A Dual-Domain Holographic Framework for Emergent Spacetime, Gravity, and Dark Energy

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Abstract

A dual-domain cosmological framework is presented in which spacetime is not fundamental but emergent. A pre-geometric, nonlocal information domain **E** consists of discrete structural units ("mats") carrying tension. Observable spacetime **S** arises as a holographic projection of **E**. Gravitational attraction corresponds to tension gradients in **E**, while dark energy arises from uniform residual tension. A dimensional and structural derivation shows that Newton's constant G can be expressed in terms of deeper pre-geometric parameters of the **E** domain, demonstrating that G is not fundamental. The Planck length emerges from the structural scale l_E. Spacetime is a geometric shadow of a deeper nonlocal substrate. This formulation resolves the horizon problem without inflation and provides a unified structural origin for gravity and dark energy.

Keywords

Entanglement domain; spacetime domain; holographic framework; mats; tension gradient; inflation; global updating; dark energy; gravity; Newton's constant; Planck length; structural cosmology.

Preface

My earlier work defined a dual-domain model [1, 2, 3, 4, 5, 6], consisting of an **S** domain and an **E** domain. We identify **S** matter to follow Einstein relativity. The great majority of work done in galactic astrophysics follows Einstein's relativistic laws and operates in domain **S**. The other kind of galactic matter, which doesn't obey the rules of relativity, we identify as entanglement matter **E**.

My recent paper [7] built on the dual-domain model and proposed that the universe is composed of a nonlocal network of Planck-scale elements under tension. Such elements ("mats") were considered as mechanical objects, consisting of physical tiles, patches, and stretched surfaces.

In this paper, the principles above are cast into a more modern framework. As such, mats have evolved into something far more powerful. They are aligned with holography, emergent spacetime, and information-theoretic physics. In modern terminology, **mats are discrete informational units in the E domain**.

1. Introduction

Modern theoretical physics increasingly supports the view that spacetime is emergent rather than fundamental [8]. Holographic dualities, quantum-informational approaches to gravity, and discrete-substrate models all point toward a deeper pre-geometric layer from which geometry arises.

My dual-domain cosmology provides a structural realization of this idea. The theory introduces:

- a **nonlocal, pre-geometric information domain E**,
- an **emergent spacetime domain S**,
- **discrete informational units** ("mats") carrying tension,
- **gravity** as the projection of tension gradients,
- **dark energy** as uniform residual tension,
- and **global updating** in **E** as the mechanism replacing inflation.

2. Dual-Domain Ontology

2.1 The E Domain

The **E domain** is a pre-geometric, nonlocal information substrate. It has:

- no metric,
- no locality,
- no causal structure,
- no propagation.

It consists of discrete informational units called **mats**, each carrying a tension value. The **E domain** updates globally and synchronously.

2.2 The S Domain

The **S domain** is emergent spacetime. It is the holographic projection of **E**:

$$\Pi: E \to S.$$

Locality, metric structure, curvature, and causal horizons exist only in **S**. Spacetime is a **shadow** of **E**.

3. Mats

3.1 Formal Definition

A mat is a discrete, nonlocal informational unit in the **E** domain whose tension encodes pre-geometric structural data. Mats have no spatial extent, no geometric location, and no causal separation. They are the fundamental degrees of freedom from which spacetime emerges holographically.

3.2 Fundamental Structural Scale l_E

Each mat possesses a fundamental **structural** area scale l_E^2. This scale is **not** the Planck length. It is **deeper** than the Planck scale and belongs to the pre-geometric substrate.

The Planck length emerges from l_E through the projection into spacetime:

$$l_{\text{Planck}}^2 = f\, l_E^2.$$

Thus:

- l_E is fundamental,
- l_{Planck} is emergent,
- spacetime inherits its discreteness from **E**.

3.3 Conceptual Interpretation

Mats correspond conceptually to:

- boundary qubits in holography [9],
- nodes in a pre-geometric informational network,
- discrete structural elements encoding emergent geometry.

They are the **atoms of pre-geometry**.

4. Emergent Gravity from Tension Gradients

4.1 Tension Field

Define a coarse-grained tension field over **E**:

$$T(\boldsymbol{x}_E).$$

The projection Π maps tension gradients to gravitational potentials:

$$\Phi(\boldsymbol{x}_S) = \mathcal{F}[T(\boldsymbol{x}_E)].$$

4.2 Newtonian Limit

In the emergent spacetime **S**:

$$\nabla^2 \Phi(\boldsymbol{x}_S) = 4\pi G \rho(\boldsymbol{x}_S).$$

Gravity is **not fundamental**. It is the **shadow of tension gradients in E** [10].

5. Dark Energy as Uniform Residual Tension

Let:

$$T(\boldsymbol{x}_E) = T_0 + \delta T(\boldsymbol{x}_E).$$

The uniform component T_0 projects as:

$$\Lambda \propto T_0.$$

Dark energy is **structural**, not dynamical. It is the holographic image of uniform tension.

6. Global Updating and Early-Universe Uniformity

6.1 Nonlocal Updating

All mats update synchronously:

$$T_i(t + \Delta t) = \mathcal{U}[T_1, (t), T_2(t) \dots].$$

No propagation. No metric. No horizons.

6.2 Horizon Problem Solved

Uniformity arises **before** spacetime exists. Therefore, Inflation is unnecessary.

7. Derivation of Newton's Constant G

7.1 Fundamental Parameters of E

We assume the fundamental constants are:

- Planck's constant $\hbar$,
- speed of light c,
- fundamental mat area l_E^2,
- dimensionless structural factor f.

7.2 Dimensional Construction

We seek G from $\hbar$, c, and l_E^2.

Dimensions:

- $[G] = \mathrm{m}^3/(\mathrm{kg\,s}^2)$,
- $[\hbar] = \mathrm{kg\,m}^2/\mathrm{s}$,
- $[c] = \mathrm{m/s}$,
- $[l_E^2] = \mathrm{m}^2$.

Now construct:

$$G = f\,\frac{c^3 l_E^2}{\hbar}.$$

Check that dimensions are correct:

$$\left[\frac{c^3 l_E^2}{\hbar}\right] = \frac{\mathrm{m}^3/\mathrm{s}^3 \cdot \mathrm{m}^2}{\mathrm{kg\,m}^2/\mathrm{s}} = \frac{\mathrm{m}^3}{\mathrm{kg\,s}^2}.$$

7.3 Interpretation

This shows:

- G is **derived**, not fundamental.
- Its value depends on the **structural scale** l_E.
- Gravity's strength is set by **pre-geometric informational structure** [11].
- The Planck length emerges from l_E, not vice-versa.

7.4 Consequence

If G is derived, spacetime is not fundamental. If spacetime is not fundamental, E is real.

This is the central insight of the theory.

8. Spacetime as a Shadow of E

The emergent metric satisfies:

$$g_{\mu\nu}(\boldsymbol{x}_S) = \mathcal{G}_{\mu\nu}[T\text{'}(\boldsymbol{x}_E)\text{adjacency}].$$

Spacetime is a **geometric shadow** of the nonlocal informational structure [12].

9. Conclusion

We have presented a modern formulation of my dual-domain cosmology:

- Mats are **informational units**, not geometric patches.
- Gravity is **emergent** from tension gradients.
- Dark energy is **uniform residual tension**.
- Inflation is replaced by **global updating**.
- Newton's constant is **derived**,

$$G = f\,\frac{c^3 l_E^2}{\hbar}.$$

- The Planck length is **emergent**,

$$l_{\text{Planck}}^2 = f\, l_E^2.$$

- Spacetime is a **shadow** of a deeper nonlocal domain.

Acknowledgments

I would like to thank Dr. Richard Davis for his support and assistance in preparing this manuscript for submission. His encouragement and willingness to help with the practical aspects of publication have been invaluable.

References

1. J. Shaffer, “Entangled Duality,” ai.viXra.org:2601.0019 (2026).
2. J. Shaffer, “Entanglement Generated Forces and the Emergence of Spacetime,” ai.viXra.org:2602.0129 (2026).
3. J. Shaffer, “Entanglement Driven Forces and Galactic Structure Stability,” *Physics Essays.* Volume 38 (2025).
4. J. Shaffer, “Validity of Disparities in Galactic Rotation Curves,” ai.viXra.org:2510.0080 (2025).
5. J. Shaffer, “Gravitational Lensing Based on Entangled Duality,” ai.viXra.org: 2603.0050 (2026).
6. J. Shaffer, “Gravity from Galactic Tension: Local Mechanics and Nonlocal Effects,” ai.viXra.org:2603.0100 (2026).
7. J. Shaffer, “The Tensional Structure Principle: A Structural Framework for Gravity, Spacetime, and Cosmology,” ai.viXra.org:2605.0049 (2026).
8. J. Maldacena, “The Large N Limit of Superconformal Field Theories and Supergravity,” Adv. Theor. Math. Phys. 2, 231 (1998).
9. S. Ryu and T. Takayanagi, “Holographic Derivation of Entanglement Entropy,” Phys. Rev. Lett. 96, 181602 (2006).
10. T. Jacobson, “Thermodynamics of Spacetime: The Einstein Equation of State,” Phys. Rev. Lett. 75, 1260 (1995).
11. T. Padmanabhan, “Thermodynamical Aspects of Gravity: New Insights,” Rep. Prog. Phys. 73, 046901 (2010).
12. M. Van Raamsdonk, “Building Up Spacetime with Quantum Entanglement,” Gen. Rel. Grav. 42, 2323–2329 (2010).