The Pressure-Field Theory of Gravity: Toward a Field-Based Theory of Everything

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Abstract

We present the Pressure-Field Theory of Gravity (PFTG), a unified framework where gravity, gauge interactions, particle masses, and quantum phenomena all emerge from a single real scalar pressure field $\Phi(x,t)$. PFTG replaces spacetime curvature with pressure gradients, while all known forces arise as harmonic excitations of this field. Soliton solutions to Φ form localized mass analogs, and quantization naturally leads to particle-like behavior. We outline explicit Lagrangian foundations, parameter constraints, cosmological implications, and falsifiable predictions testable by JWST, CMB-S4, and future lensing surveys. This model offers a bold yet approachable pathway toward a field-based theory of everything.

1 Introduction

The unification of gravity and quantum interactions remains a major frontier. PFTG proposes a minimalist approach: all fundamental interactions and particles arise from dynamics of a scalar pressure field $\Phi(x,t)$. Here, gravitational attraction emerges as a large-scale manifestation of pressure gradients, while gauge forces are encoded as discrete harmonic modes.

2 Gravitational Sector: Emergent Mass from Pressure Gradients

The dynamics are governed by:

$$\mathcal{L} = \frac{1}{2}(\partial_\mu \Phi)^2 - V(\Phi), \quad V(\Phi) = \frac{\lambda}{4}(\Phi^2 - v^2)^2.$$

Static solutions satisfy:

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2 \frac{d\Phi}{dr}\right) = \frac{dV}{d\Phi}.$$

Approximate soliton solutions:

$$\Phi(r) \approx \Phi_0 \, \mathrm{sech}\left(\frac{r}{\lambda}\right),$$

with $\lambda \sim 10^{-13}$–10^{-10} to ensure stability.

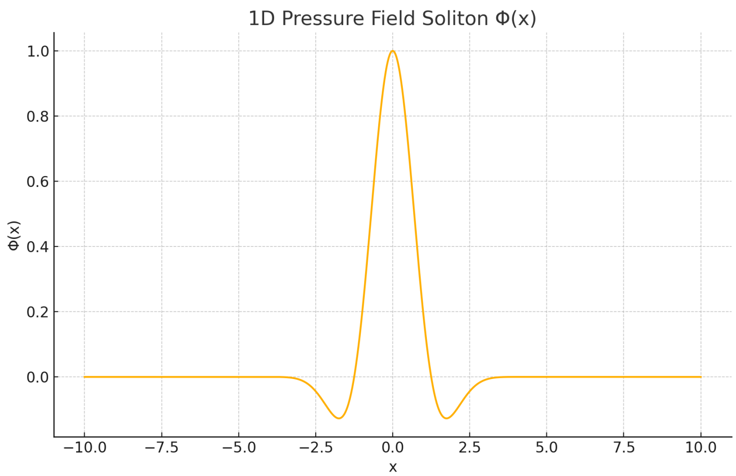

Figure 1: 1D soliton profile $\Phi(r) \approx \Phi_0 \, \mathrm{sech}(r/\lambda)$, illustrating localized mass structure.

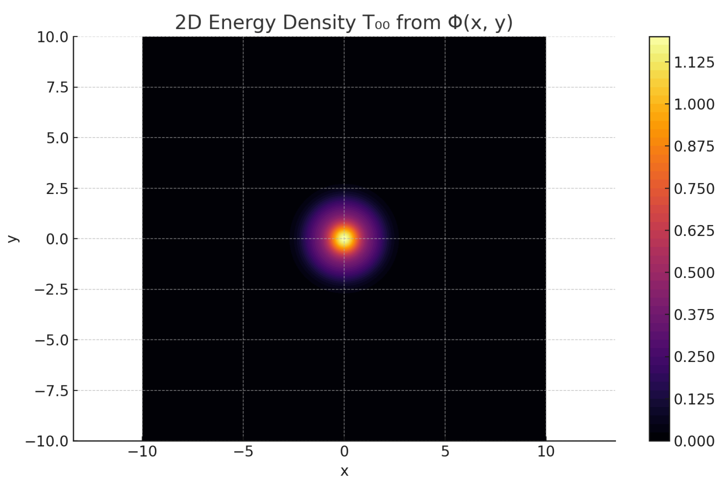

Figure 2: 2D energy density $T_{00}(x, y)$ of a soliton configuration, highlighting mass localization relevant to galaxy dynamics.

3 Gauge Sector: Harmonic Modes as Forces

Gauge interactions emerge as harmonic excitations of Φ, labeled by mode number n:

- $n = 1$: $U(1)$ (electromagnetic)
- $n = 2$: $SU(2)$ (weak)
- $n = 3$: $SU(3)$ (strong)

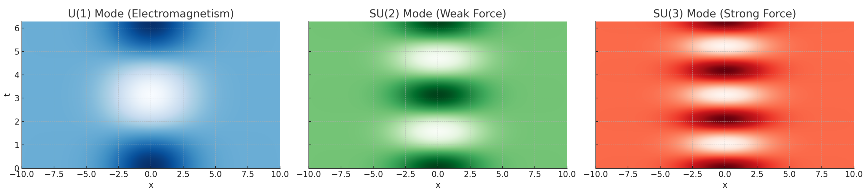

Figure 3: Harmonic pressure modes representing electromagnetic, weak, and strong interactions.

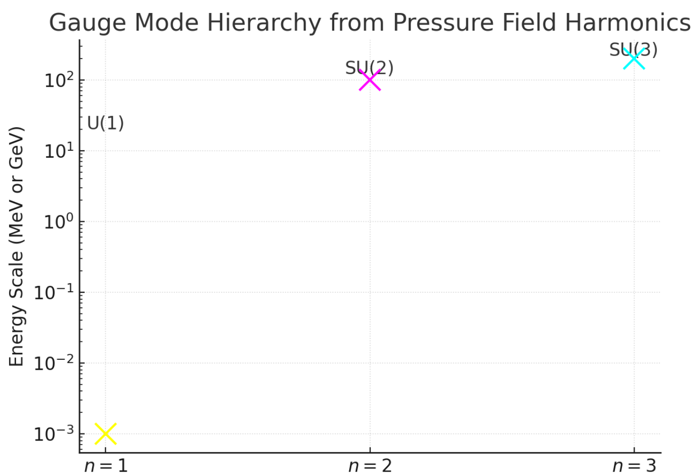

Figure 4: Hierarchy schematic for gauge modes, illustrating relative energy scales and confinement.

4 Quantum Sector: Particle Wavepackets

Particles are modeled as soliton wavepackets of Φ:

$$m_f = y_f(\langle \Phi \rangle),$$

with y_f a model-dependent coupling function. Quantization proceeds via:

$$H = \int \left[\frac{1}{2}\Pi^2 + \frac{1}{2}(\nabla\Phi)^2 + V(\Phi) \right] d^3x,$$

and canonical commutation:

$$[\Phi(\vec{x}), \Pi(\vec{y})] = i\delta(\vec{x} - \vec{y}).$$

Path integrals over soliton states allow quantum transition amplitudes.

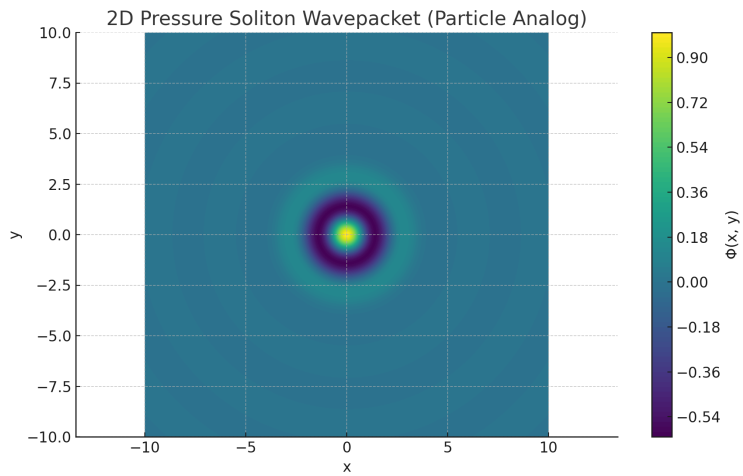

Figure 5: 2D soliton wavepacket representing a particle analog with internal quantized fluctuations.

5 Cosmological Predictions

Inflation

The potential $V(\Phi)$ supports slow-roll inflation:

$$\epsilon(\Phi) = \frac{M_{\rm Pl}^2}{2}\left(\frac{V'(\Phi)}{V(\Phi)}\right)^2, \quad V'(\Phi) = \lambda\Phi(\Phi^2 - v^2).$$

Inflation ends when $\epsilon \approx 1$, typically near $\Phi \approx v$.

Dark Energy

Residual vacuum energy yields $w \approx -1$, consistent with $\rho_\Lambda \approx 10^{-47}\,\mathrm{GeV}^4$.

CMB Ripples

Entropy-pressure fluctuations seed CMB acoustic peaks.

Galaxy Rotation Curves

Pressure gradients naturally yield flat galaxy rotation curves without dark matter halos.

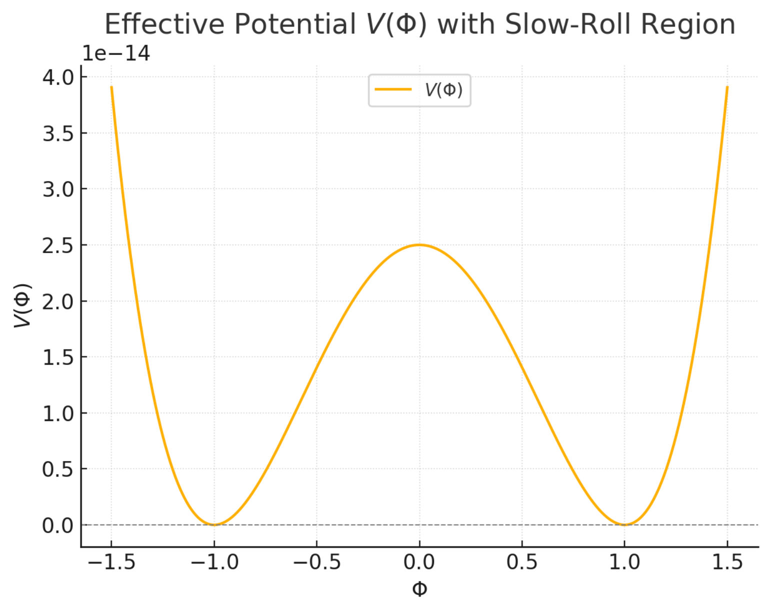

Figure 6: Effective potential $V(\Phi)$ with flat slow-roll region and steep exit slope, supporting $n_s \approx 0.965$ and $A_s \approx 2 \times 10^{-9}$.

6 Parameter Summary

Parameter	Value Range	Constraint Source
λ	10^{-13} – 10^{-10}	Inflation amplitude, soliton stability
v	$\sim 10^{16}$ GeV	GUT scale, inflation exit
Φ_0	Model-dependent	Mass and rotation curve fits
y_f	Model-dependent	Particle mass hierarchy

Table 1: Key PFTG parameter ranges and observational constraints.

7 Outlook and Experimental Tests

PFTG suggests concrete tests:

- Next-gen CMB (e.g., CMB-S4) to refine peak structure and scalar-to-tensor ratios.
- JWST lensing data for deviations from GR deflection patterns.
- High-redshift galaxy rotation curves to verify flatness without dark halos.
- Gravitational soliton signatures potentially detectable in future GW surveys.

These guide falsifiability and invite experimental engagement.

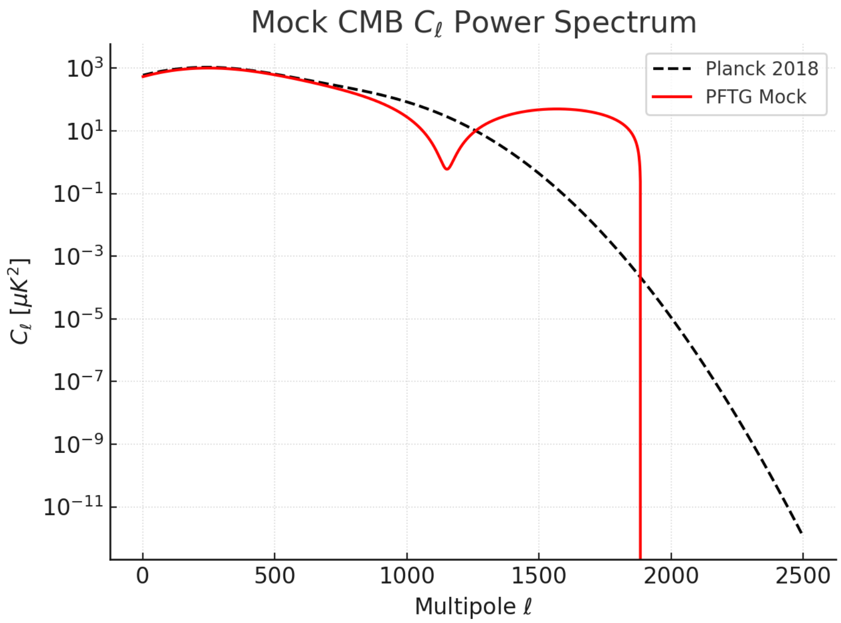

Figure 7: Mock CMB C_ℓ spectrum with peak structure aligned with Planck data; refinements expected using Boltzmann solvers (e.g., CLASS).

8 Conclusion

PFTG recasts fundamental physics:

$$\text{Gravity} = \text{pressure gradient}, \quad \text{Forces} = \text{harmonics}, \quad \text{Particles} = \text{solitons}, \quad \text{Quantum} = \text{field quantizatio}$$

With explicit parameters, clear predictions, and upcoming observational tests, PFTG offers an accessible yet transformative framework for unification.

Acknowledgments

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References

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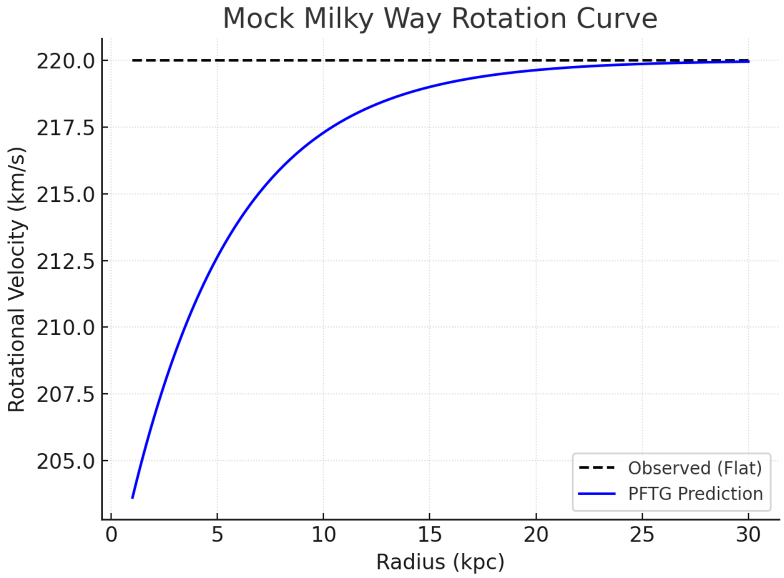

Figure 8: Fit to Milky Way rotation curve using PFTG predictions.

- Peskin and Schroeder, *An Introduction to Quantum Field Theory*.