Geometric Resonance Theory

A Unified Topological Model of Particle Mass, Dark Matter, and the Fine Structure Constant

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Abstract

Standard Model particle physics relies on 19 arbitrary parameters to determine particle masses. This paper proposes a deterministic alternative: **Geometric Resonance Theory**. We derive the mass spectrum from first principles by treating elementary particles as standing waves on closed spacetime topologies. The resulting **Pliatsikas Resonance Formula** ($m \propto n^2$) unifies fermions and bosons, predicts a discrete spectrum of Dark Matter ("The Three Kingdoms"), and derives the Fine Structure Constant ($\alpha^{-1} \approx 137.033$) with 99.998% accuracy using integer geometric modes. Finally, we propose a falsifiable experimental test involving the detection of a 32.7 MeV resonance spike in Kaon decays at the NA62 experiment.

1 First Principles: Derivation from the Hamiltonian

We begin not with arbitrary fitting, but with the quantum mechanics of a particle confined to a closed geometric topology (a "wormhole throat" of radius R).

The Hamiltonian for a free particle confined to a 1D closed loop (topology S^1) is:

$$\hat{H} = -\frac{\hbar^2}{2m_{\text{eff}}}\nabla^2 = -\frac{\hbar^2}{2m_{\text{eff}}R^2}\frac{\partial^2}{\partial\theta^2} \tag{1}$$

For the wavefunction $\psi(\theta)$ to be physically valid on a closed loop, it must satisfy the periodic boundary condition $\psi(\theta) = \psi(\theta + 2\pi)$. This restricts solutions to:

$$\psi_n(\theta) = \frac{1}{\sqrt{2\pi}}e^{in\theta}, \quad n \in \mathbb{Z} \tag{2}$$

Applying the Hamiltonian yields the energy eigenvalues:

$$E_n = \frac{\hbar^2}{2m_{\text{eff}}R^2} \cdot n^2 \tag{3}$$

Since mass is equivalent to internal energy ($E = mc^2$), we establish the fundamental scaling law of Geometric Resonance:

$$\boxed{m \propto n^2} \tag{4}$$

2 The Pliatsikas Resonance Formula

Calibrating the scaling law to the Electron, defined as the fundamental planar resonance ($n_e = 2$, $m_e = 0.511$ MeV), we derive the predictive equation:

$$m(n) = m_e \left(\frac{n}{2}\right)^2 \approx 0.12775 \cdot n^2 \text{ MeV} \tag{5}$$

This formula successfully retrodicts the mass hierarchy:

- **Photon ($n = 0$):** $m = 0$ (Exact).
- **Up Quark ($n = 4$):** $m \approx 2.04$ MeV (Within Lattice QCD bounds).
- **Down Quark ($n = 6$):** $m \approx 4.60$ MeV (Within Lattice QCD bounds).
- **W/Z Bosons ($n \approx 793, 845$):** Accurately reproduces the electroweak mass ratio.

3 Derivation of the Fine Structure Constant (α)

We propose that the electromagnetic coupling constant is not random, but the geometric resultant of the interaction between the Visible Matter sector and the Dark Matter sector.

We identify two key stability modes:

1. **Visible Sector ($n = 4$):** Corresponds to the Up Quark (Tetrahedral stability).
2. **Dark Sector ($n = 11$):** Corresponds to the X17 anomaly (Prime stability).

3.1 The Geometric Sum

Applying Pythagorean geometry to these orthogonal sectors:

$$\alpha^{-1}_{\text{integer}} = n^2_{\text{vis}} + n^2_{\text{dark}} = 4^2 + 11^2 = 16 + 121 = \mathbf{137} \tag{6}$$

3.2 The Pliatsikas Correction Term

To account for the discrepancy between 137 and the observed 137.0359, we calculate the "geometric leakage" (coupling ratio) of the Visible sector into the Dark sector square:

$$\delta = \frac{n_{\text{vis}}}{n^2_{\text{dark}}} = \frac{4}{121} \approx 0.033057 \tag{7}$$

Adding this correction:

$$\alpha^{-1}_{\text{calc}} = 137 + 0.033057 = \mathbf{137.033057} \tag{8}$$

This theoretical derivation matches the experimental value with **99.998% accuracy**, suggesting that α is a derivative constant of geometric topology.

4 Predictions: The Three Kingdoms of Dark Matter

The theory predicts that integer modes not occupied by Standard Model particles form stable, neutral "Dark Matter" resonances.

Sector	Mode Range	Physics Description	Mass Range
Kingdom I	$n = 3 \dots 28$	Light Dark Matter / "Ghost" Sector	1.1 – 100 MeV
Kingdom II	$n = 30 \dots 117$	Shadow Hadrons	115 – 1,750 MeV
Kingdom III	$n = 119 \dots 792$	WIMP Forest	1.8 – 80.1 GeV

Table 1: Predicted mass ranges for Dark Matter particles filling the gaps between Lepton generations.

5 Falsifiable Experimental Test

A scientific theory must be falsifiable. We propose a specific test using currently available technology at the **NA62 Experiment** (CERN), which studies the decay $K^+ \to \pi^+ + \nu\bar{\nu}$.

5.1 The "Comb" Prediction

Standard Model physics predicts the "missing mass" spectrum of this decay to be smooth (continuous neutrinos). Geometric Resonance Theory predicts discrete spikes corresponding to Kingdom I Dark Modes.

5.2 The 32.7 MeV Target

We specifically predict a resonance at **Mode $n = 16$**:

$$m(16) = 0.12775 \times 16^2 = \mathbf{32.7}\ \text{MeV} \tag{9}$$

The Challenge: If experimental analysis of Kaon decay data reveals a statistically significant resonance peak at 32.7±0.5 MeV (correlating with the Karimen anomaly), Geometric Resonance Theory is confirmed. If the spectrum is definitively smooth at this energy, the theory is falsified.

6 Conclusion

The Pliatsikas Resonance Formula provides a unified, deterministic framework for particle physics. By deriving the mass spectrum (n^2) and the Fine Structure Constant (α) from geometric first principles, we eliminate the need for arbitrary constants. The theory stands ready for experimental verification via the predicted 32.7 MeV spectral spike.