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A Fine-Structure Constant Can Be Explained Using the Electrochemical Method

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Abstract

We proposed an empirical equation for a fine-structure constant: $137.0359991 = 136.0113077 + 1 + \frac{1}{3 \times 13.5}$. Then, $13.5 \times 136.0113077 = 1836.152654 = \frac{m_p}{m_e}$. where m_p and m_e are the rest mass of a proton and the rest mass of an electron, respectively. In this report, using the electrochemical method, we proposed an equivalent circuit. Then, we proposed a refined version of our own old empirical equations about the electromagnetic force and gravity. Regarding the factors of 9/2 and π, we used 3.132011447 and 4.488519503, respectively. The calculated values of T_c and G are 2.726312 K and 6.673778 × 10^{-11} ($m^3 \cdot kg^{-1} \cdot s^{-2}$).

Keywords

Fine-Structure Constant, Electrochemical Method

1. Introduction

The symbol list is shown in Section 2. We discovered Equation 1 [1] [2] and [3], which appeared very simple. Equations (1)-(3) were mathematically connected [3]. However, we could not establish the background theory. Furthermore, there appeared to be dimension mismatch problems.

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

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

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \pi k T_c \times \left(1\,\frac{\mathrm{J \cdot m}}{\mathrm{C}}\right) \tag{3}$$

These equations have small errors of approximately 10^{-3} and 10^{-4} [3]. We attempted to reduce the errors in the previous reports by changing the factors of 4.5, π and T_c [4] [5]. Regarding the factors of 9/2 and π, we used 4.48870 and 3.13189, respectively. Then, the errors became smaller than 10^{-5}.

Then, 4.48870 and 3.13189 Ω are connected as follows.

$$\frac{m_p}{m_e} = \frac{1}{4.4887 \times 3.13189\ \Omega} \frac{q_m}{e} \tag{4}$$

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

$$137.0359991 = 136.0113077 + \frac{1}{3 \times 13.5} + 1 \tag{5}$$

$$13.5 \times 136.0113077 = 1836.152654 = \frac{m_p}{m_e} \tag{6}$$

To explain 136.0113077, we proposed the following values.

$$3.131777037(\Omega) = \frac{Rk}{(3 \times 136.0113077)^{1.5}} \tag{7}$$

$$4.488855463 = \sqrt{\frac{136.0113077 \times 4}{27}} \tag{8}$$

However, Equations (7) and (8) cannot be compatible with Equations (5) and (6). Main purpose of this report is to improve the compatibility between these equations.

The remainder of the paper is organized as follows. In Section 2, we show the symbol list. In Section 3, we reconsider the deviation from the factors of 9/2 and π. In Section 4, using the electrochemical method, we propose the equivalent circuit for the fine structure constant. In Section 5, we refine our three equations. In Section 6, general discussions are presented, which are mainly about the UNIT.

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

G gravitational constant: 6.6743 × 10^{-11} ($\mathrm{m^3 \cdot kg^{-1} \cdot s^{-2}}$)
(we used the compensated value 6.673778 × 10^{-11} in this 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} ($\mathrm{J\ K^{-1}}$)

c speed of light: 299,792,458 (m/s)

h Planck constant: 6.62607015 × 10^{-34} (Js)

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

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

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 used 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

3. Reconsideration for the Deviation from 4.5 and π

In this section, we reconsider the deviation from 4.5 and π. We notice that 4.48870 and 3.1319 can be rewritten as follows.

$$4.48870 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3.854377987}\right) m_p c^2} \tag{9}$$

For example, Equation (9) can be made sure as follows.

$$4.48870 = \frac{4.13567 \times 10^{-15} \times 299792458}{\left(1836.15 + 1 + \frac{1}{3.854377987}\right) \times 1.50328 \times 10^{-10}} \tag{10}$$

$$3.13189\ \Omega = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3.854377987}\right) m_e c^2}{ec} \tag{11}$$

Next, the deviation from 4.5 and π can be explained as follows.

$$\frac{4.5}{\pi} \times \frac{3.13189}{4.48870} = 0.999421207 \doteq 1 \tag{12}$$

Regarding the values for 3.131777037 and 4.88855463,

$$4.488855463 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{5.106991198}\right) m_p c^2} \tag{13}$$

$$3.1317770\ \Omega = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{5.106991198}\right) \times m_e c^2}{ec} \tag{14}$$

Next, the deviation from 4.5 and π can be explained as follows.

$$\frac{4.5}{\pi} \times \frac{3.1317770}{4.488855463} = 0.999350548 \doteq 1 \tag{15}$$

Therefore, using X, the deviation should be rewritten as follows.

$$3.1317770 = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{X}\right) \times m_e c^2}{ec} \tag{16}$$

$$4.488855463 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{X}\right) m_p c^2} \tag{17}$$

The value of 4.5 is from the degree of freedom as 9/2. Therefore, 4.488855 should be dimensionless.

$$\left(\frac{m_p}{m_e}+1+\frac{1}{X}\right)=\frac{q_m c}{4.488855463\times m_p c^2}=\frac{\mathrm{Wb\cdot m/s}}{\mathrm{J}}=\frac{\mathrm{Wb\cdot m}}{\mathrm{J\cdot s}}=\frac{\mathrm{m}}{\mathrm{C}} \tag{18}$$

The correct value of X and the UNIT will be discussed in detail in a later section.

4. Equivalent Circuit of the Fine Structure Constant with the Electrochemical Method

4.1. Explanation Using the Transference Number

For convenience, Equations (5) and (6) are rewritten as follows:

$$137.0359991=136.0113077+1+\frac{1}{3\times 13.5} \tag{19}$$

$$13.5\times 136.0113077=1836.152654=\frac{m_p}{m_e} \tag{20}$$

We strongly believe that the fine structure constant should be explained by the transference number [7]. According to Rickert [8],

$$J_1=L_{11}grad\frac{\eta_1}{T}+L_{12}grad\frac{\eta_2}{T} \tag{21}$$

$$J_2=L_{21}grad\frac{\eta_1}{T}+L_{22}grad\frac{\eta_2}{T} \tag{22}$$

where J_1 and J_2 are the current densities of two different carriers; η_1 and η_2 are the electrochemical potentials of the two different carriers; L_{11}, L_{12}, L_{21}, and L_{22} are Onsagar coefficients.

In the area of solid-state ionics, Rickert proposed the following equation.

$$L_{12}=L_{21}=0 \tag{23}$$

Then, the transference number (t_1 and t_2) can be explained as follows.

$$t_1=\frac{R_2}{R_1+R_2} \tag{24}$$

$$t_2=\frac{R_1}{R_1+R_2} \tag{25}$$

where R_1 and R_2 are different resistance values. Next, we consider the following equation.

$$\begin{pmatrix}V_1\\V_2\end{pmatrix}=Z_1\times\begin{pmatrix}1 & -\frac{1}{81}\\ -\frac{1}{81} & 136.0113077\end{pmatrix}\begin{pmatrix}I_1\\I_2\end{pmatrix} \tag{26}$$

where V_1 and V_2 are the voltage losses due to different carriers; I_1 and I_2 are the currents due to different carriers; Z_1 is the resistance, which will be explained later. In Equation (26), using an inverse of the matrix, Onsager coefficients can be obtained. Because the derivation is too complex to show here, we have:

$$V_1 = Z_1 \times I_1 - \frac{Z_1}{81} \times I_2 \tag{27}$$

$$V_2 = -\frac{Z_1}{81} \times I_1 + Z_1 \times 136.0113077 \times I_2 \tag{28}$$

Next, we consider the following situation, which implies the open circuit condition.

$$I_1 = -I_2 \tag{29}$$

Therefore, the theoretical voltage (V_{th}) is,

$$V_{th} = V_1 - V_2 = Z_1 \times \left(136.0113077 + 1 + \frac{1}{3 \times 13.5}\right) \times I_1 \tag{30}$$

In Equation (30), $-V_2$ is the voltage loss due to the opposite drift (not diffusion) current (I_2). Thus, in Equation (30), we obtained the value of a fine-structure constant. For convenience, Equation (5) is rewritten as follows.

$$137.0359991 = 136.0113077 + 1 + \frac{1}{3 \times 13.5} \tag{31}$$

Next, we define the interaction voltage (V_3) as follows.

$$V_3 = \frac{Z_1}{81} \times I_1 \tag{32}$$

The transference number for the small voltage loss (V_1) is

$$t_1 = \frac{V_3 - V_2}{V_1 - V_2} = \frac{Z_1 \times \left(136.0113 + \frac{1}{3 \times 13.5}\right) \times I_1}{Z_1 \times \left(136.0113 + 1 + \frac{1}{3 \times 13.5}\right) \times I_1} = \frac{136.0359991}{137.0359991} \tag{33}$$

Therefore, the interaction coefficient is

$$1 - t_1 = 1 - \frac{136.0359991}{137.0359991} = \frac{1}{137.0359991} = \frac{1}{\alpha} \tag{34}$$

The transference number for the large voltage loss (V_2) is

$$t_2 = \frac{V_1 - V_3}{V_1 - V_2} = \frac{Z_1 \times I_1}{Z_1 \times \left(136.0113 + 1 + \frac{1}{3 \times 13.5}\right) \times I_1} = \frac{1}{137.0359991} \tag{35}$$

Equation 35 means the strong interaction. From Equations 33 and 35, V_3 should be transferred from the carriers with a large voltage loss (V_2) to those with the small voltage loss (V_1). From Equations (33) and (35),

$$t_1 + t_2 = \frac{136.0359991}{137.0359991} + \frac{1}{137.0359991} = 1 \tag{36}$$

4.2. Determination of the Important Resistance

The total resistance is Z_0, so the large resistance (Z_2) should be

$$Z_2 = Z_0 \times 137.035999081 = 2Rk \tag{37}$$

The small resistance is

$$Z_1 = Z_0 \times \frac{137.035999081}{136.0113077} = \frac{2Rk}{136.0113077} = 379.5685505\ \Omega \tag{38}$$

We discover Z_1 as follows:

$$Z_1 = 3^3 \times \frac{q_m}{e} \times \frac{m_e}{m_p} = 27 \times \frac{25812.807459}{1836.152654} = 379.5685505\ \Omega \tag{39}$$

Therefore, our argument is not a coincidence. From Equation (32), the interaction resistance (Z_3) should be

$$Z_3 = \frac{Z_1}{81} = \frac{1}{3} \times \frac{q_m}{e} \times \frac{m_e}{m_p} = 4.686031487\ \Omega \tag{40}$$

Consequently, Equation (26) can be rewritten as follows,

$$\begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} Z_1 & -Z_3 \\ -Z_3 & Z_2 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix} \tag{26b}$$

4.3. Suitable Charge and Equivalent Circuit

We are discussing the equivalent circuit at the quantum level. Clearly, one charge is an electron. However, it is difficult to search for the other charge. The suitable charge is

$$\frac{q_m}{Z_1} = 1.08957070 \times 10^{-17}\,(\mathrm{C}) = 68.00565 \times e \tag{41}$$

Because q_m has never been observed, the charge $+\frac{q_m}{Z_1}$ should be the set of an antiparticle $-\frac{q_m}{Z_1}$, which may be related to quarks. Then, we propose the equivalent circuit in **Figure 1**. The total charge is

$$\frac{2q_m}{Z_1} = 136.0113 \times e \tag{42}$$

When the charge $+\frac{q_m}{Z_1}$ cannot be realized at the low energy level, it cannot be observed as the mass.

The direction of $+\frac{q_m}{Z_1}$ is opposite to the electrical field, which may prevent the increase of the electrical field.

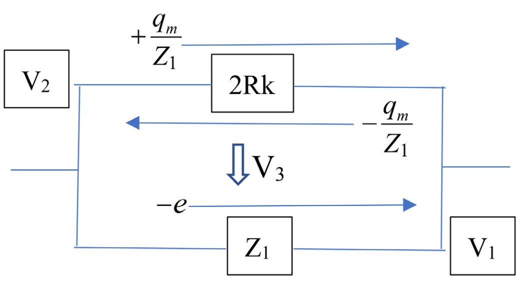

Figure 1. Equivalent circuit to explain the fine-structure constant.

5. Our Refined Three Empirical Equations

5.1. The Most Suitable Value for X

For convenience, Equations (5) and (6) are rewritten as follows:

$$137.0359991 = 136.0113077 + 1 + \frac{1}{3 \times 13.5} \tag{43}$$

$$13.5 \times 136.0113077 = 1836.152654 = \frac{m_p}{m_e} \tag{44}$$

For convenience, Equations (16) and (17) are rewritten as follows:

$$3.1317770\ \Omega = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{X}\right) \times m_e c^2}{ec} \tag{45}$$

$$4.488855463 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{X}\right) m_p c^2} \tag{46}$$

Then, we notice that X should be 3. Therefore,

$$3.132011447\ \Omega = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right) m_e c^2}{ec} = \frac{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_e c^2}{ec} = \frac{1837.48599 \times m_e c^2}{ec} \tag{47}$$

$$4.488519503 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right) m_p c^2} = \frac{q_m c}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right) m_p c^2} = \frac{q_m c}{1837.48599 \times m_p c^2} \tag{48}$$

Here, $4/3 m_e c^2$ is well known and has been discussed by Feynman. Next, the deviation from 4.5 and π can be explained as follows.

$$\frac{4.5}{\pi} \times \frac{3.132011447}{4.488519503} = 0.999500154 \doteq 1 \tag{49}$$

5.2. Determination of the Important Resistance

$\frac{1}{\frac{m_p}{m_e} + 1 + \frac{1}{3}} = \frac{1}{1837.485988}$ appears to be a transference number. The total resistance (Z_5), small resistance (Z_6), large resistance (Z_7) and interaction resistance (Z_8) can be defined.

$$Z_5 = 2 \times \frac{q_m}{e} \times \frac{1}{\frac{m_p}{m_e} + \frac{4}{3}} = 28.095787\ \Omega \tag{50}$$

$$Z_6 = 2 \times \frac{q_m}{e} \times \frac{m_e}{m_p} = \frac{2Rk}{1836.152654} = 28.11618892\ \Omega \tag{51}$$

$$Z_7 = 2 \times \frac{q_m}{e} = 2Rk \tag{52}$$

$$Z_8 = \frac{13.5}{81} \times Z_6 = \frac{13.5}{81} \times 2 \times \frac{q_m}{e} \times \frac{m_e}{m_p} = \frac{1}{3} \times \frac{q_m}{e} \times \frac{m_e}{m_p} = 4.686031487\ \Omega = Z_3 \quad (53)$$

Consequently, Z_8 is equal to Z_3.

5.3. Our Refined Three Empirical Equations

We use 2.726312143 K instead of 2.72548 K. We use 6.6737778665 × 10^{-11} $m^3 \cdot kg^{-1} \cdot s^{-2}$ instead of 6.6743 × 10^{-11} $m^3 \cdot kg^{-1} \cdot s^{-2}$. Equation (1) is refined as follows:

$$\frac{Gm_p^2}{hc} = \frac{4.488519503}{2} \frac{kT_c}{1\ \text{kg} \times c^2} \quad (54)$$

$$\frac{Gm_p^2}{hc} = \frac{6.6737778665 \times 10^{-11} \times \left(1.6726219 \times 10^{-27}\right)^2}{6.626070 \times 10^{-34} \times 2.9979246 \times 10^8} = 9.39919318 \times 10^{-40} \quad (55)$$

$$\frac{4.488519503}{2} \frac{kT_c}{1\ \text{kg} \times c^2} = \frac{4.488519503}{2} \times \frac{1.3806490 \times 10^{-23} \times 2.726312143}{\left(2.9979246 \times 10^8\right)^2} = 9.39919318 \times 10^{-40} \quad (56)$$

Equation (55) is equal to Equation (56). Therefore, the compensation method is perfect. Next, Equation (2) is refined as follows:

$$\frac{Gm_p^2}{\left(\frac{e^2}{4\pi\varepsilon_0}\right)} = \frac{4.488519503}{2 \times 3.132011447\ \Omega} \times \frac{m_e}{e} \times hc \times \left(1 \frac{\text{C} \cdot \Omega}{\text{J} \cdot \text{m}} \times \frac{1}{1\ \text{kg}}\right) \quad (57)$$

$$\frac{Gm_p^2}{\frac{e^2}{4\pi\varepsilon_0}} = \frac{6.6737778665 \times 10^{-11} \times \left(1.672621923 \times 10^{-27}\right)^2}{\frac{\left(1.60217663 \times 10^{-19}\right)^2}{4\pi \times 8.8541878 \times 10^{-12}}} = 8.0929175 \times 10^{-37} \quad (58)$$

$$\frac{4.488519503}{2 \times 3.132011447} \times \frac{m_e}{e} \times hc = \frac{4.488519503 \times 9.10938 \times 10^{-31} \times 1.986446 \times 10^{-25}}{2 \times 3.132011447 \times 1.602177 \times 10^{-19}} = 8.0929175 \times 10^{-37} \quad (59)$$

Equation (58) is equal to Equation (59). Therefore, the compensation method is perfect. Next, Equation (3) is refined as follows:

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = 3.132011447\ \Omega \times kT_c \times \left(1 \frac{\text{J} \cdot \text{m}}{\text{C} \cdot \Omega}\right) \quad (60)$$

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = \frac{9.10938 \times 10^{-31} \times \left(2.9979246 \times 10^8\right)^2 \times \left(1.60217663 \times 10^{-19}\right)^2}{1.60217663 \times 10^{-19} \times 4\pi \times 8.8541878 \times 10^{-12}} = 1.1789142 \times 10^{-22} \quad (61)$$

$$3.132011447 \times kT_c = 3.132011447 \times 1.3806490 \times 10^{-23} \times 2.726312143 = 1.1789142 \times 10^{-22} \quad (62)$$

Equation (61) is equal to Equation (62). Therefore, the compensation method is perfect.

6. Discussion

6.1. Dimension Mismatch Problem

For convenience, Equation (54) is rewritten as follows:

$$\frac{Gm_p^2}{hc} = \frac{4.488519503}{2} \frac{kT_c}{1\,\text{kg} \times c^2} \tag{63}$$

The value of 4.488519503 is the deviation from the degree of freedom 9/2, which is dimensionless.

Therefore, there are no dimension mismatch problems. For convenience, Equation (56) is rewritten as follows:

$$\frac{m_e c^2}{e} \times \left(\frac{e^2}{4\pi\varepsilon_0}\right) = 3.132011447\Omega \times kT_c \times \left(\frac{\text{J} \cdot \text{m}}{\text{C} \cdot \Omega} = Am\right) \tag{64}$$

In Equation (64), there remains the unexplained UNIT as "Am".

$$\frac{m_e c^2}{4\pi\varepsilon_0 c} = 3.132011447\ \Omega \times kT_c \times \frac{Am}{ec} \tag{65}$$

Therefore,

$$\frac{Z_0 \times m_e c^2}{3.132011447\ \Omega \times 4\pi} = kT_c \times \frac{Am}{ec} \tag{66}$$

In Equation (66), the UNITs of 1 J and 1 C can be separately defined. However,

$$1\ \text{J} = 6.241509 \times 10^{18}\ \text{eV} = 6.241509 \times 10^{18}\, ec \times \frac{V}{c} \tag{67}$$

where $\frac{V}{c}$ is the unit of the electromagnetic four potential. Therefore, $\frac{Am}{ec}$ may be Faraday constant at the quantum level. The proof is difficult and will be published in a future report. From Equations (47) and (65), we have

$$\frac{kT_c}{\frac{e^2 c}{4\pi\varepsilon_0}} \times (Am) = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)} \left(\frac{\text{C}}{\text{m}}\right) = \frac{1}{1837.485988} \left(\frac{\text{C}}{\text{m}}\right) \tag{68}$$

Next, the fine structure constant (α) is

$$\frac{e^2}{4\pi\varepsilon_0} = hc \times \frac{\alpha}{2\pi} \tag{69}$$

From Equations (68) and (69),

$$\frac{kT_c}{hc^2} = \frac{1}{\left(\frac{m_p}{m_e} + \frac{4}{3}\right)} \times \frac{\alpha}{2\pi} \times \left(\frac{1}{Am}\right) = \frac{1}{1837.485988} \times \frac{\alpha}{2\pi} \times \left(\frac{\text{s}}{\text{m}^2}\right) = 6.3206454E-07 \tag{70}$$

In Equations (68) and (70), from different coordinate systems, kT_c should be changed because the unit C/m is not Lorentz invariant. Therefore, from Equation (63), G is not Lorentz invariant.

6.2. Yukawa Potential

According to the advanced Wagner model, the diffusion time for mixed electronic and ionic currents should exponentially decrease with distance [9]. When the diffusion time for mixed electrons and quark flux should exponentially decrease with distance, the Yukawa potential can be explained.

6.3. Consideration of the Degree of Freedom inside Electrons

We have never discussed the spin of electrons. In Equation (64), the number 3.132011447 Ω is the deviation from π. We believe that π is related to the spin of the electron. Angrick *et al.* have confirmed that the spin of electrons cannot be thermodynamically ignored [10]. Furthermore, Aquino *et al.* discovered a new method for vector analysis [11]. We hope that the degrees of freedom in electrons will be clarified in detail.

7. Conclusions

We proposed an empirical equation for a fine-structure constant:
$137.0359991 = 136.0113077 + 1 + \frac{1}{3 \times 13.5}$. We proposed several empirical equations to describe the relationship between an electromagnetic force and T_c. Three equations were explained by the factors of 9/2 and π. We attempted to improve the accuracies by changing the values of 9/2 and π. For this purpose, using the electrochemical method, we proposed the equivalent circuit. Then, we proposed the following two values,

$$3.132011447\ \Omega = \frac{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right) m_e c^2}{ec}, \quad 4.488519503 = \frac{q_m c}{\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right) m_p c^2}$$

The calculated values of T_c and G are 2.726312 K and 6.673778 × 10^{-11} ($m^3 \cdot kg^{-1} \cdot s^{-2}$). $\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right)$ appears to be related to the transference number. However, there should be the UNIT (m/C) in $\left(\frac{m_p}{m_e} + 1 + \frac{1}{3}\right)$. Therefore, the values of T_c and G should not be Lorentz invariant.

Conflicts of Interest

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

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