

The T0-Model: Nullpoint-Based Derivation
of the Universal Scaling Factor
From Cosmic Microwave Background Temperature in
a Static Universe
A Field-Theoretic Approach Avoiding Cosmological Distance
Assumptions

Unifying Cosmological Phenomena through a Universal Energy Field and
Geometric Parameter

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Abstract

The T0-Model provides a field-theoretic framework for cosmological phenomena within a static universe, driven by a universal energy field E_{field} and the geometric parameter $\xi_{\text{geom}} = \frac{4}{3}$. This document derives the universal scaling factor $\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20}$ from the cosmic microwave background (CMB) temperature using a nullpoint-based methodology, which relies on quantum mechanical ground states rather than uncertain cosmological distance measurements. The mass-dependent scaling factor $\beta_{\text{scale}} = \frac{2Gm}{r}$ bridges quantum and cosmic scales, but ξ is not absolute, as each physical regime and potentially each astrophysical object (e.g., galaxy, black hole, planet) has a characteristic ξ -value. The approach ensures dimensional consistency, eliminates the need for dark matter and dark energy, and resolves cosmological issues such as the Hubble tension. Experimental validations, including the muon anomalous magnetic moment, support the model's robustness.

Contents

1	Introduction	2
2	Theoretical Foundations	3
2.1	The Universal Energy Field	3
2.2	Nullpoint-Based Methodology	3
2.3	Mass-Dependent Scaling Factor	4
2.4	Energy Scale Hierarchy	4
2.5	Scale-Dependent Parameters	5
3	Derivation of the Universal Scaling Factor from CMB Temperature	6
3.1	CMB as a Manifestation of the Energy Field	6
3.2	Nullpoint-Based Derivation of $\xi_{\text{universal}}$	6
3.3	Non-Absolute Nature of the Scaling Factor	7
4	Cosmological Applications	9
4.1	Photon Energy Loss and Redshift	9
4.2	Gravitational Light Deflection	9
4.3	Galactic Dynamics	9
4.4	Resolution of Cosmological Problems	10
5	Experimental Validation	11
5.1	Muon Anomalous Magnetic Moment	11
5.2	Cosmic-Scale Predictions	11
6	Integration with Established Physics	12
6.1	Quantum Field Theory Compatibility	12
6.2	General Relativity Relationship	12

Chapter 1

Introduction

The T0-Model reinterprets cosmological observations through a static universe paradigm, where a universal energy field E_{field} governs physical interactions via the geometric parameter $\xi_{\text{geom}} = \frac{4}{3}$. Due to the indirect nature of distance and mass measurements in the standard model, which rely on cosmological assumptions, the cosmic microwave background (CMB) temperature provides the most direct method to determine the universal scaling factor $\xi_{\text{universal}}$. This document leverages the nullpoint-based methodology, as outlined in [?], to derive $\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20}$ from the CMB temperature, incorporating the mass-dependent scaling factor $\beta_{\text{scale}} = \frac{2Gm}{r}$. The scaling factor ξ is not absolute, as different physical regimes (e.g., electroweak, QCD, atomic) and potentially individual astrophysical objects exhibit distinct ξ -values, as detailed in the energy scale hierarchy. The model ensures parameter-free consistency and compatibility with local physics predictions.

Important Insight

The nullpoint-based methodology derives scales from quantum mechanical ground states, eliminating dependence on uncertain cosmological distance measurements. The mass-dependent scaling factor β_{scale} and the energy scale hierarchy highlight the challenge of defining a unified scaling factor across all physical regimes and astrophysical objects.

Chapter 2

Theoretical Foundations

2.1 The Universal Energy Field

The T0-Model is built on the universal energy field E_{field} , satisfying:

Key Formula

Universal Field Equation:

$$\boxed{\square E_{\text{field}} = 0} \quad (2.1)$$

This is coupled with the time-energy duality:

$$T_{\text{field}} \cdot E_{\text{field}} = 1. \quad (2.2)$$

In natural units ($\hbar = c = G = k_B = 1$), dimensional consistency is verified:

$$[\square] = [E^2], \quad [E_{\text{field}}] = [E], \quad [\square E_{\text{field}}] = [E^3] = [0], \quad (2.3)$$

$$[T_{\text{field}}] = [E^{-1}], \quad [E_{\text{field}}] = [E], \quad [T_{\text{field}} \cdot E_{\text{field}}] = [1]. \quad (2.4)$$

2.2 Nullpoint-Based Methodology

Important Insight

Nullpoint-Based Principle: All scales in the T0-Model are derived from quantum mechanical ground states, ensuring independence from cosmological distance assumptions and maintaining rigorous theoretical foundations.

The universal scale is determined from the quantum ground state temperature:

Key Formula

Universal Ground Temperature:

$$T_{\text{universal}} \approx 1.8 \text{ K}. \quad (2.5)$$

This temperature is linked to cosmic neutrino backgrounds and interstellar medium minima, reflecting the energy field's quantum limit.

2.3 Mass-Dependent Scaling Factor

The T0-Model introduces a mass-dependent scaling factor β_{scale} to bridge quantum and cosmic scales:

Key Formula

Mass-Dependent Scaling Factor:

$$\beta_{\text{scale}} = \frac{r_0}{r} = \frac{2Gm}{r}, \quad (2.6)$$

where $r_0 = 2Gm$ is the Schwarzschild radius for mass m , and r is the characteristic length scale. For example:

- For elementary particles ($m \sim m_e$, $r \sim \ell_P$): $\beta_{\text{scale}} \sim 1$.
- For cosmological scales ($m \sim 10^{42}$ kg, $r \sim 10^{21}$ m): $\beta_{\text{scale}} \sim 10^{-8}$.

2.4 Energy Scale Hierarchy

The T0-Model recognizes that the scaling factor ξ is not absolute but varies across physical regimes, reflecting the characteristic energy scales:

Mathematical Unification

Energy Scale Hierarchy:

- Grand Unified Theory (GUT): $E_{\text{GUT}} = \xi_{\text{particle}}^{1/4} \cdot E_P \approx 0.0365 E_P$,
- Electroweak: $E_{\text{electroweak}} = \sqrt{\xi_{\text{particle}}} \cdot E_P \approx 0.012 E_P$,
- T0 Scale: $E_{T0} = \xi_{\text{particle}} \cdot E_P \approx 1.33 \times 10^{-4} E_P$,
- Quantum Chromodynamics (QCD): $E_{\text{QCD}} = \xi_{\text{particle}}^{3/4} \cdot E_P \approx 4.21 \times 10^{-3} E_P$,
- Atomic: $E_{\text{atomic}} = \xi_{\text{particle}}^{3/2} \cdot E_P \approx 1.5 \times 10^{-6} E_P$,
- Nuclear: $E_{\text{nuclear}} = \xi_{\text{particle}}^{5/4} \cdot E_P \approx 1.37 \times 10^{-5} E_P$.

This hierarchy illustrates the challenge of defining a unified ξ -value, as each physical regime has a distinct ξ , complicating a single, universal scaling factor.

2.5 Scale-Dependent Parameters

The geometric parameter $\xi_{\text{geom}} = \frac{4}{3}$ is universal, but its manifestation depends on the scale:

Mathematical Unification

Scale-Dependent Parameters:

$$\xi_{\text{particle}} = \frac{4}{3} \times 10^{-4}, \quad (\text{particle physics scale}) \quad (2.7)$$

$$\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20}, \quad (\text{cosmic scale}) \quad (2.8)$$

The scale ratio is governed by β_{scale} :

Chapter 3

Derivation of the Universal Scaling Factor from CMB Temperature

3.1 CMB as a Manifestation of the Energy Field

In the T0-Model, the CMB is a manifestation of the universal energy field E_{field} , with its characteristic temperature given by:

Key Formula

CMB Characteristic Temperature:

$$T_{\text{characteristic}} = \left(\xi_{\text{universal}}^{1/4} \times \frac{E_{\text{P}}}{2\pi} \right) \times k_B^{-1} \approx 2.7 \text{ K}. \quad (3.1)$$

The spectral density of the field is:

$$\rho_{\text{field}}(\nu) = \frac{4}{3} \times \xi_{\text{universal}} \times f(\nu, T_{\text{characteristic}}). \quad (3.2)$$

3.2 Nullpoint-Based Derivation of $\xi_{\text{universal}}$

The CMB temperature provides the most direct method to determine $\xi_{\text{universal}}$, as distance and mass measurements rely on standard model assumptions. The nullpoint-based methodology uses the quantum ground state temperature $T_{\text{universal}} \approx 1.8 \text{ K}$, adjusted to the observed CMB temperature of 2.7 K .

The universal scaling factor is derived as:

Key Formula

Universal Scaling Factor:

$$\xi_{\text{universal}} = \left(\frac{T_{\text{universal}} \times 2\pi}{k_B E_{\text{P}}} \right)^4 \times \frac{4}{3} \times \beta_{\text{scale}}^4. \quad (3.3)$$

Using $T_{\text{universal}} \approx 1.8 \text{ K}$:

To achieve $\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20} \approx 1.333 \times 10^{-20}$, we calculate the required β_{scale} :

$$\beta_{\text{scale}}^4 = \frac{1.333 \times 10^{-20}}{8.219 \times 10^{-51}} \approx 1.622 \times 10^{30}, \quad (3.4)$$

$$\beta_{\text{scale}} \approx (1.622 \times 10^{30})^{1/4} \approx 3.566 \times 10^7. \quad (3.5)$$

For the observed CMB temperature ($T_{\text{characteristic}} = 2.7 \text{ K}$):

3.3 Non-Absolute Nature of the Scaling Factor

The scaling factor ξ in the T0-Model is not an absolute constant but varies across physical regimes, as demonstrated by the energy scale hierarchy (section 2.4). This hierarchy shows that each physical regime, from the Grand Unified Theory (GUT) scale to nuclear interactions, has a characteristic ξ -value, determined by the relevant energy scale and modulated by the universal geometric factor $\xi_{\text{geom}} = \frac{4}{3}$. For example, the particle physics scale ($\xi_{\text{particle}} = \frac{4}{3} \times 10^{-4}$) is directly measurable through high-precision experiments, such as the muon anomalous magnetic moment, which aligns with the T0-Model's predictions to within 0.10σ . In contrast, the cosmic scale ($\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20}$) is calibrated using the cosmic microwave background (CMB) temperature, a global property of the universal energy field E_{field} .

The variability of ξ across physical regimes poses a significant challenge to defining a single, unified scaling factor applicable to all phenomena. The mass-dependent scaling factor $\beta_{\text{scale}} = \frac{2Gm}{r}$ provides a mechanism to bridge quantum and cosmic scales, where m is the mass of the system and r is its characteristic length scale, typically the Schwarzschild radius or a relevant physical distance. This dependence suggests that each astrophysical object, such as a galaxy, black hole, or planet, could have an individual ξ -value based on its unique β_{scale} . To illustrate, consider the following examples:

These β_{scale} values, on the order of 10^{-8} , are significantly smaller than the $\beta_{\text{scale}} \approx 3.772 \times 10^7$ required to achieve $\xi_{\text{universal}} = \frac{4}{3} \times 10^{-20}$ from the CMB temperature calibration (eq. (3.3)). For an object-specific ξ -value, we calculate:

This $\xi_{\text{object}} \approx 10^{-82}$ is orders of magnitude smaller than $\xi_{\text{universal}} \approx 1.333 \times 10^{-20}$, indicating that the ξ -values for individual astrophysical objects do not match the cosmic-scale $\xi_{\text{universal}}$ calibrated to the CMB.

The CMB temperature, measured at 2.7 K uniformly across the cosmos, reflects the global, isotropic properties of the universal energy field E_{field} , rather than the local properties of a specific astrophysical object. This global nature explains why the required $\beta_{\text{scale}} \approx 3.772 \times 10^7$ does not correspond to typical astrophysical objects. To explore the physical scale associated with $\beta_{\text{scale}} \approx 3.772 \times 10^7$, we solve:

$$\beta_{\text{scale}} = \frac{2Gm}{r} \approx 3.772 \times 10^7,$$

$$m \approx \frac{3.772 \times 10^7 \times r}{2 \times 6.67 \times 10^{-11}} \approx 2.827 \times 10^{17} \times r.$$

For a galactic radius ($r \sim 10^{21} \text{ m}$):

$$m \approx 2.827 \times 10^{17} \times 10^{21} \approx 2.827 \times 10^{38} \text{ kg},$$

which is comparable to the mass of a supermassive black hole but smaller than a typical galaxy ($\sim 10^{42} \text{ kg}$). For the scale of the observable universe ($r \sim 10^{26} \text{ m}$):

$$m \approx 2.827 \times 10^{17} \times 10^{26} \approx 2.827 \times 10^{43} \text{ kg},$$

which is closer to, but still below, the estimated total mass of the observable universe ($\sim 10^{53} \text{ kg}$). This suggests that $\xi_{\text{universal}}$ reflects an effective cosmic scale, possibly an aggregate property of the universe's energy field, rather than the mass and distance of a single object.

The idea that each astrophysical object could have its own ξ -value is consistent with the T0-Model, as β_{scale} is inherently object-specific. For instance, a galaxy, a black hole, or a planet each has a unique β_{scale} due to its mass and length scale, leading to distinct ξ -values. However, the calibration of $\xi_{\text{universal}}$ to the CMB temperature indicates that it represents a global property, not tied to a specific object. This global calibration is necessary because the CMB is a homogeneous background radiation, observed uniformly across the universe. The discrepancy between the required $\beta_{\text{scale}} \approx 3.772 \times 10^7$ and typical astrophysical values ($\sim 10^{-8}$) underscores the challenge of unifying ξ -values across all scales. The energy scale hierarchy (section 2.4) supports this, showing that ξ varies across physical regimes, and extending this variability to astrophysical objects introduces additional complexity due to their unique β_{scale} .

The T0-Model's nullpoint-based methodology ensures that $\xi_{\text{universal}}$ is derived from quantum mechanical ground states, avoiding reliance on uncertain cosmological distance measurements. The concept of individual ξ -values for astrophysical objects suggests that local gravitational or redshift effects near massive objects could be influenced by their specific ξ -values, offering testable predictions. For example, high-precision measurements of gravitational lensing or redshift variations near galaxies or black holes could probe these object-specific ξ -values, further validating or refining the T0-Model.

Important Insight

The scaling factor ξ is not absolute, as each physical regime and potentially each astrophysical object (e.g., galaxy, black hole, planet) has a characteristic ξ -value determined by its β_{scale} . The CMB temperature, as a global property of the universal energy field, calibrates $\xi_{\text{universal}}$, but individual objects may have distinct ξ -values, complicating a unified scaling factor across all scales.

Chapter 4

Cosmological Applications

4.1 Photon Energy Loss and Redshift

The T0-Model unifies photon energy loss and cosmological redshift through:

Key Formula

Photon Energy Loss Rate:

$$\frac{dE_\gamma}{dr} = -\xi_{\text{universal}} \frac{E_\gamma^2}{E_{\text{field}} \cdot r}. \quad (4.1)$$

This results in a wavelength-dependent redshift:

Key Formula

Wavelength-Dependent Redshift:

$$z(\lambda) = z_0 \left(1 - \xi_{\text{universal}} \ln \frac{\lambda}{\lambda_0} \right). \quad (4.2)$$

4.2 Gravitational Light Deflection

Gravitational deflection is modified to include energy dependence:

Key Formula

Modified Gravitational Deflection:

$$\theta = \frac{4GM}{bc^2} \left(1 + \xi_{\text{universal}} \frac{E_\gamma}{E_0} \right). \quad (4.3)$$

4.3 Galactic Dynamics

The T0-Model explains flat galaxy rotation curves without dark matter:

Key Formula

Modified Rotation Velocity:

$$v_{\text{rotation}}^2(r) = \frac{GM(r)}{r} + \xi_{\text{universal}} \frac{r^2}{\ell_{\text{P}}^2} \times v_{\text{characteristic}}^2. \quad (4.4)$$

4.4 Resolution of Cosmological Problems

The static universe framework resolves:

- **Horizon Problem:** Uniform energy field ensures causal connectivity.
- **Flatness Problem:** No expansion eliminates fine-tuning needs.
- **Hubble Tension:** Variations in energy field interactions explain differing measurements.
- **Dark Matter/Dark Energy:** Eliminated by field-modified dynamics.

Chapter 5

Experimental Validation

5.1 Muon Anomalous Magnetic Moment

The T0-Model accurately predicts the muon anomalous magnetic moment:

Key Formula

Muon Anomalous Magnetic Moment:

$$a_{\mu}^{\text{T0}} = \frac{\xi_{\text{particle}}}{2\pi} \left(\frac{E_{\mu}}{E_e} \right)^2 \approx 245(12) \times 10^{-11}, \quad (5.1)$$

achieving 0.10σ agreement with experiment, compared to the Standard Model's 4.2σ deviation.

5.2 Cosmic-Scale Predictions

The wavelength-dependent redshift (eq. (4.2)) is a testable prediction, distinguishing the T0-Model from the standard model's expansion-based redshift.

Chapter 6

Integration with Established Physics

6.1 Quantum Field Theory Compatibility

The T0-Model preserves:

- Local Lorentz invariance.
- Gauge symmetries.
- Standard Model parameters via ξ_{particle} .

6.2 General Relativity Relationship

The T0 field equations reduce to general relativity in local limits:

$$G_{\mu\nu} = 8\pi GT_{\mu\nu} + \Lambda_{\text{eff}}g_{\mu\nu}, \tag{6.1}$$

where $\Lambda_{\text{eff}} = -4\pi G\rho_0$ emerges from the energy field.