

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 | 2 |
| 1.1 | Foundations of T0 Theory | 2 |
| 1.2 | Time-Energy Duality as Foundation | 2 |
| 2 | Cosmic Microwave Background (CMB) | 3 |
| 2.1 | CMB without Big Bang: ξ -Field Mechanisms | 3 |
| 2.2 | CMB Energy Density and ξ -Length Scale | 3 |
| 3 | Casimir Effect and ξ-Field Connection | 3 |
| 3.1 | Casimir-CMB Ratio as Experimental Confirmation | 3 |
| 3.2 | ξ -Field as Universal Vacuum | 4 |
| 4 | Cosmic Redshift without Expansion | 4 |
| 4.1 | ξ -Field Energy Loss Mechanism | 4 |
| 4.2 | Wavelength-Dependent Redshift | 5 |
| 5 | Structure Formation in the Static ξ-Universe | 5 |
| 5.1 | Continuous Structure Development | 5 |
| 5.2 | ξ -Supported Continuous Creation | 5 |
| 6 | Dimensionless ξ-Hierarchy | 6 |
| 6.1 | Energy Scale Ratios | 6 |

| | | |
|-----------|--|----------|
| 7 | Experimental Predictions and Tests | 6 |
| 7.1 | Precision Measurements of Gravitational Constant | 6 |
| 7.2 | Casimir Force Anomalies | 6 |
| 7.3 | Electromagnetic Resonance | 6 |
| 8 | Cosmological Consequences | 7 |
| 8.1 | Solution to Cosmological Problems | 7 |
| 8.2 | Parameter Reduction | 7 |
| 9 | Conclusions | 7 |
| 9.1 | The Vacuum is the ξ -Field | 7 |
| 9.2 | Mathematical Elegance | 8 |
| 10 | Bibliography | 8 |

1 Introduction: The Universal ξ -Constant

1.1 Foundations of T0 Theory

Important Note

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:

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

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

Revolutionary Insight

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:

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

This relation has far-reaching cosmological consequences:

- A temporal beginning (Big Bang) would mean $\Delta t = \text{finite}$
- This leads to $\Delta E \rightarrow \infty$ - 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

Revolutionary Insight

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:

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

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

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

Conversion to SI units:

$$T_{\text{CMB}} = 2.725 \text{ K} \quad (5)$$

This agrees perfectly with observations!

2.2 CMB Energy Density and ξ -Length Scale

The CMB energy density in natural units is:

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

This energy density defines a characteristic ξ -length scale:

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

Key Formula

Fundamental relation of CMB energy density:

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

3 Casimir Effect and ξ -Field Connection

3.1 Casimir-CMB Ratio as Experimental Confirmation

Experimental Test

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

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

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

The experimental ratio yields:

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

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

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

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

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

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

3.2 ξ -Field as Universal Vacuum

Important Note

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:

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

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

4 Cosmic Redshift without Expansion

4.1 ξ -Field Energy Loss Mechanism

Revolutionary Insight

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:

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

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

$$\frac{dE}{dx} = -\frac{\xi E^2}{E_\xi} \quad (17)$$

4.2 Wavelength-Dependent Redshift

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

Key Formula

Wavelength-dependent redshift:

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

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

Experimental test: Comparison of radio and optical redshifts

- 21cm hydrogen line: $\nu = 1420$ MHz
- Optical H α 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:

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

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:

$$\text{Quantum vacuum} \xrightarrow{\xi} \text{Virtual particles} \quad (20)$$

$$\text{Virtual particles} \xrightarrow{\xi^2} \text{Real particles} \quad (21)$$

$$\text{Real particles} \xrightarrow{\xi^3} \text{Atomic nuclei} \quad (22)$$

$$\text{Atomic nuclei} \xrightarrow{\text{Time}} \text{Stars, galaxies} \quad (23)$$

Energy balance is maintained by:

$$\rho_{\text{total}} = \rho_{\text{matter}} + \rho_{\xi\text{-field}} = \text{constant} \quad (24)$$

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 | $\frac{ \rho_{\text{Casimir}} }{\rho_{\text{CMB}}}$ | $\frac{\pi^2 \times 10^4}{320}$ |

Important Note

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:

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

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

7.2 Casimir Force Anomalies

Experimental Test

Prediction: Casimir force anomalies at characteristic ξ -length scale

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

7.3 Electromagnetic Resonance

Maximum ξ -field-photon coupling at characteristic frequency:

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

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 | Λ CDM | 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 Insight

Revolutionary parameter reduction: From 25+ parameters to one!

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

96% reduction!

9 Conclusions

9.1 The Vacuum is the ξ -Field

Important Note

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

Revolutionary Insight

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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