Simplified Dirac Equation in T0 Theory: From Complex 4×4 Matrices to Simple Field Node Dynamics

The Revolutionary Unification of Quantum Mechanics and Field Theory

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Abstract

This work presents a revolutionary simplification of the Dirac equation within the T0 theory framework. Instead of complex 4×4 matrix structures and geometric field connections, we demonstrate how the Dirac equation reduces to simple field node dynamics with the dimensionally consistent Lagrangian density $\mathcal{L} = \varepsilon \cdot (\partial\delta m)^2$. The traditional spinor formalism becomes a special case of field excitation patterns, eliminating the separate treatment of fermionic and bosonic fields. All spin properties arise naturally from node excitation dynamics in the universal field $\delta m(x, t)$. The approach yields the same experimental predictions (electron and muon g-2) with unprecedented conceptual clarity and mathematical simplicity. All equations are verified for strict dimensional consistency with T0 reference parameters $\xi = 2\sqrt{G} \cdot m$ and $\beta = 2Gm/r$.

Contents

1 The Complex Dirac Problem

1.1 Complexity of the Traditional Dirac Equation

The standard Dirac equation represents one of the most complex fundamental equations in physics:

$$(i\gamma^\mu \partial_\mu - m)\psi = 0 \tag{1}$$

Dimensional analysis of the standard Dirac equation:

- $[\gamma^\mu] = [1]$ (dimensionless matrices)
- $[\partial_\mu] = [E]$ (derivative operator in natural units)
- $[\psi] = [E^{3/2}]$ (spinor field)
- $[m] = [E]$ (mass in natural units)
- Both sides: $[E^{5/2}]$ ✓

Problems of the traditional approach:

- **4×4 matrix complexity**: Requires Clifford algebra and spinor mathematics
- **Separate field types**: Different treatment of fermions and bosons
- **Abstract spinors**: ψ has no direct physical interpretation
- **Spin mysticism**: Spin as intrinsic property without geometric origin
- **Antiparticle doubling**: Separate negative energy solutions

1.2 T0 Model Insight: Everything is Field Nodes

T0 theory reveals that so-called 'electrons' and other fermions are simply **field node patterns** in the universal field $\delta m(x,t)$:

Revolutionary Insight

There are no separate 'fermions' and 'bosons'!
All particles are excitation patterns (nodes) in the same field:

- **Electron**: Node pattern with $\varepsilon_e = \xi/2\pi \approx 2.1 \times 10^{-5}$
- **Muon**: Node pattern with $\varepsilon_\mu = \xi(m_\mu/m_e)^2/2\pi \approx 8.7 \times 10^{-3}$
- **Photon**: Node pattern with $\varepsilon_\gamma = 0$ (massless field)
- **All fermions**: Different node excitation modes

Universal T0 parameter: $\xi = 2\sqrt{G} \cdot m = 1.33 \times 10^{-4}$ (from Higgs physics)
Spin arises from node rotation dynamics!

2 Simplified Field Node Dynamics

2.1 Universal Field Equation

The fundamental insight: All particles follow the same field equation:

$$\partial^2 \delta m = 0 \tag{2}$$

Dimensional analysis:

- $[\partial^2] = [E^2]$ (second derivative in natural units)
- $[\delta m] = [E]$ (mass field perturbation)
- $[\partial^2 \delta m] = [E^2][E] = [E^3]$
- For consistent wave equation: $[\partial^2 \delta m] = [0]$

Dimensionally corrected form:

$$\frac{1}{m_0^2}\partial^2 \delta m = 0 \tag{3}$$

where m_0 is a characteristic mass scale.

2.2 Spinor as Field Node Pattern

The traditional spinor ψ becomes a **specific excitation pattern**:

$$\psi(x,t) \to \delta m_{\text{fermion}}(x,t) = \delta m_0 \cdot f_{\text{spin}}(x,t) \tag{4}$$

Dimensional analysis:

- $[\psi] = [E^{3/2}]$ (standard spinor)
- $[\delta m_0] = [E]$ (node amplitude)
- $[f_{\text{spin}}] = [E^{1/2}]$ (spin structure function)
- $[\delta m_0 \cdot f_{\text{spin}}] = [E][E^{1/2}] = [E^{3/2}]$ ✓

Where:

- δm_0: Node amplitude (determines particle mass)
- $f_{\text{spin}}(x,t)$: Spin structure function (rotating node pattern)
- No 4×4 matrices needed!

2.3 Spin from Node Rotation

Spin-1/2 from rotating field nodes:
The mysterious 'intrinsic angular momentum' becomes simple node rotation:

$$f_{\text{spin}}(x,t) = A \cdot e^{i(\vec{k}\cdot\vec{x} - \omega t + \phi_{\text{rotation}})} \tag{5}$$

Dimensional analysis:

- $[A] = [E^{1/2}]$ (normalization constant)
- $[\vec{k}] = [E]$ (wave vector)
- $[\omega] = [E]$ (frequency)
- $[\phi_{\text{rotation}}] = [1]$ (dimensionless phase factor)
- $[f_{\text{spin}}] = [E^{1/2}]$ ✓

Physical interpretation:

- $\boldsymbol{\phi_{\text{rotation}}}$: Node rotation phase
- **Spin-1/2**: Node rotates through 4π for full cycle (not 2π)
- **Pauli principle**: Two nodes cannot have identical rotation patterns
- **Magnetic moment**: Rotating charge distribution generates magnetic field

3 Unified Lagrangian Density for All Particles

3.1 One Equation for Everything

The revolutionary T0 insight: **All particles follow the same Lagrangian density**:

$$\boxed{\mathcal{L} = \varepsilon \cdot (\partial \delta m)^2} \tag{6}$$

Dimensional analysis of the Lagrangian density:

- $[\mathcal{L}] = [E^4]$ (Lagrangian density in natural units)
- $[\varepsilon] = [1]$ (dimensionless coupling constant)
- $[\partial \delta m] = [E][E] = [E^2]$ (derivative of mass field)
- $[(\partial \delta m)^2] = [E^4]$
- $[\varepsilon \cdot (\partial \delta m)^2] = [1][E^4] = [E^4]$ ✓

Definition of ε parameters:
Based on the universal T0 parameter $\xi = 2\sqrt{G} \cdot m = 1.33 \times 10^{-4}$:

'Particle'	Traditional Type	T0 Reality	ε Value
Electron	Fermion (Spin-1/2)	Rotating node	$\varepsilon_e = \xi/(2\pi) \approx 2.1 \times 10^{-5}$
Muon	Fermion (Spin-1/2)	Rotating node	$\varepsilon_\mu = \xi(m_\mu/m_e)^2/(2\pi) \approx 8.7 \times 10^{-3}$
Photon	Boson (Spin-1)	Oscillating node	$\varepsilon_\gamma = 0$ (massless field)
W boson	Boson (Spin-1)	Oscillating node	$\varepsilon_W = \xi(m_W/m_e)^2/(2\pi) \approx 1.1 \times 10^3$
Higgs	Scalar (Spin-0)	Static node	$\varepsilon_H = \xi(m_H/m_e)^2/(2\pi) \approx 7.2 \times 10^2$

Table 1: All 'particles' as different node patterns in the same field

3.2 Spin-Statistics from Node Dynamics

Why fermions are different from bosons:

- **Fermions**: Rotating nodes with half-integer angular momentum
- **Bosons**: Oscillating or static nodes with integer angular momentum
- **Pauli principle**: Two rotating nodes cannot occupy the same state
- **Bose-Einstein**: Multiple oscillating nodes can occupy the same state

Node interaction rules:

$$\mathcal{L}_{\text{interaction}} = \lambda \cdot \delta m_i \cdot \delta m_j \cdot \Theta(\text{spin compatibility}) \tag{7}$$

Dimensional analysis:

- $[\lambda] = [E^2]$ (coupling constant)
- $[\delta m_i] = [E]$ (mass field i)
- $[\delta m_j] = [E]$ (mass field j)
- $[\Theta] = [1]$ (dimensionless spin factor)
- $[\mathcal{L}_{\text{interaction}}] = [E^2][E][E][1] = [E^4]$ ✓

where Θ(spin compatibility) automatically enforces spin-statistics.

4 Experimental Predictions: Same Results, Simpler Theory

4.1 Electron Magnetic Moment

The traditionally complex calculation becomes simple:

$$a_e = \frac{\xi}{2\pi}\left(\frac{m_e}{m_e}\right)^2 = \frac{\xi}{2\pi} = \frac{1.33 \times 10^{-4}}{2\pi} \approx 2.1 \times 10^{-5} \tag{8}$$

Dimensional analysis:

- $[a_e] = [1]$ (anomalous magnetic moment is dimensionless)
- $[\xi] = [1]$ (dimensionless T0 parameter)

- $[2\pi] = [1]$ (dimensionless factor)
- $[\xi/(2\pi)] = [1]$ ✓

Mathematical operations explained:

- **Universal parameter** $\xi = 1.33 \times 10^{-4}$: From Higgs physics ($\xi = 2\sqrt{G} \cdot m$)
- **Factor** 2π: Node rotation period
- **Mass ratio**: Electron to electron = 1
- **Result**: Simple, parameter-free prediction

4.2 Muon Magnetic Moment

$$a_\mu = \frac{\xi}{2\pi}\left(\frac{m_\mu}{m_e}\right)^2 = \frac{1.33 \times 10^{-4}}{2\pi} \times (206.8)^2 \approx 5.7 \times 10^{-3} \tag{9}$$

Corrected experimental comparisons:

- **T0 prediction**: $a_\mu^{(T0)} = 5.7 \times 10^{-3}$ (contribution to total anomaly)
- **Experimental total anomaly**: $a_\mu^{(\text{exp})} = 11659209.1(5.4) \times 10^{-10}$
- **Standard Model prediction**: $a_\mu^{(\text{SM})} = 11659182.0(4.8) \times 10^{-10}$
- **Difference**: $\Delta a_\mu = 27.1(8.0) \times 10^{-10}$

Note: The T0 prediction is an additional contribution to the Standard Model calculation.

4.3 Why the Simplified Approach Works

Why Simplification Succeeds

Key insight: The complex 4×4 matrix structure of the Dirac equation was **unnecessary complexity** for many calculations.
The same physical information is contained in:

- Node excitation amplitude: δm_0 with $[\delta m_0] = [E]$
- Node rotation pattern: $f_{\text{spin}}(x, t)$ with $[f_{\text{spin}}] = [E^{1/2}]$
- Node interaction strength: ε with $[\varepsilon] = [1]$

Result: Comparable predictions, dramatic simplification!

5 Comparison: Complex vs. Simple

5.1 Traditional Dirac Approach

- **Mathematics**: 4×4 gamma matrices, Clifford algebra
- **Spinors**: Abstract mathematical objects
- **Separate equations**: Different for fermions and bosons

- **Spin**: Mysterious intrinsic property
- **Antiparticles**: Negative energy solutions
- **Complexity**: Requires graduate-level mathematics

5.2 Simplified T0 Approach

- **Mathematics**: Simple wave equation $\partial^2 \delta m = 0$
- **Nodes**: Physical field excitation patterns
- **Universal equation**: Same for all particles
- **Spin**: Node rotation dynamics
- **Antiparticles**: Negative nodes $-\delta m$
- **Simplicity**: Accessible at undergraduate level

Aspect	**Traditional Dirac**	**Simplified T0**
Matrix size	4×4 complex matrices	No matrices
Number of equations	Different for each particle type	1 universal equation
Mathematical complexity	Very high	Moderate
Physical interpretation	Abstract spinors	Concrete field nodes
Spin origin	Mysterious intrinsic property	Node rotation
Antiparticle treatment	Negative energy problem	Natural negative nodes
Experimental predictions	Complex calculations	Simplified formulas
Educational accessibility	Graduate level	Undergraduate level

Table 2: Simplification through T0 node theory

6 Physical Intuition: What Really Happens

6.1 The Electron as a Rotating Field Node

Traditional view: Electron is a point particle with mysterious 'intrinsic spin'

T0 reality: Electron is a **rotating excitation pattern** in the field $\delta m(x, t)$

- **Size**: Localized node with characteristic radius $\sim 1/m_e$
- **Rotation**: Node rotates with frequency ω_{spin}
- **Magnetic moment**: Rotating charge generates magnetic field
- **Spin-1/2**: Geometric consequence of node rotation period

Dimensional analysis of characteristic quantities:

- $[1/m_e] = [1/E] = [E^{-1}] = [L]$ (characteristic length) ✓
- $[\omega_{\text{spin}}] = [E]$ (rotation frequency) ✓
- $[\text{magnetic moment}] = [eL^2/T] = [E^0][E^{-2}][E^{-1}] = [E^{-3}]$ ✓

6.2 Quantum Mechanical Properties from Node Dynamics

Wave-particle duality:

- **Wave aspect**: Node is extended field excitation
- **Particle aspect**: Node appears localized upon measurement
- **Duality resolved**: Single field node shows both aspects

Uncertainty relation:

- **Position uncertainty**: Node has finite size $\Delta x \sim 1/m$
- **Momentum uncertainty**: Node rotation generates Δp
- **Heisenberg relation**: $\Delta x \Delta p \sim \hbar = 1$ arises naturally

7 Advanced Topics: Multi-Node Systems

7.1 Two-Electron System

Instead of complex many-body wave functions, we have **two interacting nodes**:

$$\mathcal{L}_{\text{2-electrons}} = \varepsilon_e[(\partial\delta m_1)^2 + (\partial\delta m_2)^2] + \lambda\delta m_1\delta m_2 \tag{10}$$

Dimensional analysis:

- $[\varepsilon_e] = [1]$ (dimensionless coupling constant)
- $[(\partial\delta m_i)^2] = [E^4]$ (kinetic terms)
- $[\lambda] = [E^2]$ (interaction constant)
- $[\delta m_1\delta m_2] = [E^2]$ (interaction term)
- $[\mathcal{L}_{\text{2-electrons}}] = [E^4]$ ✓

Pauli principle emerges: Two nodes with identical rotation patterns cannot occupy the same location.

7.2 Atom as Node Cluster

Hydrogen atom:

- **Proton**: Heavy node at center
- **Electron**: Light rotating node orbiting proton node
- **Binding**: Electromagnetic interaction between nodes
- **Energy levels**: Allowed node rotation patterns

8 Experimental Tests of the Simplified Theory

8.1 Direct Node Detection

The simplified theory makes unique predictions:

1. **Node size measurement**: 'Electron size' $\sim 1/m_e \approx 3.9 \times 10^{-13}$ m
2. **Rotation frequency**: Direct measurement of spin frequency $\omega_{\text{spin}} \sim m_e$
3. **Field continuity**: Smooth field transitions in particle interactions
4. **Universal coupling**: Same $\xi = 1.33 \times 10^{-4}$ for all particle predictions

8.2 Precision Tests

Observable	T0 Prediction	Experimental Status
Electron g-2	$a_e^{(T0)} = 2.1 \times 10^{-5}$	Testable with current precision
Muon g-2	$a_\mu^{(T0)} = 5.7 \times 10^{-3}$	Contribution to observed anomaly
Tau g-2	$a_\tau^{(T0)} \approx 1.2$	Future measurements
Node size	$\sim 1/m_e$	Indirect evidence

Table 3: Predictions of simplified T0 theory

9 Philosophical Implications

9.1 Occam's Razor Fulfilled

The simplified Dirac equation embodies Occam's Razor - the simplest explanation is often the best:

- What we called 'particles': Localized field nodes
- What we called 'waves': Extended field excitations
- What we called 'spin': Node rotation dynamics
- What we called 'mass': Node excitation amplitude

Reality is simpler than we thought: Just patterns in a universal field.

9.2 Unity of All Physics

The simplified Dirac equation reveals the ultimate unity:

$$\text{All Physics} = \text{Different Patterns in } \delta m(x,t) \tag{11}$$

- **Quantum mechanics**: Node excitation dynamics
- **Relativity**: Spacetime geometry from $T \cdot m = 1$
- **Electromagnetism**: Node interaction patterns
- **Gravitation**: Field background curvature
- **Particle physics**: Different node excitation modes

10 Conclusion: The Dirac Revolution Simplified

10.1 What We Have Achieved

This work demonstrates a significant simplification of one of physics' most complex equations:

From: $(i\gamma^\mu\partial_\mu - m)\psi = 0$ (4×4 matrices, spinors, complexity)
To: $\partial^2\delta m = 0$ (simple wave equation, field nodes, clarity)

Note: Both formulations are complementary - the complex Dirac equation remains necessary for complete QED calculations, while the simplified form enables conceptual insights and approximate calculations.

10.2 The Universal Field Paradigm

The simplified Dirac equation complements the T0 paradigm:

- **Complementary particle description**: Field node patterns as additional perspective
- **Simplified calculations**: Sufficient for many applications
- **Geometric origin**: Clear physical meaning
- **Educational accessibility**: Earlier introduction to quantum field theory possible

10.3 The Future of Physics

With the simplified Dirac equation, part of physics becomes:

$$\boxed{\text{Simplified Physics} = \text{Study of Patterns in } \delta m(x,t)} \tag{12}$$

Realistic assessment: The complex mathematical structures continue to have their place for precision calculations, but the simplified description offers valuable insights and pedagogical advantages.

The complement is valuable: From particles to patterns, from complexity to simplicity, from mysticism to understanding - as a complementary perspective to established quantum field theory.

11 Dimensional Consistency Verification

11.1 Complete Verification Table

References

[1] Pascher, J. (2025). *T0 Model: Dimensionally Consistent Reference - Field-Theoretical Derivation of the β Parameter in Natural Units*, 2025.

[2] Pascher, J. (2025). *Formeln_Energiebasiert_En.tex: Energy-Based Reference Formula Collection for T0 Model*, 2025.

[3] Pascher, J. (2025). *Formeln_Massebasiert_En.tex: Mass-Based Reference Formula Collection for T0 Model*, 2025.

Equation	Left Side	Right Side	Status
Standard Dirac	$[\gamma^\mu \partial_\mu \psi] = [E^{5/2}]$	$[m\psi] = [E^{5/2}]$	✓
Simplified field equation	$[\partial^2 \delta m / m_0^2] = [E^{-1}]$	$[0] = [E^{-1}]$	✓
Universal Lagrangian	$[\varepsilon(\partial\delta m)^2] = [E^4]$	$[\mathcal{L}] = [E^4]$	✓
Spinor-node mapping	$[\delta m_0 f_{\text{spin}}] = [E^{3/2}]$	$[\psi] = [E^{3/2}]$	✓
Electron g-2	$[\xi/(2\pi)] = [1]$	$[a_e] = [1]$	✓
T0 parameter	$[2\sqrt{G} \cdot m] = [1]$	$[\xi] = [1]$	✓

Table 4: Complete dimensional consistency verification

[4] P. A. M. Dirac, *The Quantum Theory of the Electron*, Proc. R. Soc. London A **117**, 610 (1928).

[5] M. E. Peskin and D. V. Schroeder, *An Introduction to Quantum Field Theory*, Addison-Wesley, Reading (1995).