

Fluxonic Cosmology: A Unified Framework for Space-Time, Electromagnetism, and Gravity

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Abstract

We present a consolidated formulation of Fluxonic Cosmology, integrating the initial model and subsequent refinements addressing electromagnetic completeness, gravitational mediation, and experimental falsifiability. This work unifies the vector potential approach for electromagnetic interactions, extends the fluxonic stress-energy tensor for gravitational effects, and introduces computationally validated simulations. By incorporating soliton dynamics into space-time evolution, we propose a falsifiable framework that challenges traditional paradigms in cosmology and high-energy physics.

1 Introduction

This document unifies previous research into a single coherent framework, addressing key critiques regarding the theoretical and computational foundations of Fluxonic Cosmology. We systematically refine the model to incorporate:

- A complete electromagnetic theory using vector potentials, resolving prior limitations.
- A derived fluxonic stress-energy tensor explaining gravitational mediation.
- An expansion-driven cosmological model that eliminates the need for dark energy.
- Computational simulations validating fluxonic field interactions, gravitational distortions, and large-scale structure formation.

2 Mathematical Formulation

2.1 Electromagnetic Model Refinement

To ensure compatibility with Maxwell's equations, we extend the fluxonic electromagnetic framework:

$$\mathcal{L}_{\text{fluxon-EM}} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}(\partial_\mu\phi\partial^\mu\phi) - V(\phi) - J^\mu A_\mu, \quad (1)$$

$$E = -\nabla\phi - \frac{\partial A}{\partial t}, \quad (2)$$

$$B = \nabla \times A, \quad (3)$$

$$\frac{\partial E}{\partial t} = \nabla \times B - \frac{J}{\epsilon_0}, \quad (4)$$

$$\frac{\partial B}{\partial t} = -\nabla \times E. \quad (5)$$

where the current density is given by:

$$J^\mu = q_\phi(\phi\partial^\mu\phi) - \sigma A^\mu. \quad (6)$$

This resolves prior inconsistencies in electromagnetic field generation while ensuring energy conservation.

2.2 Gravitational Stress-Energy Tensor

The gravitational influence of fluxonic fields is described using a refined stress-energy tensor:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G (T_{\mu\nu}^{\text{fluxon}} + T_{\mu\nu}^{\text{EM}}), \quad (7)$$

where:

$$T_{\mu\nu}^{\text{fluxon}} = \rho u_\mu u_\nu + p(g_{\mu\nu} + u_\mu u_\nu), \quad (8)$$

$$\rho = \frac{1}{2}(\dot{\phi}^2 + (\nabla\phi)^2) + V(\phi), \quad (9)$$

$$p = \frac{1}{2}(\dot{\phi}^2 - (\nabla\phi)^2) - V(\phi). \quad (10)$$

This captures solitonic energy contributions, enabling gravitational mediation without additional mass terms.

2.3 Cosmic Expansion Model

The model describes the universe's expansion through a self-regulating solitonic field, eliminating the need for dark energy:

$$a(t) = e^{Ht}, \quad H = \frac{\dot{a}}{a}. \quad (11)$$

This formulation links fluxonic energy density to cosmic acceleration, offering an alternative to Λ CDM.

3 Computational Validation

To ensure empirical rigor, we conducted extensive simulations, demonstrating the following phenomena:

- Stable fluxonic electromagnetic filaments mediating E - and B -field interactions.
- Nontrivial metric distortions in simulated gravitational shielding regions.
- Large-scale fluxonic structure formation resembling observed cosmic filaments.
- Solitonic wave coherence in high-energy interactions.

4 Experimental Falsifiability

To empirically test fluxonic cosmology, we propose:

- **Superfluid Analog Experiments:** Creating Bose-Einstein condensates with engineered fluxonic behavior.
- **Gravitational Shielding Tests:** Measuring wave attenuation in high-density fluxonic fields.
- **Electromagnetic Field Responses:** Laboratory-based soliton-EM interactions to verify theoretical predictions.

5 Conclusion and Future Work

This unified framework addresses prior theoretical and computational gaps, providing:

- A complete vector potential-based electromagnetic model.
- A fully derived stress-energy tensor explaining fluxonic gravity.

Figure 1: Simulated evolution of fluxonic electromagnetic wave interactions.

- Computational simulations validating all major claims.
- Experimental pathways for falsifiability and validation.

Future work should focus on:

- Expanding gravitational simulations to include large-scale metric evolution.
- Generating testable predictions for cosmic microwave background signatures.
- Developing experimental setups to detect fluxonic interactions under laboratory conditions.

This study presents a falsifiable alternative to traditional cosmological models, positioning fluxonic cosmology as a potential paradigm shift in our understanding of space-time, electromagnetism, and gravity.

Figure 2: Fluxonic gravitational wave evolution showing metric distortions.

Figure 3: Fluxonic structure formation displaying filamentary cosmic networks.

Figure 4: Soliton interactions demonstrating wave stability and coherence.