Chapter 13: Chronology of Universe Creation from Fractal Time-Mass Duality

1 Chapter 13: Chronology of Universe Creation from Fractal Time-Mass Duality

The chronology of universe creation in the fractal Fundamental Fractal-Geometric Field Theory (FFGFT) describes not an explosive "Big Bang", but a deterministic phase transition from a minimal fractal pre-vacuum. This transition is completely determined by the single fundamental parameter $\xi = \frac{4}{3} \times 10^{-4}$ and inevitably follows from the Time-Mass Duality $T(x,t) \cdot m(x,t) = 1$.

1.1 The Pre-Big-Bang Phase: Fractal Zero-Vacuum

Before the phase transition, a pure phase vacuum exists with extremely low fractal dimension:

State Description:

$$\rho \approx 0 \quad \text{(nearly massless vacuum)} \tag{1}$$

$$D_f \approx 2 \quad \text{(strongly underdimensioned fractal structure)} \tag{2}$$

$$\theta = \text{constant} \quad \text{(static, disordered time structure)} \tag{3}$$

$$a_{\min} \approx l_P \cdot \xi^{-1} \approx 1.2 \times 10^{-31}\,\text{m} \tag{4}$$

Explanation:

- ρ: Amplitude density of vacuum field ($\text{kg}^{1/2}\text{ům}^{-3/2}$)
- D_f: Fractal dimension (dimensionless), close to 2 instead of 3
- θ: Phase field (dimensionless), represents pure time structure
- $a_{\min}$: Minimal effective scale (m), determined by Planck length l_P and ξ
- $l_P = \sqrt{\hbar G/c^3} \approx 1.62 \times 10^{-35}$ m: Planck length

This "zero-vacuum" is perfectly coherent, since gradients or fluctuations would require a non-zero amplitude ρ which is initially absent. The extremely low fractal dimension $D_f \approx 2$ means that spacetime is almost two-dimensional and thus highly constrained.

1.2 The Critical Phase Transition: Emergence of Mass and Time

The instability arises inevitably from the Time-Mass Duality:

Instability Mechanism:

$$\text{For } \rho \to 0 : \quad T(x,t) \to \infty \quad \text{(infinite time density)} \tag{5}$$

This divergence is not physically stable. Infinitesimal perturbations in $\delta\theta$ require a non-zero amplitude $\rho > 0$ to propagate, which triggers the phase transition:

Triggering Fluctuation:

$$\Delta\rho \approx \xi^2 \cdot \rho_P \approx 2.1 \times 10^{-96}\,\mathrm{kg}^{1/2}\mathrm{m}^{-3/2} \tag{6}$$

where $\rho_P = \sqrt{\hbar c}/l_P^{3/2} \approx 1.2 \times 10^{88}\,\mathrm{kg}^{1/2}\mathrm{m}^{-3/2}$ is the Planck density.

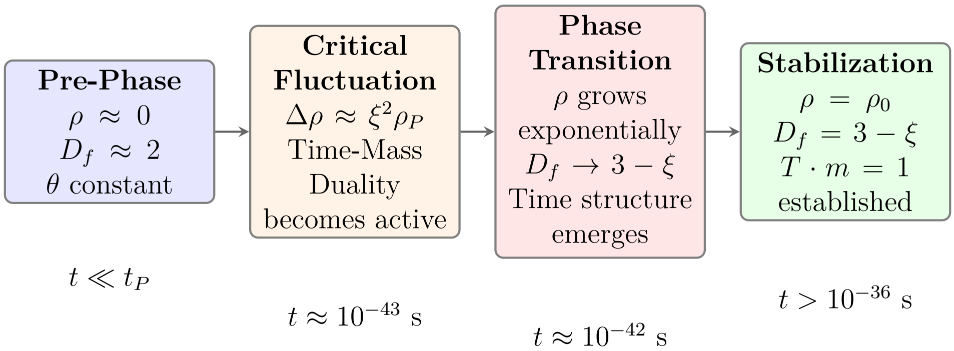
Phase Transition Potential:

$$V(\rho) = \lambda(\rho^2 - \rho_0^2)^2 \cdot (1 + \xi \ln(\rho/\rho_0)) \tag{7}$$

- $V(\rho)$: Effective vacuum potential ($\mathrm{J/m^3}$)
- λ: Coupling constant (dimensionless), $\propto \alpha$ (fine-structure constant)
- ρ_0: Vacuum expectation value ($\mathrm{kg}^{1/2}$ům$^{-3/2}$)
- The term $1 + \xi \ln(\rho/\rho_0)$: Fractal correction

At $\rho = 0$ this potential is unstable and tips to the stable minimum at $\rho = \rho_0$.

1.3 Chronology of the Transition



Detailed Chronology:

1. **Pre-Vacuum ($t < 10^{-43}$ s):**
   - $\rho \approx 0$, $D_f \approx 2$
   - Pure phase field θ, constant and disordered
   - Time-Mass Duality not yet active (since $m \approx 0$)
   - No measurable time, no measurable mass
2. **Critical Point ($t \approx 10^{-43}$ s):**

- Fractal fluctuation reaches $\Delta\rho \approx \xi^2 \rho_P$
- Time-Mass Duality becomes active: $T \cdot m > 0$
- Instability in potential $V(\rho)$ becomes relevant
- Phase transition begins

3. **Exponential Growth** ($10^{-43} < t < 10^{-42}$ **s):**

   - ρ grows exponentially: $\rho(t) \approx \Delta\rho \cdot e^{t/\tau}$
   - $\tau = \hbar/(m_P c^2 \xi^2) \approx 10^{-43}$ s: Characteristic time
   - D_f evolves from ≈ 2 to $3 - \xi$
   - Time emerges as phase evolution: $d\tau \propto d\theta/\rho$

4. **Stabilization** ($t > 10^{-36}$ **s):**

   - ρ reaches equilibrium: $\rho_0 = \sqrt{\hbar c}/(l_P^{3/2} \xi^2)$
   - D_f stabilizes at $3 - \xi \approx 2.999867$
   - Speed of light established: $c = \sqrt{K_0/\rho_0} \cdot (1 - \xi/2)$
   - Time-Mass Duality established: $T(x,t) \cdot m(x,t) = 1$

1.4 Emergence of Fundamental Quantities

Time:

$$d\tau = \frac{\hbar}{m_P c^2} \cdot \frac{d\theta}{\rho/\rho_0} \cdot \xi^{-1} \tag{8}$$

Time emerges as the derivative of phase evolution, scaled with ξ^{-1}.

Speed of Light:

$$c = \sqrt{\frac{K_0}{\rho_0}} \cdot \left(1 - \frac{\xi}{2}\right) \approx 2.9979 \times 10^8 \, \text{m/s} \tag{9}$$

The maximum signal speed emerges from vacuum stiffness K_0.

Gravitation:

$$G = \frac{c^3 l_P^2}{\hbar} \cdot \xi^2 \approx 6.674 \times 10^{-11} \, \text{m}^3\text{kg}^{-1}\text{s}^{-2} \tag{10}$$

The gravitational constant emerges as a consequence of fractal spacetime structure.

Particle Masses:

$$m_i = m_P \cdot f_i(\xi) \cdot \xi^{k_i} \tag{11}$$

where $f_i(\xi)$ are specific fractal form factors and k_i are hierarchy levels.

1.5 The Low Entropy Problem

The extremely low initial entropy of the observable universe ($\sim 10^{88} k_B$) is naturally explained in T0:

Initial Entropy:

$$S_{\text{initial}} \approx k_B \cdot \ln\left(\frac{V_{\text{eff}}}{l_P^3}\right) \cdot \xi^3 \approx 10^{88} k_B \tag{12}$$

Explanation:

- The pre-vacuum has nearly zero entropy through its fractal self-similarity
- Entropy only grows with the emergence of $\rho > 0$
- The factor $\xi^3 \approx 2.37 \times 10^{-10}$ reduces the maximum possible entropy
- This explains the “ordered” initial state without fine-tuning

1.6 Testable Consequences

1. Fractal Signatures in CMB:

$$\frac{\delta T}{T}(\vec{n}) \propto \xi \cdot \sum_n \frac{\cos(2\pi|\vec{x}_n|/\lambda_n)}{|\vec{x}_n|^{D_f/2}} \tag{13}$$

The anisotropy patterns should show fractal self-similarity with scaling exponent $D_f/2 \approx 1.5$.

2. Time Variation of ξ:

$$\left|\frac{\dot{\xi}}{\xi}\right| \approx 2.3 \times 10^{-18}\,\mathrm{s}^{-1} \tag{14}$$

This slow variation should be detectable in precision experiments with atomic clocks.

3. Modified Inflation: Instead of a separate inflation phase:

$$a(t) \propto t^{2/D_f} \approx t^{0.6667} \quad \text{(early era)} \tag{15}$$

This should be recognizable in the B-mode polarization spectrum of the CMB.

1.7 Comparison with Alternative Theories

Aspect	Loop Quantum Cosmology (LQC)	Fractal T0-Cosmology
Pre-Phase	Quantum geometry with Immirzi parameter γ	Fractal zero-vacuum with $D_f \approx 2$
Transition	Big Bounce at $\rho = \rho_{\text{crit}}$	Phase transition at $\rho \approx \xi^2 \rho_P$
Parameters	$\gamma \approx 0.2375$, ρ_{crit}	Only $\xi = \frac{4}{3} \times 10^{-4}$
Dimensions	3+1	3+1 with fractal structure $D_f = 3 - \xi$
Entropy Problem	Requires special initial conditions	Naturally explained by ξ^3 factor
Aspect	**String Theory Cosmology**	**Fractal T0-Cosmology**
Pre-Phase	Higher-dimensional branes/compactification	Fractal 4D zero-vacuum
Transition	Brane collision/tunneling	Deterministic phase transition
Parameters	Many (moduli, dilaton, etc.)	Only ξ
Dimensions	10-11 (must be compactified)	3+1 with fractal structure
Predictions	Complex, multiverse	Precise, testable deviations

1.8 Philosophical Implications

The T0-chronology has profound philosophical consequences:

- **No Singularity**: The "beginning" is a regular physical transition, not a mathematical singularity
- **Deterministic**: The transition inevitably follows from the Time-Mass Duality and ξ
- **Parameter-free**: Only ξ as fundamental parameter, all other quantities emerge
- **Static Universe**: No expansion, only fractal deepening
- **Natural Fine-Tuning**: The "fine-tuned" constants arise naturally from ξ

1.9 Conclusion

The chronology of universe creation in T0-theory offers the simplest and most parameter-sparse description of cosmological origin:

- **One Parameter**: Everything emerges from $\xi = \frac{4}{3} \times 10^{-4}$
- **No Singularity**: Big Bang as regular fractal phase transition

- **Time-Mass Duality as Driver**: $T(x,t) \cdot m(x,t) = 1$ drives the transition
- **Natural Explanation for Fine-Tuning**: All "fine-tuned" constants follow from ξ
- **Testable Predictions**: Fractal patterns in CMB, time variation of fundamental constants

Instead of an explosive beginning from a singularity, T0 describes a smooth, deterministic transition from a minimal fractal state. The universe doesn't "begin" in the conventional sense, but unfolds from a highly symmetric pre-phase through the self-consistent dynamics of the Time-Mass Duality.

This view not only eliminates the problem of the initial singularity, but also provides a natural explanation for the puzzling fine-tuning of natural constants and the extremely low initial entropy of the cosmos all emergent consequences of the single fundamental parameter ξ.