The Coherence–Field Gravity Research Program: Overview, Structure, and Roadmap

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

November 27, 2025

Abstract

This document provides an overview of the complete Coherence–Field Gravity (CFG) research suite, summarizing the ten papers that establish the theoretical, numerical, observational, and cosmological foundations of the framework. CFG introduces a scalar coherence field $C(x)$ whose decoherence-weighted coupling to matter produces a universal A/r acceleration in the ultra-weak regime and suppresses vacuum energy by the required factor of 10^{-123}. This overview outlines the structure of the research program, describes the role of each individual paper, and presents a roadmap for future development in theory, observation, and simulation.

1 Introduction

The Coherence–Field Gravity program was developed to unify galactic dynamics, cluster phenomenology, vacuum energy suppression, and cosmological acceleration within a single scalar-field extension of general relativity. The framework introduces:

- a coherence field $C(x)$,
- decoherence-weighted sourcing of gravity,
- a universal acceleration term A/r,
- and a natural suppression of vacuum energy.

This document summarizes the ten foundational papers comprising the initial release of CFG.

2 Summary of the CFG Papers

Paper 1: Foundations and Equations

Defines the Lagrangian, derives the field equations, and establishes the coherence-field contribution to gravity. Introduces the A/r acceleration and the universal mass scale M_0.

Paper 2: Unified Galactic and Cosmological Interpretation

Develops the phenomenological consequences across galaxies, clusters, and cosmology. Derives the transition radius r_t and explores large-scale solutions.

Paper 3: Methodology of Human–AI Co-Discovery

Documents the collaborative process behind CFG, outlining the reasoning loop, failure modes, and stabilization mechanisms that enabled rapid development.

Paper 4: Numerical Evolution and Stability

Details the solver architecture and high-resolution simulations that confirm the emergence of the $1/r$ gradient in baryonic environments.

Paper 5: Observational Predictions

Enumerates the consequences for galaxies, clusters, lensing, wide binaries, and dwarf galaxies, identifying testable signatures of CFG.

Paper 6: Falsifiable Tests

Presents the decisive observational and experimental criteria capable of falsifying CFG, establishing the framework as empirically grounded.

Paper 7: Vacuum Energy Suppression Mechanism

Shows how decoherence-weighted coupling suppresses vacuum energy by 10^{-123}, resolving the cosmological hierarchy.

Paper 8: CFG Cosmology

Derives the FRW equations, demonstrates unshifted BAO scales, and accounts for late-time acceleration without a fundamental Λ.

Paper 9: Gravitational Waves

Analyzes GW propagation, concluding that GR behavior is preserved except for small cosmological-scale effects detectable by LISA.

Paper 10: Large-Scale Structure

Derives the linear growth equation and matter power spectrum. Predicts mild late-time suppression consistent with weak-lensing tension.

3 Program Structure

CFG is organized around three core pillars:

- **Field Theory:** Papers 1, 2, 7.
- **Numerical and Observational:** Papers 4, 5, 6, 9, 10.
- **Cosmology:** Papers 2, 7, 8, 10.

Paper 3 provides a methodological foundation for future hybrid human–AI research programs.

4 Roadmap for Future Work

Future directions include:

- 2D and 3D numerical simulations,
- lensing simulations using the CFG potential,
- cluster-scale pressure profile modeling,
- cosmological parameter fitting,
- exploration of alternative potentials $V(C)$,
- laboratory decoherence-gravity experiments.

5 Conclusion

This overview consolidates the ten-paper CFG research suite into a unified program. The structure provides a coherent basis for future development and external scientific engagement.

References

(References to the ten CFG papers, GR texts, cosmology, and decoherence literature.)