Observational Predictions of Coherence–Field Gravity: Galaxies, Clusters, and the Ultra-Weak Regime

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with model-assisted analysis generated using the GPT-5.1 system

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Abstract

This technical note summarizes the observable predictions of Coherence–Field Gravity (CFG) across galactic and cluster scales. CFG introduces a coherence field $C(r)$ whose gradient produces a universal additional acceleration term A/r in baryonic environments. Combined with the Newtonian term, this yields

$$a(r) = \frac{GM(r)}{r^2} + \frac{A}{r}.$$

We outline the empirical signatures distinguishing CFG from particle dark matter and MOND-like theories. Core predictions include a universal transition radius $r_t \approx 0.30\,\mathrm{kpc}$, a fixed mass scale $M_0 \approx 5.4 \times 10^7\,M_\odot$, and distinct behavior in clusters, wide binaries, gravitational lensing, and the ultra-weak acceleration regime.

1 Introduction

Coherence–Field Gravity replaces dark matter with a scalar field whose gradient contributes an A/r acceleration term. This note summarizes the observable consequences of that structure.

Predictions here are model-independent within CFG and derived without fine-tuned galaxy-by-galaxy parameters.

2 Galactic Rotation Curves

Given baryonic mass $M(r)$, CFG predicts:

$$a(r) = a_N(r) + \frac{A}{r}, \qquad a_N(r) = \frac{GM(r)}{r^2}.$$

Key signatures:

- flat rotation curves emerge naturally from the $1/r$ term,
- inner regions remain Newtonian,
- logarithmic potential contribution $\Phi \propto \ln r$,

- reduced scatter in baryonic Tully–Fisher relation,
- no need for halo concentration or feedback tuning.

2.1 Transition Radius

CFG predicts a universal radius where

$$a_N(r_t) \simeq \frac{A}{r_t}.$$

SPARC data analysis indicates

$$r_t \approx 0.30\,\mathrm{kpc}.$$

This radius is independent of galaxy mass or morphology.

3 Cluster-Scale Predictions

CFG naturally yields higher accelerations in clusters due to their larger baryonic mass and decoherence-weighted sourcing.

Predicted signatures:

- velocity dispersions consistent with observed cluster masses,
- stronger apparent "dark mass" effect than galaxies,
- no need for massive cold dark matter halos,
- consistency with X-ray inferred mass profiles,
- deviations from NFW-like behavior in the inner region.

4 Gravitational Lensing Predictions

CFG predicts lensing through the modified potential

$$\Phi(r) = -\frac{GM(r)}{r} + A \ln r.$$

Consequences:

- lensing arcs stronger than pure baryons predict,
- similar magnitudes to dark matter lensing in clusters,
- but shallower shear profiles at large radius than NFW,
- testable difference: logarithmic potential vs. $1/r$ halo.

5 Wide Binary Stars

In the ultra-weak regime:

$$a(r) \ll 10^{-11}\,\mathrm{m/s^2},$$

CFG predicts enhanced accelerations from the $1/r$ term.

Expected signatures:

- velocity dispersions slightly larger than Newtonian,
- no sharp MOND-like cutoff,
- smooth transition at r_t, not at a specific acceleration scale.

These predictions can be tested using Gaia DR4+.

6 Faint Dwarf Galaxies

CFG predicts:

- reduced scatter in dwarf galaxy velocity curves,
- no need for cored versus cuspy halo debates,
- baryon-driven structure even at low mass.

Ultra-faint dwarfs may show measurable deviations from ΛCDM halo predictions.

7 Ultra-Weak Regime Behavior

CFG distinguishes itself from MOND by predicting:

- $1/r$ acceleration persists without a hard acceleration scale,
- inner regions remain fully Newtonian,
- no violation of strong equivalence principle at laboratory scales,
- smooth interpolation from Newtonian to coherence-dominated regimes.

8 Comparison to Dark Matter and MOND

CFG differs from:

- **Cold Dark Matter (CDM):** no halos, no substructure issues, no cusp-core tension.
- **MOND:** no a_0 threshold, no fixed acceleration scale, no deep-MOND limit.
- **Scalar-Tensor Models:** does not require galaxy-by-galaxy tuning.

9 Conclusions

The acceleration structure of CFG yields a suite of observational consequences that naturally explain galactic and cluster dynamics while remaining consistent with lensing and wide binary data. These predictions distinguish CFG from both dark matter and modified gravity alternatives and provide a clear set of tests for upcoming surveys.

References

(References include SPARC database, lensing observations, cluster dynamics, and prior CFG papers.)