

The T0 Model as a More Complete Theory Compared to Approximative Gravitational Theories

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Abstract

This paper analyzes the T0 model of time-mass duality in comparison to established quantum gravity approaches. We argue that the T0 model offers a more complete, fundamental description of reality, while other gravitational theories can be considered as mathematical approximations that yield similar results in specific domains. The intrinsic time field $T(x, t)$ provides a unifying framework that can accommodate aspects of String Theory, Loop Quantum Gravity, Asymptotic Safety, Causal Dynamical Triangulation, and Emergent Gravity approaches. We demonstrate how these theories approximate aspects of the T0 model's dynamics in their respective domains of validity, similar to how Newtonian mechanics approximates relativistic physics at low velocities. The T0 model and its complementary Extended Standard Model formulation illustrate how different ontological interpretations can lead to mathematically equivalent predictions, suggesting a deeper principle of theory equivalence. This perspective promotes a more conciliatory view of competing quantum gravity theories and emphasizes that progress in physics often comes not through eliminating competing theories but through integrating them into a more comprehensive conceptual framework.

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1 Introduction

The search for a theory of quantum gravity remains one of the most significant challenges in theoretical physics. Multiple approaches have been developed, each with distinct mathematical frameworks and conceptual foundations. This paper proposes a fundamentally different perspective: rather than viewing these approaches as competing theories, we suggest they can be understood as mathematical approximations that capture different aspects of a more fundamental theory—the T0 model of time-mass duality.

The T0 model [1, 2] offers a novel approach to unifying quantum mechanics and relativity by inverting the traditional relationship between time and mass. Instead of relative time and constant mass (as in relativity theory), the T0 model posits absolute time and variable mass, mediated by the intrinsic time field $T(x, t)$. This field provides a natural framework that can accommodate both quantum mechanical and gravitational phenomena within a single coherent structure.

Our central thesis is that established quantum gravity approaches—String Theory, Loop Quantum Gravity, Asymptotic Safety, Causal Dynamical Triangulation, and Emergent Gravity—capture partial aspects of the more comprehensive T0 model, each being valid in specific domains. We will demonstrate how these theories can be understood as mathematical approximations that yield equivalent results to the T0 model under specific conditions, similar to how Newtonian mechanics approximates relativistic physics at low velocities.

This paper is structured as follows: Section 2 provides an overview of the T0 model and its intrinsic time field. Section 3 compares the T0 model with established gravitational theories, showing how they can be interpreted as approximations. Section 4 examines statistical methods in quantum mechanics as approximations of the intrinsic time field dynamics. Section 5 positions the T0 model as a metatheory that unifies various approaches. Section 6 discusses mathematical equivalence in limited domains. Section 7 explores the complementary Extended Standard Model formulation. Finally, Section 9 offers conclusions and implications for our understanding of quantum gravity.

2 Overview of the T0 Model

2.1 The Intrinsic Time Field

The cornerstone of the T0 model is the intrinsic time field, defined as:

$$T(x, t) = \frac{\hbar}{\max(m(\vec{x}, t)c^2, \omega(\vec{x}, t))} \quad (1)$$

where:

- $m(\vec{x}, t)$ is the position and time-dependent mass
- $\omega(\vec{x}, t)$ is the position and time-dependent frequency/energy
- \hbar is the reduced Planck constant
- c is the speed of light

This definition elegantly captures both extremes of physical reality:

- For mass-dominated systems: $T(x, t) = \frac{\hbar}{m(\vec{x}, t)c^2}$
- For wave-dominated systems: $T(x, t) = \frac{\hbar}{\omega(\vec{x}, t)}$

The intrinsic time field serves as a mediator between these two fundamental aspects of reality, providing a natural framework for understanding the wave-particle duality that lies at the heart of quantum mechanics.

2.2 Emergent Gravitation

In the T0 model, gravitation emerges naturally from the gradients of the intrinsic time field. The gravitational potential is defined as:

$$\Phi(\vec{x}) = -\ln\left(\frac{T(x, t)}{T_0}\right) \quad (2)$$

where T_0 is a reference value of the time field.

For a point mass, the solution of the time field is:

$$T(x, t)(r) = T_0 \left(1 - \frac{M}{r} + \kappa r\right) \quad (3)$$

This leads to a modified gravitational potential:

$$\Phi(r) = -\frac{GM}{r} + \kappa r \quad (4)$$

with $\kappa \approx 4.8 \times 10^{-11} \text{ m/s}^2$ in SI units. The linear term κr naturally explains galactic rotation curves without dark matter and cosmic acceleration without dark energy [6].

2.3 Field Equations and Quantum Extension

The dynamic behavior of the intrinsic time field is governed by the field equation:

$$\partial_\mu \partial^\mu T(x, t) + T(x, t) + \frac{\rho(\vec{x}, t)}{T(x, t)^2} = 0 \quad (5)$$

where $\rho(\vec{x}, t)$ is the position and time-dependent mass-energy density.

The T0 model extends quantum mechanics through a modified Schrödinger equation:

$$i\hbar T(x, t) \frac{\partial \Psi}{\partial t} + i\hbar \Psi \left[\frac{\partial T(x, t)}{\partial t} + \vec{v} \cdot \nabla T(x, t) \right] = \hat{H} \Psi \quad (6)$$

where \vec{v} is the velocity of the quantum system, and the term in square brackets represents the total time derivative of the field as experienced by the moving quantum system [3].

3 Comparison with Established Gravitational Theories

3.1 String Theory as an Approximation

String Theory replaces point-like particles with one-dimensional strings whose different vibrational modes represent different elementary particles. It typically requires 10 or 26 dimensions and automatically includes a gravity-like interaction.

From the T0 model perspective, String Theory can be understood as an approximation that captures certain aspects of the intrinsic time field dynamics:

- The additional dimensions of String Theory could be interpreted as mathematical tools for describing the complex behavior of the intrinsic time field in high-energy regimes.

- The various vibrational modes of strings could represent different manifestations of how the time field interacts with matter and energy.
- The automatically occurring gravitational force in String Theory could be seen as a specific manifestation of the emergent gravitational potential in the T0 model.

The mathematical elegance of strings is undeniable, but from the T0 perspective, they might be effective descriptions rather than ontologically fundamental entities. This is analogous to how phonons effectively describe lattice vibrations in solids without being fundamental particles.

3.2 Loop Quantum Gravity as an Approximation

Loop Quantum Gravity (LQG) quantizes space directly by representing it as a network of discrete volumes and areas. In this approach, space itself has a discrete, granular structure at the Planck scale.

From the T0 model perspective, LQG can be understood as an approximation that captures certain aspects of the intrinsic time field in a discretized form:

- The spin networks of LQG could be interpreted as discrete approximations of the continuous time field dynamics, similar to how one might approximate a vector field with a lattice grid.
- The quantized length scales in LQG could be seen as emergent properties of the hierarchical length scales defined in the T0 model through parameters such as $\xi \approx 1.33 \times 10^{-4}$.
- The difficulty in recovering the classical limit in LQG might stem from the fact that discrete approaches approximate fundamentally continuous processes.

3.3 Asymptotically Safe Gravity as an Approximation

Asymptotically Safe Gravity (ASG) proposes that naively quantized gravity is stabilized at high energies by a non-trivial fixed point in the renormalization group flow, allowing the theory to have a consistent high-energy limit.

From the T0 model perspective, ASG can be understood as an approximation that captures certain aspects of the intrinsic time field's high-energy behavior:

- The fixed point in the renormalization group flow could be interpreted as a mathematical manifestation of the $\beta_T = 1$ parameter in the T0 model.
- The high-energy stability of ASG could be seen as a special case of the more general time field dynamics.
- The mathematical consistency at high energies emerges naturally from the more fundamental time field theory.

The equation $\lim_{E \rightarrow 0} \beta_T(E) = 1$ in the T0 model [7] can be seen as defining a natural fixed point, conceptually similar to the fixed point in ASG.

3.4 Causal Dynamical Triangulation as an Approximation

Causal Dynamical Triangulation (CDT) approximates curved spacetime through triangulation and simulates quantum gravity through statistical summation over all possible triangulations.

From the T0 model perspective, CDT can be understood as a numerical approximation that captures certain aspects of the intrinsic time field:

- The triangulation could be interpreted as a numerical method to approximate the continuous time field dynamics in complex situations.
- The special treatment of time in CDT reflects the fundamental importance of time in the T0 model.
- The successful simulations might reflect the emergent behavior of the time field in discrete approximations.

3.5 Emergent Gravity as an Approximation

Emergent Gravity approaches view gravity not as a fundamental force but as an emergent phenomenon arising from the collective behavior of more fundamental constituents.

From the T0 model perspective, Emergent Gravity approaches correctly identify the non-fundamental nature of gravity but lack a specific mechanism:

- These approaches correctly recognize the emergent character of gravity, as proposed by the T0 model.
- The T0 model specifies exactly the mechanism of emergence through the intrinsic time field.
- Various phenomenological models of emergent gravity could be understood as specific regimes or approximations of the time field dynamics.

The T0 model's formula $\vec{F}(\vec{x}, t) = -\frac{\nabla T(x, t)(\vec{x}, t)}{T(x, t)(\vec{x}, t)}$ provides a precise mechanism for how gravitational force emerges from the time field gradients, giving substance to the general idea of emergent gravity.

4 Statistical Methods as Approximations

In conventional quantum mechanics, we use statistical descriptions (wave functions, probability amplitudes) because we lack access to the underlying dynamics. Similar to how thermodynamic laws represent the statistical description of many particles, quantum mechanics itself might be a statistical approximation of a deeper reality.

In the T0 model, this deeper reality is described by the intrinsic time field $T(x, t)$. Conventional quantum mechanics then appears as a statistical approximation that emerges when one does not account for the full behavior of the time field. This explains why the modified Schrödinger equation in the T0 model:

$$i\hbar T(x, t) \frac{\partial \Psi}{\partial t} + i\hbar \Psi \left[\frac{\partial T(x, t)}{\partial t} + \vec{v} \cdot \nabla T(x, t) \right] = \hat{H} \Psi \quad (7)$$

contains the conventional Schrödinger equation as a special case when the time field is assumed to be constant.

This perspective offers a natural explanation for phenomena such as quantum decoherence and the measurement problem. The rate of quantum decoherence is linked to the local value and rate of change of $T(x, t)$, explaining why macroscopic objects (with smaller $T(x, t)$) decohere more rapidly than microscopic quantum systems [3].

5 The T0 Model as a Metatheory

The T0 model can be viewed as a "metatheory" or "framework theory" that:

1. **Unifies various approximations:** The different gravitational theories correspond to different mathematical approximations or representations of the more fundamental T0 mechanism.
2. **Explains the success of approximative methods:** The success of statistical methods in quantum mechanics becomes explainable as emergent behavior from the more fundamental time field dynamics.
3. **Resolves conceptual tensions:** The apparent contradictions between quantum mechanics and relativity theory are resolved by recognizing both as different aspects of the same underlying phenomenon.
4. **Provides ontological clarity:** While other theories often remain in mathematical abstractions, the T0 model offers a clearer ontological interpretation of physical reality.

This metatheoretical status is similar to how relativity theory provides a framework that explains why Newtonian mechanics works at low velocities while revealing its limitations.

The T0 model achieves this through a single, unifying principle—the intrinsic time field $T(x, t)$ —that mediates between quantum and gravitational phenomena, particle and wave behavior, and microscopic and macroscopic scales.

6 Mathematical Equivalence in Limited Domains

The mathematical equivalence of different theories in certain domains is a well-known phenomenon in physics. For example:

- Newtonian mechanics is an approximation of relativity theory at low velocities
- Geometric optics is an approximation of wave optics for large wavelengths
- Classical mechanics is an approximation of quantum mechanics for large quantum numbers

In this sense, the various gravitational theories could be understood as limiting cases or approximations of the more comprehensive T0 model, valid in specific regimes:

- String Theory: valid for high-energy quantum phenomena
- LQG: valid for discrete spatial structures
- ASG: valid near the UV fixed point
- CDT: valid for numerical approximations of complex geometries

- Emergent Gravity: valid at macroscopic scales

The T0 model provides the unified framework that explains why these different approximations work in their respective domains, similar to how relativity theory explains why Newtonian mechanics works at low velocities.

This perspective is supported by the observation that all these theories lead to similar predictions in certain regimes, such as recovering the Einstein field equations at appropriate scales, despite their different mathematical formulations.

7 Extended Standard Model as a Complementary Description

The Extended Standard Model (ESM) represents a mathematically equivalent but conceptually different formulation of the same physics as the T0 model [8]. The scalar field Θ in the ESM relates to the time field through a logarithmic relationship:

$$\Theta(\vec{x}, t) \propto \ln \left(\frac{T(x, t)}{T_0} \right) \quad (8)$$

While the T0 model posits absolute time and variable mass, the ESM maintains relative time and constant mass but modifies the Einstein field equations:

$$G_{\mu\nu} + \kappa g_{\mu\nu} = 8\pi G T_{\mu\nu} + \nabla_\mu \Theta \nabla_\nu \Theta - \frac{1}{2} g_{\mu\nu} (\nabla_\sigma \Theta \nabla^\sigma \Theta) \quad (9)$$

Both frameworks predict identical observable outcomes, including:

- The same modified gravitational potential $\Phi(r) = -\frac{GM}{r} + \kappa r$
- A static universe without expansion where redshift occurs through energy attenuation
- Galactic rotation curves without dark matter
- Cosmic acceleration without dark energy

This complementarity illustrates how different ontological interpretations can lead to mathematically equivalent predictions, suggesting a deeper principle of theory equivalence. It compares conceptually to the wave-particle duality in quantum mechanics, where different mathematical frameworks describe the same experimental outcomes from different starting points.

The existence of two mathematically equivalent frameworks with different ontological foundations raises profound questions about the nature of physical reality and the role of mathematical models in describing it.

8 Misinterpretations of Incomplete Theories

A significant concern regarding incomplete theories is their frequent misinterpretation as ontologically correct, leading to visualizations and conceptual models that have little connection to physical reality. When mathematical approximations are mistaken for fundamental truths, physics can drift into increasingly abstract territory disconnected from empirical foundations. This section addresses common misinterpretations of partial theories and how they should be corrected from the T0 model perspective.

8.1 String Theory Misinterpretations

- **Misinterpretation:** Extra dimensions actually exist as physical extensions of space.
- **T0 Correction:** The additional dimensions are mathematical constructs that model the complex behavior of the intrinsic time field $T(x, t)$. The apparent need for extra dimensions emerges from attempting to describe the time field's effects without recognizing its fundamental nature.
- **Misinterpretation:** Strings are fundamental objects replacing point particles.
- **T0 Correction:** Strings represent effective mathematical descriptions of how the intrinsic time field interacts with energy in specific regimes, similar to how phonons effectively describe collective lattice vibrations without being fundamental.

8.2 Loop Quantum Gravity Misinterpretations

- **Misinterpretation:** Space is fundamentally discrete and granular at the Planck scale.
- **T0 Correction:** The apparent discreteness is an artifact of approximating the continuous time field with discrete mathematical structures. Space itself remains continuous, but the interaction of the time field with matter creates preferential scales.
- **Misinterpretation:** Spin networks represent the fundamental structure of spacetime.
- **T0 Correction:** Spin networks are mathematical tools that approximate how the intrinsic time field structures space. They are not ontologically fundamental but emerge as effective descriptions of time field dynamics.

8.3 Asymptotically Safe Gravity Misinterpretations

- **Misinterpretation:** Quantized geometry is the correct approach, merely requiring proper handling of renormalization.
- **T0 Correction:** The fixed points identified in the renormalization group flow are mathematical manifestations of the more fundamental $\beta_T = 1$ parameter in the T0 model. The apparent renormalizability at high energies emerges naturally from the time field's properties.
- **Misinterpretation:** Quantum fields on curved spacetime represent the fundamental nature of reality.
- **T0 Correction:** Both quantum fields and curved spacetime are emergent descriptions of a deeper reality where the intrinsic time field $T(x, t)$ is the primary entity. Treating them as fundamental leads to conceptual contradictions.

8.4 Emergent Gravity Misinterpretations

- **Misinterpretation:** Gravity emerges from entanglement entropy or thermodynamic principles without a specific mechanism.
- **T0 Correction:** Gravity indeed emerges, but through the specific mechanism of time field gradients: $\vec{F}(\vec{x}, t) = -\frac{\nabla T(x, t)(\vec{x}, t)}{T(x, t)(\vec{x}, t)}$. The apparent connections to thermodynamics or entropy are secondary consequences of the time field dynamics.

- **Misinterpretation:** Information is a fundamental physical quantity from which gravity emerges.
- **T0 Correction:** Information is a derived concept that describes patterns in the intrinsic time field. The primary entity is the time field itself, not abstract information.

8.5 General Relativistic Misinterpretations

- **Misinterpretation:** Spacetime curvature is a fundamental property that causes gravity.
- **T0 Correction:** Spacetime curvature is a mathematical description of how matter responds to gradients in the intrinsic time field. Gravity emerges from these gradients, not from geometry itself.
- **Misinterpretation:** The Big Bang represents the beginning of time and space from a singularity.
- **T0 Correction:** The apparent Big Bang singularity is an artifact of extrapolating an incomplete theory beyond its domain of validity. The T0 model suggests a static, eternal universe where redshift emerges from energy attenuation as light propagates through the time field.

8.6 Quantum Mechanical Misinterpretations

- **Misinterpretation:** Quantum indeterminism is ontologically fundamental, representing inherent randomness in nature.
- **T0 Correction:** Quantum indeterminism represents our statistical description of a deeper, deterministic reality governed by the intrinsic time field. The probabilistic nature of quantum mechanics emerges when we do not account for the full dynamics of the time field.
- **Misinterpretation:** Wave-particle duality represents a fundamental, irreducible aspect of reality.
- **T0 Correction:** Wave-particle duality is elegantly resolved through the time field definition $T(x, t) = \frac{\hbar}{\max(m(\vec{x}, t)c^2, \omega(\vec{x}, t))}$, which naturally accommodates both aspects through the max function, showing they are different regimes of the same underlying phenomenon.

These misinterpretations arise when mathematically effective descriptions are erroneously elevated to ontological status. While each theory captures aspects of physical reality within its domain, only a more complete framework like the T0 model can integrate these partial truths into a coherent whole without introducing conceptual contradictions. The mathematical formalisms of these theories remain valid as approximations, but their ontological interpretations require correction based on a more complete understanding.

9 Conclusion and Implications

This paper has presented the T0 model as a more complete, fundamental theory, with other gravitational approaches representing mathematical approximations valid in limited domains. The intrinsic time field $T(x, t)$ provides a unifying framework that can accommodate aspects of various quantum gravity approaches within a single coherent structure.

We have shown how incomplete theories, despite their mathematical validity in limited domains, are often misinterpreted ontologically, leading to visualizations and conceptual models disconnected from physical reality. The danger lies not in the mathematical formalisms themselves, which can serve as effective approximations, but in mistaking these approximations for fundamental truths about nature. The T0 model helps correct these misinterpretations by providing a more comprehensive framework that explains why these partial approaches work in their specific domains.

The perspective we have developed has several important implications:

1. **Theory Integration:** Rather than viewing different approaches to quantum gravity as competing theories, we can understand them as complementary approximations that capture different aspects of a more fundamental reality described by the T0 model.
2. **Ontological Humility:** The complementarity between the T0 model and the ESM suggests that our ontological assumptions may be more influenced by our mathematical tools than by the underlying reality.
3. **Experimental Strategy:** This perspective suggests focusing experimental efforts on detecting phenomena where the T0 model makes distinct predictions, such as wavelength-dependent redshift and the dynamic behavior of the time field.
4. **Philosophical Implications:** The view of quantum mechanics as a statistical approximation of a deeper reality aligns with Einstein's conviction that "God does not play dice" and suggests that quantum indeterminism may be epistemic rather than ontological.
5. **Methodological Guidance:** Scientists should maintain a clear distinction between mathematically effective descriptions and claims about fundamental reality, recognizing that our most successful theories may still be approximations of a deeper structure.

The T0 model, with its intrinsic time field $T(x, t)$, offers a more elegant and conceptually coherent framework for understanding both quantum and gravitational phenomena. By recognizing how other theories approximate aspects of this more fundamental model, we can work towards a more unified understanding of physical reality while avoiding the ontological pitfalls that arise from incomplete theoretical frameworks.

9.1 Epistemological Humility Regarding the T0 Model

It is crucial to emphasize that even the T0 model itself, despite its greater comprehensiveness and explanatory power, should not be viewed as the final word in physics. Like all scientific theories, the T0 model represents our current best attempt to understand reality, but remains a human construction that will likely be refined, extended, or perhaps even superseded by future insights.

The history of physics teaches us that each theoretical framework, no matter how successful, eventually reveals its own limitations and domains where it breaks down. Newton's mechanics gave way to Einstein's relativity, which itself appears incomplete in light of quantum phenomena. We should therefore maintain epistemological humility regarding the T0 model as well, recognizing that:

- The intrinsic time field $T(x, t)$, while powerful as a unifying concept, may itself be an effective description of even deeper structures not yet conceived
- The mathematical formalism of the T0 model, like all mathematical descriptions of reality, necessarily involves idealizations and simplifications

- Future experimental findings may reveal phenomena that require further extensions or modifications to the T0 framework
- Our cognitive limitations as humans may constrain our ability to fully grasp reality's ultimate nature
- The current Lagrangian formulations appear unnecessarily complex, given that all units and constants can be reduced to energy. It seems likely that these formulations will eventually be replaced by much simpler expressions that more directly reflect the energy-based unity of physical phenomena

This last point deserves particular emphasis: Given the T0 model's demonstration that all physical quantities can be expressed in terms of energy ($[E]$) or its inverse ($[E^{-1}]$), the current mathematical structures—while functional—likely represent an intermediate formalism rather than the most fundamental description. The apparent complexity of our current mathematical machinery may be an artifact of our historical approach to physics, where different phenomena were described using different frameworks before their unity was recognized. A future, more elegant formulation of the T0 model might express all physical laws through remarkably simple equations centered on energy transformations, eliminating redundant parameters and complex tensor structures.

This epistemological humility does not diminish the value of the T0 model but rather places it within the proper context of scientific progress—as an important step forward that advances our understanding while remaining open to future refinement. The most valuable contribution of the T0 model may ultimately be not its specific formalism, but its demonstration that a more unified and coherent description of physical reality is possible beyond the fragmented approaches of conventional quantum gravity theories.

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