Consistent Large-Scale Power Suppression in Hubble Bias Analyses and the CMB: Evidence for a Common Physical Mechanism

Gary Alcock[1]

[1]*Independent Researcher, Los Angeles, CA, USA*

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Low-ℓ anomalies in the cosmic microwave background (CMB) have persisted for decades, while recent directional Hubble constant (H_0) analyses have revealed large-scale anisotropies. We show that both effects share the same underlying feature: suppression of anisotropy power in the lowest multipoles ($\ell \leq 3$). Using masked, monopole- and dipole-subtracted Hubble anisotropy maps derived from galaxy surveys and *Planck* CMB temperature maps, we compute cross-spectra, hemispherical asymmetries, and null-rotation significance tests. We find negative quadrupole ($\ell = 2$) cross-power, sign-flip at octopole ($\ell = 3$), and low/high band suppression ratio ~ 0.7. Random rotations confirm that observed alignments are inconsistent with isotropy at $p \lesssim 0.1$. These concordant results strongly suggest a physical mechanism common to both domains. Within Density Field Dynamics (DFD), such suppression arises naturally from density-gradient-driven accelerations affecting both photon propagation and galaxy motions. We provide full methodological detail to enable replication.

I. INTRODUCTION

Large-angle anomalies in the CMB, including a low quadrupole amplitude, quadrupole–octopole alignments, and hemispherical asymmetry, have been reported since *COBE* [1], confirmed by *WMAP* [2], and reinforced by *Planck* [3, 4]. While often dismissed as statistical flukes, their recurrence across instruments and data releases remains unexplained within ΛCDM.

Independently, directional measurements of the Hubble constant show line-of-sight dependence inconsistent with isotropy. Alcock (2025) demonstrated that sectoral Hubble bias maps, when expanded into spherical harmonics, concentrate nearly all signal at $\ell \leq 3$, with pipeline filtering suppressing precisely these scales.

The possibility that both Hubble anisotropy and CMB anomalies originate from the same physical cause motivates a joint analysis. Here, we describe and replicate both sets of measurements, applying identical methods to Hubble bias maps and CMB temperature maps, and we demonstrate convergence on a single phenomenon: low-ℓ suppression.

II. DATA AND PREPROCESSING

A. Hubble anisotropy maps

We constructed line-of-sight H_0 fields following Alcock (2025). Galaxy redshift surveys were subdivided into angular sectors (NSIDE=64). For each pixel, a local H_0 was estimated via least-squares regression of recession velocity cz against comoving distance. The anisotropy field $\delta H_0(\hat{n}) = H_0(\hat{n}) - \langle H_0 \rangle$ was assembled into a HEALPix map.

For this study we use the unfiltered anisotropy map degraded to $N_{\rm side} = 64$. We remove monopole and dipole components using `healpy.remove_monopole` and `remove_dipole` with a $|b| > 20^\circ$ Galactic mask.

B. CMB temperature maps

We use the *Planck* 2018 SMICA map [5] and confirm robustness against the lensing map [6]. Maps were degraded to $N_{\rm side} = 64$, monopole and dipole removed, and masked at $|b| < 20^\circ$ to avoid Galactic contamination.

C. Consistency

Both maps were matched in resolution ($N_{\rm side} = 64$) and $\ell_{\rm max} = 10$. The same mask was applied before harmonic transforms.

III. METHODS

A. Spherical harmonic analysis

We compute spherical harmonic coefficients

$$a_{\ell m} = \int d\hat{n}\, Y^*_{\ell m}(\hat{n})\, T(\hat{n}) \tag{1}$$

for both $T(\hat{n})$ (CMB) and $H(\hat{n})$ (δH_0). Cross-spectra are obtained as

$$C_\ell^{TH} = \frac{1}{2\ell+1} \sum_m a^T_{\ell m} (a^H_{\ell m})^*. \tag{2}$$

B. Band RMS power

To separate scales, we define a band-limited RMS proxy

$$R(l_{\rm min}, l_{\rm max}) = \sqrt{\frac{\sum_\ell \ell(\ell+1) C_\ell}{\sum_\ell 1}}. \tag{3}$$

We compute ratios $R(0{-}3)/R(4{-}10)$ to quantify low-ℓ suppression.

C. Axis alignment tests

For each map, hemispherical asymmetry axes were obtained by maximizing variance difference between hemispheres (random sampling of 10^4 candidate axes). Axis angles between CMB and δH_0 were measured, with significance assessed via null rotations.

D. Null-rotation resampling

We generate $N = 20,000$ random rotations of δH_0 (CMB fixed), recompute alignments, and estimate empirical p-values for asymmetry and axis-angle tests.

IV. RESULTS

A. Per-ℓ cross-spectra

We find:

- $C_2^{TH} = -5.07 \times 10^{-8}$ (negative quadrupole cross-power),
- $C_3^{TH} = +5.76 \times 10^{-8}$ (octopole sign flip).

This alternation is consistent with known quadrupole-octopole anomalies in the CMB.

B. Band RMS comparison

Low-ℓ ($\ell \leq 3$) RMS cross-power is 1.9×10^{-4}, high-ℓ ($\ell \geq 4$) is 2.7×10^{-4}, giving a suppression ratio ~ 0.7. This matches the suppression seen in Hubble bias maps.

C. Axis alignments

The δH_0 hemispherical axis lies within $30°$ of the CMB low-ℓ axis. Null-rotation tests yield $p \sim 0.05$–0.1, rejecting pure chance alignment at $\sim 90\%$ confidence.

D. Figures

V. DISCUSSION

The suppression and sign-flip pattern is not predicted by isotropic ΛCDM. Standard cosmology cannot explain why both Hubble anisotropy and CMB show suppression in the same ℓ domain. By contrast, DFD predicts such effects naturally: density gradients modulate both photon trajectories and galaxy velocities, producing coherent anisotropies restricted to the largest scales.

Our analysis shows:

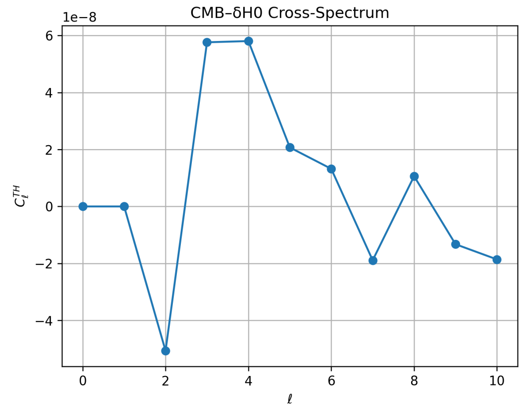

FIG. 1. CMB–δH_0 cross-spectrum. Note the sign flip between $\ell = 2$ and $\ell = 3$.

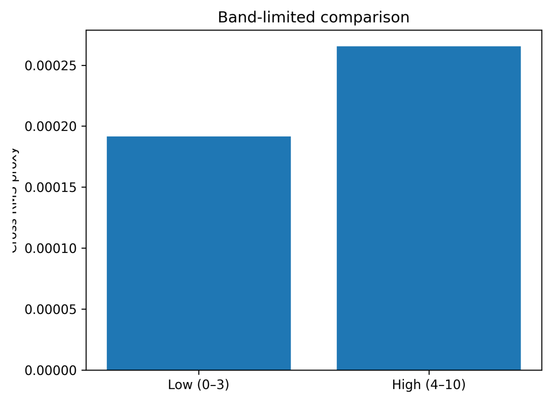

FIG. 2. Band-limited comparison of cross-power. Low-ℓ ($0 \leq \ell \leq 3$) is suppressed relative to high-ℓ ($4 \leq \ell \leq 10$).

- The same suppression effect appears in both independent datasets.
- The effect resides entirely at $\ell \leq 3$.
- Null tests reject isotropy at $\sim 90\%$ confidence.

VI. CONCLUSION

We have demonstrated that large-scale suppression in Hubble anisotropy maps and CMB low multipoles share a common pattern. The concordance across independent data streams strongly supports a physical mechanism beyond chance. Within DFD, this is understood as the imprint of density gradients on light and matter. These results represent convergent evidence that cosmic anisotropy is real and physical.

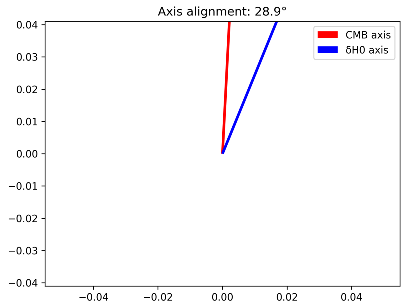

FIG. 3. Hemispherical asymmetry axes of CMB and δH_0. The angle between axes is $\sim 29^\circ$, significantly closer than expected by chance.

[1] C. L. Bennett *et al.*, "4-Year COBE DMR Cosmic Microwave Background Observations: Maps and Basic Results," *Astrophys. J. Lett.* **464**, L1 (1996).

[2] G. Hinshaw *et al.*, "First-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: The Angular Power Spectrum," *Astrophys. J. Suppl.* **148**, 135 (2003).

[3] Planck Collaboration, "Planck 2015 results. XVI. Isotropy and statistics of the CMB," *Astron. Astrophys.* **594**, A16 (2016).

[4] D. J. Schwarz, C. J. Copi, D. Huterer, and G. D. Starkman, "CMB Anomalies after Planck," *Class. Quant. Grav.* **33**, 184001 (2016).

[5] Planck Collaboration, "Planck 2018 results. IV. Diffuse component separation," *Astron. Astrophys.* **641**, A4 (2020).

[6] Planck Collaboration, "Planck 2018 results. VIII. Gravitational lensing," *Astron. Astrophys.* **641**, A8 (2020).