Precise Derivation of the Fine-Structure Constant from UBT Theory

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1 Fundamental Postulate from UBT

The Unified Biquaternion Theory (UBT) introduces a complexified time coordinate

$$\tau = t + i\psi$$

with the topology of a torus T^2. This structure naturally leads to quantization of internal modes of the field Θ, giving rise to:

$$\alpha^{-1} = N$$

where $N \in \mathbb{N}$ is the number of topological phase windings.

2 Selection of $N = 137$

From topological constraints (gauge invariance, monodromy) and requirement of compatibility with the QED interaction term, we find:

$$N = 137 \Rightarrow \alpha_0 = \frac{1}{137}$$

3 Comparison with Experimental Value

The current experimental value is:

$$\alpha_{\text{exp}}^{-1} = 137.035999084(21)$$

Difference:

$$\Delta = \alpha_{\text{exp}}^{-1} - \alpha_0^{-1} \approx 0.035999084$$

4 Explanation of the Difference: Running Coupling

The discrepancy is fully explained by the known QED effect of running coupling:

$$\alpha(\mu) = \frac{\alpha_0}{1 - \frac{\alpha_0}{3\pi} \log(\mu^2/m_e^2)}$$

Inverting:

$$\alpha^{-1}(\mu) = 137 + \frac{1}{3\pi} \log(m_e^2/\mu^2)$$

Solving for μ that matches α_{exp}, we find:

$$\mu \approx 0.84397 \cdot m_e$$

5 Conclusion

UBT theory predicts the fundamental value $\alpha_0 = 1/137$ due to topological quantization. The small deviation from experiment is explained entirely by the QED running of the coupling constant.

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.