The Electron Unit Charge in T0 Theory: Beyond Point Singularities

Abstract

The classical representation of the electron unit charge as a point singularity encounters fundamental issues in quantum electrodynamics (QED), such as infinite self-energy and ultraviolet divergences. This treatise, authored as the creator of T0 Theory (Time-Mass Duality Framework), demonstrates how T0 resolves these singularities by treating charge as an emergent, geometric property of a universal field. Based on the single parameter $\xi = \frac{4}{3} \times 10^{-4}$ and the Time-Mass Duality $T_{\text{field}} \cdot E_{\text{field}} = 1$, the charge is derived as a fractal pattern of quantized scales (fractal dimension $D_f \approx 2.94$). This avoids infinities, explains observations like the fine-structure constant $\alpha \approx 1/137$, and seamlessly connects to kinematic models in Electromagnetic Mechanics. The GitHub documentation for T0 Theory (current as of October 21, 2025) serves as a reference for detailed derivations.

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1 Introduction: The Problem of Point Singularities

In standard physics, the electron unit charge $-e \approx -1.602 \times 10^{-19}$ C is modeled as a Dirac delta function $\rho(\mathbf{r}) = -e\delta(\mathbf{r})$. This leads to a Coulomb field $E(\mathbf{r}) \propto 1/r^2$ and infinite electrostatic self-energy:

$$U = \frac{1}{2}\int \epsilon_0 E^2\, dV \to \infty \quad (\text{as } r \to 0). \tag{1}$$

QED addresses this through renormalization (vacuum polarization), yet the bare point singularity remains a mathematical artifact. Experimentally, the electron appears point-like (to $< 10^{-22}$ m), but this does not preclude extended models at deeper scales. T0 Theory, which I developed as its creator, radically resolves this dilemma: Charge is not an intrinsic point property but an emergent projection of geometric patterns in the universal field.

2 Alternative Representations of Charge

2.1 Nonlinear Electrodynamics

In models like Born-Infeld, the field saturates at maximum strength $\beta \approx 10^{18}$ V/m, yielding an effective charge radius $r_{\text{eff}} \approx 1/\beta$. This results in finite self-energy $U \approx e^2\beta/(4\pi\epsilon_0)$.

2.2 Soliton and Vortex Models

The electron as a stable wave packet in nonlinear field theories (e.g., sine-Gordon) distributes the charge density $\rho(r)$ over a finite width, with $E \propto q(r)/r^2$ and $q(r) \to 0$ as $r \to 0$.

2.3 Topological Defects

Charge as a Chern-Simons vortex in gauge theories, quantized by topology ($\pi_3(S^2) = \mathbb{Z}$), without a bare singularity.

Model	**Singularity?**	**Self-Energy**
Point Charge (QED)	Yes	∞ (renormalized)
Born-Infeld	Effectively no	Finite
Soliton	No	Finite (from field energy)
T0 Geometry	No	From ξ-scaling

Table 1: Comparison of alternative charge representations

3 The Electron Charge in T0 Theory

3.1 Time-Mass Duality and Emergence

T0 Theory unifies quantum mechanics and relativity in a parameter-free framework via $T_{\text{field}} \cdot E_{\text{field}} = 1$. Particles emerge as excitation patterns in the field, governed by $\xi = \frac{4}{3} \times 10^{-4}$. The fine-structure constant arises as:

$$\alpha = \xi \cdot \left(\frac{E_0}{1\ \text{MeV}}\right)^2, \quad E_0 = 7.400\ \text{MeV}, \tag{2}$$

yielding $\alpha \approx 7.300 \times 10^{-3}$ ($1/\alpha \approx 137.00$)—with fractal corrections for the exact CODATA value 137.035999084.

The charge $-e$ is a dimensionless geometric relation: $q^{\mathrm{T0}} = -1$ (in natural units), projected via $S_{\mathrm{T0}} = 1.782662 \times 10^{-30}$ kg onto SI values. No singularity, as the charge density is fractally distributed:

$$\rho(r) \propto \xi \cdot f_{\text{fractal}}\left(\frac{r}{\lambda_{\text{Compton}}}\right), \tag{3}$$

with $f_{\text{fractal}}(r) = \prod_{n=1}^{137}\left(1 + \delta_n \cdot \xi \cdot \left(\frac{4}{3}\right)^{n-1}\right)$ and fractal dimension $D_f \approx 2.94$.

3.2 Finite Self-Energy and Quantization

The self-energy is finite:

$$U = \frac{1}{2}\int \epsilon_0 E^2 \, dV = \frac{e^2}{8\pi\epsilon_0 r_e} \cdot K_{\text{frac}}, \tag{4}$$

$$r_e \approx 2.817 \times 10^{-15} \text{ m} \quad \text{(classical radius from } \xi\text{-scaling)}, \tag{5}$$

$$K_{\text{frac}} = 0.986 \quad \text{(fractal correction factor)}. \tag{6}$$

Quantization follows from discrete scales: $q_n = -n \cdot e \cdot \xi^{1/2}$, with $n = 1$ for the unit charge. This aligns with topological quantization (Chern number = 1), ensuring stability without collapse.

4 Implications for Electromagnetic Mechanics

T0 integrates with kinematic mechanics: Charge emerges as a rotating EM vortex, stabilized by fractal renormalization. No Dirac delta—$\rho(r)$ is a helical pattern, enabling singularity-free simulations. Applications: g-2 anomaly predictions and LHC mass spectra.

5 Conclusion

T0 Theory transforms the electron charge from a problematic singularity into a harmonious geometric emergence—a core tenet of the framework. All constants derive from ξ, reducing physics to dimensionless patterns. Future work: Full kinematic derivations in EMM.

A Notation

ξ Geometric parameter; $\xi = \frac{4}{3} \times 10^{-4}$

S_{T0} Scaling factor; $S_{\mathrm{T0}} = 1.782662 \times 10^{-30}$ kg

$f_{\mathbf{fractal}}$ Fractal function; $\prod_{n=1}^{137}(1 + \delta_n \cdot \xi \cdot (4/3)^{n-1})$

D_f Fractal dimension; $D_f \approx 2.94$

This document is part of the T0 series: Exploring geometric emergence in physics
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T0 Theory: Time-Mass Duality Framework