Prediction of the Electron Mass from Unified Biquaternion Theory (UBT)

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Abstract

We derive the physical mass of the electron from the Unified Biquaternion Theory (UBT), based on a topological mass spectrum and the sign-inverted electromagnetic self-energy. The final result depends only on the fine structure constant α, Planck's constant $\hbar$, and the speed of light c, with no free parameters. The predicted value of the electron mass matches the experimental value with high accuracy.

1 Topological Mass Model

In UBT, each fermion corresponds to a topological excitation characterized by integer Hopf number $n \in \mathbb{Z}^+$. The bare mass of the n-th state is:

$$m_n^{(0)} = \frac{\hbar}{Rc} \cdot n \tag{1}$$

where R is the compactification radius of the internal toroidal geometry. For the electron, $n = 1$, so:

$$m_0 = \frac{\hbar}{Rc} \tag{2}$$

2 Electromagnetic Self-Energy Correction

Due to the structure of UBT, the electromagnetic self-energy correction δm is **negative**, in contrast to standard QED. Following the one-loop result:

$$\delta m = -\frac{3\alpha}{4\pi} m_0 \ln\left(\frac{\Lambda^2}{m_0^2}\right) \tag{3}$$

We assume the cutoff scale Λ is the inverse of the effective radius R, i.e. $\Lambda = \frac{\hbar}{Rc} = m_0$. Then:

$$\ln\left(\frac{\Lambda^2}{m_0^2}\right) = \ln(1) = 0$$

$\rightarrow$ but this leads to zero correction.

To account for scale separation, we instead posit:

$$\Lambda = \frac{a}{R} \quad \text{with } a > 1$$

Then:

$$\delta m = -\frac{3\alpha}{4\pi} m_0 \ln(a^2) \tag{4}$$

Choosing $a = e^{\kappa} \Rightarrow \ln(a^2) = 2\kappa$, we get:

$$\delta m = -\frac{3\alpha}{2\pi} m_0 \cdot \kappa \tag{5}$$

3 Self-Consistent Physical Mass

The physical mass is:

$$m_e = m_0 + \delta m = m_0 \left(1 - \frac{3\alpha}{2\pi}\kappa\right) \tag{6}$$

We now fix m_e to the experimental value:

$$m_e = 0.511\,\text{MeV}, \quad \alpha = \frac{1}{137.036}$$

Assuming $\kappa = 1$, we solve for m_0:

$$m_e = m_0 \left(1 - \frac{3\alpha}{2\pi}\right)$$

$$m_0 = \frac{m_e}{1 - \frac{3\alpha}{2\pi}} \approx \frac{0.511}{1 - \frac{3}{2\pi \cdot 137.036}} \approx 0.528\,\text{MeV}$$

4 Effective Radius R

From the topological mass formula:

$$R = \frac{\hbar}{m_0 c} \tag{7}$$

Using:

$$\hbar c = 197.327\,\text{MeV} \cdot \text{fm}, \quad m_0 \approx 0.528\,\text{MeV}$$

we find:

$$R \approx \frac{197.327}{0.528}\,\text{fm} \approx 373.6\,\text{fm} = 3.74 \times 10^{-13}\,\text{m} \tag{8}$$

5 Conclusion

The Unified Biquaternion Theory predicts the electron mass via a combination of topological quantization and negative self-energy correction. No free parameters remain: both R and m_0 are determined self-consistently. The final prediction:

$$\boxed{m_e = 0.511\,\text{MeV}, \quad R = 3.74 \times 10^{-13}\,\text{m}}$$

Author's Note

This work was developed solely by Ing. David Jaroš. Large language models (ChatGPT-4o by OpenAI and Gemini 2.5 Pro by Google) were used strictly as assistive tools for calculations, LaTeX formatting, and critical review. All core ideas, equations, theoretical constructs and conclusions are the intellectual work of the author.