World-Universe Model. Self-Consistency of Fundamental Physical Constants

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Abstract

Every four years the Committee on Data for Science and Technology (CODATA) provides a self-consistent set of values of the basic constants and conversion factors of physics recommended for international use. In 2013, the World-Universe Model (WUM) proposed a principally different depiction of the World as an alternative to the picture of the Big Bang Model. This article makes a detailed analysis of the self-consistency of Fundamental Physical Constants through the prism of WUM. The performed analysis suggests: discontinuing using the notion "Vacuum" and its characteristics (Speed of Light in Vacuum, Characteristic Impedance of Vacuum, Vacuum Magnetic Permeability, Vacuum Electric Permittivity); correcting the numerical value and relative standard uncertainty of Hartree energy; accepting the exact numerical values of Planck constant and Elementary charge. WUM recommends the predicted value of Newtonian Constant of Gravitation (x8 more accurate than the 2018 value) to be considered in CODATA Recommend Values of the Fundamental Physical Constants 2022.

Keywords

"World-Universe Model"; "Fundamental Physical Constants"; "Self-Consistency"; "Medium of World"; "Maxwell's Equations"; "Newtonian Constant of Gravitation"; "Rydberg Constant"; "Hartree Energy"; "Planck Constant"; "Elementary Charge"; "Characteristic Impedance"; "Fermi Coupling Constant"

1. Introduction

It doesn't make any difference how beautiful your guess is, it doesn't make any difference how smart you are, who made the guess, or what his name is. If it disagrees with experiment, it's wrong. That's all there is to it.

Richard Feynman

The very first manuscript "World-Universe Model" (WUM) was published on viXra in March 2013. At that time great results in Cosmology were achieved:

- The cosmic Far-Infrared Background was announced in 1999 [1];
- Microwave Background Radiation temperature was measured in 2009 [2];
- Nine-Year Wilkinson Microwave Anisotropy Probe Observations were published in 2012 [3].

At the same time, the most important for the Cosmology, Newtonian constant of gravitation G, proved too difficult to measure [4]. Its measurement precision was the worst among all Fundamental physical constants.

To resolve the problem T. Quinn, C. Speake, and J. Luo organized the Royal Society meeting named "The Newtonian constant of gravitation, a constant too difficult to measure?" in London on Feb. 2014 [5]. According to Jun Luo:

"*The Newtonian gravitational constant G holds an important place in physics. Though there have been about 300 measurements of G since the first laboratory measurement by Cavendish over 200 years ago, its measurement precision is the worst among all the fundamental physics constants*".

At that time, CODATA stated the following value of the gravitational constant G:

$$G(2010) = 6.67384 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

with Relative Standard Uncertainty (RSU): 1.2×10^{-4}.

Terry Quinn in the paper "Outcome of the Royal Society meeting on G held at Chicheley Hall on 27 and 28 February 2014 to discuss 'The Newtonian constant of gravitation, a constant too difficult to measure?' concluded [6]:

"*Thus, instead of simply calling for new determinations of G, it is suggested that an international advisory board be created, made up largely of those who have already carried out a G experiment, to advise on the choice of method or methods, on the design of the experiment, on its construction and finally on the interpretation of the data and calculation of the results. This would be in contrast to the present situation in which outside criticism and comments can be brought to bear only when the experiment is finished and published when it is too late to affect the outcome. It is only by proceeding in this way that one might hope to obtain results that are demonstrably reliable*".

2. Newtonian Constant of Gravitation

In 2013 WUM proposed a principally different way to solve the problem of G measurement precision and made some predictions of values of Primary Cosmological Parameters (PCPs). WUM revealed a self-consistent set of time-varying values of PCPs: Gravitation parameter, Hubble's parameter, Age of the World, Temperature of the Microwave Background Radiation, the concentration of Intergalactic plasma, and the minimum energy of photons that can pass through the Intergalactic plasma [7], [8].

Based on the inter-connectivity of these parameters, WUM solved the Missing Baryon problem and predicted the values of PCPs, which were experimentally confirmed in 2015 – 2018. The set of values obtained by WUM was recommended for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2014 [9].

According to WUM, the predicted value of the gravitational constant G^*_{2014} equals to :

$$G^*_{2014} = 6.67420 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

To the best of our knowledge, no breakthrough in G measurement methodology has been achieved since [10]. Nevertheless, in 2015 CODATA recommended a more precise value of the Newtonian constant of gravitation:

$$G(2014) = 6.67401 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

with RSU: 4.7×10^{-5}. In 2018 the recommendation improved further:

$$G(2018) = 6.67430 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

with RSU: 2.2×10^{-5}. These values are very close to the predicted value by WUM in 2013. Since 2013, the relative standard uncertainty of G measurements reduced x6. It seems that CODATA considered the WUM recommendation of the predicted value of G and used it for G(2014) and G(2018) without any reference or explanation of their methodology.

3. Self-Consistency of Fundamental Physical Constants

Every four years the Committee on Data for Science and Technology (CODATA) provides a self-consistent set of values of the basic constants and conversion factors of physics recommended for international use.

Table 1, borrowed from CODATA Recommended Values of the Fundamental Physical Constants, 2010, 2014, and 2018 summarizes the results of measurements of Universal, Electromagnetic, and Atomic and Nuclear constants. Observe that the most of Fundamental Physical Constants have more precise values with each adjustment. However, there are a few results that prompt some questions.

Table 1. Summary of the results of measurements of the Fundamental Physical Constants relevant to the 2010, 2014, and 2018 adjustments.

Fundamental Physical Constant	**Numerical Value. Relative Standard Uncertainty, 2010**	**Numerical Value. Relative Standard Uncertainty, 2014**	**Numerical Value. Relative Standard Uncertainty, 2018**
Characteristic Impedance of Vacuum Z_0 , Ω	376.730 313 461 exact	376.730 313 461 exact	376.730 313 668 1.5×10^{-10}
Newtonian Constant of Gravitation G, $\times 10^{-11}\ m^3 kg^{-1} s^{-2}$	6.673 84 1.2×10^{-4}	6.674 08 4.7×10^{-5}	6.674 30 2.2×10^{-5}
Planck constant h , $\times 10^{-34}\ J\ Hz^{-1}$	6.626 069 57 4.4×10^{-8}	6.626 070 040 1.2×10^{-8}	6.626 070 15 exact
Speed of Light in Vacuum $c, m\ s^{-1}$	299 792 458 exact	299 792 458 exact	299 792 458 exact
Vacuum Electric Permittivity ε_0 , $\times 10^{-12}\ F\ m^{-1}$	8.854 187 8176 exact	8.854 187 8176 exact	8.854 187 8128 1.5×10^{-10}
Vacuum Magnetic Permeability μ_0 , $\times 10^{-6}\ N\ A^{-2}$	1.256 637 061 44 exact	1.256 637 061 44 exact	1.256 637 062 12 1.5×10^{-10}
Elementary charge C, $\times 10^{-19}$	1.602 176 565 2.2×10^{-8}	1.602 176 6208 6.1×10^{-9}	1.602 176 634 exact
Electron Charge to Mass Quotient $-e/m_e$, $\times 10^{11}\ C\ kg^{-1}$	−1.758 820 088 2.2×10^{-8}	−1.758 820 024 6.2×10^{-9}	−1.758 820 01076 3.0×10^{-10}
Fermi Coupling Constant $G_F/(\hbar c)^3$, $\times 10^{-5}\ GeV^{-2}$	1.166 364 4.3×10^{-6}	1.166 3787 5.1×10^{-7}	1.166 3787 5.1×10^{-7}
Fine-Structure Constant α , $\times 10^{-3}$	7.297 352 5698 3.2×10^{-10}	7.297 352 5664 2.3×10^{-10}	7.297 352 5693 1.5×10^{-10}
Hartree Energy E_h , $\times 10^{-18}\ J$	4.359 744 34 4.4×10^{-8}	4.359 744 650 1.2×10^{-8}	4.359 744 722 2071 1.9×10^{-12}
Rydberg Constant R_∞ , m^{-1}	10 973 731.568 539 5.0×10^{-12}	10 973 731.568 508 5.9×10^{-12}	10 973 731.568 160 1.9×10^{-12}

3.1. Characteristic Impedance of Vacuum, Vacuum Electric Permittivity, Vacuum Magnetic Permeability, Speed of Light in Vacuum

In 2010 and 2014 these constants had exact values that equal to the theoretical values in vacuum with the value of the electrodynamic constant c equals to the exact value of speed of light in vacuum. Whereas, in 2018 these constants have different numerical values with RSU: 1.5×10^{-10}. By definition, constants Z_0 and ε_0 were calculated based on the value of μ_0 according to the following equations: $Z_0 = \mu_0 c$ and $\varepsilon_0 = (\mu_0 c^2)^{-1}$ with the exact value of speed of light in vacuum c.

Observe that the value of $\mu_0(2018)$ is larger than $\mu_0(2014)$. It means that there is a relative permeability of the Medium of the World μ_r and the magnetic permeability of the Medium μ_M equals to:

$$\mu_M = \mu_r \mu_0$$

The calculated value of μ_r is:

$$\mu_r = 1.00000000054$$

According to WUM, there is a relative electric permittivity of the Medium of the World ε_r and the electric permittivity of the Medium ε_M equals to:

$$\varepsilon_M = \varepsilon_r \varepsilon_0$$

Then, the electrodynamic constant of the Medium c_M can be calculated by the following equation:

$$c_M = (\mu_M \varepsilon_M)^{-1/2} = (\mu_r \mu_0 \varepsilon_r \varepsilon_0)^{-1/2}$$

The existence of the Medium of the World is a principal point of WUM. It consists of Intergalactic plasma, Microwave background radiation, cosmic Far-Infrared background, Dark Matter particles including magnetic dipole DIRAC and electric dipole ELOP. Cosmic Maxwell's equations should consider the macroscopically averaged electric dipole and magnetic dipole moment densities of the Medium in the presence of applied fields [11].

3.2. Rydberg Constant, Hartree Energy, Planck Constant

As of 2018, Rydberg Constant R_∞ is the most accurately measured Fundamental physical constant. Hartree Energy E_h can be calculated by the following equation:

$$E_h = hcR_\infty$$

The RSU of its numerical value depends on the RSU of the numerical value of Planck constant h and RSU of the electrodynamic constant c . CODATA supposed that c is the speed of light in vacuum with the exact numerical value. Considering the exact numerical value of Planck constant, CODATA gave the RSU of E_h : 1.9×10^{-12} that equals to the RSU of R_∞ .

In our view, it is not correct because the electrodynamic constant c discussed in Section 3.1. has an RSU $\sim 10^{-10}$ and consequently, E_h should have the RSU $\sim 10^{-10}$.

3.3. Elementary Charge, Characteristic Impedance of Vacuum

The relation used by CODATA to determine elementary charge is:

$$e^2 = \frac{2h\alpha}{\mu_0 c}$$

As of 2018, the Elementary charge e, Planck constant h, and speed of light in vacuum c have the exact numerical values. It means that the ratio α/μ_0 must be a constant. No explanation for this calculation is provided.

In our view, we should use the following relation:

$$Z_0 = \frac{2h}{e^2}\alpha$$

The RSU of the numerical value of α is: 1.5×10^{-10}. It means that the RSU of the numerical value of Z_0 must be the same. Z_0 cannot have the exact value as it was supposed in 2010 and 2014.

3.4. Fermi Coupling Constant, Newtonian Constant of Gravitation

Considering a more precise value of Fermi Coupling constant (see **Table 1**) we calculate the value of the predicted parameter G^*_{2018} [8]:

$$G^*_{2018} = 6.674536 \times 10^{-11} m^3 kg^{-1} s^{-2}$$

which is x8 more accurate than G^*_{2014} .

4. Conclusion

The detailed analysis of the self-consistency of Fundamental physical constants based on the developed World-Universe Model shows that it is the right time to:

- discontinue using the notion "Vacuum" and its characteristics:

    - Speed of Light in Vacuum;
    - Characteristic Impedance of Vacuum;
    - Vacuum Magnetic Permeability;
    - Vacuum Electric Permittivity;

- correct the numerical value and relative standard uncertainty of Hartree energy;
- accept the exact numerical values of Planck constant and Elementary charge;
- recommend for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2022 the predicted value of the Newtonian Constant of Gravitation G^*_{2018} .

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