

# Chapter 1

## 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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## 1.1 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:

$$U = \frac{1}{2} \int \epsilon_0 E^2 dV \rightarrow \infty \quad (\text{as } r \rightarrow 0). \quad (1.1)$$

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.

## 1.2 Alternative Representations of Charge

### 1.2.1 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  $U \approx e^2\beta/(4\pi\epsilon_0)$ .

### 1.2.2 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  $q(r) \rightarrow 0$  as  $r \rightarrow 0$ .

### 1.2.3 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	$\infty$ (renormalized)
Born-Infeld	Effectively no	Finite
Soliton	No	Finite (from field energy)
T0 Geometry	No	From $\xi$ -scaling

Table 1.1: Comparison of alternative charge representations

## 1.3 The Electron Charge in T0 Theory

### 1.3.1 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:

$$\alpha = \xi \cdot \left( \frac{E_0}{1 \text{ MeV}} \right)^2, \quad E_0 = 7.400 \text{ MeV}, \quad (1.2)$$

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

$$\rho(r) \propto \xi \cdot f_{\text{fractal}} \left( \frac{r}{\lambda_{\text{Compton}}} \right), \quad (1.3)$$

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  $D_f \approx 2.94$ .

### 1.3.2 Finite Self-Energy and Quantization

The self-energy is finite:

$$U = \frac{1}{2} \int \epsilon_0 E^2 dV = \frac{e^2}{8\pi\epsilon_0 r_e} \cdot K_{\text{frac}}, \quad (1.4)$$

$$r_e \approx 2.817 \times 10^{-15} \text{ m} \quad (\text{classical radius from } \xi\text{-scaling}), \quad (1.5)$$

$$K_{\text{frac}} = 0.986 \quad (\text{fractal correction factor}). \quad (1.6)$$

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.

## 1.4 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.

## 1.5 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  $\xi$ , reducing physics to dimensionless patterns. Future work: Full kinematic derivations in EMM.

### .1 Notation

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

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

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

$D_f$  Fractal dimension;  $D_f \approx 2.94$

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*This document is part of the T0 series: Exploring geometric emergence in physics*  
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[T0 Theory: Time-Mass Duality Framework](#)