The Finite Universal Energy-Mass Singularity (FUEMS) Model: A Theoretical Resolution of the Big Bang Singularity through Finite Energy and Spacetime Elasticity

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Abstract

The standard Big Bang model predicts an initial singularity of infinite density, where general relativity breaks down. I propose the Finite Universal Energy-Mass Singularity (FUEMS) model, which replaces the infinite singularity with a finite total energy equal to the present-day observable universe's mass-energy content ($\approx 1.4 \times 10^{70}$ J). I postulate that spacetime possesses an elastic limit—a maximum curvature $\mathcal{C}_{\max}$—beyond which it cannot be compressed. When curvature approaches $\mathcal{C}_{\max}$, the Heisenberg uncertainty principle generates a large quantum fluctuation, triggering a tunneling event. This changes the effective gravitational constant from attractive to repulsive ($G_{\text{eff}} < 0$), producing a sudden quantum kick that creates space itself and initiates the Big Bang. The model explains dark energy as residual elastic relaxation and predicts that the universe will end in inertial disintegration, not heat death. The FUEMS model eliminates mathematical infinities, conserves total energy, and offers testable predictions for CMB observations.

Keywords: Big Bang · Singularity · Finite energy · Spacetime elasticity · Quantum kick · Dark energy · Inertial disintegration · FUEMS model.

1 Introduction

General relativity (GR) successfully describes gravity on large scales but fails at the Big Bang singularity, where density and curvature become infinite [3]. This infinity signals the incompleteness of GR, suggesting the need for a quantum gravity treatment. In this paper, I propose a new theoretical framework—the Finite Universal Energy-Mass Singularity (FUEMS) model—that resolves the singularity problem by two simple postulates: (i) the total energy of the universe is finite, and (ii) spacetime has an elastic limit.

I begin by defining the finite energy constant (§2.1), then introduce the spacetime elasticity hypothesis (§2.2). I show how the Heisenberg uncertainty principle generates a quantum kick (§2.3) and derive a master equation for instability (§2.4). The transition from attraction to repulsion is described in §2.5. I then present the theoretical findings (§3), including the resolution of the singularity, the cause of the Big Bang, the explanation of dark energy, and the prediction of inertial disintegration. Finally, I discuss the model's strengths, limitations, and future research directions (§4), followed by conclusions (§5).

2 Methodology (Theoretical Framework)

2.1 Finite Total Energy

The total mass-energy of the observable universe is finite and conserved. Based on current observational data from the Planck satellite [1], I take:

$$E_{\text{total}} = E_{\text{matter}} + E_{\text{dark matter}} + E_{\text{radiation}} + E_{\text{dark energy}} \approx 1.4 \times 10^{70} \text{ J} \tag{1}$$

At the pre-Big Bang state, I assume this energy is confined within a minimal volume $V_{\text{min}} \approx \ell_P^3$, where $\ell_P = \sqrt{\hbar G/c^3} \approx 1.6 \times 10^{-35}$ m is the Planck length. Hence the density is:

$$\rho = \frac{E_{\text{total}}}{V_{\text{min}}} \tag{2}$$

This density is extremely high but **finite**—no infinity appears. This is the first key departure from the standard model.

2.2 Spacetime Elasticity Hypothesis

I propose that spacetime behaves as an elastic medium with a maximum curvature limit $\mathcal{C}_{\text{max}}$. The curvature induced by energy density is given by Einstein's field equations:

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \tag{3}$$

When $\mathcal{C} \to \mathcal{C}_{\text{max}}$, spacetime can no longer be compressed further. This is analogous to the yield point of a material. The existence of such a limit is the second key postulate of the FUEMS model.

2.3 Heisenberg Uncertainty and Quantum Kick

In the singularity phase, the time interval Δt is extremely small (approaching the Planck time). The Heisenberg uncertainty principle [2] states:

$$\Delta E \cdot \Delta t \geq \frac{\hbar}{2} \tag{4}$$

As $\Delta t \to 0$, this forces ΔE to become very large—finite but enormous. This quantum fluctuation enables tunneling through the elastic barrier. I call this the "quantum kick."

2.4 Master Equation of Instability

I define the instability index Ξ as:

$$\Xi = \frac{\rho}{\rho_{\text{max}}} \cdot \frac{1}{1 - \frac{\mathcal{C}}{\mathcal{C}_{\text{max}}}} + \frac{\Delta E_{\text{quantum}}}{E_{\text{total}}} \tag{5}$$

where $\rho_{\text{max}} = E_{\text{total}}/V_{\text{min}}$. The first term represents the compression stress relative to the elastic limit; the second term represents the quantum fluctuation contribution. When Ξ exceeds a critical threshold Ξ_c, the system undergoes a phase transition—the Big Bang.

2.5 From Attraction to Repulsion

I introduce an effective gravitational constant:

$$G_{\text{eff}}(\rho) = G\left(1 - \frac{\rho}{\rho_{\text{max}}}\right) \tag{6}$$

As $\rho \to \rho_{\text{max}}^{-}$, $G_{\text{eff}} \to 0$. Through quantum tunneling, ρ effectively tries to exceed ρ_{max}, causing G_{eff} to become negative—repulsive gravity. The repulsive kick impulse is:

$$J_{\text{kick}} \sim \frac{\hbar}{\ell_P} \cdot \frac{\Delta E}{E_P} \tag{7}$$

where $E_P = \sqrt{\hbar c^5/G} \approx 1.96 \times 10^9$ J is the Planck energy.

3 Results (Theoretical Findings)

3.1 Resolution of the Singularity

The FUEMS model removes the infinite density by replacing it with a finite energy constant. No mathematical divergence appears; the singularity becomes a finite compression state. This resolves the long-standing singularity problem in classical cosmology [4].

3.2 Cause of the Big Bang

The Big Bang is not a creation from nothing but a necessary phase transition. When the curvature reaches $\mathcal{C}_{\text{max}}$, the quantum kick triggers repulsive gravity, creating space itself. The expansion metric is isotropic:

$$ds^2 = -c^2 dt^2 + a(t)^2 \left(dr^2 + r^2 d\Omega^2\right) \tag{8}$$

with a rapid increase in the scale factor $a(t)$. This provides a physical cause for the Big Bang—something the standard model lacks.

3.3 Dark Energy as Residual Elastic Relaxation

After the initial expansion, the spacetime fabric does not instantly return to zero curvature. The remaining "memory" of compression manifests as dark energy:

$$\rho_{\text{DE}} = \alpha \cdot E_{\text{total}} \cdot \frac{\mathcal{C}_{\text{residual}}}{\mathcal{C}_{\text{max}}} \tag{9}$$

where α is a geometric factor. Because E_{total} is finite, dark energy will eventually decay to zero.

3.4 Ultimate Fate: Inertial Disintegration

After the kinetic energy of expansion is exhausted, inertia continues to stretch the universe. This leads to sequential disintegration: galaxy clusters → galaxies → solar systems → atoms → nuclei → quarks. The final state is an infinitely dilute, non-interacting, ultra-cold gas of elementary particles—the **Big Disintegration**.

4 Discussion

4.1 Comparison with Existing Theories

Unlike the standard model's infinite singularity, FUEMS eliminates infinities by positing a finite total energy. Unlike the Big Bounce or cyclic models [6], FUEMS introduces a quantum kick mechanism driven by the Heisenberg uncertainty principle. Unlike inflationary models [5], FUEMS provides a physical trigger (the elastic limit + quantum kick) rather than an ad-hoc scalar field. The explanation of dark energy as residual elastic relaxation is novel and testable.

4.2 Strengths of the FUEMS Model

I identify five main strengths:

1. **No mathematical infinities:** The model replaces infinite density with a finite compression state.
2. **Respects conservation of energy:** The Big Bang is a transformation, not a creation from nothing.
3. **Provides a physical cause for the Big Bang:** The elastic limit + quantum kick mechanism explains why the Bang occurred.
4. **Explains dark energy naturally:** Dark energy is the residual elastic relaxation of spacetime.
5. **Predicts a final inertial disintegration:** Not heat death, but a complete breakdown of all structures.

4.3 Limitations

The model is currently theoretical; it requires experimental validation. The exact value of $\mathcal{C}_{\max}$ and the critical threshold Ξ_c are not yet determined. The quantum kick mechanism needs further mathematical refinement within a full quantum gravity framework. Additionally, the model does not yet provide a precise prediction for the CMB cutoff scale.

4.4 Future Research Directions

I propose three avenues for future investigation:

1. **CMB power spectrum cutoff:** Search for a predicted cutoff at high multipoles—the imprint of the quantum kick.

2. **Dark energy deceleration:** Observe whether dark energy decelerates over time using missions like Euclid or the Roman Space Telescope.

3. **Quantum gravity formulation:** Develop a complete quantum gravity formulation of the elastic spacetime hypothesis, possibly within loop quantum cosmology or emergent gravity frameworks.

5 Conclusion

The FUEMS model resolves the Big Bang singularity by postulating a finite total energy and an elastic limit of spacetime. It unifies general relativity with quantum uncertainty at the initial instant, explains dark energy as elastic relaxation, and predicts a final inertial disintegration. The model is mathematically consistent, respects energy conservation, and offers falsifiable predictions. I invite further theoretical and observational investigation of these ideas.

References

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