A Phenomenological Harmonic Scaling Law for Fundamental Particle Masses

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Abstract

This paper proposes a discrete harmonic scaling relationship for particle masses based on the electron ground state. The model suggests that stable particle masses scale quadratically with an integer quantum number n, according to the formula $m(n) = m_e(n/2)^2$. While phenomenological in nature, this relationship successfully reproduces the masses of the Muon, Proton, Tau, and Z-boson with high precision. Furthermore, the model predicts a stable resonance at $n = 864$ corresponding to a mass of **95.36 GeV**, which aligns within 0.04% of the persistent "mass excess" currently observed in CMS and ATLAS data.

1 The Hypothesis

Current Standard Model parameters for particle masses are empirical inputs. This model proposes that mass is a geometric property derived from a fundamental standing wave resonance. Defining the electron ($m_e \approx 0.511$ MeV) as the fundamental geometric ground state ($n = 2$), the mass spectrum is given by:

$$m(n) = m_e \times \left(\frac{n}{2}\right)^2 \tag{1}$$

Where n is an integer.

2 Physical Motivation: Deriving the Muon ($n = 29$)

The selection rules for stable integers n appear to be governed by vacuum impedance matching. The stability of a higher harmonic depends on its coupling to the electromagnetic vacuum, defined by the Fine Structure Constant ($\alpha \approx 1/137.036$).

For a spherical geometric resonance, the stability criterion is approximated by the relationship where the mass scales inversely to the coupling strength:

$$\frac{m_n}{m_e} \approx \frac{3}{2\alpha} \tag{2}$$

Substituting the mass formula:

$$\left(\frac{n}{2}\right)^2 \approx \frac{3}{2(1/137.036)}$$

$$n^2 \approx \frac{12}{\alpha} \approx 6 \times 137.036 \approx 822.2$$

$$n \approx \sqrt{822.2} \approx 28.67$$

The integer constraint forces the geometry to "snap" to the nearest integer resonance: $n = 29$.

- **Predicted Mass ($n = 29$):** 107.4 MeV
- **Observed Muon Mass:** 105.66 MeV
- **Interpretation:** The Muon is the first excited state allowed by vacuum impedance matching. The slight discrepancy (the "tension" between 28.67 and 29) may account for the anomalous magnetic moment ($g - 2$).

3 Results: Fit to Known Particles

Applying this integer scaling to heavier particles yields striking correlations with the Standard Model.

Particle	Integer (n)	Predicted Mass	Observed Mass	Error
Electron	**2**	**0.511 MeV**	**0.511 MeV**	**Input**
Muon	**29**	**107.4 MeV**	**105.7 MeV**	**∼1.6%**
Proton	**86**	**944.8 MeV**	**938.3 MeV**	**∼0.7%**
Tau	**118**	**1778.8 MeV**	**1776.8 MeV**	**0.1%**
Z Boson	**845**	**91.19 GeV**	**91.19 GeV**	**<0.01%**

Table 1: Comparison of predicted harmonic masses vs experimental values.

Note: The Proton mass defect (observed is lighter than predicted) suggests a binding energy subtraction, potentially corresponding to the subtraction of a fundamental $n = 7$ loop (6.26 MeV).

4 Predictive Power: The 96 GeV Anomaly

The primary utility of this model is prediction. The Standard Model does not predict any particles between the Z Boson (91 GeV) and the Higgs Boson (125 GeV). However, experimental data from the Large Hadron Collider (CMS and ATLAS) has shown a persistent excess of events at approximately **95.4 GeV**.

Using the harmonic formula to search for a resonance in this gap:

$$m(n) \approx 95,400 \text{ MeV}$$

$$n \approx 2 \times \sqrt{\frac{95,400}{0.511}} \approx 864.14$$

The nearest integer resonance is $n = 864$.

Calculating the precise mass for $n = 864$:

$$m(864) = 0.511 \times \left(\frac{864}{2}\right)^2 = 0.511 \times (432)^2$$

$$m(864) = \mathbf{95.36} \text{ GeV} \tag{3}$$

5 Conclusion

The formula $m(n) = m_e(n/2)^2$ predicts a particle at **95.36 GeV**, which matches the observed CERN anomaly at **95.4 GeV** with an error of only **0.04%**.

This suggests that the mass hierarchy of the universe may be governed by a discrete geometric harmonic series rather than arbitrary couplings. I invite further phenomenological investigation into this scaling law.