

Dark Energy in the T0 Model: A Mathematical Analysis of Energy Dynamics

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Zusammenfassung

This work develops a detailed mathematical analysis of dark energy within the framework of the T0 model with absolute time and variable mass. Unlike the Λ CDM standard model, dark energy is not considered a driving force of cosmic expansion but emerges as a dynamic effect of energy exchange in a static universe, mediated by the intrinsic time field $T(x)$. The document builds on foundations from [4] and the gravitation theory from [1], characterizes energy transfer rates, analyzes the radial density profile of dark energy, and explains the observed redshift as a result of photon energy loss to this field (see [2]). Experimental tests to distinguish this interpretation from the standard model conclude the analysis.

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1 Introduction

The discovery of accelerated cosmic expansion through supernova observations in the late 1990s led to the introduction of dark energy as the dominant component of the universe in the Λ CDM standard model, where it is modeled as a cosmological constant (Λ) with negative pressure, accounting for approximately 68% of the energy content. This work pursues an alternative approach within the T0 model, based on time-mass duality (see [4], Section “Time-Mass Duality”). Here, time is absolute, and mass varies, with dark energy not being a separate entity driving expansion but an emergent effect of the intrinsic time field $T(x)$. Cosmic redshift is explained not by spatial expansion but by the energy loss of photons to $T(x)$, as detailed in [2] (Section “Energy Loss and Redshift”) and [3] (Section “Temperature Scaling”). The energy dynamics are mathematically analyzed below, referencing established derivations such as gravitation theory in [1] and parameters in [4]. Experimental tests to differentiate from the standard model conclude the work.

2 Mathematical Foundations of the T0 Model

2.1 Time-Mass Duality

The T0 model postulates a duality between time and mass, enabling two descriptions:

1. **Standard View:** Time dilation ($t' = \gamma t$), constant rest mass (m_0).
2. **T0 Model:** Absolute time (T_0), variable mass ($m = \gamma m_0$).

The complete derivation and transformations are provided in [4] (Section “Time-Mass Duality”) and [1] (Section “Foundations”). An overview is given in the table:

Quantity	Standard View	T0 Model
Time	$t' = \gamma t$	$t = \text{const.}$
Mass	$m = \text{const.}$	$m = \gamma m_0$
Intrinsic Time	$T = \frac{\hbar}{mc^2}$	$T = \frac{\hbar}{\gamma m_0 c^2}$

Tabelle 1: Transformations in the T0 Model (see [4])

2.2 Intrinsic Time

The intrinsic time $T(x)$ is central to the T0 model:

Definition 2.0.1 (Intrinsic Time). For a particle with mass m :

$$T(x) = \frac{\hbar}{mc^2} \tag{1}$$

The derivation is detailed in [4] (Section “Definition of Intrinsic Time”).

Corollary 2.1 (Scalar Field). *As a field:*

$$T(x) = \frac{\hbar}{y\langle\Phi\rangle c^2} \tag{2}$$

Details on the Higgs field are in [6] (Section “Higgs Mechanism”).

2.3 Modified Derivative Operators

The operators were introduced in [5] (Section “Lagrangian Formulation”):

Definition 2.1.1 (Modified Time Derivative).

$$\partial_{t/T} = T \frac{\partial}{\partial t} \quad (3)$$

Definition 2.1.2 (Covariant Derivative). For a field Ψ :

$$D_{T,\mu}\Psi = T(x)D_\mu\Psi + \Psi\partial_\mu T(x) \quad (4)$$

Definition 2.1.3 (Higgs Field Derivative).

$$D_{T,\mu}\Phi = T(x)(\partial_\mu + igA_\mu)\Phi + \Phi\partial_\mu T(x) \quad (5)$$

3 Modified Field Equations for Dark Energy

3.1 Modified Lagrangian Density

The Lagrangian density is derived in [5] (Section “Total Lagrangian Density”):

$$\mathcal{L}_{\text{Total}} = \mathcal{L}_{\text{Boson}} + \mathcal{L}_{\text{Fermion}} + \mathcal{L}_{\text{Higgs-T}} \quad (6)$$

With:

$$\mathcal{L}_{\text{Boson}} = -\frac{1}{4}T(x)^2 F_{\mu\nu}F^{\mu\nu} \quad (7)$$

$$\mathcal{L}_{\text{Fermion}} = \bar{\psi}i\gamma^\mu T(x)D_\mu\psi + \psi\partial_\mu T(x) - y\bar{\psi}\Phi\psi \quad (8)$$

$$\mathcal{L}_{\text{Higgs-T}} = (D_{T,\mu}\Phi)^\dagger(D_{T,\mu}\Phi) - \lambda(|\Phi|^2 - v^2)^2 \quad (9)$$

3.2 Dark Energy as an Emergent Effect

Dark energy arises from $T(x)$ variations, as described in [1] (Section “Emergent Gravitation”):

$$\rho_{\text{DE}}(r) \approx \frac{\kappa}{r^2} \quad (10)$$

Details on κ are in [4] (Section “Parameter Derivations”).

3.3 Energy Density Profile

$$\rho_{\text{DE}}(r) \approx \frac{1}{2}(\nabla T(x))^2 \approx \frac{\kappa}{r^2} \quad (11)$$

See [1] (Section “Energy Density”).

3.4 Emergent Gravitation

Theorem 3.1 (Emergence of Gravitation).

$$\nabla T(x) = -\frac{\hbar}{m^2 c^2} \nabla m \sim \nabla \Phi_g \quad (12)$$

Full derivation in [1] (Section “Emergent Gravitation”).

Beweis. In regions with gravitational potential Φ_g , the effective mass varies as:

$$m(\vec{r}) = m_0 \left(1 + \frac{\Phi_g(\vec{r})}{c^2} \right) \quad (13)$$

Thus:

$$\nabla m = \frac{m_0}{c^2} \nabla \Phi_g \quad (14)$$

Substituting into the gradient of the intrinsic time field:

$$\nabla T(x) = -\frac{\hbar}{m^2 c^2} \cdot \frac{m_0}{c^2} \nabla \Phi_g \quad (15)$$

□

The Poisson equation is:

$$\nabla^2 \Phi = 4\pi G \rho + \kappa^2 \quad (16)$$

4 Energy Transfer and Redshift

4.1 Photon Energy Loss

Redshift results from energy loss, derived in [2] (Section “Energy Loss”):

$$\frac{dE_\gamma}{dx} = -\alpha E_\gamma, \quad E_\gamma(x) = E_{\gamma,0} e^{-\alpha x} \quad (17)$$

$$1 + z = e^{\alpha d}, \quad \alpha = \frac{H_0}{c} \approx 2.3 \times 10^{-18} \text{ m}^{-1} \quad (18)$$

Details on α in [4] (Section “Derivation of α ”).

4.2 Modified Energy-Momentum Relation

Theorem 4.1 (Energy-Momentum Relation).

$$E^2 = (pc)^2 + (mc^2)^2 + \alpha_E \frac{\hbar c}{T} \quad (19)$$

See [7] (Section “Physics Beyond the Speed of Light”).

Theorem 4.2 (Wavelength Dependence).

$$z(\lambda) = z_0(1 + \beta_T \ln(\lambda/\lambda_0)) \quad (20)$$

With $\beta_T^{SI} \approx 0.008$, $\beta_T^{nat} = 1$ (see [4]).

4.3 Energy Balance Equation

$$\rho_{\text{total}} = \rho_{\text{Matter}} + \rho_\gamma + \rho_{\text{DE}} = \text{const.} \quad (21)$$

$$\frac{d\rho_{\text{Matter}}}{dt} = -\alpha c \rho_{\text{Matter}} \quad (22)$$

$$\frac{d\rho_\gamma}{dt} = -\alpha c \rho_\gamma \quad (23)$$

$$\frac{d\rho_{\text{DE}}}{dt} = \alpha c (\rho_{\text{Matter}} + \rho_\gamma) \quad (24)$$

See [2] (Section “Energy Balance”).

5 Quantitative Determination of Parameters

5.1 Parameters in Natural Units

Theorem 5.1 (Key Parameters).

$$\kappa = \beta_T \frac{yv}{r_g} \quad (25)$$

$$\alpha = \frac{\lambda_h^2 v}{L_T} \quad (26)$$

$$\beta_T = \frac{\lambda_h^2 v^2}{4\pi^2 \lambda_0 \alpha_0} \quad (27)$$

Derivation in [4] (Section “Parameter Derivations”).

In SI units:

$$\alpha_{\text{SI}} \approx 2.3 \times 10^{-18} \text{ m}^{-1} \quad (28)$$

$$\beta_T^{\text{SI}} \approx 0.008 \quad (29)$$

$$\kappa_{\text{SI}} \approx 4.8 \times 10^{-11} \text{ m s}^{-2} \quad (30)$$

5.2 Gravitational Potential

Theorem 5.2 (Gravitational Potential).

$$\Phi(r) = -\frac{GM}{r} + \kappa r \quad (31)$$

See [1] (Section “Modified Gravitational Potential”).

6 Dark Energy and Cosmological Observations

6.1 Type Ia Supernovae

$$d_L = \frac{c}{H_0} \ln(1+z)(1+z) \quad (32)$$

See [2] (Section “Supernovae”).

6.2 Energy Density Parameter

$$\Omega_{DE}^{\text{eff}} \approx \frac{3\kappa}{R_U H_0^2} \approx 0.68 \quad (33)$$

7 Experimental Tests

7.1 Fine Structure Constant

$$\frac{d\alpha_{\text{EM}}}{dt} \approx 1 \times 10^{-18} \text{ yr}^{-1} \quad (34)$$

See [7] (Section “Experimental Verification”).

7.2 Environment-Dependent Redshift

$$\frac{z_{\text{Cluster}}}{z_{\text{Void}}} \approx 1 + 0.003 \quad (35)$$

7.3 Differential Redshift

$$\frac{z(\lambda_1)}{z(\lambda_2)} \approx 1 + \beta_{\text{T}} \frac{\lambda_1 - \lambda_2}{\lambda_0} \quad (36)$$

8 Outlook and Summary

The T0 model provides a framework for a static universe where dark energy emerges from $T(x)$. Future tests (e.g., Euclid) can validate it.

Literatur

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