

# Cosmic Observations

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2025

## **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.

# 1 Introduction: The Universal $\xi$ -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:

$$\xi = \frac{4}{3} \times 10^{-4} = 1.33333... \times 10^{-4} \quad (1)$$

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](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:

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

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: $\xi$ -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  $\xi$ -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 $\xi$ -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  $\xi$ -length scale:

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

Fundamental relation of CMB energy density:

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

## 3 Casimir Effect and $\xi$ -Field Connection

### 3.1 Casimir-CMB Ratio as Experimental Confirmation

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

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

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

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 $\xi$ -Field as Universal Vacuum

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

The characteristic  $\xi$ -length scale  $L_\xi$  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 $\xi$ -Field Energy Loss Mechanism

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

Photons lose energy through interaction with the  $\xi$ -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:

Wavelength-dependent redshift:

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

where  $\lambda_0$  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 H $\alpha$  line:  $\nu = 457$  THz
- Predicted ratio:  $z_{\text{21cm}}/z_{\text{H}\alpha} = 3.1 \times 10^{-6}$

## 5 Structure Formation in the Static $\xi$ -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  $S_\xi$  is the  $\xi$ -field source term for continuous matter/energy transformation.

### 5.2 $\xi$ -Supported Continuous Creation

The  $\xi$ -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 $\xi$ -Hierarchy

### 6.1 Energy Scale Ratios

All  $\xi$ -relations reduce to exact mathematical ratios:

Table 1: Dimensionless  $\xi$ -ratios

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

All  $\xi$ -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:  $\pi^2$

NO arbitrary decimal numbers! Everything follows from  $\xi$ -geometry.

## 7 Experimental Predictions and Tests

### 7.1 Precision Measurements of Gravitational Constant

T0-theory predicts:

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

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

### 7.2 Casimir Force Anomalies

Prediction: Casimir force anomalies at characteristic  $\xi$ -length scale

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

### 7.3 Electromagnetic Resonance

Maximum  $\xi$ -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          | $\Lambda$ 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 parameter reduction: From 25+ parameters to one!

- Standard model of particle physics: 19+ parameters
- $\Lambda$ CDM cosmology: 6 parameters
- T0-theory: 1 parameter ( $\xi$ )

96% reduction!

# 9 Conclusions

## 9.1 The Vacuum is the $\xi$ -Field

Fundamental insight of T0-theory:

- The vacuum is identical with the  $\xi$ -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  $\xi$ -geometry
- Cosmic redshift arises from  $\xi$ -energy loss

## 9.2 Mathematical Elegance

T0-theory establishes:

1. **Universal  $\xi$ -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.

## 10 Bibliography

### References

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