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Explanation of the Necessity of the Empirical Equations That Relate the Gravitational Constant and the Temperature of the CMB

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Abstract

In previous papers, we proposed an empirical equation for the fine-structure constant. Using this equation, we proposed a refined version of our own former empirical equations about the electromagnetic force and gravity in terms of the temperature of the cosmic microwave background. The calculated values of the temperature of the cosmic microwave background (T_c) and the gravitational constant (G) were 2.726312 K and 6.673778 × 10^{-11} $m^3 \cdot kg^{-1} \cdot s^{-2}$, respectively. Then, for the values of the factors 9/2 and π in our equations, we used 4.488519503 and 3.132011447, respectively. However, we could not provide a theoretical explanation for the necessity of these empirical equations. In this paper, using the redefinition method for the UNIT, we show the necessity for our empirical equations.

Keywords

Gravitational Constant, Temperature of the Cosmic Microwave Background

1. Introduction

The symbol list is shown in Section 2. Previously, we discovered Equations (1)-(3) [1] [2] [3] in terms of the temperature of the cosmic microwave background (CMB), which are mathematically connected [3].

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

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times hc \times \left(\frac{\text{C}}{\text{J}\cdot\text{m}} \times \frac{1}{\text{kg}} = \frac{1}{\text{V}\cdot\text{m}} \times \frac{1}{\text{kg}}\right) \tag{2}$$

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0} \right) = \pi \times kT_c \times \left(\frac{\text{J} \cdot \text{m}}{\text{C}} = \text{V} \cdot \text{m} \right) \quad (3)$$

We attempted to reduce the errors in the previous papers by changing the values of 4.5, π and the temperature of the cosmic microwave background (T_c) [4] [5]. Next, we discovered an empirical equation for the fine-structure constant [6].

$$137.0359991 = 136.0113077 + \frac{1}{3 \times 13.5} + 1 \quad (4)$$

$$13.5 \times 136.0113077 = 1836.152654 = \frac{m_p}{m_e} \quad (5)$$

We thought that Equations (4) and (5) should be related to the transference number [7] [8]. Then, we proposed an equivalent circuit and the following values as the deviation for the values of 9/2 and π [8].

$$3.13201\,\Omega = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3} \right) m_e c^2}{ec} \quad (6)$$

$$4.48852 = \frac{q_m c}{\left(\frac{m_p}{m_e} + \frac{4}{3} \right) m_p c^2} \quad (7)$$

Then, $\left(\frac{m_p}{m_e} + \frac{4}{3} \right)$ have the unit of $\left(\frac{\text{m}}{\text{C}} \right)$. We can freely define the UNITs for 1 C, 1 Wb and 1 kg. Therefore, we must show the necessity for Equations (6) and (7) that these values are related to 4.5 and π. Using the redefinition method for the UNIT, we can show the necessity for our empirical equations in this report.

The remainder of the paper is organized as follows. In Section 2, we show the symbol list. In Section 3, we discuss the purpose of this report. In Section 4, we explain the redefinition method for the UNIT. In Section 5, using the redefinition method, we can refine Equations (1)-(3). Furthermore, we propose a fourth empirical equation that relates the gravitational constant and the temperature of the cosmic microwave background. In Section 6, our conclusions are described.

2. Symbol List (These Values Were Obtained from Wikipedia)

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

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

T_c: temperature of the cosmic microwave background: 2.72548 (K)

(we used the compensated value 2.726312 K in this report).

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

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

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

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

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

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: $1.6726219059 \times 10^{-27}$ (kg)
(we used the compensated value $1.672621923 \times 10^{-27}$ kg in this report).

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.

3. Purpose

In this section, we show the purpose of this report. For convenience, Equations (5) and (6) are rewritten as follows. The units have been corrected.

$$3.132011447\left(\text{V}\cdot\text{m}\right) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_e c^2}{ec} \left(\frac{\text{m}^2}{\text{s}} \times \frac{\text{J}}{\text{A}\cdot\text{m}} = \frac{\text{J}\cdot\text{m}}{\text{C}} = \text{V}\cdot\text{m}\right) \tag{8}$$

$$4.488519503\left(\frac{1}{\text{A}\cdot\text{m}}\right) = \frac{q_m c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_p c^2} \left(\frac{\text{s}}{\text{m}^2} \times \frac{\text{V}\cdot\text{m}}{\text{J}} = \frac{\text{V}}{\text{J}} \times \frac{\text{s}}{\text{m}} = \frac{\text{s}}{\text{C}\cdot\text{m}} = \frac{1}{\text{A}\cdot\text{m}}\right) \tag{9}$$

Then, $\left(\frac{m_p}{m_e} + \frac{4}{3}\right)$ have the unit of $\left(\frac{\text{m}^2}{\text{s}}\right)$. Next, the deviation from 4.5 and π can be explained as follows.

$$\frac{4.5}{\pi} \times \frac{3.132011447}{4.488519503} = 0.999500154 \doteq 1 \tag{10}$$

Then, we can freely define the UNITs for 1 C, 1 Wb and 1 kg. It does not seem necessary that these values are related to 4.5 and π. Unfortunately, we could not establish the background theory. Using the redefinition method for the UNIT, we can show the necessity why these values should be related to 4.5 and π.

4. Methods

4.1. Redefinitions for the Electric Charge of One Electron and the Magnetic Charge of One Magnetic Monopole

We redefine the electric charge of one electron as follows.

$$e_{\text{new}} = e \times \frac{4.48852}{4.5} = 1.59809E-19\left(\text{C}\right) \tag{11}$$

We redefine the magnetic charge of one magnetic monopole as follows.

$$q_{m\_\text{new}} = q_m \times \frac{\pi}{3.13201} = 4.14832E-15\left(\text{Wb}\right) \tag{12}$$

Then, we can redefine the Planck constant and von Klitzing constant as follows.

$$h_{\text{new}} = e_{\text{new}} \times q_{m\_\text{new}} = h \times \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} = 6.62938E-34 \quad (13)$$

$$Rk_{\_\text{new}} = \frac{q_{m\_\text{new}}}{e_{\_\text{new}}} = Rk \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 25958.0(\Omega) \quad (14)$$

Then, we can redefine the wave impedance in free space, electric constant and magnetic constant.

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

$$\mu_{0\_\text{new}} = \frac{Z_{0\_\text{new}}}{c} = \mu_0 \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 1.26371E-06\left(\text{N}\cdot\text{A}^{-2}\right) \quad (16)$$

$$\varepsilon_{0\_\text{new}} = \frac{1}{Z_{0\_\text{new}} \times c} = \varepsilon_0 \times \frac{4.48852}{4.5} \times \frac{3.13201}{\pi} = 8.80466E-12\left(\text{F}\cdot\text{m}^{-1}\right) \quad (17)$$

Next, we must ensure that there are no contradictions.

$$c_{\_\text{new}} = \frac{1}{\sqrt{\varepsilon_{0\_\text{new}}\mu_{0\_\text{new}}}} = \frac{1}{\sqrt{\varepsilon_0\mu_0}} = c = 299792458\left(\text{m}\cdot\text{s}^{-1}\right) \quad (18)$$

$$\begin{aligned} Z_{0\_\text{new}} &= \sqrt{\frac{\mu_{0\_\text{new}}}{\varepsilon_{0\_\text{new}}}} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} \\ &= Z_0 \times \frac{4.5}{4.48852} \times \frac{\pi}{3.13201} = 378.849(\Omega) \end{aligned} \quad (19)$$

The value in the speed of light should not be changed because the UNITs for 1 m and 1 s are unchanged. In Equation (19), the value of the impedance in free space is the same as the value in Equation (15).

4.2. The Macroscopic Explanation of Our Redefinition Method

By our redefinition method for the units of the particles, 1 C and 1 Wb as MKSA units are not fixed. We redefine the electric charge of one electron. Then, the number of electrons in 1 C is changed.

$$N_1 = \frac{1\,\text{C}}{e} = \frac{1}{1.60218E-19} = 6.24151E+18 \quad (20)$$

$$N_2 = \frac{1\,\text{C}}{e_{\text{new}}} = \frac{1\,\text{C}}{\frac{4.48852}{4.5} \times e} = \frac{4.5}{4.48852} \times 6.24151E+18 \quad (21)$$

Then, the number of magnetic monopoles in 1 Wb is changed.

$$N_3 = \frac{1\,\text{Wb}}{q_m} = \frac{1}{4.13567E-15} = 2.41799E+14 \quad (22)$$

$$N_4 = \frac{1\,\text{Wb}}{q_{m\_\text{new}}} = \frac{1\,\text{Wb}}{\frac{\pi}{3.13201} \times 1q_m} = \frac{3.13201}{\pi} \times 2.41799E+14 \quad (23)$$

The number of electrons in 1 C is related to the Faraday constant and the Avogadro's number. Therefore, we redefined the Faraday constant and the Avogadro's number, which will be explained in the later section.

$$\frac{1\,\mathrm{C}_{\mathrm{new}}}{1\,\mathrm{C}}=\frac{4.5}{4.48852} \tag{24}$$

$$\frac{1\,\mathrm{Wb}_{\mathrm{new}}}{1\,\mathrm{Wb}}=\frac{3.13201}{\pi} \tag{25}$$

However, the relationship between Equations (26) and (27) should hold.

$$1\,\mathrm{J}\cdot\mathrm{s}_{\mathrm{new}}=1\,\mathrm{C}_{\mathrm{new}}\times 1\,\mathrm{Wb}_{\mathrm{new}} \tag{26}$$

$$1\,\Omega_{\mathrm{new}}=\frac{1\,\mathrm{Wb}_{\mathrm{new}}}{1\,\mathrm{C}_{\mathrm{new}}} \tag{27}$$

We used $\mathrm{A\cdot m}_{\_\mathrm{new}}$ and $\mathrm{C}_{\mathrm{new}}$ in the later sections. Then, these units are from the microscopic redefinition. From the macroscopic redefinition, $\mathrm{A\cdot m}_{\_\mathrm{new}}$ and $\mathrm{C}_{\mathrm{new}}$ should be different values.

4.3. Redefinitions of the Mass of One Electron and One Proton

The Compton wavelength (λ) is as follows.

$$\lambda=\frac{h}{mc} \tag{28}$$

This value should (λ) be unchanged since the UNIT for 1 m is unchanged. However, in Equation (13), the Planck constant is changed. Therefore, the UNIT for the mass of one electron and one proton should be redefined.

$$m_{e\_\mathrm{new}}=\frac{4.48852}{4.5}\times\frac{\pi}{3.13201}\times m_e=9.11394E-31\left(\mathrm{kg}\right) \tag{29}$$

$$m_{p\_\mathrm{new}}=\frac{4.48852}{4.5}\times\frac{\pi}{3.13201}\times m_p=1.67346E-27\left(\mathrm{kg}\right) \tag{30}$$

Next, we must ensure that the following equation is satisfied.

$$\frac{m_{p\_\mathrm{new}}}{m_{e\_\mathrm{new}}}=\frac{1.67346E-27}{9.11394E-31}=1836.152654=\frac{m_p}{m_e} \tag{31}$$

4.4. Redefinitions of Equations (8) and (9)

Equations (8) and (9) can be redefined as follows.

$$\begin{aligned}\frac{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\times m_{e\_\mathrm{new}}c^2}{e_{\mathrm{new}}c}&=3.13201\left(\mathrm{V\cdot m}\right)\times\frac{4.5}{4.48852}\times\frac{4.48852}{4.5}\times\frac{\pi}{3.13201}\\&=\pi\left(\mathrm{V\cdot m}\right)\end{aligned} \tag{32}$$

$$\begin{aligned}\frac{q_{m\_\mathrm{new}}c}{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)m_{p\_\mathrm{new}}c^2}&=4.48852\left(\frac{1}{\mathrm{A\cdot m}}\right)\times\frac{\pi}{3.13201}\times\frac{4.5}{4.48852}\times\frac{3.13201}{\pi}\\&=4.5\left(\frac{1}{\mathrm{A\cdot m}}\right)\end{aligned} \tag{33}$$

Using Equations (32) and (33), Equations (34) and (35) can be obtained.

$$\frac{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\times m_{e\_\text{new}}c^2}{e_{\text{new}}c}\times\frac{q_{m\_\text{new}}c}{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)m_{p\_\text{new}}c^2} = \frac{m_{e\_\text{new}}}{e_{\text{new}}}\times\frac{q_{m\_\text{new}}}{m_{p\_\text{new}}} = 4.5\times\pi\left(\frac{\text{V}\cdot\text{m}}{\text{A}\cdot\text{m}}=\Omega\right) \tag{34}$$

$$\frac{\dfrac{q_{m\_\text{new}}c}{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)m_{p\_\text{new}}c^2}}{\dfrac{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\times m_{e\_\text{new}}c^2}{e_{\text{new}}c}} = \frac{h_{\text{new}}c^2}{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2\times m_{e\_\text{new}}c^2\times m_{p\_\text{new}}c^2} = \frac{4.5}{\pi}\left(\frac{1}{\text{A}\cdot\text{m}\times\text{V}\cdot\text{m}}=\frac{\text{s}}{\text{J}\times\text{m}^2}\right) \tag{35}$$

5. Results

5.1. Explanation for the Necessity of Using the Values of 4.5 and π

When we define the Avogadro's number (N_A) and the Faraday constant (F) as follows,

$$N_A=\frac{1\,\text{g}}{m_p}=5.97565E+23\approx 6.02214076E+23 \tag{A}$$

$$F=e\times N_A=9.57405E+04\approx 9.6485E+04 \tag{B}$$

The redefined Avogadro's number(N_A) and the refined Faraday constant (F) are as follows,

$$N_{A\_\text{new}}=\frac{1\,\text{g}}{m_{p\_\text{new}}}=\frac{1\,\text{g}}{m_p}\times\frac{4.5}{4.48852}\times\frac{3.13201}{\pi} \tag{C}$$

$$F_{\text{new}}=e_{\text{new}}\times N_{A\_\text{new}}=\frac{1\,\text{g}}{m_p}\times\frac{3.13201}{\pi} \tag{D}$$

Next, we can define 1 J freely. Using arbitrary number (a), N_5 and N_6 can be calculated as follows.

$$N_5=\frac{a\times 1\,\text{J}}{\left(\frac{m_p}{m_e}+\frac{4}{3}\right)m_{e\_\text{new}}c^2}\left(\frac{\text{s}}{\text{m}^2}\right)=a\times 6.64398E+09\left(\frac{\text{s}}{\text{m}^2}\right) \tag{36}$$

$$N_6=\frac{a\times 1\,\text{J}}{e_{\_\text{new}}c}\left(\frac{\text{J}}{\text{A}\cdot\text{m}}\right)=a\times 2.08726E+10\left(\frac{\text{J}}{\text{A}\cdot\text{m}}\right) \tag{37}$$

$$\frac{N_6}{N_5}=\frac{2.08726E+10}{6.64398E+09}\left(\frac{\text{J}}{\text{A}\cdot\text{m}}\times\frac{\text{m}^2}{\text{s}}=\frac{\text{J}\cdot\text{m}}{\text{C}}=\text{V}\cdot\text{m}\right)=\pi\left(\text{V}\cdot\text{m}\right) \tag{38}$$

The ratio should be π V·m and constant. Next,

$$N_7 = \frac{a \times 1\,\text{J}}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{p\_\text{new}} c^2} \left(\frac{\text{s}}{\text{m}^2}\right) = a \times 3.61843E+06 \left(\frac{\text{s}}{\text{m}^2}\right) \tag{39}$$

$$N_8 = \frac{a \times 1\,\text{J}}{q_{m\_\text{new}} c} \left(\frac{\text{J}}{\text{Wb} \cdot \text{m/s}} = \frac{\text{J} \cdot \text{s}}{\text{Wb} \cdot \text{m}} = \frac{\text{C}}{\text{m}}\right) = a \times 8.04095E+05 \left(\frac{\text{C}}{\text{m}}\right) \tag{40}$$

$$\frac{N_7}{N_8} = \frac{3.61843E+06}{8.04095E+05} = 4.5 \left(\frac{\text{s}}{\text{m}^2} \times \frac{\text{m}}{\text{C}} = \frac{1}{\text{A} \cdot \text{m}}\right) \tag{41}$$

The ratio should be 4.5 and π are constant. Consequently, we can explain the necessity for the values of 4.5 and π in Equations (8) and (9).

5.2. Explanation for the Necessity of Using the Values of 4.5 and π in Equations (1)-(3)

5.2.1. Our Main Three Equations

Equations (1)-(3) are our main three equations. Then, the unit (V·m and 1/A·m) should be replaced. Alternatively, the redefinition of V·m and 1/A·m is needed in the equations.

$$\frac{Gm_p^2}{hc} = \frac{4.48852}{2} \frac{kT_c}{1\,\text{kg} \times c^2} \times (\text{A} \cdot \text{m}) \tag{42}$$

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.48852}{2 \times 3.13201} \times \frac{m_e}{e} \times hc \times \left(\text{A} \cdot \text{m} \times \text{V} \cdot \text{m} \times \frac{1}{\text{V} \cdot \text{m}} \times \frac{1}{\text{kg}} = \text{A} \cdot \text{m} \times \frac{1}{\text{kg}}\right) \tag{43}$$

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = 3.13201 \times kT_c \times \left(\frac{1}{\text{V} \cdot \text{m}} \times \text{V} \cdot \text{m} = 1\right) \tag{44}$$

5.2.2. Our Fourth Equation

Our fourth equation can be derived as follows. From Equation (43),

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)^2} = \frac{4.48852}{2 \times 3.13201} \times \frac{m_e}{e} \times \frac{2\pi}{\alpha} \times \left(\text{A} \cdot \text{m} \times \frac{1}{\text{kg}}\right) \tag{45}$$

From Equation (44),

$$\frac{e^2}{4\pi\varepsilon_0} = 3.13201 \times kT_c \times \frac{e}{m_e c^2} \tag{46}$$

From Equations (45) and (46),

$$\frac{Gm_p^2}{\left(3.13201 \times kT_c \times \frac{e}{m_e c^2}\right)^2} = \frac{4.48852}{2 \times 3.13201} \times \frac{m_e}{e} \times \frac{2\pi}{\alpha} \times \left(\text{A} \cdot \text{m} \times \frac{1}{\text{kg}}\right) \tag{47}$$

Therefore,

$$\frac{Gm_p^2}{(kT_c)^2} = 4.48852 \times 3.13201 \times \frac{e}{m_e c^4} \times \frac{\pi}{\alpha} \times \left(\text{A} \cdot \text{m} \times \frac{1}{\text{kg}}\right) \tag{48}$$

Here,

$$4.48852 \times 3.13201(\Omega) = \frac{q_m}{e} \times \frac{m_e}{m_p}(\Omega) \tag{49}$$

In Equation (48), the unit of Ω is already considered. Therefore,

$$Gm_p^2 = \frac{q_m}{m_p c^4} \times \frac{\pi}{\alpha} \times (kT_c)^2 \times \left(\mathrm{A} \cdot \mathrm{m} \times \frac{1}{\mathrm{kg}}\right) \tag{50}$$

Equation (50) is our fourth equation.

5.2.3. Redefinition for Equation (42)

We define *G* free from 1 kg (G_N) as follows.

$$G_N = G \times 1\,\mathrm{kg} \tag{51}$$

The UNIT for G_N is $\mathrm{m}^3 \cdot \mathrm{s}^{-2}$. By our redefinition method, the UNITs for 1 m and 1 s are unchanged. However, when G_N is a function of C or Wb, G_N should be changed.

$$G_{N\_new} \neq G_N \tag{52}$$

From Equations (42) and (51),

$$\frac{G_N m_p^2}{hc} = \frac{4.4885}{2} \frac{kT_c}{c^2} \times (\mathrm{A} \cdot \mathrm{m}) \tag{53}$$

Therefore,

$$\frac{G_N m_{p\_\mathrm{new}}^2 \times \left(\frac{4.5}{4.48852} \times \frac{3.13201}{\pi}\right)^2}{h_{\mathrm{new}} \times \frac{4.5}{4.48852} \times \frac{3.13201}{\pi} c} = \frac{4.48852}{2} \frac{kT_c}{c^2} \times \mathrm{A} \cdot \mathrm{m} \tag{54}$$

Therefore,

$$\frac{G_N m_{p\_\mathrm{new}}^2}{h_{\mathrm{new}} c} = \frac{4.5}{2} \times \left(\frac{4.48852}{4.5}\right)^2 \times \frac{\pi}{3.13201} \times \frac{kT_c}{c^2} \times (\mathrm{A} \cdot \mathrm{m}) \tag{55}$$

Next, using G_{N_new} and kT_{c_new}, we proposed the following equation, which is the same formula as Equation (1). Then, the unit of 4.5 is 1/A·m in Equation (9).

$$\frac{G_{N\_\mathrm{new}} m_{p\_\mathrm{new}}^2}{h_{\mathrm{new}} c} = \frac{4.5}{2} \times \frac{kT_{c\_\mathrm{new}}}{c^2} \times (\mathrm{A} \cdot \mathrm{m})_{\mathrm{new}} \tag{56}$$

Therefore,

$$\frac{G_{N\_\mathrm{new}}}{G_N} = \left(\frac{4.5}{4.48852}\right)^2 \times \frac{3.13201}{\pi} \times \frac{kT_{c\_\mathrm{new}}}{kT} \times \frac{(\mathrm{A} \cdot \mathrm{m})_{\mathrm{new}}}{\mathrm{A} \cdot \mathrm{m}} \tag{57}$$

5.2.4. Redefinition of Equation (43)

Using G_N, Equation (43) is rewritten as follows.

$$\frac{G_N m_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.48852}{2 \times 3.13201} \times \frac{m_e}{e} \times hc \times (\mathrm{A} \cdot \mathrm{m}) \tag{58}$$

Therefore,

$$G_N m_{p\_\text{new}}^2 = \frac{m_{e\_\text{new}} e_\text{new} h_\text{new} c}{4\pi\varepsilon_{0\_\text{new}}} \times \frac{4.48852}{2\times 3.13201} \times \frac{4.5}{4.48852} \times \frac{4.48852}{4.5} \times \frac{3.13201}{\pi} \times (\text{A}\cdot\text{m}) \tag{59}$$

Using G_{N_new} and $\text{A}\cdot\text{m}_\text{new}$, we propose the following equation, which is the same formula as Equation (2).

$$\frac{G_{N\_\text{new}} m_{p\_\text{new}}^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)_\text{new}} = \frac{4.5}{2\times\pi} \times \frac{m_{e\_\text{new}}}{e_{\_\text{new}}} \times h_{\_\text{new}} c \times (\text{A}\cdot\text{m})_\text{new} \tag{60}$$

Therefore,

$$\frac{G_{N\_\text{new}}}{G_N} = \frac{4.5}{4.48852} \times \frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} \tag{61}$$

5.2.5. Redefinition of Equation (44)

Equation (44) is rewritten as follows.

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = 3.13201 \times kT_c \tag{62}$$

Therefore,

$$\frac{m_{e\_\text{new}} c^2}{e_\text{new}} \times \frac{e_\text{new}^2}{4\pi\varepsilon_{0\_\text{new}}} \times \frac{4.5}{4.48852} \times \frac{3.13201}{\pi} = \pi \times kT_c \tag{63}$$

Next, using kT_{c_new}, we propose the following Equation, which is the same formula as Equation (3).

$$\frac{m_{e\_\text{new}} c^2}{e_\text{new}} \times \frac{e_\text{new}^2}{4\pi\varepsilon_{0\_\text{new}}} = \pi \times kT_{c\_\text{new}} \tag{64}$$

Therefore,

$$\frac{kT_{c\_\text{new}}}{kT_c} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} \tag{65}$$

5.2.6. Redefinition of Equation (50)

Using G_N, Equation (50) is rewritten as follows.

$$G_N m_p^2 = \frac{q_m}{m_p c^4} \times \frac{\pi}{\alpha} \times (kT_c)^2 \times (\text{A}\cdot\text{m}) \tag{66}$$

Therefore,

$$G_N = \frac{q_{m\_\text{new}}}{m_{p\_\text{new}}^3} \times \frac{\pi}{\alpha} \times \frac{(kT_c)^2}{c^4} \times \left(\frac{4.48852}{4.5}\right)^3 \times \left(\frac{\pi}{3.13201}\right)^2 \times (\text{A}\cdot\text{m}) \tag{67}$$

Next, using G_{N_new}, kT_{c_new} and $\text{A}\cdot\text{m}_\text{new}$, we propose the following equation.

$$G_{N\_\text{new}} = \frac{q_{m\_\text{new}}}{m_{p\_\text{new}}^3} \times \frac{\pi}{\alpha} \times \frac{(kT_{c\_\text{new}})^2}{c^4} \times (\text{A}\cdot\text{m})_\text{new} \tag{68}$$

Therefore,

$$\frac{G_{N\_new}}{G_N} = \left(\frac{4.5}{4.48852}\right)^3 \times \left(\frac{3.13201}{\pi}\right) \times \left(\frac{kT_{c\_\text{new}}}{kT_c}\right)^2 \times \frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} \tag{69}$$

5.2.7. Redefinition of kT_c and Vm

Equations (57), (61), (65) and (69) are rewritten as follows.

$$\frac{G_{N\_\text{new}}}{G_N} = \left(\frac{4.5}{4.48852}\right)^2 \times \frac{3.13201}{\pi} \times \frac{kT_{c\_\text{new}}}{kT} \times \frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} \tag{70}$$

$$\frac{G_{N\_\text{new}}}{G_N} = \frac{4.5}{4.48852} \times \frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} \tag{71}$$

$$\frac{kT_{c\_\text{new}}}{kT_c} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} \tag{72}$$

$$\frac{G_{N\_\text{new}}}{G_N} = \left(\frac{4.5}{4.48852}\right)^3 \times \left(\frac{3.13201}{\pi}\right) \times \left(\frac{kT_{c\_\text{new}}}{kT_c}\right)^2 \times \frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} \tag{73}$$

In Equation (72), kT_c is redefined and determined. Next,

$$\frac{(\text{A}\cdot\text{m})_\text{new}}{\text{A}\cdot\text{m}} = \frac{(\text{C}\times\text{m/s})_\text{new}}{\text{C}\times\text{m/s}} = \frac{\text{C}_\text{new}}{\text{C}} = \frac{4.48852}{4.5} \tag{74}$$

From Equations (71) and (74),

$$\frac{G_{N\_\text{new}}}{G_N} = 1 \tag{75}$$

Then, Equations (70) and (73) can be explained. In Equation (72), redefinition of kT_c is from redefinition of the mass of the particle as follows:

$$\frac{kT_{c\_\text{new}}}{kT} = \frac{4.48852}{4.5} \times \frac{\pi}{3.13201} = \frac{m_{e\_\text{new}}}{m_e} \tag{76}$$

However, the unit Am remains in the three equations. We proposed the following unit. We will explain the unit ($G_{N/Am}$) in a future report, which maybe different from the standard approach for G and thermodynamics [9].

$$\frac{G_{N/Am\_\text{new}}}{G_{N/Am}} = \frac{\left(G\times\frac{1\,\text{kg}}{\text{A}\cdot\text{m}}\right)_\text{new}}{G\times\frac{1\,\text{kg}}{\text{A}\cdot\text{m}}} = \frac{\left(\frac{G_N}{\text{A}\cdot\text{m}}\right)_\text{new}}{\frac{G_N}{\text{A}\cdot\text{m}}} = \frac{4.5}{4.48852} \tag{77}$$

5.2.8. Making Sure for the Calculation

Equation (56) is rewritten as follows:

$$\frac{G_{N/Am\_\text{new}} m_{p\_\text{new}}^2}{h_\text{new} c} = \frac{4.5}{2} \times \frac{kT_{c\_\text{new}}}{c^2} = 9.4279464618E-40 \tag{78}$$

Equation (60) is rewritten as follows:

$$\frac{G_{N/Am\_\text{new}} m_{p\_\text{new}}^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)_\text{new}} = \frac{4.5}{2\times\pi} \times \frac{m_{e\_\text{new}}}{e_{\_\text{new}}} \times h_{\_\text{new}} c = 8.1176747490E-37 \tag{79}$$

Equation (64) is rewritten as follows:

$$\frac{m_{e\_\text{new}}c^2}{e_{\text{new}}} \times \frac{e_{\text{new}}^2}{4\pi\varepsilon_{0\_\text{new}}} = \pi \times kT_{c\_\text{new}} = 1.18311202E-22 \quad (80)$$

Equation (68) is rewritten as follows:

$$G_{N/Am\_\text{new}} = \frac{q_{m\_\text{new}}}{m_{p\_\text{new}}^3} \times \frac{\pi}{\alpha} \times \frac{\left(kT_{c\_\text{new}}\right)^2}{c^4} = 6.6908477020E-11 \quad (81)$$

Consequently, our four equations can be redefined successfully.

5.2.9. The Other Equations

From Equation (8),

$$3.132011447\left(\text{V}\cdot\text{m}\right) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)m_e c^2}{ec}\left(\frac{\text{m}^2}{\text{s}} \times \frac{\text{J}}{\text{A}\cdot\text{m}} = \frac{\text{J}\cdot\text{m}}{\text{C}} = \text{V}\cdot\text{m}\right) \quad (82)$$

From Equation (44),

$$\frac{m_e c^2 \times ec}{4\pi\varepsilon_0 c} = 3.132011447\left(\text{V}\cdot\text{m}\right) \times kT_c \quad (83)$$

In Equation (83), there are no dimension mismatch problems. From Equations (81) and (82),

$$\frac{m_e c^2 \times ec}{4\pi\varepsilon_0 c} = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)m_e c^2}{ec} \times kT_c \quad (84)$$

Therefore,

$$\frac{kT_c}{\frac{e^2 c}{4\pi\varepsilon_0}} = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)}\left(\frac{\text{s}}{\text{m}^2}\right) = \frac{1}{1837.485988}\left(\frac{\text{s}}{\text{m}^2}\right) \quad (85)$$

Therefore,

$$\left(\frac{kT_c}{\frac{e^2 c}{4\pi\varepsilon_0}}\right)_{\text{new}} \frac{1}{1837.485988}\left(\frac{\text{s}}{\text{m}^2}\right) = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)}\left(\frac{\text{s}}{\text{m}^2}\right) \quad (86)$$

Consequently, Equation (85) can be successfully redefined. Therefore,

$$\left(\frac{kT_c}{hc^2}\right)_{\text{new}} = \frac{1}{6.3206454E-07} = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)} \times \frac{\alpha}{2\pi} \quad (87)$$

Furthermore, Equation (87) can also be redefined.

6. Conclusions

In this report, using the redefinition method for the UNIT, we showed the necessity for our empirical equations. The redefinition method was explained in detail. Then, we proposed four empirical equations.

$$\frac{G_{N/Am\_new} m_{p\_new}^2}{h_{new} c} = \frac{4.5}{2}\left(\frac{1}{\mathrm{A \cdot m}}\right) \times \frac{kT_{c\_new}}{c^2} = 9.4279464618E-40 \quad (88)$$

where $G_{N/Am} = G \times 1$ kg/A·m

$$\frac{G_{N/Am\_new} m_{p\_new}^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)_{new}} = \frac{4.5}{2\times\pi}\left(\frac{1}{\mathrm{A \cdot m \times V \cdot m}}\right) \times \frac{m_{e\_new}}{e_{\_new}} \times h_{\_new} c = 8.1176747490E-37 \quad (89)$$

$$\frac{m_{e\_new} c^2}{e_{new}} \times \frac{e_{new}^2}{4\pi\varepsilon_{0\_new}} = \pi(\mathrm{V \cdot m}) \times kT_{c\_new} = 1.18311202E-22 \quad (90)$$

$$G_{N/Am\_new} = \frac{q_{m\_new}}{m_{p\_new}^3} \times \frac{\pi(\mathrm{V \cdot m})}{\alpha} \times \frac{\left(kT_{c\_new}\right)^2}{c^4} = 6.6908477020E-11 \quad (91)$$

Furthermore, we derived four important equations.

$$\frac{m_{e\_new}}{e_{new}} \times \frac{q_{m\_new}}{m_{p\_new}} = 4.5 \times \pi\left(\frac{\mathrm{V \cdot m}}{\mathrm{A \cdot m}} = \Omega\right) \quad (92)$$

$$\frac{h_{new} c^2}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)^2 \times m_{e\_new} c^2 \times m_{p\_new} c^2} = \frac{4.5}{\pi}\left(\frac{1}{\mathrm{A \cdot m \times V \cdot m}} = \frac{\mathrm{s}}{\mathrm{J \times m^2}}\right) \quad (93)$$

$$\frac{kT_c}{\frac{e^2 c}{4\pi\varepsilon_0}} = \frac{1}{1837.485988}\left(\frac{\mathrm{s}^2}{\mathrm{m}}\right) = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)}\left(\frac{\mathrm{s}^2}{\mathrm{m}}\right) \quad (94)$$

$$\left(\frac{kT_c}{hc^2}\right)_{new} = \frac{1}{6.3206454E-07} = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)} \times \frac{\alpha}{2\pi}\left(\frac{\mathrm{s}^2}{\mathrm{m}}\right) \quad (95)$$

About numerical connections considering the units, our redefinition is perfect, in which there are not any dimension mismatch problems. About the unit ($G_{N/Am}$), we will explain in the future report.

Conflicts of Interest

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

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