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Structural resolution of the lepton mass anomaly: A deterministic axiomatic model

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Abstract

The mass hierarchy of the stable leptons (electron, muon, tau) remains a foundational problem in particle physics because the Standard Model (SM) cannot predict their specific values. This work introduces a novel, deterministic theoretical framework that posits particle mass as an emergent property of a particle's structural state within a universal medium. We established an axiomatic structural model constrained by factors including the Dimensionality Factor and the Golden Ratio to define the precise relationship between lepton generations. By calibrating this model against the measured masses of the electron and muon, we derived a Law of Hyper-Acceleration governing generational growth. This structural law was then used to successfully predict the mass of the third lepton, the Tau. The calculated prediction ($m_{\tau} \approx 1776.91 \text{ MeV}/c^2$) aligns precisely with current experimentally determined data ($1776.86 \pm 0.12 \text{ MeV}/c^2$), thereby achieving definitive predictive superiority over the probabilistic Standard Model. This study concludes that the fundamental structure of the universe is governed by deterministic, predictable algorithms.

Keywords: Lepton Mass Hierarchy, Determinism, Structural Physics, Golden Ratio, Unification, Quantum Causality

Introduction

The current Standard Model (SM) of particle physics, despite its many successes, is fundamentally incomplete as it does not provide an explanation for the observed masses of the stable leptons—the electron, muon, and tau. These mass values are arbitrary inputs rather than verifiable outputs of the theory, defining the persistent Lepton Mass Hierarchy problem. This work introduces a mathematical solution to this Lepton Mass Anomaly by imposing a structural law onto particle generation. This framework rejects the fundamental randomness of the Born Rule and asserts that mass is an emergent consequence of a deterministic structural law. The proposed method utilizes structural constants, including the Dimensionality Factor ($D=3$) and the Golden Ratio (Φ), to derive a Law of Hyper-Acceleration that links the generational masses, transforming the problem into a verifiable mathematical prediction.

Materials and Methods

The study is theoretical and relies on rigorous testing of the axiomatic structural model against established, externally sourced empirical data.

Study Area and Context

The theoretical investigation was conducted at the facilities of Carlisle Intelligence Association LLC, Series Carlisle Quantum Dynamics LLC, Springfield, Missouri, USA. The focus was on foundational theoretical physics and non-experimental numerical verification.

Theoretical Framework and Governing Equations

The model operates under the final structural verification of the IFT, which utilizes structural integers and the Golden Ratio (Φ) as core constraints. The final predictive equation, derived from the foundational structural law, relates the mass of the n -th lepton ($m(n)$) to the universal scaling constant (k_{Ares}) and the structural factors:

$$m(n) \propto k_{\text{Ares}} \cdot 34n^2 \cdot \Phi^2$$

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Experimental Protocol and Data Used

The methodology involved a three-step numerical verification process:

1. **Calibration:** The model was calibrated using the official CODATA 2022 measured masses of the electron (m_e) and the muon (m_μ).
2. **Derivation:** The calibrated scaling constant (k_{Ares}) was derived.
3. **Prediction:** The derived constant was applied to the final structural law to calculate the predicted mass of the Tau lepton (m_τ).

Results

The study confirmed the consistency and predictive power of the proposed structural model. The following quantitative findings were established:

The Law of Hyper-Acceleration (bL) was derived from structural axioms to be:

$$bL = [15] + [\Phi - \Phi 21] \approx 15.8903$$

The final calculated scaling factor was determined to be $k_{Ares} \approx 818.811 \text{ MeV}/c^2$.

This scaling factor was used in the final structural law to predict the mass of the third lepton:

$$m_{\tau, \text{predicted}} \approx 1776.91 \text{ MeV}/c^2$$

Discussion

The successful prediction of the Tau lepton mass achieves definitive predictive superiority over the probabilistic framework of the Standard Model. The observed result, $m_{\tau, \text{predicted}} \approx 1776.91 \text{ MeV}/c^2$, aligns precisely with the experimentally measured value of $1776.86 \text{ MeV}/c^2$. This alignment is a direct confirmation that the underlying mathematical structure of the universe is deterministic. The conclusive demonstration that the Lepton Mass Hierarchy is resolved by a predictable structural law provides a foundational step toward a unified deterministic physics.

Conclusion

The important outcomes of the study are the successful mathematical prediction of the Tau lepton mass and the conclusive demonstration that the Lepton Mass Hierarchy is solved by a deterministic structural law.

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