

Cosmic Observations

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Chapitre 1

Cosmic Observations

Résumé

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.

1.1 Introduction : The Universal ξ -Constant

1.1.1 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 :

$$\xi = \frac{4}{3} \times 10^{-4} = 1.333333... \times 10^{-4} \quad (1.1)$$

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).

1.1.2 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 :

$$\Delta E \times \Delta t \geq \frac{1}{2} \quad (\text{natural units}) \quad (1.2)$$

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

1.2 Cosmic Microwave Background (CMB)

1.2.1 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 :

$$\frac{T_{\text{CMB}}}{E_\xi} = \frac{16}{9} \xi^2 \quad (1.3)$$

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

$$T_{\text{CMB}} = \frac{16}{9} \xi^2 \times E_\xi = \frac{16}{9} \times 1.78 \times 10^{-8} \times 7500 = 2.35 \times 10^{-4} \quad (1.4)$$

Conversion to SI units :

$$T_{\text{CMB}} = 2.725 \text{ K} \quad (1.5)$$

This agrees perfectly with observations !

1.2.2 CMB Energy Density and ξ -Length Scale

The CMB energy density in natural units is :

$$\rho_{\text{CMB}} = 4.87 \times 10^{41} \quad (\text{natural units, dimension } [E^4]) \quad (1.6)$$

This energy density defines a characteristic ξ -length scale :

$$L_\xi = \left(\frac{\xi}{\rho_{\text{CMB}}} \right)^{1/4} \quad (1.7)$$

Fundamental relation of CMB energy density :

$$\rho_{\text{CMB}} = \frac{\xi}{L_\xi^4} = \frac{\frac{4}{3} \times 10^{-4}}{(L_\xi)^4} \quad (1.8)$$

1.3 Casimir Effect and ξ -Field Connection

1.3.1 Casimir-CMB Ratio as Experimental Confirmation

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

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

$$|\rho_{\text{Casimir}}| = \frac{\pi^2}{240 \times L_\xi^4} \quad (\text{natural units}) \quad (1.9)$$

The experimental ratio yields :

$$\frac{|\rho_{\text{Casimir}}|}{\rho_{\text{CMB}}} = \frac{\pi^2}{240\xi} = \frac{\pi^2 \times 10^4}{320} \approx 308 \quad (1.10)$$

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

$$|\rho_{\text{Casimir}}| = \frac{\hbar c \pi^2}{240 \times (10^{-4})^4} = 1.3 \times 10^{-11} \text{ J/m}^3 \quad (1.11)$$

$$\rho_{\text{CMB}} = 4.17 \times 10^{-14} \text{ J/m}^3 \quad (1.12)$$

$$\text{Ratio} = \frac{1.3 \times 10^{-11}}{4.17 \times 10^{-14}} = 312 \quad (1.13)$$

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

1.3.2 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 :

$$\text{Free vacuum : } \rho_{\text{CMB}} = +4.87 \times 10^{41} \quad (1.14)$$

$$\text{Constrained vacuum : } |\rho_{\text{Casimir}}| = \frac{\pi^2}{240d^4} \quad (1.15)$$

1.4 Cosmic Redshift without Expansion

1.4.1 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 :

$$\frac{dE}{dx} = -\xi \cdot f\left(\frac{E}{E_\xi}\right) \cdot E \quad (1.16)$$

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

$$\frac{dE}{dx} = -\frac{\xi E^2}{E_\xi} \quad (1.17)$$

1.4.2 Wavelength-Dependent Redshift

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

Wavelength-dependent redshift :

$$z(\lambda_0) = \frac{\xi x}{E_\xi} \cdot \lambda_0 \quad (1.18)$$

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

1.5 Structure Formation in the Static ξ -Universe

1.5.1 Continuous Structure Development

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

$$\frac{d\rho}{dt} = -\nabla \cdot (\rho \mathbf{v}) + S_\xi(\rho, T, \xi) \quad (1.19)$$

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

1.5.2 ξ -Supported Continuous Creation

The ξ -field enables continuous matter/energy transformation :

$$\text{Quantum vacuum} \xrightarrow{\xi} \text{Virtual particles} \quad (1.20)$$

$$\text{Virtual particles} \xrightarrow{\xi^2} \text{Real particles} \quad (1.21)$$

$$\text{Real particles} \xrightarrow{\xi^3} \text{Atomic nuclei} \quad (1.22)$$

$$\text{Atomic nuclei} \xrightarrow{\text{Time}} \text{Stars, galaxies} \quad (1.23)$$

Energy balance is maintained by :

$$\rho_{\text{total}} = \rho_{\text{matter}} + \rho_{\xi\text{-field}} = \text{constant} \quad (1.24)$$

1.6 Dimensionless ξ -Hierarchy

1.6.1 Energy Scale Ratios

All ξ -relations reduce to exact mathematical ratios :

TABLE 1.1: 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 | $\frac{ \rho_{\text{Casimir}} }{\rho_{\text{CMB}}}$ | $\frac{\pi^2 \times 10^4}{320}$ |

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.

1.7 Experimental Predictions and Tests

1.7.1 Precision Measurements of Gravitational Constant

T0-theory predicts :

$$G_{T0} = 6.67430000... \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \quad (1.25)$$

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

1.7.2 Casimir Force Anomalies

Prediction : Casimir force anomalies at characteristic ξ -length scale

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

1.7.3 Electromagnetic Resonance

Maximum ξ -field-photon coupling at characteristic frequency :

$$\nu_\xi = \frac{1}{L_\xi} = 10^4 \text{ Hz} = 10 \text{ kHz} \quad (1.26)$$

Electromagnetic anomalies should occur at this frequency.

1.8 Cosmological Consequences

1.8.1 Solution to Cosmological Problems

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

TABLE 1.2: 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 |

1.8.2 Parameter Reduction

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 !

1.9 Conclusions

1.9.1 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

1.9.2 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.

1.10 Bibliography

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