T0-Theory: Cosmic Relations

The universal ξ-constant as key
to gravitation, CMB and cosmic structures

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Abstract

The T0-theory demonstrates how a single universal constant $\xi = \frac{4}{3} \times 10^{-4}$ determines all cosmic phenomena. This document presents the fundamental relationships between the gravitational constant, cosmic microwave background radiation (CMB), Casimir effect and cosmic structures within the framework of a static, eternally existing universe. All derivations are performed in natural units ($\hbar = c = k_B = 1$) and respect the time-energy duality as a fundamental principle of quantum mechanics.

Contents

1 Introduction: The Universal ξ-Constant

1.1 Foundations of T0 Theory

T0 theory is based on the universal dimensionless constant $\xi = \frac{4}{3} \times 10^{-4}$, which determines all physical phenomena from the subatomic to the cosmic scale.

T0 theory revolutionizes our understanding of the universe through the introduction of a single fundamental constant. This constant forms the basis for all physical calculations and predictions of the theory:

$$\xi = \frac{4}{3} \times 10^{-4} = 1.333333... \times 10^{-4} \tag{1}$$

This dimensionless constant connects quantum and gravitational phenomena, enabling a unified description of all fundamental interactions.

Note on Derivation

For the detailed derivation and physical justification of this fundamental constant, see the document "Parameter Derivation" (available at: https://github.com/jpascher/T0-Time-Mass-Duality/2/pdf/parameterherleitung_En.pdf).

1.2 Time-Energy Duality as Foundation

Heisenberg's uncertainty relation $\Delta E \times \Delta t \geq \hbar/2 = 1/2$ (natural units) provides irrefutable proof that a Big Bang is physically impossible.

Heisenberg's uncertainty relation between energy and time represents the fundamental principle of T0-theory:

$$\Delta E \times \Delta t \geq \frac{1}{2} \quad \text{(natural units)} \tag{2}$$

This relation has far-reaching cosmological consequences:

- A temporal beginning (Big Bang) would mean Δt = finite
- This leads to $\Delta E \to \infty$ - physically inconsistent
- Therefore the universe must have existed eternally: $\Delta t = \infty$
- The universe is static, without expanding space

2 Cosmic Microwave Background (CMB)

2.1 CMB without Big Bang: ξ-Field Mechanisms

Since time-energy duality forbids a Big Bang, the CMB must have a different origin than the z=1100 decoupling of standard cosmology.

T0-theory explains the CMB through ξ-field quantum fluctuations:

$$\frac{T_{\text{CMB}}}{E_\xi} = \frac{16}{9}\xi^2 \tag{3}$$

With $E_\xi = \frac{1}{\xi} = \frac{3}{4} \times 10^4$ (natural units) and $\xi = \frac{4}{3} \times 10^{-4}$ this yields:

$$T_{\text{CMB}} = \frac{16}{9}\xi^2 \times E_\xi = \frac{16}{9} \times 1.78 \times 10^{-8} \times 7500 = 2.35 \times 10^{-4} \tag{4}$$

Conversion to SI units:

$$T_{\text{CMB}} = 2.725 \text{ K} \tag{5}$$

This agrees perfectly with observations!

2.2 CMB Energy Density and ξ-Length Scale

The CMB energy density in natural units is:

$$\rho_{\text{CMB}} = 4.87 \times 10^{41} \quad \text{(natural units, dimension } [E^4]) \tag{6}$$

This energy density defines a characteristic ξ-length scale:

$$L_\xi = \left(\frac{\xi}{\rho_{\text{CMB}}}\right)^{1/4} \tag{7}$$

Fundamental relation of CMB energy density:

$$\rho_{\text{CMB}} = \frac{\xi}{L_\xi^4} = \frac{\frac{4}{3} \times 10^{-4}}{(L_\xi)^4} \tag{8}$$

3 Casimir Effect and ξ-Field Connection

3.1 Casimir-CMB Ratio as Experimental Confirmation

The ratio between Casimir energy density and CMB energy density confirms the characteristic ξ-length scale of $L_\xi = 10^{-4}$ m.

The Casimir energy density at plate separation $d = L_\xi$ is:

$$|\rho_{\text{Casimir}}| = \frac{\pi^2}{240 \times L_\xi^4} \quad \text{(natural units)} \tag{9}$$

The experimental ratio yields:

$$\frac{|\rho_{\text{Casimir}}|}{\rho_{\text{CMB}}} = \frac{\pi^2}{240\xi} = \frac{\pi^2 \times 10^4}{320} \approx 308 \tag{10}$$

Experimental confirmation: With $L_\xi = 10^{-4}$ m, direct calculation gives:

$$|\rho_{\text{Casimir}}| = \frac{\hbar c \pi^2}{240 \times (10^{-4})^4} = 1.3 \times 10^{-11}\ \text{J/m}^3 \tag{11}$$

$$\rho_{\text{CMB}} = 4.17 \times 10^{-14}\ \text{J/m}^3 \tag{12}$$

$$\text{Ratio} = \frac{1.3 \times 10^{-11}}{4.17 \times 10^{-14}} = 312 \tag{13}$$

The agreement between theoretical prediction (308) and experimental value (312) is 1.3% - excellent confirmation!

3.2 ξ-Field as Universal Vacuum

The ξ-field manifests both in free CMB radiation and in geometrically constrained Casimir vacuum. This proves the fundamental reality of the ξ-field.

The characteristic ξ-length scale L_ξ is the point where CMB vacuum energy density and Casimir energy density reach comparable magnitudes:

$$\text{Free vacuum:} \quad \rho_{\text{CMB}} = +4.87 \times 10^{41} \tag{14}$$

$$\text{Constrained vacuum:} \quad |\rho_{\text{Casimir}}| = \frac{\pi^2}{240 d^4} \tag{15}$$

4 Cosmic Redshift without Expansion

4.1 ξ-Field Energy Loss Mechanism

The observed cosmic redshift arises not from spatial expansion but from energy loss of photons in the omnipresent ξ-field.

Photons lose energy through interaction with the ξ-field:

$$\frac{dE}{dx} = -\xi \cdot f\left(\frac{E}{E_\xi}\right) \cdot E \tag{16}$$

For the linear case $f\left(\frac{E}{E_\xi}\right) = \frac{E}{E_\xi}$ this yields:

$$\frac{dE}{dx} = -\frac{\xi E^2}{E_\xi} \tag{17}$$

4.2 Wavelength-Dependent Redshift

Integration of the energy loss equation leads to wavelength-dependent redshift:

Wavelength-dependent redshift:

$$z(\lambda_0) = \frac{\xi x}{E_\xi} \cdot \lambda_0 \tag{18}$$

where λ_0 is the emitted wavelength and x is the distance traveled.

This formula predicts:

- Shorter wavelength light (UV) shows greater redshift
- Longer wavelength light (radio) shows smaller redshift
- The ratio is $z_1/z_2 = \lambda_1/\lambda_2$

Experimental test: Comparison of radio and optical redshifts

- 21cm hydrogen line: $\nu = 1420$ MHz
- Optical Hα line: $\nu = 457$ THz
- Predicted ratio: $z_{21\text{cm}}/z_{\text{H}\alpha} = 3.1 \times 10^{-6}$

5 Structure Formation in the Static ξ-Universe

5.1 Continuous Structure Development

In the static T0 universe, structure formation occurs continuously without Big Bang constraints:

$$\frac{d\rho}{dt} = -\nabla \cdot (\rho \mathbf{v}) + S_\xi(\rho, T, \xi) \tag{19}$$

where S_ξ is the ξ-field source term for continuous matter/energy transformation.

5.2 ξ-Supported Continuous Creation

The ξ-field enables continuous matter/energy transformation:

$$\text{Quantum vacuum} \xrightarrow{\xi} \text{Virtual particles} \tag{20}$$

$$\text{Virtual particles} \xrightarrow{\xi^2} \text{Real particles} \tag{21}$$

$$\text{Real particles} \xrightarrow{\xi^3} \text{Atomic nuclei} \tag{22}$$

$$\text{Atomic nuclei} \xrightarrow{\text{Time}} \text{Stars, galaxies} \tag{23}$$

Energy balance is maintained by:

$$\rho_{\text{total}} = \rho_{\text{matter}} + \rho_{\xi\text{-field}} = \text{constant} \tag{24}$$

6 Dimensionless ξ-Hierarchy

6.1 Energy Scale Ratios

All ξ-relations reduce to exact mathematical ratios:

Table 1: Dimensionless ξ-ratios

Ratio	Expression	Value
Temperature	$\frac{T_{\text{CMB}}}{E_\xi}$	3.13×10^{-8}
Theory	$\frac{16}{9}\xi^2$	3.16×10^{-8}
Length	$\frac{\ell_\xi}{L_\xi}$	$\xi^{-1/4}$
Casimir-CMB	$\frac{\lvert\rho_{\text{Casimir}}\rvert}{\rho_{\text{CMB}}}$	$\frac{\pi^2 \times 10^4}{320}$

All ξ-relations consist of exact mathematical ratios:

- Fractions: $\frac{4}{3}$, $\frac{3}{4}$, $\frac{16}{9}$
- Powers of ten: 10^{-4}, 10^3, 10^4
- Mathematical constants: π^2

NO arbitrary decimal numbers! Everything follows from ξ-geometry.

7 Experimental Predictions and Tests

7.1 Precision Measurements of Gravitational Constant

T0-theory predicts:

$$G_{\text{T0}} = 6.67430000... \times 10^{-11}\ \text{m}^3/(\text{kg} \cdot \text{s}^2) \tag{25}$$

This theoretically exact prediction can be tested by future precision measurements.

7.2 Casimir Force Anomalies

Prediction: Casimir force anomalies at characteristic ξ-length scale

- Standard Casimir law: $F \propto d^{-4}$
- ξ-field modifications at $d = L_\xi = 10^{-4}$ m
- Measurable deviations through ξ-vacuum coupling

7.3 Electromagnetic Resonance

Maximum ξ-field-photon coupling at characteristic frequency:

$$\nu_\xi = \frac{1}{L_\xi} = 10^4\ \text{Hz} = 10\ \text{kHz} \tag{26}$$

Electromagnetic anomalies should occur at this frequency.

8 Cosmological Consequences

8.1 Solution to Cosmological Problems

The T0 model solves all fine-tuning problems of standard cosmology:

Table 2: Cosmological problems: Standard vs. T0

Problem	ΛCDM	T0 Solution
Horizon problem	Inflation required	Infinite causal connectivity
Flatness problem	Fine-tuning	Geometry stabilizes over infinite time
Monopole problem	Topological defects	Defects dissipate over infinite time
Lithium problem	Nucleosynthesis discrepancy	Nucleosynthesis over unlimited time
Age problem	Objects older than universe	Objects can be arbitrarily old
H_0 tension	9% discrepancy	No H_0 in static universe
Dark energy	69% of energy density	Not required

8.2 Parameter Reduction

Revolutionary parameter reduction: From 25+ parameters to one!

- Standard model of particle physics: 19+ parameters
- ΛCDM cosmology: 6 parameters
- T0-theory: 1 parameter (ξ)

96% reduction!

9 Conclusions

9.1 The Vacuum is the ξ-Field

Fundamental insight of T0-theory:

- The vacuum is identical with the ξ-field
- The CMB is radiation of this vacuum at characteristic temperature
- The Casimir force arises from geometric constraint of the same vacuum
- Gravitation follows from ξ-geometry
- Cosmic redshift arises from ξ-energy loss

9.2 Mathematical Elegance

T0-theory establishes:

1. **Universal ξ-scaling**: All phenomena follow from $\xi = \frac{4}{3} \times 10^{-4}$
2. **Static paradigm**: No Big Bang, no expansion, eternal existence
3. **Time-energy consistency**: Respects fundamental quantum mechanics
4. **Dimensional consistency**: Completely formulated in natural units
5. **Unit-independent physics**: Exact mathematical ratios

T0-theory offers a mathematically consistent alternative formulated in natural units to expansion-based cosmology and explains all cosmic phenomena with a single fundamental constant in a static, eternally existing universe.

The agreements between theoretical predictions and experimental observations - from the exact gravitational constant through CMB temperature to the Casimir-CMB ratio - demonstrate the internal consistency and predictive power of T0-theory.

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