CODATA 2010 recommended value

$$G_{2010} = 6.67384 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

Because the three groups are mutually exclusive, it is likely that only one group reflects the correct value of (G), while the remaining groups are affected by unidentified systematic errors. Consequently, selecting the correct value of (G) based solely on experimental measurements appeared to be an almost hopeless task. The situation closely resembled the later Hubble tension, where several precise but mutually inconsistent determinations of (H_0) coexist [4].

3. Dirac Large Number (Q)

The constancy of the fundamental constants of nature, including the Newtonian gravitational constant (G), is widely accepted today. However, the constancy of (G) has never been established conclusively as an experimental fact. Any conclusion regarding the temporal behavior of (G) is necessarily model-dependent [1]. In our view, neither the absolute constancy nor the variability of (G) can be proven definitively. Consequently, the possibility that (G) varies with cosmological time remains a legitimate subject of investigation.

A variety of alternative cosmological models incorporating a time-varying gravitational parameter have been proposed and discussed in the literature (see, for example, [1] and references therein).

It is commonly assumed that gravity has no established relation to the other interactions and that no connection exists between (G) and the remaining fundamental constants. As a result, it is generally believed that (G) cannot be derived from more accurately measured quantities, as is routinely done in other areas of physics.

The Hypersphere World–Universe Model adopts a different viewpoint. According to WUM, all physical parameters are interconnected through a dimensionless, time-dependent quantity (Q), which serves as a measure of both the size and the age of the World. This quantity is identified with Dirac’s Large Number:

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

where (R) is the radius of the World, (A_τ) is its age, (a) is a fundamental length scale,

$$a = 1.7705641 \times 10^{-14} \text{ m};$$

and (t_0) is a fundamental time scale,

$$t_0 = a/c = 5.9059662 \times 10^{-23} \text{ s}$$

Here, (c) is the gravitodynamic constant, analogous to the electrodynamic constant (c). For the present epoch,

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

4. Interconnectivity of the Primary Cosmological Parameters

One of the principal features of WUM is that all macro- and microphysical properties of the World are determined by only two fundamental parameters: the dimensionless Rydberg constant (α),

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

which was later named the fine-structure constant, and the dimensionless quantity (Q).

While (α) remains constant, (Q) increases with cosmological time and serves as a measure of the size, age, and evolution of the World. Through various rational exponents of (α) and (Q), WUM establishes quantitative relationships among all primary cosmological parameters.

According to WUM, the following parameters depend on (α) and (Q):

- Newtonian parameter of gravitation G

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

- Hubble 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

$$R = a \times Q$$

- Concentration of intergalactic plasma n_{IGP}

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

- Minimum energy of photons E_{ph}

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

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

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

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

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

Here $E_0 = hc/a$ is a fundamental energy unit, (k_B) is the Boltzmann constant, (h) is the Planck constant and (m_e/m_p) is the electron-to-proton mass ratio.

These relations demonstrate the central role of (Q) in WUM. Rather than treating the primary cosmological parameters as independent quantities determined solely through observation, WUM expresses them as members of a self-consistent and interconnected system governed by a small set of fundamental parameters.

5. Gravitational Parameter in WUM

In 2013, the two primary cosmological parameters known with the highest precision were the Newtonian gravitational constant (G), with relative uncertainty 120 ppm, and the Microwave Background Radiation temperature (T_{MBR}), with relative uncertainty 210 ppm. Within the framework of WUM, a more precise determination of (T_{MBR}) could, in principle, be used to identify the correct group of (G) measurements discussed above.

However, such discrimination would require the uncertainty in (T_{MBR}) to be reduced well below 30 ppm. At that time, the available measurements were not sufficiently precise, and the selection of the correct group of (G) measurements appeared to be an almost hopeless task.

Within WUM, we derived the following expression for the Fermi coupling constant (G_F) [2]:

$$\frac{G_F}{(\hbar c)^3} = \sqrt{30} (2\alpha \frac{m_e}{m_p})^{1/4} \frac{m_p}{m_e} \frac{1}{E_0^2} \times Q_F^{-1/4} = 1.166364 \times 10^{-5} \text{ GeV}^{-2}$$

where ($\hbar = h/2\pi$) is the reduced Planck constant.

Using the 2010 CODATA value of the Fermi coupling constant, whose relative standard uncertainty was 4.3 ppm, we obtained

$$Q_F = 0.759960 \times 10^{40}$$

Substituting this value into the WUM relations yielded the predicted value

$$G_F = 6.67420 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

This value is notably close to the average value of the first measurement group,

$$G_1 = 6.67401 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}.$$

suggesting that Group 1 represented the most probable determination of the Newtonian gravitational constant.

After obtaining these results, we communicated them to members of the CODATA Task Group on Fundamental Physical Constants and participants of the Royal Society Meeting on the Newtonian gravitational constant [5]. The main point of the communication was that WUM provides a self-consistent framework relating the Fermi coupling constant, Newtonian gravitational constant, Hubble parameter, age of the World, and Microwave Background Radiation temperature through the dimensionless quantity (Q).

At that time, the CODATA 2010 recommended value was

$$G_{2010} = 6.67384 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

with a relative uncertainty of 120 ppm [3].

In discussing the difficulties associated with measurements of (G) , Terry Quinn concluded following the Royal Society Meeting in 2014 [6]:

“Thus, instead of simply calling for new determinations of (G) , it is suggested that an international advisory board be created ... It is only by proceeding in this way that one might hope to obtain results that are demonstrably reliable.”

This statement reflected the widespread recognition that the determination of (G) remained one of the most challenging problems in experimental physics.

Despite the absence of a major breakthrough in measurement methodology, the CODATA 2014 adjustment recommended a substantially improved value

$$G_{2014} = 6.67408 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2}$$

with a relative standard uncertainty of 46 ppm [7], approximately three times smaller than the uncertainty assigned in 2010.

Using the more precise 2014 value of the Fermi coupling constant,

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

with relative standard uncertainty 0.51 ppm, WUM yielded an updated prediction in 2018:

$$G_{teor}(2018) = 6.674536 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2}$$

This value is in excellent agreement with the measurements reported by Q. Li *et al.* in 2018 using two independent experimental methods [8]:

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

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

The average of these measurements is

$$G_{exp} = 6.674512 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2}$$

The ratio of the theoretical prediction to the experimental result is

$$\frac{G_{2018}}{G_{exp}} = \frac{6.674536}{6.674512} = 1.0000036$$

The difference between the predicted and measured values is therefore only 3.6 parts per million, providing a remarkably close agreement between theory and experiment.

In 2018, CODATA further refined its recommendation to

$$G_{2018} = 6.67430 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2}$$

with a relative standard uncertainty of 22 ppm [9]. Thus, between 2010 and 2018, the uncertainty in the recommended value of the Newtonian gravitational constant decreased from 120 ppm to 22 ppm. At the same time, the experimentally determined values moved substantially closer to the value predicted by WUM.

6. Hubble Parameter

The situation surrounding measurements of the Hubble parameter in 2019 [4] closely resembled the situation that existed for measurements of the Newtonian gravitational constant in 2013. In both cases, precise measurements obtained by different methods yielded statistically inconsistent results. WUM may

provide useful guidance in identifying the measurement techniques most closely related to the fundamental value of the Hubble parameter.

In 2013, WUM predicted the following value:

$$H_0 = 68.7494 \text{ km/s Mpc}$$

This prediction was in good agreement with the value reported by the WMAP team [10]:

$$H_0 = 69.32 \pm 0.8 \text{ km/s Mpc}$$

According to WUM, the Hubble parameter should be determined from observations of the Cosmic Microwave Background Radiation rather than from measurements involving local distance indicators.

The value obtained in 2021 using Cosmic Microwave Background data alone [11],

$$H_0 = 68.7 \pm 1.5 \text{ km/s Mpc}$$

is in excellent agreement with the value predicted by WUM eight years earlier.

From the WUM perspective, the persistent Hubble Tension is not an anomaly requiring ad hoc corrections, but a natural observational signature of the Patchwork Quilt structure of the Visible World. It reflects the inappropriate mixing of local, environment-dependent measurements with a global parameter that characterizes the World as a whole [12].

7. Missing Baryon Problem

The Missing Baryon Problem arises from the discrepancy between the theoretically predicted abundance of baryonic matter and the amount directly observed in the Universe. Measurements by the Planck mission in 2015 indicated that baryonic matter constitutes approximately 4.85% of the total cosmic energy density [13]. However, inventories of known baryonic matter accounted for less than half of this amount [14]. The missing baryons were therefore believed to reside in the warm-hot intergalactic medium.

The existence of a Cosmic Medium is a fundamental feature of WUM. Its presence is supported by observations of intergalactic plasma, the Cosmic Microwave Background Radiation, and the Far-Infrared Background Radiation. In WUM, there is no truly empty space. The intergalactic voids observed by astronomers are interpreted as regions where the Cosmic Medium exists in its purest form.

A detailed analysis of intergalactic plasma performed in 2013 [1] showed that the concentrations of protons and electrons are given by

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

The corresponding energy density of protons in the Cosmic Medium is

$$\rho_p = n_p E_p$$

The relative energy density of protons,

$$\Omega_p = \frac{\rho_p}{\rho_{cr}} = \frac{2\pi^2 \alpha}{3} = 0.048014655$$

where (ρ_{cr}) is the critical energy density of the World, becomes 0.048014655.

According to WUM, the relative energy density of baryons contained within macroobjects is

$$\Omega_{MO} = \frac{1}{2}\Omega_p = \frac{\pi^2\alpha}{3} = 0.024007318$$

These values are in good agreement with the estimates reported in 2015 [13,14].

Direct measurements of the intergalactic plasma density could be achieved through observations of Fast Radio Bursts. These millisecond-duration radio signals are dispersed while propagating through intergalactic plasma. Their dispersion measures, combined with redshift determinations, provide a powerful tool for probing the density of ionized baryons in the intergalactic medium [15].

In 2016, E. F. Keane *et al.* reported a direct determination of the cosmic density of ionized baryons from FRB observations [15]:

$$\Omega_{IGM} = 4.9 \pm 1.3\%$$

This result is in excellent agreement with the value predicted by WUM:

$$\Omega_p = 4.8\%$$

Thus, the intergalactic plasma parameters predicted by WUM in 2013 were subsequently confirmed by observations conducted in 2016.

8. Minimum Photon Energy

An analysis of intergalactic plasma within WUM yields the lowest plasma frequency [1]:

$$\nu_{pl} = \frac{c}{a} \left(\frac{m_e}{m_p}\right)^{1/2} \times Q^{-1/2} = 4.5322 \text{ Hz}$$

Photons with energies below

$$E_{min} = h\nu_{pl}$$

cannot propagate through plasma. Consequently, $(E_{min} = h\nu_{pl})$ represents the minimum photon energy permitted in the intergalactic medium.

Following Bonetti *et al.* [19], this quantity may also be interpreted as an effective rest energy of the photon:

$$E_{min} = 1.8743 \times 10^{-14} \text{ eV}$$

This value, predicted by WUM in 2013, is in good agreement with the upper limit obtained by Bonetti *et al.* in 2017 [16]:

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

More precisely, (E_{ph}) may be regarded as the minimum energy of photons capable of propagating through intergalactic plasma. Since

$$E_{min} \propto \tau^{-1/2}$$

this quantity decreases with cosmological time.

9. Microwave Background Radiation Temperature

Within WUM, the blackbody spectrum of the Cosmic Microwave Background Radiation arises from the thermodynamic equilibrium between photons and the low-density intergalactic plasma consisting of protons and electrons.

Using the WUM framework, the Microwave Background Radiation temperature is calculated to be

$$T_{MBR} = 2.72522 K$$

This result is in excellent agreement with the experimentally measured value [17]:

$$T_{MBR} = 2.72548 \pm 0.00057 K$$

To the best of our knowledge, no other cosmological model provides a direct calculation of the MBR temperature with comparable precision.

The close agreement among the predicted values of (G) , (H_0) , and (T_{MBR}) is particularly significant because these parameters are not independent within WUM but arise from a common theoretical framework governed by the parameter (Q) . The consistency of these results supports the conclusion that the first group of gravitational constant measurements discussed earlier corresponds to the correct value of (G) .

10. Peak Temperature of the Far-Infrared Background Radiation

In 2014, WUM calculated the equilibrium temperature of Cosmic Large Grains, corresponding to the peak temperature of the Far-Infrared Background Radiation:

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

The resulting value,

$$T_{FIRB} = 28.955 K$$

is in excellent agreement with the experimentally determined peak temperature of FIRB [18]:

$$T_{FIRB} \sim 29 K$$

This agreement provides an additional example of a quantitative result obtained from the interconnected system of cosmological parameters defined by WUM.

11. Conclusion

A summary of the cosmological parameters calculated by WUM in 2013 and their subsequent experimental determinations is presented in **Table 2**.

Table 2. Cosmological parameters predicted by WUM and subsequently measured experimentally.

| Parameter | Calculated (2013) | Measured | Year | Ref |
|-----------------------|--|---|------|------|
| Gravitational | $6.67420 \times 10^{-11} m^3 kg^{-1} s^{-2}$ | $6.674184 \times 10^{-11} m^3 kg^{-1} s^{-2}$ | 2018 | [8] |
| Hubble | $68.733 km s^{-1} Mpc^{-1}$ | $68.7 \pm 1.3 km s^{-1} Mpc^{-1}$ | 2021 | [11] |
| Ionized Baryons | 4.8 % | $4.9 \pm 1.3 \%$ | 2016 | [15] |
| Minimum Photon Energy | $1.87433 \times 10^{-14} eV$ | $\lesssim 2.2 \times 10^{-14} eV$ | 2017 | [16] |
| MBR Temperature | 2.725245 K | $2.72548 \pm 0.00057 K$ | 2009 | [17] |
| FIRB Temperature Peak | 28.955 K | 29 K | 1998 | [18] |

The results demonstrate that WUM not only yields precise calculations of quantities that had previously been known only through experiment, such as the Microwave Background Radiation temperature and the peak temperature of the Far-Infrared Background Radiation but also provides quantitative makes verifiable predictions.

WUM is founded on two fundamental parameters: the dimensionless Rydberg constant (α) and the dimensionless, time-dependent quantity (Q). Within this framework, the primary cosmological parameters of the World are not independent quantities, but members of a self-consistent system connected through simple mathematical relationships.

The principal result of this paper is that WUM made quantitative predictions in 2013 that were subsequently confirmed by observations and measurements. These include the Newtonian gravitational parameter (G), the Hubble parameter (H_0), the density of ionized baryons in the intergalactic medium, and the minimum photon energy. In addition, WUM provides direct calculations of the Microwave Background Radiation temperature and the peak temperature of Far-Infrared Background Radiation, quantities that had previously been known only through experiment.

The ability to predict measurable quantities before their observational confirmation is a fundamental test of any physical theory. The agreements summarized in this paper demonstrate that WUM possesses genuine predictive power and merits further investigation as an alternative cosmological framework. Nearly ninety years after Paul Dirac proposed a cosmology based on a variable gravitational parameter and continuous matter creation, the quantitative successes of WUM suggest that some of these ideas deserve renewed consideration in modern physics.

The recent discoveries made by the James Webb Space Telescope, together with the predictive successes summarized here, reinforce the importance of examining alternative cosmological frameworks. Whether WUM ultimately proves to be correct, its ability to generate quantitative, testable predictions prior to observation provides a clear criterion by which its scientific value may be assessed.

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