Scientific Research Publishing

Journal of Modern Physics, 2025, 16(12), 1861-1877
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Solution for the Interpretation Problems Regarding Empirical Equations for Calculating the Cosmic Microwave Background Temperature

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How to cite this paper: Miyashita, T. (2025) Solution for the Interpretation Problems Regarding Empirical Equations for Calculating the Cosmic Microwave Background Temperature. *Journal of Modern Physics*, **16**, 1861-1877.
https://doi.org/10.4236/jmp.2025.1612085

Received: November 22, 2025
Accepted: December 19, 2025
Published: December 22, 2025

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Abstract

We build upon previously proposed empirical equations involving the cosmic microwave background (CMB) temperature and extend the approach to include an empirical formulation for the fine-structure constant. To ensure consistency across these relationships, revised values for the CMB temperature (T_c) and the gravitational constant (G) were obtained. The recalculated gravitational constant, $6.68917534 \times 10^{-11}$ $m^3 \cdot kg^{-1} \cdot s^{-2}$, remains marginally greater than the accepted value of 6.6743×10^{-11}. A recalculated CMB temperature of 2.7256307 K matched the observed value of 2.72548 ± 0.00057 K. We subsequently tried to validate Equation (12) independent of the MKSA unit system. However, interpretation problems occurred in our proof. In this report, we propose a correct proof for Equation (12) with an explanation for the relationship between macroscopic units and microscopic units. Furthermore, using our algorithms, we can explain the relationships among the various units within and outside the MKSA unit system.

Keywords

Temperature of the Cosmic Microwave Background, Minimum Mass, Ratio of the Gravitational Force to the Electric Force, Dimensional Analysis, Fine-Structure Constant

1. Introduction

The symbol list is shown in Section 2. We describe 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 derived an empirical equation for the fine-structure constant [6]. Equations (4) and (5) are related to the transference number [7] [8].

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

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

Deviations of the values of 9/2 and π have been discussed for reducing the induced errors [9]-[14]. We named the coefficient related to length (m^2/s) as follows [15]. In general, we used k_L. When we used MKSA units, we used k_{L0}.

$$k_L\left(\frac{\text{m}^2}{\text{s}}\right) = 1837.94538\left(\frac{\text{m}^2}{\text{s}}\right)_{\text{MKSA}} \equiv k_{L0}\left(\frac{\text{m}^2}{\text{s}}\right)_{\text{MKSA}} \tag{6}$$

where the subscript "MKSA" indicates the MKSA unit system.

$$3.1327945(\text{V} \cdot \text{m}) = \frac{k_{L0} \times m_e c^2}{ec} \tag{7}$$

$$4.4873976\left(\frac{1}{\text{A} \cdot \text{m}}\right) = \frac{q_m c}{k_{L0} \times m_p c^2} \tag{8}$$

By redefining the von Klitzing constant (Ω), these values can be adjusted back to 9/2 and π [15].

$$\pi(\text{V} \cdot \text{m}) = \frac{k_{L0} \times m_e c^2}{e_{new} c} \tag{9}$$

$$4.5\left(\frac{1}{\text{A} \cdot \text{m}}\right) = \frac{q_{m\_new} c}{k_{L0} \times m_p c^2} \tag{10}$$

Then, the value of k_{L0} can be obtained using the following equation.

$$\frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = 1 \tag{11}$$

Then, we introduce the following simple equation.

$$m_p c^2 \times m_e c^2 \times \frac{4.5}{\pi} hc^2 = \left(2\pi(1) \times \frac{kT_c}{\alpha}\right)^2 = 1.04985584\text{E}-39 \tag{12}$$

The calculated CMB temperature of 2.7256307 K matched the observed value of 2.72548 ± 0.00057 K. We then tried to prove the validity of Equation (12) independent of the MKSA unit system [15]. However, interpretation problems occurred with respect to the units used in the previous proof. In this report, to solve these problems, we propose a correct proof for Equation (12) with an explanation of the relationship between macroscopic units and microscopic units. Furthermore, using our algorithms, we can explain the relationships among the various units within and outside the MKSA unit system. Quantum mechanics [16] and gravity [17] have been used to provide thermodynamic explanations for the validity of this equation. Our motivation is to use thermodynamic principles in the area of solid-state ionics, which we discovered [18].

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 the correct proof of Equation (12) with an explanation for the relationship between macroscopic units and microscopic units. In Section 4, we attempt to explain the relationships among the various units within and outside the MKSA unit system. In Section 5, our conclusions are provided.

2. Symbol List

2.1. MKSA Units (These Values Were Obtained from Wikipedia)

G: Gravitational constant: 6.6743×10^{-11} ($m^3 \cdot kg^{-1} \cdot s^{-2}$)
(we used the compensated value of $6.68917534 \times 10^{-11}$ in this study)
T_c: CMB temperature: 2.72548 ± 0.00057 (K)
(we used the compensated value of 2.725630647 K in this study)
k: Boltzmann constant: 1.380649×10^{-23} ($J \cdot K^{-1}$)
c: Speed of light: 299,792,458 (m/s)
h: Planck constant: $6.62607015 \times 10^{-34}$ (J·s)
ε_0: Electric constant: $8.8541878128 \times 10^{-12}$ ($N \cdot m^2 \cdot C^{-2}$)
μ_0: Magnetic constant: $1.25663706212 \times 10^{-6}$ ($N \cdot A^{-2}$)
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: Resting mass of a proton: $1.67262192369 \times 10^{-27}$ (kg)
m_e: Resting mass of an electron: $9.1093837015 \times 10^{-31}$ (kg)
R_k: 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 Obtained after the Redefinition Process

$$e_{new} = e \times \frac{4.4873976}{4.5} = 1.5976897\text{E}-19(\text{C}) \quad (13)$$

$$q_{m\_new} = q_m \times \frac{\pi}{3.1327945} = 4.1472823\text{E}-15(\text{Wb}) \quad (14)$$

$$h_{new} = e_{new} \times q_{m\_new} = h \times \frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = 6.62607015\text{E}-34(\text{J} \cdot \text{s}) = h \quad (15)$$

Therefore, the value of Planck's constant is unchanged.

$$Rk_{\_new} = \frac{q_{m\_new}}{e_{\_new}} = Rk \times \frac{4.5}{4.4873976} \times \frac{\pi}{3.1327945} = 25957.997(\Omega) \quad (16)$$

Equation (16) can be rewritten as follows:

$$Rk_{new} = 4.5\left(\frac{1}{\mathrm{A \cdot m}}\right) \times \pi(\mathrm{V \cdot m}) \times \frac{m_p}{m_e} = 25957.997(\Omega) \quad (17)$$

$$Z_{0\_new} = \alpha \times \frac{2h_{new}}{e_{new}^2} = 2\alpha \times Rk_{new} = Z_0 \times \frac{4.5}{4.4873976} \times \frac{\pi}{3.1327945} = 378.84931(\Omega) \quad (18)$$

Equation (18) can be rewritten as follows:

$$Z_{0\_new} = 4.5\left(\frac{1}{\mathrm{A \cdot m}}\right) \times \pi(\mathrm{V \cdot m}) \times 2\alpha \times \frac{m_p}{m_e} = 378.84931(\Omega) \quad (19)$$

$$\mu_{0\_new} = \frac{Z_{0\_new}}{c} = \mu_0 \times \frac{4.5}{4.4873976} \times \frac{\pi}{3.1327945} = 1.2637053\mathrm{E}-06\left(\mathrm{N \cdot A^{-2}}\right) \quad (20)$$

$$\varepsilon_{0\_new} = \frac{1}{Z_{0\_new} \times c} = \varepsilon_0 \times \frac{4.4873976}{4.5} \times \frac{3.1327945}{\pi} = 8.8046642\mathrm{E}-12\left(\mathrm{F \cdot m^{-1}}\right) \quad (21)$$

$$c_{\_new} = \frac{1}{\sqrt{\varepsilon_{0\_new}\mu_{0\_new}}} = \frac{1}{\sqrt{\varepsilon_0\mu_0}} = c = 299792458\left(\mathrm{m \cdot s^{-1}}\right) \quad (22)$$

Therefore, the value of the speed of light can remain unchanged. Next, the Compton wavelength (λ) is as follows:

$$\lambda = \frac{h}{mc} \quad (23)$$

When the values of Planck's constant and the speed of light are unchanged, the following values in Equations (24), (25) and (26) can be kept constant.

$$m_{e\_new} = m_e \times \frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = m_e = 9.1093837\mathrm{E}-31(\mathrm{kg}) \quad (24)$$

$$m_{p\_new} = m_p \times \frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = m_p = 1.6726219\mathrm{E}-27(\mathrm{kg}) \quad (25)$$

$$kT_{c\_new} = kT_c \times \frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = kT_c = 3.7631393\mathrm{E}-23(\mathrm{J}) \quad (26)$$

To simplify the calculation, G_N is defined as follows:

$$G_N = G \times 1\,\mathrm{kg}\left(\mathrm{m^3 \cdot s^{-2}}\right) = 6.68917521\mathrm{E}-11\left(\mathrm{m^3 \cdot s^{-2}}\right) \quad (27)$$

In the previous report, we proposed the following compensation relation.

$$G_{N\_new} = G_N \times \frac{1}{(1.001113745)^2}\left(\frac{\mathrm{m^3}}{\mathrm{s^2}}\right) = 6.6743\mathrm{E}-11\left(\frac{\mathrm{m^3}}{\mathrm{s^2}}\right) \quad (28)$$

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]:

$$m_{e\_new}c^2 \times k_{L0}^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) = \frac{\pi}{4.5}(\mathrm{V}\cdot\mathrm{m}\times\mathrm{A}\cdot\mathrm{m})\times\lambda_p c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) = 2.76564\mathrm{E}-07\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) \quad (29)$$

$$e_{new}c \times k_{L0}\left(\frac{\mathrm{A}\cdot\mathrm{m}^3}{\mathrm{s}}\right) = \frac{1}{4.5}(\mathrm{A}\cdot\mathrm{m})\times\lambda_p c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) = 8.80330\mathrm{E}-08\left(\frac{\mathrm{A}\cdot\mathrm{m}^3}{\mathrm{s}}\right) \quad (30)$$

$$m_{p\_new}c^2 \times k_{L0}^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) = \frac{\pi}{4.5}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\times\lambda_e c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) = 5.07814\mathrm{E}-04\left(\frac{\mathrm{J}\cdot\mathrm{m}^4}{\mathrm{s}^2}\right) \quad (31)$$

$$q_{m\_new}c \times k_{L0}\left(\frac{\mathrm{V}\cdot\mathrm{m}^3}{\mathrm{s}}\right) = \pi(\mathrm{V}\cdot\mathrm{m})\times\lambda_e c\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) = 2.28516\mathrm{E}-03\left(\frac{\mathrm{V}\cdot\mathrm{m}^3}{\mathrm{s}}\right) \quad (32)$$

$$kT_{c\_new} \times \frac{2\pi}{\alpha}\times k_{L0}^3\left(\frac{\mathrm{J}\cdot\mathrm{m}^6}{\mathrm{s}^3}\right) = \frac{\pi}{4.5}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right)\times\lambda_p c\times\lambda_e c = 2.011697\mathrm{E}-10\left(\frac{\mathrm{J}\cdot\mathrm{m}^6}{\mathrm{s}^3}\right) \quad (33)$$

$$\begin{aligned} G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) &= \left(\lambda_p c\right)^2\left(\frac{\mathrm{m}^4}{\mathrm{s}^2}\right)\times c\left(\frac{\mathrm{m}}{\mathrm{s}}\right)\times\alpha c\frac{4.5(1)}{4\pi(1)}\times k_{L0}^{-1}\left(\frac{\mathrm{m}^2}{\mathrm{s}}\right) \\ &= 6.6891752\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) \end{aligned} \quad (34)$$

In Equation (34), $4\pi(1)$ and $4.5(1)$ are dimensionless quantities.

2.4. Symbol List for the Algorithms Used to Explain Our Empirical Equations

2.4.1. Equations for Establishing the First Symbol List

Equations (35) and (36) are important for establishing the first symbol list. The following expressions can be obtained on the basis of Equations (29)-(34) [13].

$$\frac{h}{m_p} = \frac{h_{new}}{m_{p\_new}} = 3.9614871\mathrm{E}-07 = \text{experimental result} \quad (35)$$

$$\frac{h}{m_e} = \frac{h_{new}}{m_{e\_new}} = 7.2738951\mathrm{E}-04 = \text{experimental result} \quad (36)$$

$$e_{new}c(\mathrm{A}\cdot\mathrm{m}) = \frac{1}{4.5}\times\frac{h}{m_p}\times k_{L0}^{-1}(\mathrm{A}\cdot\mathrm{m}) = 4.78975317\mathrm{E}-11(\mathrm{A}\cdot\mathrm{m}) \quad (37)$$

$$q_{m\_new}c(\mathrm{V}\cdot\mathrm{m}) = \pi\times\frac{h}{m_e}\times k_{L0}^{-1}(\mathrm{V}\cdot\mathrm{m}) = 1.24332398\mathrm{E}-06(\mathrm{V}\cdot\mathrm{m}) \quad (38)$$

$$m_{e\_new}c^2(\mathrm{J}) = \frac{\pi}{4.5}\times\frac{h}{m_p}\times k_{L0}^{-2}(\mathrm{J}) = m_e c^2(\mathrm{J}) = 8.18710591\mathrm{E}-14(\mathrm{J}) \quad (39)$$

$$m_{p\_new}c^2(\mathrm{J}) = \frac{\pi}{4.5}\times\frac{h}{m_e}\times k_{L0}^{-2}(\mathrm{J}) = m_p c^2 = 1.50327764\mathrm{E}-10(\mathrm{J}) \quad (40)$$

$$h_{new}c^2\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right) = \frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times k_{L0}^{-2}\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right) = hc^2 = 5.95521\mathrm{E}-17\left(\frac{\mathrm{J}\cdot\mathrm{m}^2}{\mathrm{s}}\right) \quad (41)$$

$$\frac{kT_{c\_new}}{\alpha}(\mathrm{J}) = \frac{1}{2\pi(1)}\times\frac{\pi}{4.5}\times\frac{h}{m_p}\times\frac{h}{m_e}\times k_{L0}^{-3}(\mathrm{J}) = \frac{kT_c}{\alpha}(\mathrm{J}) = 5.15685567\mathrm{E}-21(\mathrm{J}) \quad (42)$$

$$\frac{G_{N\_new}}{c}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) = \alpha\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p}\right)^2\times k_{L0}^{-1}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) = 2.2312686696\mathrm{E}-18 \quad (43)$$

2.4.2. Equations for Establishing the Second Symbol List

An arbitrary value of the speed of light is used, and the following example is given:

$$c_{\text{arbitrary}} = 12345\left(\frac{\text{m}_{\text{arbitrary}}}{\text{s}}\right) \tag{44}$$

where $c_{\text{arbitrary}}$ and 1 $\text{m}_{\text{arbitrary}}$ are the values of c and 1 m, respectively, when an arbitrary value of the speed of light is used. Importantly, Equation (44) does not indicate a change in the speed of light.

When $c_{\text{arbitrary}}$ is used, the calculated values on the right sides of Equations (37)-(43) can remain unchanged. This means that except for the value of kTc/α, the values of e, q_m, h, m_e, m_p and G change.

Consequently, we can establish the second list.

2.5. Useful Equations in the Previous Report

$$Rk_{new}(\Omega) = 4.5\left(\frac{1}{\text{A}\cdot\text{m}}\right)\times\pi(\text{V}\cdot\text{m})\times\frac{m_p}{m_e} = 25957.997(\Omega) \tag{45}$$

$$Z_{0\_new}(\Omega) = 4.5\left(\frac{1}{\text{A}\cdot\text{m}}\right)\times\pi(\text{V}\cdot\text{m})\times 2\alpha\times\frac{m_p}{m_e} = 378.84931(\Omega) \tag{46}$$

$$\frac{1}{\varepsilon_{0\_new}c}\left(\Omega = \frac{\text{kg}}{\text{C}^2}\cdot\frac{\text{m}^2}{\text{s}}\right) = \frac{kT_c/\alpha c^2}{(e_{new})^2}\times k_{L0}\times 2\pi(1)\times 2\alpha = 378.8493064(\Omega) = Z_{0\_new} \tag{47}$$

$$\mu_{0\_new}c\left(\Omega = \frac{\text{kg}}{\text{C}^2}\cdot\frac{\text{m}^2}{\text{s}}\right) = \frac{kT_c/\alpha c^2}{(e_{new})^2}\times k_{L0}\times 2\pi(1)\times 2\alpha = 378.8493064(\Omega) = Z_{0\_new} \tag{48}$$

$$m_p c^2(\text{J})\times 4.5 e_{new} c(1) = 2\pi(1)\times\frac{kT_c}{\alpha}(\text{J}) = 3.24014789\text{E}-20(\text{J}) \tag{49}$$

$$m_e c^2(\text{J})\times\frac{q_m c}{\pi}(1) = 2\pi(1)\times\frac{kT_c}{\alpha c^2}(\text{J}) = 3.24014789\text{E}-20(\text{J}) \tag{50}$$

$$hc^2\times k_{L0}^{-1}(\text{J}) = 2\pi(1)\times\frac{kT_c}{\alpha}(\text{J}) = 3.24014789\text{E}-20(\text{J}) \tag{51}$$

$$e_{new}(\text{C}) = \sqrt{\frac{h(\text{J}\cdot\text{s})}{4.5\pi(\Omega)}\times\frac{m_e}{m_p}} = 1.597689670\text{E}-19(\text{C}) \tag{52}$$

$$q_{m\_new}(\text{Wb}) = \sqrt{h(\text{J}\cdot\text{s})\times 4.5\pi(\Omega)\times\frac{m_p}{m_e}} = 4.147282338\text{E}-15(\text{Wb}) \tag{53}$$

$$\frac{\pi}{4.5}\times hc^2 = m_p c^2\times k_{L0}\times m_e c^2\times k_{L0} = 4.15752428\text{E}-17 \tag{54}$$

In the previous report, the value of k_{L0} could be obtained using Equation (54).

2.6. Useful Equations Unpublished in the Previous Report

The list of equations in this section can be easily deduced from the equations published in the previous report.

$$\frac{4.5}{\pi}\times hc^2 = \frac{(2\pi(1)\times kT_c/\alpha)}{m_p c^2}\times\frac{(2\pi(1)\times kT_c/\alpha)}{m_e c^2} = 8.530216942\text{E}-17 \tag{55}$$

Equation (55) is equal to Equation (12). In Equation (55), the right side is the multiplication of the mass ratio. Therefore, the left side should be dimensionless and constant.

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times(4.5\times e_{new}c)\times e_{new}c\times\frac{q_{m\_new}c}{m_pc^2}=6.6891752\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) \tag{56}$$

$$G_{N\_new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times(4.5\times e_{new}c)^2\times e_{new}c\times\frac{\pi(\mathrm{V}\cdot\mathrm{m})}{m_ec^2}=6.6891752\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right) \tag{57}$$

Equations (56) and (57) were published in the previous report. However, many variations exist.

$$G_{new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times(4.5e_{new}c)^2\times\frac{k_{L0}}{1\,\mathrm{kg}}=6.6891752\mathrm{E}-11 \tag{58}$$

$$G_{new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{q_mc}{\pi}\right)^2\times\frac{k_{L0}}{1\,\mathrm{kg}}\times\left(\frac{m_e}{m_p}\right)^2=6.6891752\mathrm{E}-11 \tag{59}$$

$$G_{new}\left(\frac{\mathrm{m}^3}{\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{4.5}{\pi}hc^2\right)\times\frac{k_{L0}}{1\,\mathrm{kg}}\times\left(\frac{m_e}{m_p}\right)=6.6891752\mathrm{E}-11 \tag{60}$$

2.7. Relationship between the Number of a Particle Mass in 1 kg (MKSA Units) and k_{L0}

Utilizing k_{L0}, the mass number of a particle in kg (MKSA units) can be defined as follows.

$$\frac{1\,\mathrm{kg}}{m_p}=5.9786374066\mathrm{E}+26=\frac{4.5}{\pi}\left(\frac{1}{\mathrm{A}\cdot\mathrm{m}\cdot\mathrm{V}\cdot\mathrm{m}}=\frac{\mathrm{s}}{\mathrm{J}\cdot\mathrm{m}^2}\right)\times\frac{\pi}{q_{m\_new}c}\times k_{L0}\times1\,\mathrm{kg}\times c^2 \tag{61}$$

$$\frac{1\,\mathrm{kg}}{m_e}=1.09776911\mathrm{E}+30=\frac{4.5}{\pi}\times\frac{1}{4.5e_{new}c}\times k_{L0}\times1\,\mathrm{kg}\times c^2 \tag{62}$$

$$1\,\mathrm{kg}\Big/\left(2\pi(1)\times\frac{kT_c}{\alpha c^2}\right)=2.7738091\mathrm{E}+36=\frac{1}{hc^2}\times k_{L0}\times1\,\mathrm{kg}\times c^2 \tag{63}$$

Equations (61)-(63) can be deduced from Equations (49)-(51). An easier explanation will be given in a later section. The definition of the minimum mass ($M_{\min}$) should be changed from Equation (64) to Equation (65).

$$M_{\min}=\frac{kT_c}{\alpha c^2}=5.73777561\mathrm{E}-38(\mathrm{kg}) \tag{64}$$

$$M_{\min}=2\pi(1)\times\frac{kT_c}{\alpha c^2}=3.60515074\mathrm{E}-37(\mathrm{kg}) \tag{65}$$

3. Methods

In this section, we explain Equation (12). For convenience, Equation (12) is rewritten as follows:

$$m_p c^2 \times m_e c^2 \times \frac{4.5}{\pi} hc^2 = \left(2\pi(1) \times \frac{kT_c}{\alpha}\right)^2 = 1.04985584\text{E}-39 \tag{66}$$

Since the constant value of 4.5 has units of 1/A·m and π has units of V·m, the value of 4.5/π × hc^2 is dimensionless.

We must prove that the value of 4.5/π × hc^2 can be treated as the fundamental constant. However, problems occurred with regard to the units in the previous proof. We explain Equation (12) via the following procedure. In this section, we examine Step 1 below.

Step 1: Without using MKSA units, we mathematically prove Equation (12) with an explanation for the relationship between macroscopic units and microscopic units.

Step 2: We attempt to explain the relationships among the various units within and outside the MKSA unit system.

3.1. Interpretation Problems Encountered in the Previous Report

Equation (102) from the previous report is written as follows.

$$4.5\left(\frac{1}{\text{A}\cdot\text{m}}\right)_{\text{MKSA}} = 4.5\times10^{-3}\left(\frac{1}{\text{C}}\right)\times10^{-3}\left(\frac{\text{s}}{\text{mm}}\right) = 4.5\times10^{-6}\left(\frac{\text{s}}{\text{C}\cdot\text{mm}}\right) \tag{67}$$

Afterward, the units of C were changed without any explanation. A reviewer noted the error. Furthermore, in the previous report, Equations (52) and (53) were used to prove Equation (12), which should have been avoided for a distinct proof. The redefined values should not have been used.

3.2. Relationship between Macroscopic Units and Microscopic Units

The relationship between macroscopic units and microscopic units is explained in this section. Utilizing macroscopic units,

$$1(\text{J}\cdot\text{s})_{\text{MKSA}} = 1(\text{C})_{\text{MKSA}} \times 1(\text{Wb})_{\text{MKSA}} \tag{68}$$

Utilizing microscopic units,

$$(h)_{\text{MKSA}} = (e)_{\text{MKSA}} \times (q_m)_{\text{MKSA}} \tag{69}$$

The relationship between macroscopic units and microscopic units is as follows:

$$1(\text{C})_{\text{MKSA}} = \frac{1}{1.60217663\text{E}-19} = 6.24150907\text{E}+18 \times e(\text{C})_{\text{MKSA}} \tag{70}$$

$$1(\text{Wb})_{\text{MKSA}} = \frac{1}{4.13566770\text{E}-15} = 2.41798924\text{E}+14 \times q_m(\text{Wb})_{\text{MKSA}} \tag{71}$$

$$1(\text{J}\cdot\text{s})_{\text{MKSA}} = \frac{1}{6.62607015\text{E}-34} \times (h)_{\text{MKSA}} = 1.50919018\text{E}+33 \times (h)_{\text{MKSA}} \tag{72}$$

When Equations (68) and (69) are defined outside the MKSA unit system, we must prove that the value of 4.5/π × hc^2 can be treated as the fundamental constant.

3.3. Definition of the Resistance (Ω)

We define the resistance (Ω). Utilizing macroscopic units and microscopic units,

$$1(\text{Wb})_{\text{MKSA}} = 1(\text{C})_{\text{MKSA}} \times 1(\Omega)_{\text{MKSA}} \tag{73}$$

$$(q_m)_{\text{MKSA}} = (e)_{\text{MKSA}} \times (Rk)_{\text{MKSA}} \tag{74}$$

Then, Rk (A microscopic unit) × 1Ω (A macroscopic unit) should be constant. When we change the definition of 1Ω, the ratio between the numbers of e in 1 C and q_m in 1 Wb should be changed. In our proof, we use 1Ω in the MKSA unit. But there are not any problems, the ratio between the numbers of e in 1 C and q_m in Wb are unchanged in our proof.

3.4. The Proof for Equation (12)

We want to prove that 4.5/p × hc^2 in Equation (12) is unchanged when MKSA units are not used.

Step 1: The value is unchanged when the definition of 1 m is changed.

Step 2: The value is unchanged when the definition of 1 1 s is changed.

Step 3: The value is unchanged when the definition of 1 kg is changed.

3.4.1. Explanation for Changing the Definition of 1 m

When we use a distance of 1 mm instead of 1 m,

$$1(\text{m})_{\text{MKSA}} = 10^3 \times 1(\text{m})_{\text{mmKSA}} \tag{75}$$

where the subscript "mmKSA" indicates that a distance of 1 mm is used instead of 1 m in the MKSA unit system.

Afterward, the values of the Planck constant and the speed of light change.

$$h = 6.62607015\text{E}-34 \times 10^6 = 6.62607015\text{E}-28\left(\text{kg}\cdot\frac{\text{mm}^2}{\text{s}}\right) \tag{76}$$

$$c = 299792458 \times 10^3 \left(\frac{\text{mm}}{\text{s}}\right) \tag{77}$$

$$hc^2 = 5.9552149\text{E}-17 \times 10^{12} = 5.9552149\text{E}-5\left(\text{kg}\cdot\frac{\text{mm}^2}{\text{s}}\cdot\frac{\text{mm}^2}{\text{s}^2}\right) \tag{78}$$

We must consider the following relationship:

$$1(\text{J}\cdot\text{s})_{\text{mmKSA}} = 1(\text{C})_{\text{mmKSA}} \times 1(\text{Wb})_{\text{mmKSA}} \tag{79}$$

$$(h)_{\text{mmKSA}} = (e_{new})_{\text{mmKSA}} \times (q_{m\_new})_{\text{mmKSA}} \tag{80}$$

Then, the definitions of e and q_m are changed.

$$e_{\text{mmKSA}} = e_{\text{MKSA}} \times 10^3 = 1.60217663\text{E}-16(\text{C})_{\text{mmKSA}} \tag{81}$$

$$q_{m\_\text{mmKSA}} = q_{m\_\text{MKSA}} \times 10^3 = 4.13566770\text{E}-12(\text{Wb})_{\text{mmKSA}} \tag{82}$$

When the number of electrons contained in 1 C is decreased, the actual value of 1 C is decreased.

$$1(\mathrm{C})_{\mathrm{MKSA}} = 10^3 \times 1(\mathrm{C})_{\mathrm{mmKSA}} \tag{83}$$

$$1(\mathrm{Wb})_{\mathrm{MKSA}} = 10^3 \times 1(\mathrm{Wb})_{\mathrm{mmKSA}} \tag{84}$$

Therefore,

$$(\mathrm{A}\cdot\mathrm{m})_{\mathrm{MKSA}} = \left(\frac{\mathrm{C}\cdot\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{MKSA}} = 10^3(\mathrm{C})_{\mathrm{mmKSA}} \times 10^3\left(\frac{\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{mmKSA}} = 10^6\left(\frac{\mathrm{C}\cdot\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{mmKSA}} \tag{85}$$

$$(\mathrm{V}\cdot\mathrm{m})_{\mathrm{MKSA}} = \left(\frac{\mathrm{Wb}\cdot\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{MKSA}} = 10^3(\mathrm{Wb})_{\mathrm{mmKSA}} \times 10^3\left(\frac{\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{mmKSA}} = 10^6\left(\frac{\mathrm{Wb}\cdot\mathrm{m}}{\mathrm{s}}\right)_{\mathrm{mmKSA}} \tag{86}$$

From Equations (78), (85) and (86),

$$\left(\frac{4.5}{\pi}hc^2\right)_{\mathrm{mmKSA}} = 5.95521\mathrm{E}-17 \times 10^{12} \times 10^{-12} = 5.95521\mathrm{E}-17 = \left(\frac{4.5}{\pi}hc^2\right)_{\mathrm{MKSA}} \tag{87}$$

Consequently, the value of 4.5/π × hc^2 can be treated as the fundamental constant.

3.4.2. Explanation for Changing the Definition of 1 s

1) Simpler explanation

When we use a distance of 1 ms instead of 1 s, the value for the speed of the light changes.

$$c = 299792458 \times 10^{-3}\left(\frac{\mathrm{m}}{\mathrm{ms}}\right) \tag{88}$$

Then,

$$c = 299792458 \times 10^{-3}\left(\frac{\mathrm{km}}{\mathrm{s}}\right) \tag{89}$$

Therefore, we use a distance of 1 km instead of 1 m. Then, the proof for changing the definition of 1 s is the same as that for changing the definition of 1 m.

Consequently, the value of 4.5/π × hc^2 can be treated as the fundamental constant.

2) The other explanation

The units of the Planck constant are as follows.

$$h = 6.62607015\mathrm{E}-34\left(\frac{\mathrm{kg}\cdot\mathrm{m}^2}{\mathrm{s}}\right) \tag{90}$$

In Equation (90), the units of "seconds" is only one. However, the units of the distance are two. Thus, we cannot use the same method explained in Section 3.4.1. We change the unit of the Planck constant to a Lorentz-invariant mass of 1 (1 kg × 1 s) instead of 1 kg.

$$h = 6.62607015\mathrm{E}-34\left((\mathrm{kg}\cdot\mathrm{s})\cdot\frac{\mathrm{m}^2}{\mathrm{s}^2}\right) \tag{91}$$

Then, the value of the Planck constant is changed.

$$h = 6.62607015\mathrm{E}-34 \times 10^{-6} = 6.62607015\mathrm{E}-40\left((\mathrm{kg}\cdot\mathrm{s})\cdot\frac{\mathrm{m}^2}{\mathrm{ms}^2}\right) \tag{92}$$

Then,

$$h = 6.62607015\text{E}-34\times10^{-6} = 6.62607015\text{E}-40\left((\text{kg}\cdot\text{s})\cdot\frac{\text{km}^2}{\text{s}^2}\right) \tag{93}$$

Therefore, we use a distance of 1 km instead of 1 m. Then, the proof for changing the definition of 1 s is the same as that for changing the definition of 1 m.

Consequently, the value of 4.5/π × hc^2 can be treated as the fundamental constant.

3.4.3. Explanation for Changing the Definition of 1 kg

When we use 1 mg as the definition of the mass instead of 1 kg,

$$1(\text{kg})_{\text{MKSA}} = 10^6\times1(\text{kg})_{\text{MmgSA}} \tag{94}$$

where the subscript "MmgSA" indicates that a mass of 1 mg is used instead of 1 kg in the MKSA unit system.

Afterward, the values of the Planck constant change.

$$h(\text{J}\cdot\text{s})_{\text{MmgSA}} = 6.62607015\text{E}-34\times10^{6} = 6.62607015\text{E}-28\left((\text{kg}\cdot\text{s})\cdot\frac{\text{m}^2}{\text{s}^2}\right)_{\text{MmgSA}} \tag{95}$$

In this case, the definition of the speed of light is unchanged. Considering the relationship between macroscopic units and microscopic units, the definitions of e and q_m are changed.

$$e_{\text{MmgSA}} = e_{\text{MKSA}}\times10^3 = 1.60217663\text{E}-16(\text{C})_{\text{MmgSA}} \tag{96}$$

$$q_{m\_\text{MmgSA}} = q_{m\_\text{MKSA}}\times10^3 = 4.13566770\text{E}-12(\text{Wb})_{\text{MmgSA}} \tag{97}$$

When the number of electrons contained in 1 C is decreased, the actual value of 1 C is decreased.

$$1(\text{C})_{\text{MKSA}} = 10^3\times1(\text{C})_{\text{MmgSA}} \tag{98}$$

$$1(\text{Wb})_{\text{MKSA}} = 10^3\times1(\text{Wb})_{\text{MmgSA}} \tag{99}$$

Therefore,

$$(\text{A}\cdot\text{m})_{\text{MKSA}} = \left(\frac{\text{C}\cdot\text{m}}{\text{s}}\right)_{\text{MKSA}} = 10^3(\text{C})_{\text{MmgSA}}\times1\left(\frac{\text{m}}{\text{s}}\right)_{\text{MmgSA}} = 10^3\left(\frac{\text{C}\cdot\text{m}}{\text{s}}\right)_{\text{MmgSA}} \tag{100}$$

$$(\text{V}\cdot\text{m})_{\text{MKSA}} = \left(\frac{\text{Wb}\cdot\text{m}}{\text{s}}\right)_{\text{MKSA}} = 10^3(\text{Wb})_{\text{MmgSA}}\times1\left(\frac{\text{m}}{\text{s}}\right)_{\text{MmgSA}} = 10^3\left(\frac{\text{Wb}\cdot\text{m}}{\text{s}}\right)_{\text{MmgSA}} \tag{101}$$

From Equations (95), (100) and (101),

$$\left(\frac{4.5}{\pi}hc^2\right)_{\text{MmgSA}} = 5.95521\text{E}-17\times10^6\times10^{-6} = 5.95521\text{E}-17 = \left(\frac{4.5}{\pi}hc^2\right)_{\text{MKSA}} \tag{102}$$

Consequently, the value of 4.5/π × hc^2 can be treated as the fundamental constant.

4. Results

In this section, using our algorithm, we attempt to explain the relationships among the various units within and outside the MKSA unit system.

4.1. The Meanings of the Compton Length and k_{L0}

We define the minimum mass ($M_{\min}$) as follows:

$$M_{\min} = 2\pi(1)\times\frac{kT_c}{\alpha c^2} = 3.60515074\text{E}-37(\text{kg}) \quad (103)$$

$$M_{\min}\times c^2 = 2.02234\text{E}-01(\text{eV}) \quad (104)$$

Then, we note that the Compton length of the minimum mass is as follows:

$$\lambda_{M\min} = \frac{h}{2\pi\times kT_c/\alpha c^2\times c} = \frac{k_{L0}}{c} = 6.1307259(\mu\text{m}) \quad (105)$$

In Equation (105), the reason for dividing the value by the light speed is to express the units (m/s) in the MKSA unit system. Next, we consider the units of K_{L0}, which are expressed in the MKSA unit system.

$$k_{L0} = 1837.94538\left(\frac{\text{m}^2}{\text{s}}\right) = 1837.94538\left(\text{s}\cdot\frac{\text{m}}{\text{s}}\cdot\frac{\text{m}}{\text{s}}\right) \quad (106)$$

In Equation (104), the units of m/s are increased. To express the increased unit (m/s) in the MKSA unit system, the value should be divided by the light speed. So,

$$\frac{k_{L0}}{c^2} = \frac{k_{L0}}{c^2} = \frac{1837.94538}{299792458^2} = 2.044990\text{E}-14(\text{s}) = \frac{1}{4.889999\text{E}+13}(\text{s}) \quad (107)$$

According to Einstein,

$$E = mc^2 \quad (108)$$

$$E = h\nu \quad (109)$$

Therefore,

$$\nu = \frac{mc^2}{h} \quad (110)$$

Then, we propose the following equation,

$$\nu\times\frac{k_{L0}}{c^2} = \frac{mc^2}{h}\times\frac{k_{L0}}{c^2} \quad (111)$$

So, when the $M_{\min}$ is used as the mass (m),

$$\nu\times\frac{k_{L0}}{c^2} = \frac{(M_{\min}\times k_{L0})\times c^2}{hc^2} = 1 \quad (112)$$

In Equation (112), the calculated value is 1.

4.2. Relationship between the Macroscopic Units and Microscopic Units of k_{L0} and 1 kg

Next, we must consider the relationship between the macroscopic units and microscopic units of k_{L0} and 1 kg.

For convenience, Equations (61)-(63) are rewritten as follows:

$$\frac{1\,\text{kg}}{m_p} = 5.9786374066\text{E}+26 = \frac{4.5}{\pi}\left(\frac{1}{\text{A}\cdot\text{m}\cdot\text{V}\cdot\text{m}} = \frac{\text{s}}{\text{J}\cdot\text{m}^2}\right)\times\frac{\pi}{q_{m\_new}c}\times k_{L0}\times 1\,\text{kg}\times c^2 \quad (113)$$

$$\frac{1\,\mathrm{kg}}{m_e} = 1.09776911\mathrm{E}+30 = \frac{4.5}{\pi} \times \frac{1}{4.5 e_{new} c} \times k_{L0} \times 1\,\mathrm{kg} \times c^2 \quad (114)$$

$$1\,\mathrm{kg} \Big/ \left(2\pi(1) \times \frac{kT_c}{\alpha c^2} \right) = 2.7738091\mathrm{E}+36 = \frac{1}{hc^2} \times k_{L0} \times 1\,\mathrm{kg} \times c^2 \quad (115)$$

Utilizing macroscopic units and microscopic units,

$$1\,\mathrm{kg}_{\mathrm{standard}} = 1\,\mathrm{kg}_{\mathrm{MKSA}} \times k_{L0}(1)^{-1} = 5.44086\mathrm{E}-04(\mathrm{kg})_{\mathrm{MKSA}} \quad (116)$$

$$m_{p\_\mathrm{standard}} = m_p \times k_{L0}(1) = 3.074187738\mathrm{E}-24(\mathrm{kg})_{\mathrm{MKSA}} \quad (117)$$

where $k_{L0}(1)$ is 1837.94538 and dimensionless. 1 $\mathrm{kg}_{\mathrm{standard}}$ is the standard macroscopic mass. m_{p_standard} is the standard microscopic mass of a proton. Then, from Equations (113)-(115),

$$\frac{1\,\mathrm{kg}_{\mathrm{standard}}}{m_p \times k_{L0}} = 3.2528918\mathrm{E}+23 = \frac{4.5}{\pi} \left(\frac{1}{\mathrm{A} \cdot \mathrm{m} \cdot \mathrm{V} \cdot \mathrm{m}} = \frac{\mathrm{s}}{\mathrm{J} \cdot \mathrm{m}^2} \right) \times \frac{\pi}{q_{m\_new} c} \times 1\,\mathrm{kg}_{\mathrm{standard}} \times c^2 \quad (118)$$

$$\frac{1\,\mathrm{kg}_{\mathrm{standard}}}{m_e \times k_{L0}} = 5.97280593\mathrm{E}+26 = \frac{4.5}{\pi} \times \frac{1}{4.5 e_{new} c} \times 1\,\mathrm{kg}_{\mathrm{standard}} \times c^2 \quad (119)$$

$$1\,\mathrm{kg}_{\mathrm{standard}} \Big/ \left(2\pi(1) \times \frac{kT_c}{\alpha c^2} \right) \times k_{L0} = 1.509190180\mathrm{E}+33 = \frac{1}{hc^2} \times 1\,\mathrm{kg}_{\mathrm{standard}} \times c^2 \quad (120)$$

In Equations (118)-(120), the number of particles can be changed.

4.3. Modifying the List Given in the Section 2.4.1

We can modify the list written in Section 2.4.1.

$$e_{new} c(\mathrm{A} \cdot \mathrm{m}) = \frac{1}{4.5} \times \frac{h}{m_p \times k_{L0}} (\mathrm{A} \cdot \mathrm{m}) = 4.78975317\mathrm{E}-11(\mathrm{A} \cdot \mathrm{m}) \quad (121)$$

$$q_{m\_new} c(\mathrm{V} \cdot \mathrm{m}) = \pi \times \frac{h}{m_e \times k_{L0}} (\mathrm{V} \cdot \mathrm{m}) = 1.24332398\mathrm{E}-06(\mathrm{V} \cdot \mathrm{m}) \quad (122)$$

$$m_e c^2 \times k_{L0} \left(\mathrm{J} \cdot \frac{\mathrm{m}^2}{\mathrm{s}} \right) = \frac{\pi}{4.5} \times \frac{h}{m_p \times k_{L0}} = 1.50474532\mathrm{E}-10 \left(\mathrm{J} \cdot \frac{\mathrm{m}^2}{\mathrm{s}} \right) \quad (123)$$

$$m_p c^2 \times k_{L0} \left(\mathrm{J} \cdot \frac{\mathrm{m}^2}{\mathrm{s}} \right) = \frac{\pi}{4.5} \times \frac{h}{m_e \times k_{L0}} \left(\mathrm{J} \cdot \frac{\mathrm{m}^2}{\mathrm{s}} \right) = 2.76294215\mathrm{E}-07 \left(\mathrm{J} \cdot \frac{\mathrm{m}^2}{\mathrm{s}} \right) \quad (124)$$

$$hc^2 \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) = \frac{\pi}{4.5} \times \frac{h}{m_p \times k_{L0}} \times \frac{h}{m_e \times k_{L0}} \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) = 5.95521\mathrm{E}-17 \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) \quad (125)$$

$$\frac{kT_c}{\alpha} \times k_{L0} \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) = \frac{1}{2\pi} \times \frac{\pi}{4.5} \times \frac{h}{m_p \times k_{L0}} \times \frac{h}{m_e \times k_{L0}} \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) = 9.47801882\mathrm{E}-18 \left(\frac{\mathrm{J} \cdot \mathrm{m}^2}{\mathrm{s}} \right) \quad (126)$$

$$G_{N\_new} \left(\frac{\mathrm{m}^3}{\mathrm{s}^2} \right) = \alpha c \frac{4.5(1)}{4\pi(1)} \times \left(\frac{h}{m_p \times k_{L0}} \right)^2 \times k_{L0} \left(\frac{\mathrm{m}^3}{\mathrm{s}^2} \right) = 6.6891752\mathrm{E}-11 \left(\frac{\mathrm{m}^3}{\mathrm{kg} \cdot \mathrm{s}^2} \right) \quad (127)$$

Then, Equation (127) can be written as follows:

$$G_{new}\left(\frac{\mathrm{m}^3}{\mathrm{kg}\cdot\mathrm{s}^2}\right)=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p\times k_{L0}}\right)^2\times\frac{k_{L0}}{1\ \mathrm{kg}}=6.6891752\mathrm{E}-11\left(\frac{\mathrm{m}^3}{\mathrm{kg}\cdot\mathrm{s}^2}\right)\quad(128)$$

Therefore,

$$\begin{aligned}G_{new}\left(\frac{\mathrm{m}^3}{\mathrm{kg}_{\mathrm{standard}}\cdot\mathrm{s}^2}\right)&=\alpha c\frac{4.5(1)}{4\pi(1)}\times\left(\frac{h}{m_p\times k_{L0}}\right)^2\times\frac{1\left(\mathrm{m}^2\cdot\mathrm{s}^{-1}\right)}{1\ \mathrm{kg}_{\mathrm{standard}}}\\&=3.639485\mathrm{E}-14\left(\frac{\mathrm{m}^3}{\mathrm{kg}_{\mathrm{standard}}\cdot\mathrm{s}^2}\right)\end{aligned}\quad(129)$$

In Equation (129), k_{L0} disappears. However, when 1 $\mathrm{kg}_{\mathrm{standard}}$ is compensated, the calculated value remains greater than the accepted value. Perhaps a suitable coefficient is needed.

4.4. Verification of the List

For convenience, Equations (1)-(3) are rewritten and recalculated as follows:

$$\frac{Gm_p^2}{hc}\times k_{L0}(1)=\frac{4.5}{2}\times\frac{kT_c}{1\ \mathrm{kg}_{\mathrm{standard}}\times c^2}\times k_{L0}(1)=1.7315060\mathrm{E}-36\quad(130)$$

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)}\times k_{L0}(1)=\frac{4.5}{2\pi}\times\frac{m_e}{e}\times hc\times\frac{k_{L0}(1)}{1\ \mathrm{kg}_{\mathrm{standard}}}=1.4908658\mathrm{E}-33\quad(131)$$

$$\frac{m_ec^2}{e}\times\left(\frac{e^2}{4\pi\varepsilon_0}\right)\times k_{L0}(1)=\pi\times kT_c\times k_{L0}(1)=2.17286512\mathrm{E}-19\quad(132)$$

Consequently, the modified list can be verified.

5. Conclusions

We proposed Equation (12), which is very simple, and comprehensively compared it with equations derived from a past study. The calculated value was 2.7256307 K, and the observed value was 2.72548 ± 0.00057 K. In a previous study, we tried to validate Equation (12) independent of the MKSA unit system. Afterward, the units of C were changed without any explanation. A reviewer noted the error. However, we could not fix the error immediately. Furthermore, in the previous report, Equations (52) and (53) were used to prove Equation (12), which should have been avoided for a distinct proof. The redefined values should not have been used.

We thought that these errors were not fundamental flaws but rather interpretation problems. The reason is that there were no intentional embedded coefficients in Equation (12). In this report, we propose a correct proof for Equation (12) with an explanation of the relationship between macroscopic units and microscopic units. This method seems to be a classical approach, but no one has pointed out this relationship.

Furthermore, we proposed the use of a Lorentz-invariant mass. Utilizing this concept, we attempted to explain the meaning of the Compton length. The operation of dividing by the speed of light was performed to express meters in the MKSA unit system. Without dividing by the speed of light, the Compton length is related to time. The real meaning of K_{l0} is related to 1837.94538 seconds, which is expressed in MKSA units. We tried to explain the relationship between Einstein's famous two equations.

Our expression for the number of particles seems to be unusual and can change with changing K_{l0}. The list given in Section 2.5.1 can be modified and verified. Then, the gravitational constant G can be expressed without using K_{l0}. However, the calculated value in G when 1 kg is compensated remains greater than the accepted value. A suitable coefficient may be needed.

Conflicts of Interest

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

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Appendix

In this section, we clarify the two roles of k_{L0} in the redefinition method, which is difficult to understand.

Role1: Changing the definition of 1Ω (a macroscopic unit)

Role2: Changing the definition of 1 kg (a macroscopic unit)

Appendix A1. Changing the Definition of 1Ω (a Macroscopic Unit)

By utilizing macroscopic units and microscopic units,

$$\begin{aligned}(Rk)_{new} &= \frac{25957.9968739}{25812.807459} = \frac{4.5}{4.4873976} \times \frac{\pi}{3.1327945} \\ &= 1.005624705 \times (Rk)_{\text{MKSA}}\end{aligned} \tag{A1}$$

$$1(\Omega)_{new} = \frac{1}{1.005624705} \times 1(\Omega)_{\text{MKSA}} \tag{A2}$$

Therefore,

$$(Z_0)_{new} = \frac{378.8493104}{376.7303137} \times (Z_0)_{\text{MKSA}} = 1.005624705 \times (Z_0)_{\text{MKSA}} \tag{A3}$$

$$(\varepsilon_0)_{new} = \frac{8.8541878\text{E}-12}{8.8046642\text{E}-12} \times (\varepsilon_0)_{\text{MKSA}} = \frac{1}{1.005624705} \times (\varepsilon_0)_{\text{MKSA}} \tag{A4}$$

$$(\mu_0)_{new} = \frac{1.2637053\text{E}-06}{1.2566370\text{E}-06} \times (\mu_0)_{\text{MKSA}} = 1.005624705 \times (\mu_0)_{\text{MKSA}} \tag{A5}$$

$$(e)_{new} = \frac{1.59768967\text{E}-19}{1.60217663\text{E}-19} \times (e)_{\text{MKSA}} = \frac{1}{\sqrt{1.005624705}} \times (e)_{\text{MKSA}} \tag{A6}$$

Afterward, the following equation was used.

$$\left(\frac{e^2}{\varepsilon_0}\right)_{new} = \frac{\left(\sqrt{1.005624705}\right)^2}{1.005624705} = \left(\frac{e^2}{\varepsilon_0}\right)_{\text{MKSA}} \tag{A7}$$

$$(q_m)_{new} = \frac{4.14728234\text{E}-15}{4.13566770\text{E}-15} \times (q_m)_{\text{MKSA}} = \sqrt{1.005624705} \times (q_m)_{\text{MKSA}} \tag{A8}$$

Appendix A2. Changing the Definition of 1 kg (a Macroscopic Unit)

By utilizing macroscopic units and microscopic units,

$$1\,\text{kg}_{\text{standard}} = 1\,\text{kg}_{\text{MKSA}} \times k_{L0}(1)^{-1} = 5.44086\text{E}-04(\text{kg})_{\text{MKSA}} \tag{A9}$$

$$M_{\text{min\_standard}} = M_{\text{min}} \times k_{L0}(1) = 6.62607015\text{E}-34(\text{kg})_{\text{MKSA}} \tag{A10}$$

Appendix A3. Conclusion

From (A10), 6.62607015E−34 ($\text{kg}\cdot\text{m}^2\cdot\text{s}^{-1}$) is the Planck constant. Due to satisfy the conditions, using the following Equations, k_{L0} can be uniquely determined within the MKSA unit system.

$$\frac{4.4873976}{4.5} \times \frac{\pi}{3.1327945} = 1 \tag{A11}$$