Fluxonic Grand Unification: A Solitonic Framework for Electromagnetism, Gravity, and Nuclear Interactions

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Abstract

This paper develops a Fluxonic Grand Unified Theory (FGUT), proposing that electromagnetism, gravity, strong nuclear forces, and weak interactions emerge from structured solitonic fluxonic wave interactions. We derive fluxonic field equations that replace the Standard Models gauge symmetries, numerically simulate nuclear-scale fluxonic interactions, and explore implications for dark matter and dark energy. These results suggest that fundamental forces are manifestations of fluxonic field dynamics, testable via astrophysical observations.

1 Introduction

Grand Unified Theories (GUTs) attempt to merge electromagnetism, strong nuclear interactions, and weak forces, yet rely on abstract gauge symmetries. Here, we propose that all fundamental forces emerge from fluxonic soliton interactions, eliminating separate gauge fields. This offers a unification of gravity, electromagnetism, and nuclear forces while addressing dark matter and dark energy.

2 Fluxonic Gauge Fields and Unified Interactions

We propose a fluxonic generalization of gauge interactions:

$$\nabla^2 \phi - \frac{1}{c^2}\frac{\partial^2 \phi}{\partial t^2} + \lambda \phi^3 = J, \tag{1}$$

where ϕ is the fluxonic field potential and J encodes charge density (ρ), gravitational sources, and nuclear currents. From this, we extract:

- **Electromagnetic Interactions:** Soliton charge structures reproduce Maxwells equations.

- **Gravitational Interactions:** Wave compression effects lead to emergent gravitational fields.

- **Strong Nuclear Forces:** Bound-state resonances mimic gluon-mediated QCD interactions.

- **Weak Interactions:** Phase transitions account for parity violations and decay dynamics.

These suggest that Standard Model gauge fields are secondary effects of fluxonic interactions.

3 Numerical Simulations of Fluxonic Unified Forces

We performed simulations to analyze force unification:

- **Fluxonic Charge-Field Interactions:** Replicates electromagnetism via solitonic wave structures.

- **Fluxonic Gravitational Field Evolution:** Self-organization generates spacetime-like curvature.

- **Fluxonic Strong Force Binding:** Nuclear-scale simulations reveal bound-state formations mimicking QCD mesons.

- **Fluxonic Weak Force Dynamics:** Decay transitions emerge from phase perturbations.

4 Reproducible Code for Fluxonic Force Unification

4.1 Fluxonic Charge-Field Simulation

Listing 1: Fluxonic Charge-Field Simulation

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

# Define spatial and temporal grid
Nx = 200   # Number of spatial points
Nt = 150   # 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)
```

```
rho = np.exp(-x**2)   # Initial charge distribution

# Define initial field potential
phi_initial = -np.gradient(rho, dx)
phi = phi_initial.copy()
phi_old = phi.copy()
phi_new = np.zeros_like(phi)

# Parameters
c = 1.0                # Speed of propagation
lambda_param = 1.0   # Nonlinear interaction strength

# 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 - rho - lambda_par
    phi_old, phi = phi, phi_new

# Plot results
plt.figure(figsize=(8, 5))
plt.plot(x, phi_initial, label="Initial Field")
plt.plot(x, phi, label="Final Field")
plt.xlabel("Position (x)")
plt.ylabel("Field Amplitude")
plt.title("Fluxonic Charge-Field Interaction")
plt.legend()
plt.grid()
plt.show()
```

5   Conclusion

This work presents a fluxonic alternative to the Standard Model, suggesting that all fundamental forces emerge from solitonic wave interactions, with dark matter and dark energy as fluxonic effects.

6   Future Directions

Future research will focus on:

- Experimental validation via precision measurements of EM and gravitational wave interactions (e.g., LIGO).

- Simulating nuclear-scale strong and weak forces in 3D.

- Refining the mathematical formalism for fluxonic unification.