

# Unified Reconstruction of Cosmology via Spacetime Hysteresis and Gravitational Entanglement

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## Abstract

Contemporary cosmology is grappling with a fundamental crisis: the persistent failure to detect Dark Matter particles and the escalating "Hubble Tension." Recent high-redshift observations from the James Webb Space Telescope (JWST) have revealed massive, mature galaxies that defy the 13.8 billion-year timeline of the standard Lambda-CDM model.

This dissertation proposes a revolutionary paradigm shift by redefining the vacuum of spacetime as an "**Elastic Medium with Memory**" (**Spacetime Hysteresis**). We introduce **Kim's Law ( $E = \kappa * \psi$ )**, which identifies the origin of mass-energy as the topological entanglement density ( **$\psi$** ) of the spacetime lattice. By incorporating a new stress-energy tensor, the **Kim Tensor**, into Einstein's Field Equations, we demonstrate that galactic rotation curves and gravitational lensing anomalies are manifestations of spacetime's emergent rigidity, eliminating the need for hypothetical dark matter particles.

Furthermore, we identify "**Elastic Redshift**"—energy dissipation within the strained spacetime medium—as a hidden variable in cosmic expansion. Correcting for this factor resolves the Hubble Tension and establishes a

recalibrated cosmic age of **16.54 billion years**. This theory provides the necessary temporal window for the evolution of early massive galaxies and offers a unified, dark-matter-free framework satisfying both quantum logic and general relativistic principles.

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## Chapter 1. Introduction

**1.1 The Breakdown of the Standard Cosmological Model** For nearly a century, the Lambda-CDM model has served as the cornerstone of cosmology. However, it relies on two unverified assumptions: the existence of non-baryonic Dark Matter and a constant expansion rate that ignores the physical properties of the vacuum. The consistent absence of empirical evidence for dark matter particles suggests that observed gravitational anomalies are caused by a fundamental misunderstanding of the medium of spacetime itself.

**1.2 The JWST Anomaly: A Temporal Paradox** JWST has identified fully-formed galaxies (masses  $\sim 10^{11}$  solar masses) at redshifts  $z > 10$ . Under the current 13.8 Gyr timeline, there is insufficient time for such mature structures to evolve. This "early galaxy paradox" indicates that our measurement of cosmic time is flawed.

**1.3 Proposal: Spacetime as a Physical Lattice** This research proposes that spacetime is a discrete, physical lattice possessing elastic properties and memory. Gravity is a manifestation of topological entanglement within this medium, providing a parsimonious solution to both galactic dynamics and cosmological expansion discrepancies.

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## Chapter 2. Theoretical Foundation: Kim's Law

**2.1 The Concept of Spacetime Entanglement** We posit that mass is an emergent phenomenon—a localized manifestation of the topological knotting or entanglement of the spacetime medium. We define **Spacetime Entanglement (psi)** as the degree of microscopic complexity per unit volume within the 4D vacuum lattice.

**2.2 Derivation of Kim's Energy-Mass Equivalence** To bridge spacetime geometry and energy, we propose **Kim's Law**:

$$E = \kappa * \psi \text{ (Word format: } E = \kappa * \psi \text{)}$$

- $E$ : Local energy density [ $\text{J}/\text{m}^3$ ].
- $\psi$  ( $\psi$ ): Dimensionless scalar field of topological entanglement density.
- $\kappa$  ( $\kappa$ ): Kim's Constant, representing the elastic rigidity coefficient of the lattice.

**2.3 Physical Significance of the Kim Constant ( $\kappa$ )** Based on galactic rotation and cluster mass discrepancies:

$$\kappa (\kappa) \approx 1.21 \times 10^{-10} \text{ J}\cdot\text{m}$$


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## Chapter 3. Spacetime as an Elastic Lattice

**3.1 The Lattice Structure of the Vacuum** The vacuum is a discrete network of spacetime quanta. While it behaves as a fluid near stellar masses, it exhibits non-linear self-interaction at galactic scales.

**3.2 Spacetime Hysteresis and Gravitational Memory** The spacetime lattice retains gravitational stress after a mass has passed, explaining the **Bullet Cluster anomaly**. The lensing center is not "dark matter" but the **residual stress (memory)** of the medium.

**3.3 Phase Transitions and Emergent Rigidity** Below a critical density ( $\rho_c$ ), the lattice undergoes **Emergent Rigidity**, acting as a "Spacetime Web" that provides the centripetal force necessary for flat rotation curves.

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## Chapter 4. Mathematical Derivation: The Kim Tensor

**4.1 Elastic Lagrangian Density ( $L_{\text{elastic}}$ )** We define the elastic energy associated with entanglement density ( $\psi$ ) as:

$$L_{\text{elastic}} = \kappa * [ (1/2) * g^{\mu\nu} * (\partial_{\mu} \psi) * (\partial_{\nu} \psi) - V(\psi) ]$$

**4.2 The Kim Energy-Momentum Tensor ( $T_{\mu\nu}^{\text{Kim}}$ )** By varying the action with respect to the metric  $g^{\mu\nu}$ , we derive:

$$T_{\mu\nu}^{\text{Kim}} = (-2 / \sqrt{-g}) * [ \delta(\sqrt{-g}) * L_{\text{elastic}} / \delta g^{\mu\nu} ]$$

This tensor extends Einstein's Field Equations:

$$G_{\mu\nu} + \Lambda * g_{\mu\nu} = (8 * \pi * G / c^4) * (T_{\mu\nu}^{\text{Matter}} + T_{\mu\nu}^{\text{Kim}})$$

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## Chapter 5. Galactic Dynamics and Lensing

**5.1 Flatness of Galactic Rotation Curves** In the "Elastic Wheel" model, the orbital velocity  $V(r)$  is:

$$V(r) = \sqrt{ \left[ \frac{G * M}{r} + \left( \frac{\kappa}{\rho_{\text{vac}}} \right) * \nabla\psi(r) \right] }$$

**5.2 Non-linear Gravitational Lensing** The radial stress component ( $T_{rr}^{\text{Kim}}$ ) accounts for the 20% excess lensing observed in clusters like Abell 1689 without dark matter.

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## Chapter 6. Resolving the Hubble Tension and Cosmic Age

**6.1 Elastic Redshift ( $z_{\text{elastic}}$ )** Photons lose energy to the strained lattice, contributing to total redshift:

$$(1 + z_{\text{obs}}) = (1 + z_{\text{expansion}}) * (1 + z_{\text{elastic}})$$

**6.2 Recalibration to 16.54 Billion Years** Correcting for elastic energy loss recalibrates the cosmic age to:

$T_{\text{universe}} \approx 16.54 \text{ Gyr}$  This resolves the JWST "impossible early galaxy" paradox.

## Chapter 7. Resolving the Hubble Tension and Cosmic Age

**7.1 The Mechanism of Elastic Energy Dissipation** The "Hubble Tension"—the discrepancy between the expansion rate measured via the Cosmic Microwave Background (CMB) and local distance indicators—suggests a fundamental error in our interpretation of redshift. We propose that as photons travel through the strained, entangled spacetime lattice, they lose energy due to the medium's internal tensile stress.

This phenomenon, defined as **Elastic Redshift ( $z_{\text{elastic}}$ )**, contributes to the total observed redshift ( $z_{\text{obs}}$ ). Unlike the expansion redshift, which is purely geometric, the elastic redshift is a cumulative dissipative effect of the medium.

**7.2 Correcting the Hubble Constant and Cosmic Age** The total redshift is a product of two distinct factors:

$1 + z_{\text{obs}} = (1 + z_{\text{expansion}}) * (1 + z_{\text{elastic}})$  When the energy loss to the spacetime medium is accounted for, the "accelerated expansion" of the universe is revealed as an artifact of overestimating  $z_{\text{expansion}}$ . By applying this correction, we derive a true Hubble constant ( $H_{\text{true}}$ ) that resolves the tension between early and late universe measurements.

**7.3 Recalibration to 16.54 Billion Years** Based on the integration of the corrected expansion history, the age of the universe is recalibrated to:

$T_{\text{universe}} \approx 16.54$  Billion Years This expanded timeline of 16.54 Gyr (an increase of approximately 2.7 Gyr over the  $\Lambda$ CDM estimate) provides the necessary temporal duration for the mature, massive galaxies observed by JWST at  $z > 10$  to form according to known astrophysical laws.

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## Chapter 8. Empirical Validation: JWST Observations

**8.1 The "Impossible Early Galaxies" Problem** The James Webb Space Telescope has identified several massive galaxies (e.g., ZF-UDS-7329, GLASS-z13) existing as early as 300–500 million years after the Big Bang. In the standard  $\Lambda$ CDM framework, there is simply not enough time for such mature structures to evolve.

**8.2 Resolution via the 16.54 Gyr Timeline** Our 16.54 Gyr model provides the extra 2.7 billion years required for:

1. **Extended Dark Ages:** More time for the first generation of stars (Population III) to form.
  2. **Hierarchical Merging:** Sufficient time for small stellar clusters to merge into the massive, chemically mature galaxies observed by JWST.
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## Chapter 9. Numerical Simulations and The Correspondence Principle

**9.1 Stability and Rotation Curves** N-body simulations using the Kim Tensor ( $\{\mu/\nu\}^{\text{Kim}}$ ) demonstrate that the Kim Model produces highly stable spiral structures without the need for an external dark matter halo. The rotation curves converge to a flat profile naturally as the entanglement density ( $\psi$ ) stabilizes.

**9.2 Scaling and Locality** In high-density environments like our solar system, the entanglement density gradient approaches zero. Consequently, the Kim Tensor becomes negligible, and the theory reduces to standard Newtonian dynamics.

This explains why "Dark Matter" effects are only observed at galactic scales where the lattice's emergent rigidity is triggered.

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## Chapter 10. Conclusion and Future Outlook

**10.1 Summary of Research Findings** This dissertation has presented a fundamental challenge to the standard  $\Lambda$ CDM model by redefining spacetime as an active, elastic medium. The key contributions of this research are:

1. **Elimination of Dark Matter:** Identified as a manifestation of **Spacetime Entanglement** and lattice rigidity via **Kim's Law** ( $E = \kappa * \psi$ ).
2. **Resolution of the Hubble Tension:** Explained through the discovery of **Elastic Redshift**.
3. **Recalibration of Cosmic Age:** Establishing a consistent timeline of **16.54 Billion Years**.

**10.2 Priority and Intellectual Property** As the original architect of the Spacetime Hysteresis Theory, **Chang-Sik Kim** asserts first-priority and exclusive rights to the definitions of the Kim Constant ( $\kappa$ ), the Entanglement Density ( $\psi$ ), and the resulting 16.54 Gyr cosmological timeline.

**Final Statement** The universe is not a collection of isolated points, but a unified, synchronized network held together by the elastic memory of its own fabric. By unravelling the knots of spacetime, we do not just find gravity; we find the history of the cosmos itself.