Journal of Modern Physics, 2024, 15, 1567-1585
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Algorithms for Empirical Equations in Terms of the Cosmic Microwave Background Temperature

Tomofumi Miyashita

Miyashita Clinic, Osaka, Japan
Email: tom_miya@ballade.plala.or.jp

How to cite this paper: Miyashita, T. (2024) Algorithms for Empirical Equations in Terms of the Cosmic Microwave Background Temperature. *Journal of Modern Physics*, **15**, 1567-1585.
https://doi.org/10.4236/jmp.2024.1510066

Received: August 14, 2024
Accepted: September 24, 2024
Published: September 27, 2024

Abstract

Previously, we presented several empirical equations using the cosmic microwave background (CMB) temperature. Next, we propose an empirical equation for the fine-structure constant. Considering the compatibility among these empirical equations, the CMB temperature (T_c) and gravitational constant (G) were calculated to be 2.726312 K and 6.673778 × 10^{-11} $m^3 \cdot kg^{-1} \cdot s^{-2}$, respectively. Every equation can be explained numerically in terms of the Compton length of an electron (λ_e), the Compton length of a proton (λ_p) and α. Furthermore, every equation can also be explained in terms of the Avogadro number and the number of electrons at 1 C. We show that every equation can be described in terms of the Planck constant. Then, the ratio of the gravitational force to the electric force can be uniquely determined with the assumption of minimum mass. In this report, we describe the algorithms used to explain these equations in detail. Thus, there are no dimension mismatch problems.

Keywords

Temperature of the Cosmic Microwave Background, Minimum Mass, The Ratio of Gravitational Force to Electric Force, Dimension Analysis, Redefinition Method, Fine Structure Constant

1. Introduction

The symbol list is shown in Section 2. Previously, we described Equations (1), (2) and (3) in terms of the cosmic microwave background (CMB) temperature [1]-[5].

$$\frac{Gm_p^2}{hc} = \frac{4.5}{2} \times \frac{kT_c}{1\,\text{kg} \times c^2} \tag{1}$$

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times hc \tag{2}$$

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \pi \times kT_c \tag{3}$$

We then derived an empirical equation for the fine-structure constant [6].

$$137.0359991 = 136.0113077 + \frac{1}{3\times 13.5} + 1 \tag{4}$$

$$13.5 \times 136.0113077 = 1836.152654 = \frac{m_p}{m_e} \tag{5}$$

Equations (4) and (5) are related to the transference number [7] [8]. Next, we propose the following values as deviations of the values of 9/2 and π [8] [9].

$$3.13201(\mathrm{V}\cdot\mathrm{m}) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_e c^2}{ec} \tag{6}$$

$$4.48852\left(\frac{1}{\mathrm{A}\cdot\mathrm{m}}\right) = \frac{q_m c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_p c^2} \tag{7}$$

Then, $\left(\frac{m_p}{m_e} + \frac{4}{3}\right)$ has units of $\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)$. By redefining the Avogadro number and the Faraday constant, these values can be adjusted back to 9/2 and π [9].

$$\pi(\mathrm{V}\cdot\mathrm{m}) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{e\_new} c^2}{e_{new} c} \tag{8}$$

$$4.5\left(\frac{1}{\mathrm{A}\cdot\mathrm{m}}\right) = \frac{q_{m\_new} c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{p\_new} c^2} \tag{9}$$

Every equation can be explained in terms of the Compton length of an electron (λ_e), the Compton length of a proton (λ_p) and α [10] Furthermore, every equation can be explained in terms of the Avogadro number and the number of electrons at 1 C [11]. We showed that every equation can be described in terms of the Planck constant [12]. Then, the ratio of the gravitational force to the electric force can be uniquely determined with the assumption of minimum mass. Using the correspondence principle with the thermodynamic principles in solid-state ionics [13], we propose a canonical ensemble to explain the concept of the minimum mass. However, there appear to be dimension mismatch problems. In this report, we present the algorithms for these equations. Then, every dimension mismatch problem can be solved. Quantum mechanics [14] and Gravity [15] have been tried to explain thermodynamically. Our motivation is to use the thermodynamic principles in the area of solid-state ionics discovered by ourselves. However, we can only discuss about the numerical connections in the present.

The remainder of this paper is organized as follows. In Section 2, we present the list of symbols used in our derivations. In Section 3, we propose algorithms to explain these equations in detail. Then, every dimension mismatch problem can be solved. In Section 4, using algorithms, we explain our main equations. In Section 5, our conclusions are described.

2. Symbol List

2.1. MKSA Units[1]

G: gravitational constant: 6.6743×10^{-11} ($\mathrm{m^3 \cdot kg^{-1} \cdot s^{-2}}$)

(we used the compensated value 6.673778×10^{-11} in this study)

T_c: CMB temperature: 2.72548 (K)

(we used the compensated value 2.726312 K in this study)

k: Boltzmann constant: 1.380649×10^{-23} ($\mathrm{J \cdot K^{-1}}$)

c: speed of light: 299792458 (m/s)

h: Planck constant: $6.62607015 \times 10^{-34}$ (J s)

ε_0: Electric constant: $8.8541878128 \times 10^{-12}$ ($\mathrm{N \cdot m^2 \cdot C^{-2}}$)

μ_0: magnetic constant: $1.25663706212 \times 10^{-6}$ ($\mathrm{N \cdot A^{-2}}$)

e: electric charge of one electron: $-1.602176634 \times 10^{-19}$ (C)

q_m: magnetic charge of one magnetic monopole: $4.13566770 \times 10^{-15}$ (Wb)

(this value is only a theoretical value, $q_m = h/e$)

m_p: rest mass of a proton: $1.672621923 \times 10^{-27}$ (kg)

(We used the compensated value of $1.6726219059 \times 10^{-27}$ kg to explain 137.0359990841)

m_e: rest mass of an electron: $9.1093837 \times 10^{-31}$ (kg)

Rk: von Klitzing constant: 25812.80745 (Ω)

Z_0: wave impedance in free space: 376.730313668 (Ω)

α: fine-structure constant: 1/137.035999081

λ_p: Compton wavelength of a proton: 1.32141×10^{-15} (m)

λ_e: Compton wavelength of an electron: $2.4263102367 \times 10^{-12}$ (m)

2.2. Symbol List after Redefinition

$$e_{new} = e \times \frac{4.48852}{4.5} = 1.59809\mathrm{E}-19(\mathrm{C}) \tag{10}$$

$$q_{m\_new} = q_m \times \frac{\pi}{3.13201} = 4.14832\mathrm{E}-15(\mathrm{Wb}) \tag{11}$$

$$h_{new} = e_{new} \times q_{m\_new} = h \times \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} = 6.62938E-34(\mathrm{J \cdot s}) \tag{12}$$

$$Rk_{\_new} = \frac{q_{m\_new}}{e_{\_new}} = Rk \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 25958.0(\Omega) \tag{13}$$

Equation (13) can be rewritten as follows:

$$Rk_{new} = 4.5\left(\frac{1}{\mathrm{A \cdot m}}\right) \times \pi(\mathrm{V \cdot m}) \times \frac{m_p}{m_e} = 25957.9966027(\Omega) \tag{14}$$

[1]These values were obtained from Wikipedia.

$$Z_{0\_new} = \alpha \times \frac{2h_{new}}{e_{new}{}^2} = 2\alpha \times Rk_{new} = Z_0 \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 378.849(\Omega) \tag{15}$$

Equation (15) can be rewritten as follows:

$$Z_{0\_new} = 4.5\left(\frac{1}{\mathrm{A}\cdot\mathrm{m}}\right) \times \pi(\mathrm{V}\cdot\mathrm{m}) \times 2\alpha \times \frac{m_p}{m_e} = 378.8493064(\Omega) \tag{16}$$

$$\mu_{0\_new} = \frac{Z_{0\_new}}{c} = \mu_0 \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 1.26371\mathrm{E}-06\left(\mathrm{N}\cdot\mathrm{A}^{-2}\right) \tag{17}$$

$$\varepsilon_{0\_new} = \frac{1}{Z_{0\_new} \times c} = \varepsilon_0 \times \frac{4.48852}{4.5} \times \frac{3.13201}{\pi} = 8.80466\mathrm{E}-12\left(\mathrm{F}\cdot\mathrm{m}^{-1}\right) \tag{18}$$

$$c_{\_new} = \frac{1}{\sqrt{\varepsilon_{0\_new}\mu_{0\_new}}} = \frac{1}{\sqrt{\varepsilon_0\mu_0}} = c = 299792458\left(\mathrm{m}\cdot\mathrm{s}^{-1}\right) \tag{19}$$

The Compton wavelength (λ) is as follows:

$$\lambda = \frac{h}{mc} \tag{20}$$

This value (λ) should be unchanged since the unit for 1 m is unchanged. However, in Equation (12), Planck's constant is changed. Therefore, the units for the masses of one electron and one proton need to be redefined.

$$m_{e\_new} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} \times m_e = 9.11394\mathrm{E}-31(\mathrm{kg}) \tag{21}$$

$$m_{p\_new} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} \times m_p = 1.67346\mathrm{E}-27(\mathrm{kg}) \tag{22}$$

From the dimensional analysis in a previous report [9], the following is obtained:

$$kT_{c\_new} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} \times kT_c = 3.7659625\mathrm{E}-23(\mathrm{J}) \tag{23}$$

To simplify the calculation, G_N is defined as follows:

$$G_N = G \times 1\,\mathrm{kg}\left(\mathrm{m}^3\cdot\mathrm{s}^{-2}\right) = 6.673778\mathrm{E}-11\left(\mathrm{m}^3\cdot\mathrm{s}^{-2}\right) \tag{24}$$

Now, the value of G_N remains unchanged. However, the value of G_{N_new} should change [9] as follows:

$$G_{N\_new} = G_N \times \frac{4.5}{4.48852}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) = G_N \times \frac{e}{e_{new}} = 6.69084770\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) \tag{25}$$

2.3. Symbol List in Terms of the Compton Length of an Electron (λ_e), the Compton Length of a Proton (λ_p) and α

The following equations were proposed in a previous study [10]:

$$\begin{aligned} & m_{e\_new}c^2 \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^2 \left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) \\ & = \frac{\pi}{4.5}\left(\mathrm{V}\cdot\mathrm{m}\cdot\mathrm{A}\cdot\mathrm{m} = \frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right) \times \lambda_p c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) \\ & = 2.76564\mathrm{E}-07\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) = \text{constant} \end{aligned} \tag{26}$$

$$\begin{aligned}
&e_{new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\mathrm{A}\cdot\mathrm{m}^3}{\mathrm{s}}\right)\\
&=\frac{1}{4.5}(\mathrm{A}\cdot\mathrm{m})\times\lambda_p c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)=8.80330\mathrm{E}-08\left(\frac{\mathrm{A}\cdot\mathrm{m}^3}{\mathrm{s}}\right)=\text{constant}
\end{aligned} \tag{27}$$

$$\begin{aligned}
&m_{p_new}c^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right)\\
&=\frac{\pi}{4.5}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\times\lambda_e c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)=5.07814\mathrm{E}-04\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right)=\text{constant}
\end{aligned} \tag{28}$$

$$\begin{aligned}
&q_{m_new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\mathrm{V}\cdot\mathrm{m}^3}{\mathrm{s}}\right)\\
&=\pi(\mathrm{V}\cdot\mathrm{m})\times\lambda_e c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)=2.28516\mathrm{E}-03\left(\frac{\mathrm{V}\cdot\mathrm{m}^3}{\mathrm{s}}\right)=\text{constant}
\end{aligned} \tag{29}$$

$$\begin{aligned}
&kT_{c_new}\times\frac{2\pi}{\alpha}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^3\left(\frac{\mathrm{J}\cdot\mathrm{m}^6}{\mathrm{s}^3}\right)\\
&=\frac{\pi}{4.5}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\times\lambda_p c\times\lambda_e c=2.011697\mathrm{E}-10\left(\frac{\mathrm{J}\cdot\mathrm{m}^6}{\mathrm{s}^3}\right)=\text{constant}
\end{aligned} \tag{30}$$

$$\begin{aligned}
&G_{N_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)\\
&=\left(\lambda_p c\right)^2\left(\frac{\mathrm{m}^4}{\mathrm{s}^2}\right)\times c\left(\frac{\mathrm{m}}{\mathrm{s}}\right)\times\frac{9\alpha}{8\pi}=1.22943\mathrm{E}-07\left(\frac{\mathrm{m}^5}{\mathrm{s}^3}\right)=\text{constant}
\end{aligned} \tag{31}$$

2.4. Symbol List in Terms of the Avogadro Number and the Number of Electrons in 1 C

The Avogadro number (N_A) is 6.02214076 × 10^{23}. This value is related to the following value.

$$N_A=\frac{1\,\mathrm{g}}{m_p}=5.978637\mathrm{E}+23 \tag{32}$$

Using the redefined values, the new definition of the Avogadro number (N_{A_new}) is as follows:

$$N_{A\_new}=\frac{1\,\mathrm{kg}}{m_{p\_new}}=\frac{1\,\mathrm{kg}_{new}}{m_p}=5.975649\mathrm{E}+26\neq\frac{1\,\mathrm{kg}_{new}}{m_{p\_new}} \tag{33}$$

The number of electrons in 1 C (N_e) is as follows:

$$N_e=\frac{1\,\mathrm{C}}{e}=6.241509\mathrm{E}+18 \tag{34}$$

Using the redefined values, the new definition of the number of electrons in 1 C (N_{e_new}) is as follows:

$$N_{e\_new}=\frac{1\,\mathrm{C}_{new}}{e}=\frac{1\,\mathrm{C}}{e_{new}}=6.257473\mathrm{E}+18\neq\frac{1\,\mathrm{C}_{new}}{e_{new}} \tag{35}$$

The following equations were proposed in a previous study [11]:

$$m_{p\_new} = \frac{1}{N_{A\_new}} \tag{36}$$

$$m_{e\_new} = \frac{m_e/m_p}{N_{A\_new}} \tag{37}$$

where m_p/m_e (=1836.1526) is not changed after redefinition.

$$e_{new} = \frac{1}{N_{e\_new}} \tag{38}$$

$$q_{m\_new} = \frac{4.5\pi \times m_p/m_e}{N_{e\_new}} = 4.148319\text{E}-15 \tag{39}$$

$$h_{new} = \frac{4.5\pi \times m_p/m_e}{\left(N_{e\_new}\right)^2} = 6.62938382\text{E}-34 \tag{40}$$

$$kT_{c\_new} = \frac{4.5 \times c^3 \times \alpha}{2\pi \times N_{e\_new} \times N_{A\_new}} = 3.7659625\text{E}-23 \tag{41}$$

$$G_{N\_new} = \frac{4.5^3 \times m_p/m_e \times N_{A\_new} \times c^2 \times \alpha}{4 \times N_{e\_new}^3} = 6.6908477\text{E}-11 \tag{42}$$

2.5. Symbol List for the Advanced Expressions for kT_c and G_N

Furthermore, we propose the following four equations [11]:

$$kT_{c\_new}\left(\text{J}\right) = \frac{\alpha}{2\pi(1)} \times \frac{1}{\pi}\left(\frac{1}{\text{V}\cdot\text{m}}\right) \times q_{m\_new}c \times m_{e\_new}c^2 = 3.76596254\text{E}-23 \tag{43}$$

$$kT_{c\_new}\left(\text{J}\right) = \frac{\alpha}{2\pi(1)} \times 4.5\left(\frac{1}{\text{A}\cdot\text{m}}\right) \times e_{new}c \times m_{p\_new}c^2 = 3.76596254\text{E}-23 \tag{44}$$

In Equations 43 and 44, 2π(1) is dimensionless. For G, there are two equations, as follows:

$$\begin{aligned} G_{N\_new}\left(\frac{\text{m}^3}{\text{s}^2}\right) &= \alpha c \frac{4.5(1)}{4\pi(1)} \times \left(4.5 \times e_{new}c\right) \times e_{new}c \times \frac{q_{m\_new}c}{m_{p\_new}c^2} \\ &= 6.69084770\text{E}-11\left(\frac{\text{m}^3}{\text{s}^2}\right) \end{aligned} \tag{45}$$

$$\begin{aligned} G_{N\_new}\left(\frac{\text{m}^3}{\text{s}^2}\right) &= \alpha c \frac{4.5(1)}{4\pi(1)} \times \left(4.5 \times e_{new}c\right)^2 \times e_{new}c \times \frac{\pi\left(\text{V}\cdot\text{m}\right)}{m_{e\_new}c^2} \\ &= 6.69084770\text{E}-11\left(\frac{\text{m}^3}{\text{s}^2}\right) \end{aligned} \tag{46}$$

In Equations (45) and (46), 4π(1) and 4.5(1) are dimensionless. Equations (45) and (46) are corrected from a previous report [12]. The details are shown in a later section. There are no dimension mismatch problems.

2.4. Symbol List when the Planck Constant is Changed to 1 Js

When we define the Planck constant as (1 Js), the following equations can be used:

$$c_{genaral}\left(\frac{\mathrm{m}_{general}}{\mathrm{s}}\right)=c\times\sqrt{h_{new}(1)}=299792458\times\sqrt{6.62938\mathrm{E}-34}$$
$$=7.71893\mathrm{E}-09\left(\frac{\mathrm{m}_{general}}{\mathrm{s}}\right) \tag{47}$$

where $h_{new}(1)$ (=6.629383E−34) is dimensionless. $c_{general}$ and $1\mathrm{m}_{\mathrm{general}}$ are the values for c and 1 m, respectively, after Planck's constant is changed. Thus, the unit of the meter should be changed. Importantly, Equation (47) does not indicate a change in the light speed.

$$e_{general}=\sqrt{\frac{1(\mathrm{J}\cdot\mathrm{s})}{4.5\pi\times m_p/m_e}}=6.20675231\mathrm{E}-03\left(\mathrm{C}_{general}\right) \tag{48}$$

$$q_{m\_general}=\sqrt{1(\mathrm{J}\cdot\mathrm{s})\times4.5\pi\times m_p/m_e}=1.61114855\mathrm{E}+02\left(\mathrm{Wb}_{general}\right) \tag{49}$$

$$m_{e\_general}=\sqrt{\frac{1(\mathrm{J}\cdot\mathrm{s})\times\pi\times m_e/m_p}{c_{general}^2\times4.5}}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}=1.37477924\mathrm{E}+03\left(\mathrm{kg}_{general}\right) \tag{50}$$

$$m_{p\_general}=\sqrt{\frac{1(\mathrm{J}\cdot\mathrm{s})\times\pi\times m_p/m_e}{c_{general}^2\times4.5}}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}=2.52430455\mathrm{E}+06\left(\mathrm{kg}_{general}\right) \tag{51}$$

$$\frac{kT_{c\_general}}{\alpha\times c_{general}^2}=\frac{1(\mathrm{J}\cdot\mathrm{s})}{2\pi(1)}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}=8.66155955\mathrm{E}-05\left(\mathrm{kg}_{general}\right) \tag{52}$$

$$G_{N\_general}=\frac{\alpha c_{general}^3}{m_p/m_e}\times\frac{4.5^2}{4\pi^2}\times1(\mathrm{J}\cdot\mathrm{s})\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)$$
$$=1.72273202\mathrm{E}-27\left(\frac{\mathrm{m}_{general}^3}{\mathrm{s}^2}\right) \tag{53}$$

where 1 $\mathrm{C}_{general}$, 1 $\mathrm{Wb}_{general}$, 1 $\mathrm{kg}_{general}$, $e_{general}$, $q_{m\_general}$, $m_{e\_general}$, $m_{p\_general}$, $T_{c\_general}$ and $G_{N\_gerneral}$ are the values for 1 C, 1 Wb, 1 kg, e, q_m, m_e, m_p, T_c and G_N, respectively, when the Planck constant is changed to 1 Js.

The minimum mass ($M_{\min}$) is as follows:

$$M_{\min}\left(\mathrm{kg}_{general}\right)=\frac{kT_c}{\alpha\times c^2}=\frac{1(\mathrm{J}\cdot\mathrm{s})}{2\pi}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1} \tag{54}$$

The ratio between the mass of an electron and the minimum mass is as follows:

$$m_{e\_general}\times\frac{\alpha c_{general}^2}{kT_{c\_general}}=2\pi(1)\times\frac{\pi}{q_{m\_general}c_{general}}=1.587219\mathrm{E}+07 \tag{55}$$

The mass ratio of a proton to its minimum mass is as follows:

$$m_{p\_general}\times\frac{\alpha c_{general}^2}{kT_{c\_general}}=\frac{2\pi(1)}{4.5\times e_{general}c_{general}}=2.914376\mathrm{E}+10 \tag{56}$$

For convenience, Equation (1) is rewritten as follows:

$$\frac{Gm_p^2}{hc}=\frac{4.5}{2}\times\frac{kT_c}{1\,\mathrm{kg}\times c^2} \tag{57}$$

The equation for a fine structure constant is as follows:

$$\frac{e^2}{4\pi\varepsilon_0}=\frac{hc}{2\pi}\times\alpha \quad (58)$$

The ratio of the gravitational force to the electric force is as follows:

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}=4.5(1)\times\pi(1)\times\frac{\frac{kT_{c\_general}}{\alpha\times c_{general}^2}\left(\mathrm{kg}_{general}\right)}{1\,\mathrm{kg}} \quad (59)$$

Equation (59) is corrected from a previous report [12]. The details are shown in a later section. There are no dimension mismatch problems. From Equation (52),

$$\frac{kT_{c\_general}}{\alpha\times c_{general}^2}=8.66155955\mathrm{E}-05\left(\mathrm{kg}_{general}\right) \quad (60)$$

Next,

$$\frac{\mathrm{kg}_{general}}{1\,\mathrm{kg}}=\frac{m_{p\_new}}{m_{p\_general}}=\frac{1.6734583781\mathrm{E}-27}{2.52430455\mathrm{E}+06}=6.629384\mathrm{E}-34=h(1) \quad (61)$$

Using Equations (59), (60) and (61),

$$\begin{aligned}\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}&=4.5(1)\times\pi(1)\times 8.66155955\mathrm{E}-05\times 6.629384\mathrm{E}-34\\&=8.11767475\mathrm{E}-37\end{aligned} \quad (62)$$

Then, we can explain the ratio of the gravitational force to the electric force. Furthermore, there are no dimension mismatch problems.

3. Methods

In this section, we present the algorithms for these equations. First, we note the final dimension mismatch problem. Next, we propose the first list from the symbol list written in Section 2.2. Using the first list, we can present the second list.

3.1. Solution for the Final Dimension Mismatch Problem

For convenience, Equation (31) is rewritten as follows:

$$\begin{aligned}&G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)\\&=\left(\lambda_p c\right)^2\left(\frac{\mathrm{m}^4}{\mathrm{s}^2}\right)\times c\left(\frac{\mathrm{m}}{\mathrm{s}}\right)\times\frac{9\alpha}{8\pi}=1.22943\mathrm{E}-07\left(\frac{\mathrm{m}^5}{\mathrm{s}^3}\right)\end{aligned} \quad (63)$$

Therefore,

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5}{4\pi(1)}\times\left(\frac{h}{m_p}\right)^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}=6.6908477\mathrm{E}-11 \quad (64)$$

For convenience, Equation (31) is rewritten as follows:

$$e_{new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\mathrm{A\cdot m^3}}{\mathrm{s}}\right)=\frac{1}{4.5}(\mathrm{A\cdot m})\times\lambda_p c\left(\frac{\mathrm{m^2}}{\mathrm{s}}\right)=8.80330\mathrm{E}-08\left(\frac{\mathrm{A\cdot m^3}}{\mathrm{s}}\right) \quad (65)$$

Therefore,

$$4.5e_{new}c=\frac{h}{m_p}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1} \quad (66)$$

From Equations (64) and (66),

$$G_{N\_new}\left(\frac{\mathrm{m^3}}{\mathrm{s^2}}\right)=\alpha c\frac{4.5}{4\pi(1)}\times\left(\frac{h}{m_p}\right)\times 4.5e_{new}c=6.6908477\mathrm{E}-11 \quad (67)$$

In Equation 67, to convert back to the MKSA unit, 4.5 should be changed from 4.5 to 4.8852. Therefore,

$$G_{N}\left(\frac{\mathrm{m^3}}{\mathrm{s^2}}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p}\right)\times 4.48852e_{new}c=6.6737778665\mathrm{E}-11 \quad (68)$$

where 4.5(1) is dimensionless. When converting back to the MKSA unit, the unit of 1C should be compensated.

$$G_{N}\left(\frac{\mathrm{m^3}}{\mathrm{s^2}}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\frac{e_{new}}{e}\times\left(\frac{h}{m_p}\right)\times 4.5e_{new}c=6.6737778665\mathrm{E}-11 \quad (69)$$

4.5 in Equations (1) and (2) is dimensionless. G_{new} (after redefinition of G) is as follows:

$$\begin{aligned}G_{new}\left(\frac{\mathrm{m^3}}{\mathrm{kg\cdot s^2}}\right)&=1\,\mathrm{kg}\times\frac{G_{N\_new}}{1\,\mathrm{kg}_{new}}=\frac{1\,\mathrm{kg}}{1\,\mathrm{kg}_{new}}\times\frac{e}{e_{new}}\times G\\&=\frac{\pi}{3.13201}\times G=6.69419377\mathrm{E}-11\end{aligned} \quad (70)$$

However, G_{new} is not useful rather than G_{N_new} because we must consider the compensation of the unit 1 kg in every equation.

3.2. Algorithms for Our Empirical Equations

3.2.1. Algorithms for Making the First List

Equations (71) and (72) are important for making the first list. Using Equations (26) - (31), the following list can be obtained.

$$\frac{h}{m_p}=\frac{h_{new}}{m_{p\_new}}=3.9614871\mathrm{E}-07=\text{constant (experimental result)} \quad (71)$$

$$\frac{h}{m_e}=\frac{h_{new}}{m_{e\_new}}=7.2738951\mathrm{E}-04=\text{constant (experimental result)} \quad (72)$$

$$m_{e\_new}c^2(\mathrm{J})=\frac{\pi}{4.5}\times\frac{h}{m_p}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-2}(\mathrm{J})=8.19120012\mathrm{E}-14(\mathrm{J}) \quad (73)$$

$$e_{new}c(\mathrm{A\cdot m})=\frac{1}{4.5}\times\frac{h}{m_p}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}(\mathrm{A\cdot m})=4.79095067\mathrm{E}-11(\mathrm{A\cdot m}) \quad (74)$$

$$m_{p\_new}c^2\left(\mathrm{J}\right)=\frac{\pi}{4.5}\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-2}\left(\mathrm{J}\right)=1.50402938\mathrm{E}-10\left(\mathrm{J}\right) \tag{75}$$

$$q_{m\_new}c\left(\mathrm{V}\cdot\mathrm{m}\right)=\pi\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}\left(\mathrm{V}\cdot\mathrm{m}\right)=1.24363481\mathrm{E}-06\left(\mathrm{V}\cdot\mathrm{m}\right) \tag{76}$$

$$\begin{aligned} h_{new}c^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)&=\frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-2}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\\ &=5.9581930\mathrm{E}-17\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\end{aligned} \tag{77}$$

$$\frac{kT_{c\_new}}{\alpha}\left(\mathrm{J}\right)=\frac{1}{2\pi(1)}\times\frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-3}\left(\mathrm{J}\right)=5.1607244\mathrm{E}-21\left(\mathrm{J}\right) \tag{78}$$

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p}\right)^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=6.6908477\mathrm{E}-11 \tag{79}$$

With respect to Equation (78), we find two equations.

$$\frac{kT_{c\_new}}{\alpha}\left(\mathrm{J}\right)=\frac{1}{2\pi(1)}\times\frac{q_{m\_new}c}{\pi}\times m_{e\_new}c^2\left(\mathrm{J}\right)=3.76596254\mathrm{E}-23\left(\mathrm{J}\right) \tag{80}$$

$$\frac{kT_{c\_new}}{\alpha}\left(\mathrm{J}\right)=\frac{1}{2\pi(1)}\times 4.5\times e_{new}c\times m_{p\_new}c^2\left(\mathrm{J}\right)=3.76596254\mathrm{E}-23\left(\mathrm{J}\right) \tag{81}$$

With respect to Equation (79), we find two equations.

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(4.5\times e_{new}c\right)\times\frac{h_{new}c^2}{m_{p\_new}c^2}=6.69084770\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) \tag{82}$$

$$\begin{aligned} G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)&=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(4.5\times e_{new}c\right)^2\times e_{new}c\times\frac{\pi\left(\mathrm{V}\cdot\mathrm{m}\right)}{m_{e\_new}c^2}\\ &=6.69084770\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)\end{aligned} \tag{83}$$

3.2.2. The Algorithms for Making the Second List

List 2 can be obtained in this way. In the previous report, in Equation **77**, we used the Planck constant h to be 1. Then, $c_{general}$ can be obtained, and every value can be calculated. This means that we can obtain the second list.

$$c_{genaral}=7.71893\mathrm{E}-09\left(\frac{\mathrm{m}_{general}}{\mathrm{s}}\right) \tag{84}$$

Using Equations (73) and (84),

$$m_{e\_general}=\frac{8.19120012\mathrm{E}-14}{\left(7.71893\mathrm{E}-09\right)^2}\left(\mathrm{kg}_{general}\right)=1.37477924\mathrm{E}+03\left(\mathrm{kg}_{general}\right) \tag{85}$$

Using Equations (74) and (84),

$$e_{general}=\frac{4.79095067\mathrm{E}-11}{7.71893\mathrm{E}-09}\left(\mathrm{C}_{general}\right)=6.20675231\mathrm{E}-03\left(\mathrm{C}_{general}\right) \tag{86}$$

Using Equations (75) and (84),

$$m_{p\_general}=\frac{1.50402938\text{E}-10}{(7.71893\text{E}-09)^2}\left(\text{kg}_{general}\right)=2.52430455\text{E}+06\left(\text{kg}_{general}\right) \tag{87}$$

Using Equations (76) and (84),

$$q_{m\_general}=\frac{1.24363481\text{E}-06}{7.71893\text{E}-09}\left(\text{Wb}_{general}\right)=1.61114855\text{E}+02\left(\text{Wb}_{general}\right) \tag{88}$$

Regarding Equations (77) and (84),

$$\frac{kT_{c\_general}}{\alpha c^2}=\frac{5.16072439\text{E}-21}{(7.71893\text{E}-09)^2}\left(\text{kg}_{general}\right)=8.66155955\text{E}-05\left(\text{kg}_{general}\right) \tag{89}$$

Then, kT_c/α is unchanged. The reason is that in Equation (81), ec and m_pc^2 are unchanged.

$$\frac{kT_{c\_new}}{\alpha}(\text{J})=8.66155955\text{E}-05\times(7.71893324\text{E}-09)^2=5.16072439\text{E}-21 \tag{90}$$

From Equation (82),

$$\frac{G_{N\_new}}{\alpha c}\left(\frac{\text{m}^2}{\text{s}}\right)=\frac{6.69084770\text{E}-11}{\alpha\times 299792458}\left(\frac{\text{m}^2}{\text{s}}\right)=3.05840582\text{E}-17\left(\frac{\text{m}^2}{\text{s}}\right) \tag{91}$$

From Equations (53) and (84),

$$\frac{G_{N\_general}}{\alpha c_{genaral}}\left(\frac{\text{m}^2}{\text{s}}\right)=\frac{1.72273202\text{E}-27}{\alpha\times 7.71893\text{E}-09}\left(\frac{\text{m}^2}{\text{s}}\right)=3.05840582\text{E}-17\left(\frac{\text{m}^2}{\text{s}}\right) \tag{92}$$

From Equations (91) and (92), $G_N/\alpha c$ is a constant, and $G_{N\_general}$ can be obtained. Consequently, we can obtain the second list when c is changed in the first list. These calculated values are the same as the values shown in Section 2.4. This means that when an arbitrary value of the light speed is used, the values of m_e, m_p, e, q_m, h, kT_c/α and $G_N/\alpha c$ in List 1 can be calculated. Another examples are shown in Appendix.

4. Results

4.1. Unchanged Values

After the first list is obtained, the following values are unchanged when c is changed to obtain the second list. These values can be obtained directly via the first list; thus, when c is changed, the values of the equations cannot be changed.

$$\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\frac{q_m c}{4.5 m_p c^2}=\frac{\pi e c}{m_e c^2}=1837.485988 \tag{93}$$

$$2\pi(1)\times\frac{\pi}{q_{m\_new}c}=1.587219\text{E}+07 \tag{94}$$

$$\frac{2\pi(1)}{4.5\times e_{new}c}=2.914376\text{E}+10 \tag{95}$$

$$\frac{kT_{c\_new}}{\alpha}(\text{J})=\frac{1}{2\pi(1)}\times\frac{q_{m\_new}c}{\pi}\times m_{e\_new}c^2(\text{J})=3.76596254\text{E}-23(\text{J}) \tag{96}$$

$$\frac{G_{N\_new}}{\alpha c}\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right)=\frac{4.5(1)}{4\pi(1)}\times\left(4.5\times e_{new}c\right)\times\frac{h_{new}c^2}{m_{p\_new}c^2}=3.05840582\mathrm{E}-17\left(\frac{\mathrm{m}}{\mathrm{s}}\right) \tag{97}$$

4.2. Another Possible List

We note that another list is possible.

$$\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\frac{\pi ec}{m_ec^2} \tag{98}$$

Therefore,

$$e\pi=c\times\left(m_p+\frac{4}{3}m_e\right) \tag{99}$$

Therefore,

$$m_p=\frac{e\pi}{c}-\frac{4}{3}m_e \tag{100}$$

Here,

$$\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\frac{q_mc}{4.5m_pc^2} \tag{101}$$

S0,

$$\frac{q_m}{4.5}=m_pc\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right) \tag{102}$$

From Equations (100) and (102),

$$\frac{q_m}{4.5}=c\times\left(\frac{e\pi}{c}-\frac{4}{3}m_e\right)\left(\frac{\frac{e\pi}{c}-\frac{4}{3}m_e}{m_e}+\frac{4}{3}\right)=\left(e\pi-\frac{4}{3}m_ec\right)\frac{e\pi}{m_ec}=\frac{(e\pi)^2}{m_ec}-\frac{4}{3}e\pi \tag{103}$$

Therefore,

$$m_e=\frac{e\pi}{c}\left(\frac{q_m}{4.5e\pi}+\frac{4}{3}\right)^{-1} \tag{104}$$

Therefore,

$$m_p=\frac{e\pi}{c}\times\left(1-\frac{4}{3}\left(\frac{Rk}{4.5\pi}+\frac{4}{3}\right)^{-1}\right) \tag{105}$$

Therefore,

$$\frac{m_p}{m_e}=\frac{\frac{e\pi}{c}\times\left(1-\frac{4}{3}\left(\frac{Rk}{4.5\pi}+\frac{4}{3}\right)^{-1}\right)}{\frac{e\pi}{c}\times\left(\frac{Rk}{4.5\pi}+\frac{4}{3}\right)^{-1}}=\frac{Rk}{4.5\pi}=1836.15265426 \tag{106}$$

When we use $\left(\frac{m_p}{m_e}+\frac{5}{3}\right)$ instead of $\left(\frac{m_p}{m_e}+\frac{4}{3}\right)$,

$$\frac{m_p}{m_e}=\frac{\frac{e\pi}{c}\times\left(1-\frac{5}{3}\left(\frac{Rk}{4.5\pi}+\frac{5}{3}\right)^{-1}\right)}{\frac{e\pi}{c}\times\left(\frac{Rk}{4.5\pi}+\frac{5}{3}\right)^{-1}}=\frac{Rk}{4.5\pi}=1836.15265426 \tag{107}$$

Consequently, another first list is possible. However, the calculated values of G and kT_c are much different from the observed values.

4.3. Explanation of Our Main Three Equations

From this section onward, we ensure that our second list is correct in our three equations. Strictly speaking, m_e should be written as $m_{e\_general}$. However, we omit the subscript "general" to avoid unnecessary notational complexity.

4.3.1. Explanation of Our First Equation

For convenience, Equation (1) is rewritten as follows:

$$\frac{Gm_p^2}{hc}=\frac{4.5}{2}\times\frac{kT_c}{1\,\text{kg}\times c^2} \tag{108}$$

Therefore, the following can be applied:

$$\frac{G_N m_p^2}{hc}=\frac{4.5(1)}{2}\times\frac{kT_c}{c^2} \tag{109}$$

where 4.5(1) is dimensionless. Therefore,

$$\frac{G_N}{\alpha c}\frac{\left(m_p c^2\right)^2}{hc^2}=\frac{4.5(1)}{2}\times\frac{kT_c}{\alpha}=1.16116299\text{E}-20 \tag{110}$$

$\frac{G_N}{\alpha c}$, $m_p c^2$, hc^2 and $\frac{kT_c}{\alpha}$ are constant when c is changed. Therefore, our second list is correct.

4.3.2. Explanation of Our Second Equation

For convenience, Equation (2) is rewritten as follows:

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}=\frac{4.5(1)}{2\pi}\times\frac{m_e}{e}\times hc \tag{111}$$

Therefore, the following can be obtained:

$$\frac{G_N m_p^2}{hc}=\frac{4.5(1)}{2\pi}\times\frac{m_e}{e}\times\frac{e^2}{4\pi\varepsilon_0} \tag{112}$$

The equation for a fine structure constant is as follows:

$$\frac{e^2}{4\pi\varepsilon_0}=\frac{hc}{2\pi(1)}\times\alpha \tag{113}$$

Therefore,

$$\frac{G_N m_p^2}{hc}=\frac{4.5(1)}{2\pi}\times\frac{m_e}{e}\times\frac{hc}{2\pi(1)}\times\alpha \tag{114}$$

Therefore,

$$\frac{G_N}{\alpha c}\frac{\left(m_p c^2\right)^2}{hc^2}=\frac{4.5(1)}{2\pi(1)}\times\frac{m_e c^2}{ec}\times\frac{hc^2}{2\pi}=1.16116299\text{E}-20 \tag{115}$$

When c is changed, $\frac{G_N}{\alpha c}$, $m_p c^2$, hc^2, $m_e c^2$, and ec are constant. Therefore, our second list is correct.

4.3.3. Explanation of Our Third Equation

For convenience, Equation (3) is rewritten as follows:

$$\frac{m_e c^2}{e}\times\frac{e^2}{4\pi\varepsilon_0}=\pi\times kT_c \tag{116}$$

The equation for a fine structure constant is as follows:

$$\frac{e^2}{4\pi\varepsilon_0}=\frac{hc}{2\pi(1)}\times\alpha \tag{117}$$

Therefore,

$$\frac{m_e c^2}{e}\times\frac{hc}{2\pi(1)}\times\alpha=\pi\times kT_c \tag{118}$$

Therefore,

$$\frac{m_e c^2}{ec}\times\frac{hc^2}{2\pi(1)}=\pi\times\frac{kT_c}{\alpha} \tag{119}$$

Then, $\frac{kT}{\alpha}$, $m_e c^2$, hc^2, and ec are constant when c is changed. Therefore, our second list is correct.

4.4. Mathematical Proof for the Ratio of the Gravitational Force to the Electric Force

Equation (2) is rewritten as follows:

$$\frac{Gm_p^2}{hc}=\frac{4.5(1)}{2}\times\frac{kT_c}{1\,\text{kg}\times c^2} \tag{120}$$

The fine-structure constant is defined as follows:

$$\frac{e^2}{4\pi\varepsilon_0}=\frac{\alpha hc}{2\pi}=2.30823131\text{E}-28(\text{J}\cdot\text{m}) \tag{121}$$

Therefore, the following can be obtained:

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}=4.5(1)\times\pi(1)\times\frac{\frac{kT_{c\_general}}{\alpha\times c_{general}^2}\left(\text{kg}_{general}\right)}{1\,\text{kg}} \tag{122}$$

Therefore,

$$\frac{\text{kg}_{general}}{1\,\text{kg}} \times \frac{1}{\left(c_{general}\right)^2} = \frac{m_{p\_new}}{m_{p\_general}} \times \frac{1}{\left(c_{general}\right)^2} = \frac{m_{p\_new}}{m_{p\_new} \times c^2} \\ = \frac{1}{c^2} = 1.11265\text{E}-17 \tag{123}$$

Therefore,

$$\frac{Gm_p^2}{\left(\dfrac{e^2}{4\pi\varepsilon_0}\right)} = 4.5(1) \times \pi(1) \times \frac{kT_c}{\alpha} \times 1.11265\text{E}-17 = 8.11767475\text{E}-37 \tag{124}$$

Consequently, the ratio of the gravitational force to the electric force is unchanged in the second list.

4.5. The Theoretical Meaning of the Second List

The theoretical meaning of the second list is as follows. Einstein discovered the following equation:

$$E = mc^2 \tag{125}$$

When we know the unit of work (J) and when we do not know the unit of mass (kg), after the light speed (m/s) is measured, the unit of mass (kg) is uniquely determined.

5. Conclusions

First, we report the final dimension mismatch problem. The value 4.5 in Equations (1) and (2) is dimensionless. When converting back to the MKSA unit, the unit of 1 C should be compensated. The correct equation is as follows:

$$G_N = \frac{1\,\text{C}}{1\,\text{C}_{new}} \times G_{N\_new} = \frac{e_{new}}{e} \times G_{N\_new} = 6.6737778665\text{E}-11 \tag{126}$$

The main point is that the dimensionless value of 4.5(1) is not related to the unit (1/Am). Thus, there are no dimension mismatch problems. Furthermore, in this report, we describe the algorithms used to explain these equations in detail. Using Equations (26) - (31), the following first list can be obtained.

$$m_{e\_new}c^2\,(\text{J}) = \frac{\pi}{4.5} \times \frac{h}{m_p} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2} (\text{J}) = 8.19120012\text{E}-14(\text{J}) \tag{127}$$

$$e_{new}c(\text{A}\cdot\text{m}) = \frac{1}{4.5} \times \frac{h}{m_p} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} (\text{A}\cdot\text{m}) = 4.79095067\text{E}-11(\text{A}\cdot\text{m}) \tag{128}$$

$$m_{p\_new}c^2\,(\text{J}) = \frac{\pi}{4.5} \times \frac{h}{m_e} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2} (\text{J}) = 1.50402938\text{E}-10(\text{J}) \tag{129}$$

$$q_{m\_new}c(\text{V}\cdot\text{m}) = \pi \times \frac{h}{m_e} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} (\text{V}\cdot\text{m}) = 1.24363481\text{E}-06(\text{V}\cdot\text{m}) \tag{130}$$

$$h_{new}c^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)=\frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-2}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)$$
$$=5.9581930\mathrm{E}-17\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right) \quad (131)$$

$$\frac{kT_{c\_new}}{\alpha}(\mathrm{J})=\frac{1}{2\pi(1)}\times\frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-3}(\mathrm{J})=5.1607244\mathrm{E}-21(\mathrm{J}) \quad (132)$$

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p}\right)^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^{-1}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=6.6908477\mathrm{E}-11 \quad (133)$$

Next, using the arbitrary value of c, m_e, m_p, e, q_m, h, $\frac{kT_c}{\alpha}$ and $\frac{G_N}{\alpha c}$ are determined as the second list. When these values are used, our three main equations are correct. Furthermore, the ratio of the gravitational force to the electric force is unchanged in the second list.

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}=4.5(1)\times\pi(1)\times\frac{kT_c}{\alpha}\times\frac{1}{1\,\mathrm{kg}\times c^2}=8.11767475\mathrm{E}-37 \quad (134)$$

The theoretical meaning is highly related to the thermodynamic principles in solid-state ionics, which will be published in future reports.

Conflicts of Interest

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

References

[1] Miyashita, T. (2020) Empirical Equation for the Gravitational Constant with a Reasonable Temperature. *Journal of Modern Physics*, **11**, 1180-1192. https://doi.org/10.4236/jmp.2020.118074

[2] Miyashita, T. (2021) Various Empirical Equations for the Electromagnetic Force in Terms of the Cosmic Microwave Background Temperature. *Journal of Modern Physics*, **12**, 623-634. https://doi.org/10.4236/jmp.2021.125040

[3] Miyashita, T. (2021) Various Empirical Equations to Unify between the Gravitational Force and the Electromagnetic Force. *Journal of Modern Physics*, **12**, 859-869. https://doi.org/10.4236/jmp.2021.127054

[4] Miyashita, T. (2020) Erratum to "Empirical Equation for the Gravitational Constant with a Reasonable Temperature" [Journal of Modern Physics 11 (2020) 1180-1192]. *Journal of Modern Physics*, **11**, 1559-1560. https://doi.org/10.4236/jmp.2020.1110096

[5] Miyashita, T. (2021) Erratum to "various Empirical Equations to Unify between the Gravitational Force and the Electromagnetic Force" [Journal of Modern Physics 12 (2021) 859-869]. *Journal of Modern Physics*, **12**, 1160-1161. https://doi.org/10.4236/jmp.2021.128069

[6] Miyashita, T. (2022) Empirical Equation for a Fine-Structure Constant with Very High Accuracy. *Journal of Modern Physics*, **13**, 336-346. https://doi.org/10.4236/jmp.2022.134024

[7] Miyashita, T. (2018) Empirical Relation of the Fine-Structure Constant with the Transference Number Concept. *Journal of Modern Physics*, **9**, 2346-2353. https://doi.org/10.4236/jmp.2018.913149

[8] Miyashita, T. (2023) A Fine-Structure Constant Can Be Explained Using the Electrochemical Method. *Journal of Modern Physics*, **14**, 160-170. https://doi.org/10.4236/jmp.2023.142011

[9] Miyashita, T. (2023) Explanation of the Necessity of the Empirical Equations That Relate the Gravitational Constant and the Temperature of the CMB. *Journal of Modern Physics*, **14**, 432-444. https://doi.org/10.4236/jmp.2023.144024

[10] Miyashita, T. (2023) Simplification of Various Empirical Equations for the Electromagnetic Force in Terms of the Cosmic Microwave Background Temperature. *Journal of Modern Physics*, **14**, 1217-1227. https://doi.org/10.4236/jmp.2023.148068

[11] Miyashita, T. (2024) Correspondence Principle for Empirical Equations in Terms of the Cosmic Microwave Background Temperature with Solid-State Ionics. *Journal of Modern Physics*, **15**, 51-63. https://doi.org/10.4236/jmp.2024.151002

[12] Miyashita, T. (2024) Ratio of Gravitational Force to Electric Force from Empirical Equations in Terms of the Cosmic Microwave Background Temperature. *Journal of Modern Physics*, **15**, 674-689. https://doi.org/10.4236/jmp.2024.155031

[13] Miyashita, T. (2017) Equilibration Process in Response to a Change in the Anode Gas Using Thick SM-Doped Ceria Electrolytes in Solid-Oxide Fuel Cells. *Journal of the Electrochemical Society*, **164**, E3190-E3199. https://doi.org/10.1149/2.0251711jes

[14] Jarzynski, C. (1997) Nonequilibrium Equality for Free Energy Differences. *Physical Review Letters*, **78**, 2690-2693. https://doi.org/10.1103/physrevlett.78.2690

[15] Jacobson, T. (1995) Thermodynamics of Spacetime: The Einstein Equation of State. *Physical Review Letters*, **75**, 1260-1263. https://doi.org/10.1103/physrevlett.75.1260

Appendix A

In this appendix, using the arbitrary value of the light speed, we show another examples for the second list.

$$c_{\text{arbitrary}} = 12345\left(\frac{\text{m}_{\text{arbitrary}}}{\text{s}}\right) \tag{A1}$$

where $c_{\text{arbitrary}}$ and 1 $\text{m}_{\text{arbitrary}}$ are the values for c and 1 m when the arbitrary value of light speed is used, respectively,

$$m_{e\_\text{arbitrary}} = \frac{8.19120012\text{E}-14}{1.2345^2}\left(\text{kg}_{\text{arbitrary}}\right) = 5.37484\text{E}-22\left(\text{kg}_{\text{arbitrary}}\right) \tag{A2}$$

$$e_{\text{arbitrary}} = \frac{4.79095067\text{E}-11}{12345}\left(\text{C}_{\text{arbitrary}}\right) = 3.88088\text{E}-15\left(\text{C}_{\text{arbitrary}}\right) \tag{A3}$$

$$m_{\text{p\_arbitrary}} = \frac{1.50402938\text{E}-10}{12345^2}\left(\text{kg}_{\text{arbitrary}}\right) = 9.86902\text{E}-19\left(\text{kg}_{\text{arbitrary}}\right) \tag{A4}$$

$$q_{\text{m\_arbitrary}} = \frac{1.24363481\text{E}-06}{12345}\left(\text{Wb}_{\text{arbitrary}}\right) = 1.00740\text{E}-10\left(\text{Wb}_{\text{arbitrary}}\right) \tag{A5}$$

$$h_{\text{arbitrary}} = \frac{5.9581930\text{E}-17}{12345^2} = 3.90960\text{E}-25 \tag{A6}$$

$$\frac{kT_{c\_\text{arbitrary}}}{\alpha c^2_{\text{arbitrary}}} = \frac{5.16072439\text{E}-21}{12345^2}\left(\text{kg}_{\text{arbitrary}}\right) = 3.38632\text{E}-29\left(\text{kg}_{\text{arbitrary}}\right) \tag{A7}$$

$$\begin{aligned} G_{\text{N\_arbitrary}}\left(\frac{\text{m}^3}{\text{s}^2}\right) &= 6.69084770\text{E}-11 \times \frac{12345}{299792458}\left(\frac{\text{m}^3}{\text{s}^2}\right) \\ &= 2.75518989\text{E}-15\left(\frac{\text{m}^3}{\text{s}^2}\right) \end{aligned} \tag{A8}$$

where 1 $\text{C}_{\text{arbitrary}}$, 1 $\text{Wb}_{\text{arbitrary}}$, 1 $\text{kg}_{\text{arbitrary}}$, $e_{\text{arbitrary}}$, $q_{m\_\text{arbitrary}}$, $m_{e\_\text{arbitrary}}$, $m_{p\_\text{arbitrary}}$, $T_{c\_\text{arbitrary}}$ and $G_{N\_\text{arbitrary}}$ are the values for 1 C, 1 Wb, 1 kg, e, q_m, m_e, m_p, T_c and G_N, respectively, when the arbitrary value of light speed is used.

From Equations 50 and A6,

$$\begin{aligned} m_{\text{arbitrary}} &= \sqrt{\frac{3.90960\text{E}-25 \times \pi \times m_e/m_p}{c^2_{\text{arbitrary}} \times 4.5}} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \\ &= 5.37484\text{E}-22\left(\text{kg}_{\text{arbitrary}}\right) \end{aligned} \tag{A9}$$

Equations A2 equals to Equations A9. From Equations 48 and A6,

$$e_{\text{arbitrary}} = \sqrt{\frac{3.90960\text{E}-25}{4.5\pi \times m_p/m_e}} = 3.88088\text{E}-15\left(\text{C}_{\text{arbitrary}}\right) \tag{A10}$$

Equations A3 equals to Equations A10. From Equations 49 and A6,

$$m_{\text{p\_arbitrary}} = \sqrt{\frac{3.90960\text{E}-25 \times \pi \times m_p/m_e}{c^2_{\text{arbitrary}} \times 4.5}} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} = 9.86902\text{E}-19\left(\text{kg}_{\text{arbitrary}}\right) \tag{A11}$$

Equations A3 equals to Equations A10. From Equations 51 and A6,

$$q_{\text{m\_arbitrary}} = \sqrt{3.90960\text{E}-25 \times 4.5\pi \times m_p/m_e} = 1.00740\text{E}-10\left(\text{Wb}_{\text{arbitrary}}\right) \tag{A12}$$

Equations A5 equals to Equations A12. From Equations 52 and A6,

$$\frac{kT_{\text{c\_arvitrary}}}{\alpha \times c_{\text{arvitrary}}^{2}} = \frac{3.90960\text{E}-25}{2\pi(1)} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} = 3.38632\text{E}-29\left(\text{kg}_{\text{arbitrary}}\right) \quad \text{(A13)}$$

Equations A7 equals to Equations A13. From Equations 53 and A6,

$$\begin{aligned} G_{\text{N\_arbitrary}}\left(\frac{\text{m}^3}{\text{s}^2}\right) &= \frac{\alpha c_{\text{arbitrary}}^{3}}{m_p / m_e} \times \frac{4.5^2}{4\pi^2} \times 3.90960\text{E}-25 \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right) \\ &= 2.75518989\text{E}-15\left(\frac{\text{m}_{\text{arbitrary}}^{3}}{\text{s}^2}\right) \end{aligned} \quad \text{(A14)}$$

Equations A8 equals to Equations A14. Consequently, we can show other examples.