Simplified Description of Fundamental Forces with Time-Mass Duality

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1 Unified Lagrangian Density with Dual Time-Mass Concept

Physics describes the world through four fundamental forces—strong, weak, electromagnetic, and gravitational—traditionally considered separately. However, in the T0 model, based on time-mass duality, these forces can be unified in a single Lagrangian density that naturally encompasses both known interactions and gravitation. This density is given by:

$$\mathcal{L}_{\text{total}} = \mathcal{L}_{\text{SM}} + \mathcal{L}_{\text{Higgs}} + \mathcal{L}_{\text{intrinsic}} \tag{1}$$

Here, $\mathcal{L}_{\text{SM}}$ represents the interactions of the Standard Model—the strong, electromagnetic, and weak forces—$\mathcal{L}_{\text{Higgs}}$ describes the dynamics of the Higgs field, and $\mathcal{L}_{\text{intrinsic}}$ introduces the concept of intrinsic time, reflecting time-mass duality. Notably, gravitation is not added as a separate force but emerges from the dynamics of the intrinsic time field, as detailed in "Mathematical Core Formulations"[6] and Ëmergent Gravitation in the T0 Model"[10].

1.1 Standard Model

The Standard Model forms the basis for describing the three forces that govern particle behavior at the atomic level. Its Lagrangian density is composed of:

$$\mathcal{L}_{\text{SM}} = \mathcal{L}_{\text{strong}} + \mathcal{L}_{\text{em}} + \mathcal{L}_{\text{weak}} \tag{2}$$

Here, $\mathcal{L}_{\text{strong}} = -\frac{1}{4}F^a_{\mu\nu}F^{a\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m_\psi(\phi))\psi$ represents the strong nuclear force, binding quarks into protons and neutrons; $\mathcal{L}_{\text{em}} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m_\psi(\phi))\psi$ represents the electromagnetic force, coupling electrons to nuclei; and $\mathcal{L}_{\text{weak}} = -\frac{1}{4}W^a_{\mu\nu}W^{a\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m_\psi(\phi))\psi$ represents the weak force, governing processes like radioactive decay. This conventional description follows the standard quantum field theory formulation [18].

In the T0 model, this description is adjusted by replacing time dilation with mass variation, leading to a dual formulation:

$$\mathcal{L}_{\text{SM-T}} = \mathcal{L}_{\text{strong-T}} + \mathcal{L}_{\text{em-T}} + \mathcal{L}_{\text{weak-T}} \tag{3}$$

Here, the time derivative is tied to the intrinsic time $T(x)$, such that $\partial_t \to \partial_{t/T}$, an adjustment that reinterprets dynamics under absolute time. This modification is fundamental to the T0 model's approach and connects directly to the concept of time as an emergent property described in [1].

1.2 Higgs Field

The Higgs field, responsible for mass generation, is described in the Standard Model by:

$$\mathcal{L}_{\text{Higgs}} = (D_\mu\phi)^\dagger(D^\mu\phi) - V(\phi) \tag{4}$$

where ϕ is the Higgs field and $V(\phi) = \mu^2\phi^\dagger\phi + \lambda(\phi^\dagger\phi)^2$ is the potential. This formulation follows the original work by Higgs, Englert, and Brout [16, 17].

In the T0 model, this formula is extended to incorporate intrinsic time:

$$\mathcal{L}_{\text{Higgs-T}} = (D_{T\mu}\phi_T)^\dagger(D^\mu_T\phi_T) - V_T(\phi_T) \tag{5}$$

The covariant derivative $D_{T\mu}$ accounts for time-mass duality, highlighting the Higgs field's role as a medium for mass and time, as elaborated in "Mathematical Formulation of the Higgs Mechanism"[9]. This modification reveals the deeper connection between mass generation and the intrinsic timescale of particles, a key insight of the T0 model that transcends the standard interpretation of the Higgs mechanism.

1.3 Lagrangian Density for Intrinsic Time

The central innovation of the T0 model is the Lagrangian density for intrinsic time, given by:

$$\mathcal{L}_{\text{intrinsic}} = \bar{\psi}\left(i\hbar\gamma^0 \frac{\partial}{\partial(t/T)} - i\hbar\gamma^0 \frac{\partial}{\partial t}\right)\psi \tag{6}$$

Here, $T(x) = \frac{\hbar}{mc^2}$ is the intrinsic time, dependent on mass. This formulation, developed in "The Necessity of Extending Standard Quantum Mechanics"[8], links particle dynamics to their individual timescales, enabling a unified description of all forces. The intrinsic time has dimension $[E^{-1}]$ in natural units, maintaining dimensional consistency throughout the formalism, as discussed in [11] and [12].

2 Simplified Description of Mass Terms with Time-Mass Duality

In the Standard Model, a particle's mass is defined by its coupling to the Higgs field: $m_\psi(\phi) = y_\psi \phi$, where mass remains constant and time is variable. In the T0 model, this view is reversed: time remains absolute, and mass varies with the Lorentz factor γ:

$$m_\psi(\phi_T) = y_\psi \phi_T \cdot \gamma, \quad \gamma = \frac{1}{\sqrt{1 - v^2/c^2}} \tag{7}$$

This dual description, derived in "Time-Mass Duality Theory"[3], explains the same phenomena as time dilation but offers a new perspective on the role of mass. This reformulation of special relativity effects preserves the experimental predictions of Einstein's theory [15] while providing a conceptually different framework that aligns with the fundamental time-mass duality, as explored in [2].

3 The Higgs Field as a Universal Medium with Intrinsic Time

The Higgs field is more than a mechanism for mass generation—in the T0 model, it also determines particles' intrinsic timescales. This relationship is expressed as:

$$T(x) = \frac{\hbar}{m(\phi)c^2} = \frac{\hbar}{y_\psi \phi \cdot c^2} \tag{8}$$

A particle's intrinsic time is thus inversely proportional to its mass, generated by the Higgs field. This perspective expands the Higgs field's role as a universal medium influencing all interactions, as explored in "Higgs Mechanism"[9]. The unique position of the Higgs boson in the particle spectrum takes on new significance in this framework, as it mediates not only mass but also the fundamental temporal properties of all other particles.

In natural units where $\hbar = c = 1$, this relationship simplifies to $T(x) = \frac{1}{m}$, highlighting the fundamental duality between time and mass. When additionally setting $\alpha_{\text{EM}} = \beta_{\text{T}} = 1$ in the unified natural unit system, this relationship reveals further elegance and simplicity, as discussed in [12].

4 The Higgs Field and the Vacuum: A Complex Relationship with Intrinsic Time

Vacuum energy, a central issue in modern physics, is reinterpreted in the T0 model. Instead of a sum of zero-point energies, it could be described as:

$$E_{\text{vacuum}} = \sum_i \frac{\hbar}{2T_i} \tag{9}$$

where T_i is the intrinsic time of quantum fluctuations. This formulation links vacuum energy to the dynamics of the Higgs field and time-mass duality, offering new insights into the cosmological constant problem [19]. By connecting vacuum energy directly to the intrinsic timescales of quantum fluctuations, the T0 model provides a potential path toward resolving the enormous discrepancy between quantum field theory predictions and astronomical observations of vacuum energy.

5 Quantum Entanglement and Nonlocality in Time-Mass Duality

The apparent instantaneity of quantum entanglement is reconsidered in the T0 model through intrinsic time. In the T_0 model, correlations arise not instantaneously but through mass variations. For entangled particles with different masses, time evolution varies with their intrinsic times. For photons, this is defined as:

$$T(x) = \frac{\hbar}{E_\gamma} e^{\alpha^{\text{SI}} x}, \quad \alpha^{\text{SI}} = \frac{H_0}{c} \approx 2.3 \times 10^{-18}\,\text{m}^{-1} \tag{10}$$

reflecting energy loss over distances, as described in "Dynamic Mass of Photons"[7]. This approach offers a novel perspective on the paradoxes of quantum nonlocality [20] by reinterpreting the apparent instantaneous action at a distance in terms of the varying intrinsic timescales of quantum systems. Further implications for quantum correlations and Bell's theorem are explored in [13].

6 Cosmological Implications of Time-Mass Duality

The T0 model provides natural explanations for cosmological phenomena through three key parameters: $\alpha^{\text{SI}} \approx 2.3 \times 10^{-18}\,\text{m}^{-1}$ describes photon energy loss over cosmic distances, $\kappa^{\text{SI}} \approx 4.8 \times 10^{-11}\,\text{m}\,\text{s}^{-2}$ characterizes the strength of the dark energy field in galactic dynamics, and $\beta_{\text{T}}^{\text{SI}} \approx 0.008$ quantifies the coupling to baryonic matter. The gravitational potential becomes:

$$\Phi(r) = -\frac{GM}{r} + \kappa r \tag{11}$$

where κ has dimension $[E]$ in natural units. These parameters, derived in "Mass Variation in Galaxies"[4] and "Measurement Differences"[5], explain flat rotation curves and redshift without requiring dark matter or cosmic expansion.

This modified gravitational potential aligns with observational evidence from galaxy rotation curves [21] and the radial acceleration relation [22], while providing a more parsimonious explanation than dark matter models. The linear term κr in the potential leads to an additional constant force component that dominates at large distances, naturally explaining the flattening of galaxy rotation curves.

Moreover, the T0 model's interpretation of cosmic redshift as energy loss rather than expansion offers an alternative to the standard ΛCDM cosmology [23], potentially resolving tensions in Hubble constant measurements without requiring dark energy.

7 Summary of the Unified Theory

The unified theory is described by the action:

$$S_{\text{unified}} = \int \left(\mathcal{L}_{\text{standard}} + \mathcal{L}_{\text{complementary}} + \mathcal{L}_{\text{coupling}}\right) d^4x \tag{12}$$

where $\mathcal{L}_{\text{standard}}$ is the Standard Model, $\mathcal{L}_{\text{complementary}}$ the dual formulation, and $\mathcal{L}_{\text{coupling}}$ the time-mass interaction. This approach bridges quantum mechanics and gravitation, offers new insights into entanglement and cosmological phenomena, and is experimentally testable.

The T0 model does not require exotic components like dark matter or dark energy, instead explaining these phenomena through the fundamental properties of the intrinsic time field. This unification of seemingly disparate physical phenomena through a single conceptual framework represents a significant step toward a more coherent understanding of nature.

8 Experimental Testability

The T0 model makes several specific, experimentally testable predictions that distinguish it from the Standard Model and conventional cosmology:

- **Photon Energy Loss:** The parameter $\alpha^{\text{SI}} \approx 2.3 \times 10^{-18}\,\text{m}^{-1}$ predicts a distance-dependent energy loss for photons that could be tested through precision spectroscopic measurements of distant sources.
- **Modified Gravitational Potential:** The parameter $\kappa^{\text{SI}} \approx 4.8 \times 10^{-11}\,\text{m}\,\text{s}^{-2}$ leads to deviations from Newtonian gravity at large distances, which could be detected through careful measurements of galaxy dynamics or solar system ephemerides.
- **Wavelength-Dependent Redshift:** The model predicts a logarithmic dependence of redshift on wavelength, characterized by $\beta_{\text{T}}^{\text{SI}} \approx 0.008$, which could be tested with multi-wavelength observations of distant galaxies.
- **Mass-Dependent Quantum Coherence:** The intrinsic time field coupling predicts that quantum coherence times should depend on mass, which could be verified through interference experiments with particles of different masses.

These predictions are detailed in "Parameter Derivations"[3] and "Measurement Differences"[5], providing a clear path for experimental verification or falsification of the T0 model.

9 References to Further Works

This theory builds on my previous works, listed in the bibliography, which explore various aspects of time-mass duality in depth. Together, these papers form a comprehensive framework that addresses fundamental questions in physics from a novel perspective, offering potential solutions to long-standing problems in quantum gravity, cosmology, and the unification of fundamental forces.

Literatur

[1] Pascher, J. (2025). Time as an Emergent Property in Quantum Mechanics: A Connection Between Relativity, Fine-Structure Constant, and Quantum Dynamics. March 23, 2025.

[2] Pascher, J. (2025). Time and Mass: A New Look at Old Formulas – and Liberation from Traditional Constraints. March 22, 2025.

[3] Pascher, J. (2025). Time-Mass Duality Theory (T0 Model): Derivation of Parameters κ, α, and β. April 4, 2025.

[4] Pascher, J. (2025). Mass Variation in Galaxies: An Analysis in the T0 Model with Emergent Gravitation. March 30, 2025.

[5] Pascher, J. (2025). Compensatory and Additive Effects: An Analysis of Measurement Differences Between the T0 Model and the ΛCDM Standard Model. April 2, 2025.

[6] Pascher, J. (2025). From Time Dilation to Mass Variation: Mathematical Core Formulations of Time-Mass Duality Theory. March 29, 2025.

[7] Pascher, J. (2025). Dynamic Mass of Photons and Its Implications for Nonlocality in the T0 Model. March 25, 2025.

[8] Pascher, J. (2025). The Necessity of Extending Standard Quantum Mechanics and Quantum Field Theory. March 27, 2025.

[9] Pascher, J. (2025). Mathematical Formulation of the Higgs Mechanism in Time-Mass Duality. March 28, 2025.

[10] Pascher, J. (2025). Emergent Gravitation in the T0 Model: A Comprehensive Derivation. April 1, 2025.

[11] Pascher, J. (2025). Energy as a Fundamental Unit: Natural Units with $\alpha_{\mathrm{EM}} = 1$ in the T0 Model. March 26, 2025.

[12] Pascher, J. (2025). Unified Unit System in the T0 Model: The Consistency of $\alpha_{\mathrm{EM}} = 1$ and $\beta_{\mathrm{T}} = 1$. April 5, 2025.

[13] Pascher, J. (2025). Field Theory and Quantum Correlations: A New Perspective on Instantaneity. March 28, 2025.

[14] Pascher, J. (2025). Adjustment of Temperature Units in Natural Units and CMB Measurements. April 2, 2025.

[15] Einstein, A. (1905). On the Electrodynamics of Moving Bodies. *Annalen der Physik*, 322(10), 891-921.

[16] Higgs, P. W. (1964). Broken Symmetries and the Masses of Gauge Bosons. *Physical Review Letters*, 13(16), 508-509.

[17] Englert, F., & Brout, R. (1964). Broken Symmetry and the Mass of Gauge Vector Mesons. *Physical Review Letters*, 13(9), 321-323.

[18] Weinberg, S. (1995). *The Quantum Theory of Fields, Volume I: Foundations*. Cambridge University Press.

[19] Weinberg, S. (1989). The Cosmological Constant Problem. *Reviews of Modern Physics*, 61(1), 1-23.

[20] Bell, J. S. (1964). On the Einstein Podolsky Rosen Paradox. *Physics*, 1(3), 195-200.

[21] Rubin, V. C., Ford, W. K., & Thonnard, N. (1980). Rotational Properties of 21 SC Galaxies with a Large Range of Luminosities and Radii. *The Astrophysical Journal*, 238, 471-487.

[22] McGaugh, S. S., Lelli, F., & Schombert, J. M. (2016). Radial Acceleration Relation in Rotationally Supported Galaxies. *Physical Review Letters*, 117(20), 201101.

[23] Planck Collaboration. (2020). Planck 2018 Results. VI. Cosmological Parameters. *Astronomy & Astrophysics*, 641, A6.