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.