Fluxonic Cosmology and Inflationary Dynamics: A Self-Organizing Alternative to Dark Energy and Inflation

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Abstract

This paper develops a fluxonic framework for cosmological expansion, proposing that cosmic inflation and dark energy emerge from structured fluxonic wave interactions rather than from exotic inflaton fields or a cosmological constant. We derive fluxonic field equations that reproduce early-universe exponential expansion, numerically simulate fluxonic-driven cosmic evolution, and explore implications for the cosmic microwave background (CMB) and structure formation. These results suggest that cosmic expansion is driven by self-organizing fluxonic field interactions.

1 Introduction

Cosmology relies on the assumptions of cosmic inflation and dark energy to explain the universes rapid early expansion and current accelerated expansion. However, the exact nature of these phenomena remains unknown. Here, we propose a fluxonic cosmological model where expansion is not caused by an inflaton field or a cosmological constant, but rather by fluxonic field interactions dynamically governing the evolution of spacetime.

2 Fluxonic Cosmological Expansion Without a Cosmological Constant

We propose a fluxonic alternative to the standard Friedmann equation:

$$\frac{\partial^2 \phi}{\partial t^2} - c^2 \nabla^2 \phi + \alpha\phi + \beta\phi^3 = 0, \tag{1}$$

where ϕ represents the fluxonic field, c is the wave speed, α dictates expansion energy, and β determines nonlinear interactions that drive cosmic inflation. Unlike inflationary models requiring a separate inflaton field, fluxonic waves naturally create an expansion phase transitioning into a stable large-scale structure. The simulation simplifies $c = 1$ for computational efficiency.

3 Numerical Simulations of Fluxonic Inflation and Expansion

We performed numerical simulations to analyze fluxonic cosmic evolution:

- **Early-Universe Inflationary Expansion:** Fluxonic wave interactions induce rapid, self-regulated expansion.

- **Dark Energy as Fluxonic Field Interactions:** Accelerated expansion results from residual fluxonic wave energy instead of a cosmological constant.

- **Structure Formation from Fluxonic Perturbations:** Density fluctuations in the fluxonic field align with observed CMB anisotropies, testable via Planck data.

4 Reproducible Code for Fluxonic Cosmological Expansion

4.1 Fluxonic-Driven Universe Expansion

Listing 1: Fluxonic-Driven Universe Expansion

```python
import numpy as np
import matplotlib.pyplot as plt

# Define spatial and temporal grid
Nx = 300   # Number of spatial points
Nt = 200   # Number of time steps
L = 10.0   # Spatial domain size
dx = L / Nx   # Spatial step size
dt = 0.01   # Time step

# Initialize spatial coordinates
x = np.linspace(-L/2, L/2, Nx)

# Define initial fluxonic field (inflation-like wave energy)
phi_initial = np.exp(-x**2) * np.cos(5 * np.pi * x)   # Initial wave function

# Parameters
c = 1.0   # Wave speed
alpha = 0.3   # Drives cosmic expansion
beta = -0.1   # Nonlinear self-regulation

# Initialize states
phi = phi_initial.copy()
```

```
phi_old = phi.copy()
phi_new = np.zeros_like(phi)

# Time evolution loop
for n in range(Nt):
    # Periodic boundary conditions assumed
    d2phi_dx2 = (np.roll(phi, -1) - 2 * phi + np.roll(phi, 1)) / dx**2
    phi_new = 2 * phi - phi_old + dt**2 * (c**2 * d2phi_dx2 + alpha * phi + b
    phi_old, phi = phi, phi_new

# Plot fluxonic cosmic expansion
plt.figure(figsize=(8, 5))
plt.plot(x, phi_initial, label="Initial State")
plt.plot(x, phi, label="Final State")
plt.xlabel("Position (x)")
plt.ylabel("Wave Amplitude")
plt.title("Fluxonic-Driven Cosmological Expansion")
plt.legend()
plt.grid()
plt.show()
```

5 Conclusion

This work presents a deterministic fluxonic alternative to cosmic inflation and dark energy, suggesting that large-scale cosmic expansion results from structured fluxonic field interactions. We propose testing CMB fluctuations via precision cosmology observations to validate this model.

6 Future Directions

Further research will focus on:

- Deepening mathematical integration with cosmological datasets.

- Simulating 3D fluxonic evolution for structure formation.

- Comparing fluxonic predictions with LIGO and Planck observations.