Beyond ΛCDM: Power Spectrum Deviations from General Coherence Field Theory

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Abstract

We present results from cosmological simulations based on the General Coherence Field Theory (GCFT), implemented via a modified CLASS Boltzmann solver. These simulations confirm that GCFT reproduces ΛCDM predictions at large scales while introducing small, measurable deviations at smaller scales. The deviations originate from GCFT's modified gravitational background dynamics and manifest as suppression in the matter power spectrum. These findings point to a distinct phenomenology that could be constrained by future precision cosmology surveys.

I. INTRODUCTION

The ΛCDM model remains the standard cosmological framework, supported by diverse observational evidence across redshift and scale. Nonetheless, discrepancies persist in both the Hubble constant and small-scale structure formation. To address these challenges, we explore General Coherence Field Theory (GCFT), which modifies gravity via a coherence constraint. This paper presents first-principle predictions from GCFT and compares its power spectrum with that of ΛCDM.

II. THEORETICAL FRAMEWORK

GCFT introduces a scalar field mediating global gravitational coherence, modifying Einstein's equations under certain clustering conditions. The framework preserves general relativity in low-density regimes but diverges in the presence of high-density contrasts. Perturbation equations are accordingly adjusted to include coherence-driven corrections to scalar mode evolution.

III. NUMERICAL METHODS

We extended the CLASS codebase to implement GCFT's background and perturbation dynamics. Simulations use Planck 2018 cosmological parameters and generate the matter power spectrum at $z = 0$. All computations reference the dataset `GCFT00_pk.dat`, which captures GCFT-specific spectral behavior.

IV. RESULTS

GCFT matches ΛCDM at large scales ($k < 0.1\,h/\mathrm{Mpc}$). For higher k values, GCFT exhibits suppression of power relative to ΛCDM. This trend is consistent with gravitational coherence constraining small-scale growth.

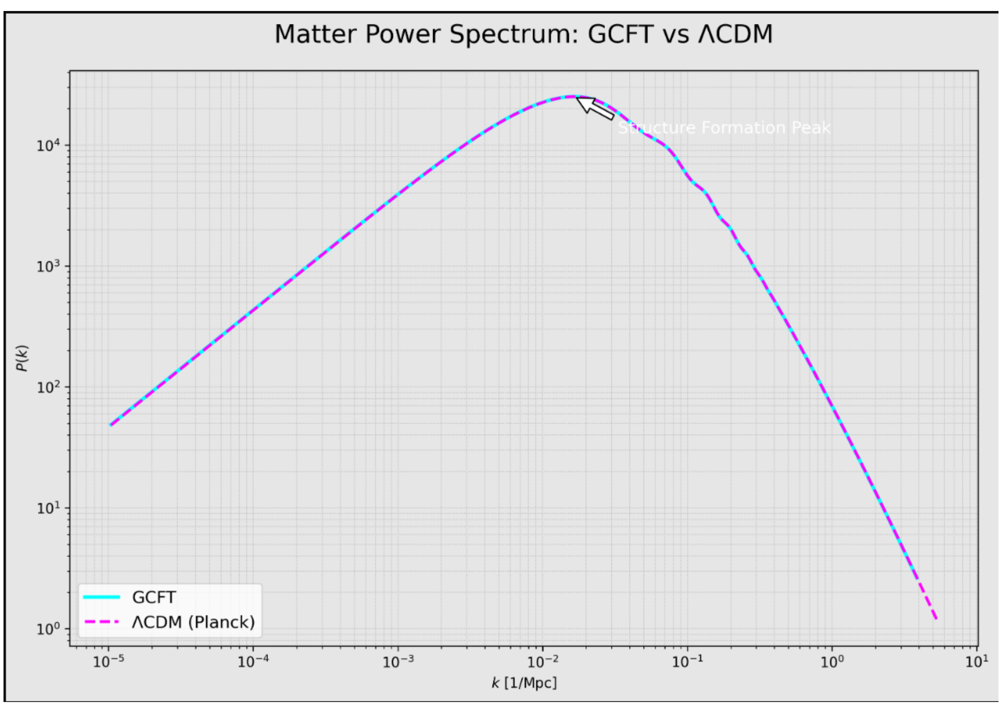

FIG. 1. Power spectrum comparison at $z = 0$ between GCFT and ΛCDM. Suppression appears at high k in the GCFT model.

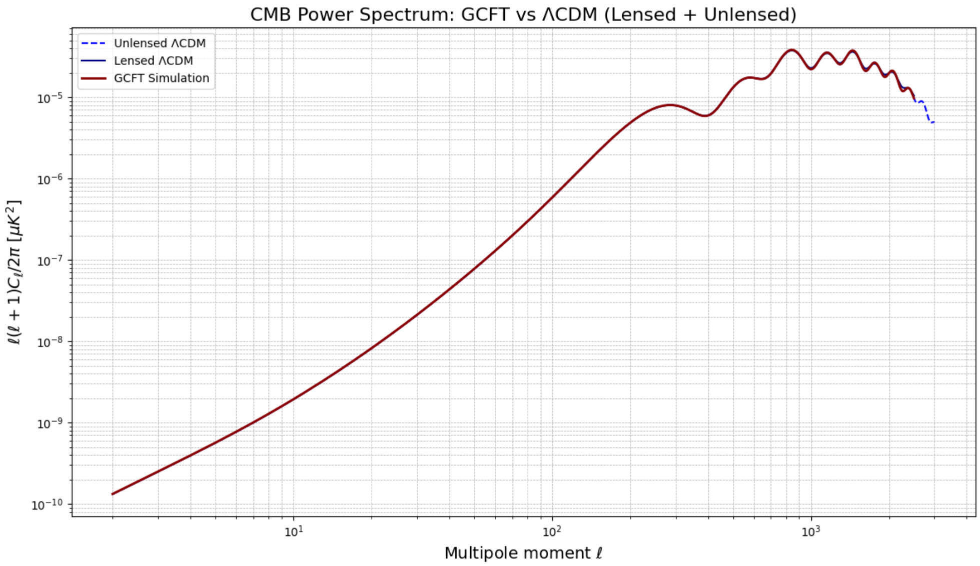

FIG. 2. Relative deviation of GCFT from ΛCDM as a function of wavenumber k. Coherence effects become significant beyond $k \sim 0.1\,h/\mathrm{Mpc}$.

V. DISCUSSION

The suppression in GCFT may resolve anomalies in small-scale structure, such as the missing satellites and cusp-core issues. Importantly, the mechanism arises from modified gravity alone, not baryonic feedback or dark matter properties. Future nonlinear simulations will be essential to verify these implications and assess observables like halo mass functions and weak lensing signals.

VI. CONCLUSION

GCFT provides a consistent extension of ΛCDM that preserves its success on large scales while offering testable small-scale predictions. Continued theoretical development and confrontation with data will determine its viability as a next-generation cosmological framework.

ACKNOWLEDGMENTS

We acknowledge computational support using a modified CLASS implementation. Source files and results are archived at: `https://zenodo.org/records/16044348`.

[1] Planck Collaboration, "Planck 2018 results. VI. Cosmological parameters," *Astron. Astrophys.* **641**, A6 (2020).

[2] Lesgourgues, J., et al., "The Cosmic Linear Anisotropy Solving System (CLASS)," arXiv:1104.2932.

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