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Simplification of Various Empirical Equations for the Electromagnetic Force in Terms of the Cosmic Microwave Background Temperature

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Abstract

Previously, we presented several empirical equations using the temperature of the cosmic microwave background (CMB), which were simple and mathematically connected. Next, we proposed an empirical equation for the fine-structure constant. Considering the compatibility among these empirical equations, the values of the CMB temperature (T_c) and the gravitational constant (G) were calculated to be 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 4.48852 and 3.13201, respectively. Using the redefinition of Avogadro's number and the Faraday constant, we explained that these values can be adjusted back to 9/2 and π. However, our arguments have become quite complex. Thus, we now attempt to simplify these empirical equations. We show that 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.

Keywords

Gravitational Constant, Temperature of the Cosmic Microwave Background

1. Introduction

The symbol list is shown in Section 2. We previously discovered Equations (1), (2) and (3) [1] [2] and [3] expressed in terms of the temperature of the CMB, which appear to be simple and mathematically connected [3]. We then attempted to reduce their errors by modifying the values of 4.5, π and the CMB temperature (T_c) [4] [5].

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

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

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

Next, we discovered an empirical equation for the fine-structure constant [6].

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

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

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

$$3.13201(\text{V}\cdot\text{m}) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_e c^2}{ec} \left(\frac{\text{m}^2}{\text{s}} \times \frac{\text{J}}{\text{A}\cdot\text{m}} = \frac{\text{J}\cdot\text{m}}{\text{C}} = \text{V}\cdot\text{m}\right) \tag{6}$$

$$4.48852\left(\frac{1}{\text{A}\cdot\text{m}}\right) = \frac{q_m c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_p c^2} \left(\frac{\text{s}}{\text{m}^2} \times \frac{\text{V}\cdot\text{m}}{\text{J}} = \frac{\text{V}}{\text{J}} \times \frac{\text{s}}{\text{m}} = \frac{\text{s}}{\text{C}\cdot\text{m}} = \frac{1}{\text{A}\cdot\text{m}}\right) \tag{7}$$

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

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

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

Our first purpose is to simplify these equations, and we have attempted to explain them using thermodynamic principles discovered in the area of solid-state ionics. Unfortunately, the background theory could not be completed. Furthermore, our discussions have become quite complex. Therefore, the purpose of this report is to simplify these equations. 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 discuss the purpose of this report. In Section 4, we propose six equations that are functions of the Compton length of an electron (λ_e), the Compton length of a proton (λ_p) and α. In Section 5, using these six equations, we explain our main equations. The compatibility with the theory of special relativity is discussed. In Section 6, our conclusions are described.

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 use the compensated value 6.673778 × 10^{-11} in this report)
T_c: temperature of the CMB: 2.72548 (K)
(we use the compensated value 2.726312 K in this report)
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 × 10^{-34} (J·s)
ε_0: electric constant: 8.8541878128 × 10^{-12} ($N \cdot m^2 \cdot C^{-2}$)
μ_0: magnetic constant: 1.25663706212 × 10^{-6} ($N \cdot A^{-2}$)
e: electric charge of one electron: −1.602176634 × 10^{-19} (C)
q_m: magnetic charge of one magnetic monopole: 4.13566770 × 10^{-15} (Wb)
(this value is only a theoretical value, $q_m = h/e$)
m_p: rest mass of a proton:1.6726219059 × 10^{-27} (kg)
(we use the compensated value 1.672621923 × 10^{-27} kg in this report)
m_e: rest mass of an electron: 9.1093837 × 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 × 10^{-12} (m)

2.2. Symbol List after Redefinition

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

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

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

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

We observe that Equation (13) can be rewritten as follows.

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

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

We observe that Equation (15) can be rewritten as follows.

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

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

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

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

In Equation (19), the value of the speed of light should not be changed because the units for 1 m and 1 s are unchanged. 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), the Planck constant is changed. Therefore, the unit for the masses of one electron and one proton should be redefined.

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

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

From the dimensional analysis in the previous report [9],

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

Next, to simplify the calculation, G_N is defined as follows.

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

Now, we hope that the value of G_N should remain unchanged. However, according to the dimensional analysis in the previous report [9], G_N should change, which will be explained in a later section.

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

3. Purpose

As a result of our previously proposed redefinition method [9], our calculations become very complex.

Procedure 1: The MKSA units should be redefined.

Procedure 2: The equations should be recalculated using the redefined values.

Procedure 3: The calculated values should be converted back to the MKSA units.

For convenience, Equations (8) and (9) are rewritten as follows.

$$\pi\left(\text{V}\cdot\text{m}\right) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{e\_new} c^2}{e_{new} c}\left(\text{V}\cdot\text{m}\right) \tag{26}$$

$$4.5\left(\frac{1}{\text{A}\cdot\text{m}}\right) = \frac{q_{m\_new} c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{p\_new} c^2}\left(\frac{1}{\text{A}\cdot\text{m}}\right) \tag{27}$$

We observe that the coefficient $\left(\frac{m_p}{m_e}+\frac{4}{3}\right)$ cannot be uniquely determined. For example, $\left(\frac{m_p}{m_e}+\frac{3.78}{3}\right)$ is allowed. In this case, the value of G should be 6.67431E−11, which may be a more suitable value. However, the calculated value of T_c is then 2.72642 K and becomes larger than the observed value. The purpose of this report is to simplify every equation to elucidate the redefinition method. To simplify very complex calculations from the unexpected original aspects is useful to combine two different theories to give a single unified theory [10] [11].

4. Methods

4.1. Six Equations Expressed in Terms of the Compton Length of an Electron (λ_e), the Compton Length of a Proton (λ_p) and α

We propose the following 6 equations. After redefinition, the Compton wavelength (λ) is unchanged. Therefore, the right side of each of these equations should be constant.

$$m_{e\_new}c^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2\left(\frac{\text{J}\cdot\text{m}^4}{\text{s}^2}\right) = \frac{\pi}{4.5}\left(\text{V}\cdot\text{m}\cdot\text{A}\cdot\text{m}=\frac{\text{J}\cdot\text{m}^2}{\text{s}}\right)\times\lambda_p c\left(\frac{\text{m}^2}{\text{s}}\right)=2.76564\text{E}-07\left(\frac{\text{J}\cdot\text{m}^4}{\text{s}^2}\right)=\text{constant} \quad (28)$$

$$e_{new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\text{A}\cdot\text{m}^3}{\text{s}}\right) = \frac{1}{4.5}(\text{A}\cdot\text{m})\times\lambda_p c\left(\frac{\text{m}^2}{\text{s}}\right)=8.80330\text{E}-08\left(\frac{\text{A}\cdot\text{m}^3}{\text{s}}\right)=\text{constant} \quad (29)$$

$$m_{p\_new}c^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2\left(\frac{\text{J}\cdot\text{m}^4}{\text{s}^2}\right) = \frac{\pi}{4.5}\left(\frac{\text{J}\cdot\text{m}^2}{\text{s}}\right)\times\lambda_e c\left(\frac{\text{m}^2}{\text{s}}\right)=5.07814\text{E}-04\left(\frac{\text{J}\cdot\text{m}^4}{\text{s}^2}\right)=\text{constant} \quad (30)$$

$$q_{m\_new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\text{V}\cdot\text{m}^3}{\text{s}}\right) = \pi(\text{V}\cdot\text{m})\times\lambda_e c\left(\frac{\text{m}^2}{\text{s}}\right)=2.28516\text{E}-03\left(\frac{\text{V}\cdot\text{m}^3}{\text{s}}\right)=\text{constant} \quad (31)$$

$$kT_{c\_new}\times\frac{2\pi}{\alpha}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^3\left(\frac{\text{J}\cdot\text{m}^6}{\text{s}^3}\right) = \frac{\pi}{4.5}\left(\frac{\text{J}\cdot\text{m}^2}{\text{s}}\right)\times\lambda_p c\times\lambda_e c=2.011697\text{E}-10\left(\frac{\text{J}\cdot\text{m}^6}{\text{s}^3}\right)=\text{constant} \quad (32)$$

$$G_{N\_new}\left(\frac{m^3}{s^2}\right)\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)\left(\frac{\text{m}^2}{\text{s}}\right) = \left(\lambda_p c\right)^2\left(\frac{\text{m}^4}{\text{s}^2}\right)\times c\left(\frac{\text{m}}{\text{s}}\right)\times\frac{9\alpha}{8\pi}=1.22943\text{E}-07\left(\frac{\text{m}^5}{\text{s}^3}\right)=\text{constant} \quad (33)$$

4.2. The Main Problem and the Solution in This Method

Every equation is written using the values after redefinition. However, the calculated values should be converted back to the MKSA units. The main problem is Equation (25). For convenience, Equation (25) is rewritten as follows.

$$G_{N\_new} = G_N \times \frac{4.5}{4.48852}\left(\mathrm{m}^3 \cdot \mathrm{s}^{-2}\right) = 6.69084770\mathrm{E}-11\left(\mathrm{m}^3 \cdot \mathrm{s}^{-2}\right) \tag{34}$$

To explain Equation (34), we have discovered the following equations.

$$\frac{m_{e\_new}}{e_{new}} = \frac{m_e}{e} \times \frac{\pi}{3.13201} \tag{35}$$

It means that the mass-to-charge ratio should be changed. But the ratio between the number of electrons in 1C and the number of electrons in 1kg should not be changed. Therefore,

$$\frac{1C_{new}}{1C} = \frac{e}{e_{new}} = \frac{4.5}{4.48852} \tag{36a}$$

$$\frac{1kg_{new}}{1kg} = \frac{e}{e_{new}} = \frac{m_e}{m_{e\_new}} \times \frac{\pi}{3.13201} = \frac{4.5}{4.48852} \times \frac{3.13201}{\pi} \times \frac{\pi}{3.13201} = \frac{4.5}{4.48852} \tag{36b}$$

Therefore,

$$\frac{G_N}{1kg} = \frac{G_{N\_new}}{1kg_{new}} \times \frac{4.48852}{4.5}\left(\frac{m^3 s^{-2}}{kg}\right) = 6.6737778667\mathrm{E}-11\left(\frac{m^3 s^{-2}}{kg}\right) \tag{37}$$

Therefore, the associated problem can be solved.

5. Results

From this section onward, the values used are those obtained after redefinition. Strictly speaking, therefore, m_e should be written as m_{e_new}. However, we omit the subscript "new" to avoid unnecessarily notational complexity.

5.1. Explanation of Our First Equation

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

$$\frac{Gm_p^2}{hc} = \frac{4.5}{2} \times \frac{kT_c}{1\,\mathrm{kg} \times c^2} \tag{38}$$

$$\frac{G_N m_p^2}{hc} = \frac{4.5}{2} \times \frac{kT_c}{c^2} \tag{39}$$

Using Equations (28)-(33), the left side is rewritten as

$$\frac{G_N m_p^2}{hc} = \frac{\left(\lambda_p c\right)^2 \times c \times \frac{9\alpha}{8\pi} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \times \left\{\frac{\pi}{4.5} \times \lambda_e c^{-1} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2}\right\}^2}{\frac{1}{4.5} \times \lambda_p \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \times \pi \times \lambda_e \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \times c} \tag{40}$$

Therefore,

$$\frac{G_N m_p^2}{hc} = \lambda_p \times \lambda_e \times \frac{\alpha}{4} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{41}$$

The right side is

$$\frac{4.5}{2} \times \frac{kT_c}{c^2} = \frac{4.5}{2c^2} \times \frac{\lambda_p c}{9} \times \lambda_e c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \times \alpha = \lambda_p \times \lambda_e \times \frac{\alpha}{4} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{42}$$

From Equations (41) and (42), we obtain

$$\frac{Gm_p^2}{hc} = \frac{4.5}{2} \times \frac{kT_c}{1\,\text{kg} \times c^2} \tag{43}$$

5.2. Explanation of Our Second Equation

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

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times hc \times \left(\frac{\text{C}}{\text{J} \cdot \text{m}} \times \frac{1}{\text{kg}} = \frac{1}{\text{V} \cdot \text{m}} \times \frac{1}{\text{kg}}\right) \tag{44}$$

Therefore,

$$\frac{G_N m_p^2}{hc} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) \tag{45}$$

According to Equation (41), the left side is

$$\frac{G_N m_p^2}{hc} = \lambda_p \times \lambda_e \times \frac{\alpha}{4} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{46}$$

Regarding the right side,

$$\frac{4.5}{2\pi} \times \frac{m_e}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \frac{4.5}{2\pi} \times m_e \times \frac{ec}{4\pi\varepsilon_0 c} = \frac{4.5}{2\pi} \times m_e \times \frac{ec}{4\pi} \times Z_0 \tag{47}$$

For convenience, Equation (16) is rewritten as follows.

$$Z_0 = 9\pi \times \alpha \times \frac{m_p}{m_e} \tag{48}$$

Therefore,

$$\frac{4.5}{2\pi} \times \frac{m_e}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \frac{4.5}{2\pi} \times m_e \times \frac{ec}{4\pi} \times 9\pi \times \alpha \times \frac{m_p}{m_e} = \frac{4.5}{8\pi} \times 9m_p \times ec \times \alpha \tag{49}$$

Hence,

$$\frac{4.5}{8\pi} \times 9\alpha \times ec \times m_p = \frac{\alpha}{4} \times \lambda_e \times \lambda_p \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{50}$$

From Equations (46) and (50), we obtain

$$\frac{G_N m_p^2}{hc} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) \tag{51}$$

Therefore,

$$\frac{Gm_p^2}{\left(\dfrac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.5}{2\pi} \times \frac{m_e}{e} \times hc \tag{52}$$

5.3. Explanation of Our Third Equation

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

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \pi \times kT_c \times \left(\frac{\mathrm{J}\cdot\mathrm{m}}{\mathrm{C}} = \mathrm{V}\cdot\mathrm{m}\right) \tag{53}$$

The left side is

$$m_e c^2 \times \frac{e}{4\pi\varepsilon_0} = m_e c^2 \times \frac{ec}{4\pi\varepsilon_0 c} = m_e c^2 \times \frac{ec}{4\pi} \times Z_0 \tag{54}$$

Therefore, using Equation (48), we obtain

$$m_e c^2 \times \frac{ec}{4\pi} \times Z_0 = m_e c^2 \times \frac{ec}{4\pi} \times 9\pi \times \alpha \times \frac{m_p}{m_e} = m_p c^2 \times ec \times \frac{9}{4}\alpha \tag{55}$$

Using Equations (29) and (30), we obtain

$$m_p c^2 \times ec \times \frac{9}{4}\alpha = \frac{\pi}{4.5} \times \lambda_e c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2} \times \frac{1}{4.5} \times \lambda_p c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \times \frac{9}{4}\alpha \tag{56}$$

Therefore,

$$m_p c^2 \times ec \times \frac{9}{4}\alpha = \frac{\pi\alpha}{9} \times \lambda_e c \times \lambda_p c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{57}$$

The right side is

$$\pi \times kT = \frac{\pi\alpha}{9} \times \lambda_e c \times \lambda_p c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{58}$$

From Equations (57) and (58), we obtain

$$m_e c^2 \times \frac{e}{4\pi\varepsilon_0} = \pi \times kT_c \tag{59}$$

5.4. Other Important Equations

We attempt to prove the following Equation (60).

$$\frac{kT_c}{\dfrac{e^2 c}{4\pi\varepsilon_0}} = \frac{1}{1837.485988}\left(\frac{\mathrm{s}^2}{\mathrm{m}}\right) = \frac{1}{\left(\dfrac{m_p}{m_e} + \dfrac{4}{3}\right)}\left(\frac{\mathrm{s}^2}{\mathrm{m}}\right) \tag{60}$$

$$\begin{aligned}\frac{e^2 c}{4\pi\varepsilon_0} &= \frac{e^2 c^2}{4\pi} \times Z_0 = \frac{1}{4\pi} \times \left\{\frac{1}{4.5} \times \lambda_p c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1}\right\}^2 \times 9\pi\alpha \times \frac{\lambda_e}{\lambda_p} \\ &= \frac{\alpha}{9}\lambda_p \lambda_e c^2 \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2}\end{aligned} \tag{61}$$

According to Equation (32),

$$kT_c = \frac{\alpha}{9} \times \lambda_e c \times \lambda_p c \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-3} \tag{62}$$

From Equations (61) and (62), we obtain

$$\frac{kT_c}{\frac{e^2 c}{4\pi\varepsilon_0}} = \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-1} \tag{63}$$

We attempt to prove the following Equation (64).

$$\frac{9 \times m_e \times m_p \times c^2}{2\pi h} = \frac{9 \times m_e \times m_p \times c^2}{2\pi\left(e \times q_m\right)} = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)^2} = 2.96177\text{E}-07 \tag{64}$$

From Equations (28)-(31), we obtain

$$\begin{aligned} &\frac{9 \times m_e \times m_p \times c^2}{2\pi h} \\ &= \frac{9}{2\pi} \times \frac{\pi}{4.5} \times \lambda_p c \times \frac{\pi}{4.5} \times \lambda_e c \times \left(\frac{1}{4.5} \times \lambda_p c \times \pi \times \lambda_e c\right)^{-1} \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2} \end{aligned} \tag{65}$$

Therefore,

$$\frac{9 \times m_e \times m_p \times c^2}{2\pi h} = \left(\frac{m_p}{m_e} + \frac{4}{3}\right)^{-2} \tag{66}$$

5.5. Compatibility with the Theory of Special Relativity

For convenience, Equation (8) is rewritten as follows.

$$\pi\left(\text{V} \cdot \text{m}\right) = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_{e\_new} c^2}{e_{new} c} \left(\text{V} \cdot \text{m}\right) \tag{67}$$

According to the theory of special relativity, the value of the electric charge should not be changed.

$$m_{e\_new} c^2 \times \left(\frac{m_p}{m_e} + \frac{4}{3}\right) = \pi \times e_{new} c \tag{68}$$

However, according to special relativity, the mass should be increased.

$$\left(\frac{m_p}{m_e} + \frac{4}{3}\right) \frac{m_e c^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = ec \times \pi \tag{69}$$

where v is the velocity. Then, $\left(\frac{m_p}{m_e} + \frac{4}{3}\right)$ has units of $\left(\frac{\text{m}^2}{\text{s}}\right)$. Therefore,

$$\left\{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) \times \sqrt{1 - \left(\frac{v}{c}\right)^2}\right\} \times \frac{m_e c^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = ec \times \pi = \text{unchanged} \tag{70}$$

Hence, when $\left(\frac{m_p}{m_e}+\frac{4}{3}\right)$ is unchanged, compatibility with special relativity is maintained.

6. Conclusions

Our first purpose is to simplify our equations, and we have attempted to explain them using thermodynamic principles discovered in the area of solid-state ionics. Unfortunately, the background theory could not be completed. Furthermore, our discussions have become complex. Therefore, the purpose of the report is to simplify these equations. In this report, we attempt to simplify our empirical equations by proposing the following six equations.

$$m_{e\_new}c^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2=\frac{\pi}{4.5}\times\lambda_p c=2.7656397\text{E}-07=\text{constant} \tag{71}$$

$$e_{new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\frac{1}{4.5}\times\lambda_p c=8.80330473\text{E}-08=\text{constant} \tag{72}$$

$$m_{p\_new}c^2\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^2=\frac{\pi}{4.5}\times\lambda_e c=5.07814\text{E}-04=\text{constant} \tag{73}$$

$$q_{m\_new}c\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\pi\times\lambda_e c=2.28516154\text{E}-03=\text{constant} \tag{74}$$

$$kT_{c\_new}\times\frac{2\pi}{\alpha}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)^3=\frac{\pi}{4.5}\times\lambda_p c\times\lambda_e c=2.011697\text{E}-10=\text{constant} \tag{75}$$

$$G_{N\_new}\times\left(\frac{m_p}{m_e}+\frac{4}{3}\right)=\left(\lambda_p c\right)^2\times c\times\frac{9\alpha}{8\pi}=1.22943389\text{E}-07=\text{constant} \tag{76}$$

Regarding Equation (76), to solve the associated problem, the following expression is also proposed.

$$\frac{G_N}{1kg}=\frac{G_{N\_new}}{1kg_{new}}\times\frac{4.48852}{4.5}\left(\frac{m^3s^{-2}}{kg}\right)=6.6737778667\text{E}-11\left(\frac{m^3s^{-2}}{kg}\right) \tag{77}$$

Using these six equations, we have proven our three main equations and two other important equations. Furthermore, the compatibility with the theory of special relativity is discussed.

Conflicts of Interest

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

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