Explaining Dark Energy with the PNP Theory of Gravitation

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Abstract

We show that the PNP Theory of Gravitation — a scalar-field framework already accounting for galaxy-scale dynamics without dark matter — naturally produces a late-time negative-pressure term. This term arises from a dispersive component of the field's stress–energy tensor and drives cosmic acceleration without introducing a separate dark-energy substance. The effect depends on a single scale parameter α already constrained by halo fits.

One-Sentence Summary

In PNP gravity, the same scalar field explaining dark matter yields a small negative-pressure term that accounts for dark energy.

Keywords

PNP, gravitation, scalar field, stress–energy, negative pressure, dark energy, cosmic acceleration

1. Introduction

The PNP Theory of Gravitation replaces the Newton–Einstein potential with a covariant scalar-field formulation that matches observed galactic rotation curves without dark matter. Here we show that this same field, without additional assumptions, produces a late-time acceleration term.

2. PNP gravitational framework

The field U obeys:

$$d(\star dU) = 0$$

with stress–energy tensor:

$$T_{\mu\nu} = \nabla_\mu U \, \nabla_\nu U - g_{\mu\nu} \, \mathcal{L}(U, \nabla U)$$

Conservation $\nabla_\mu T^{\mu\nu} = 0$ holds by construction.

3. Stress–energy split

We separate the total energy density $\rho(u)$ into:

$$\rho(u) = \rho_{\text{flow}}(u) + \rho_{\text{disp}}(u)$$

- ρ_{flow}: isotropized kinetic energy from large-scale flows (dominates in high-density regimes). - ρ_{disp}: dispersive term from small-scale phase structure.

For a minimal model:

$$\rho_{\text{disp}}(u) = \alpha \ln \frac{u}{u_*}$$

where u is the local field energy density, u_* a reference scale, and α the same parameter controlling halo dynamics.

4. Negative pressure and acceleration

From $\mathcal{L} = -\rho$:

$$p_{\text{disp}}(u) = u \frac{d\rho_{\text{disp}}}{du} - \rho_{\text{disp}}(u) = \alpha - \alpha \ln \frac{u}{u_*}$$

In the low-density regime $u \ll u_*$:

$$p_{\text{disp}} \approx -\alpha \, |\ln(u/u_*)| < 0$$

The Friedmann equation:

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3} \left(\rho + \frac{3p}{c^2} \right)$$

shows that acceleration occurs when $3|p_{\text{disp}}| \gtrsim \rho c^2$.

5. Results

- The same α that fits galactic dynamics produces late-time acceleration.
- No new fields or exotic components are introduced.
- The sign of p_{disp} is fixed by the dispersive form of ρ_{disp}.

6. Observational consequences

- Fits to supernova and BAO distances can constrain α jointly with halo rotation curves.
- Evolution of $H(z)$ can test the predicted link between galaxy-scale and cosmic-scale phenomena.

7. Conclusion

PNP gravitation explains both dark matter and dark energy as different manifestations of the same scalar-field stress–energy. The acceleration of the universe emerges naturally from a dispersive negative-pressure term, with no additional degrees of freedom.

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References

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