Large Linear Cosmology and CMB/LSS Safety of the Mid–Band Portal in a 7D 2 time Principal of Least Information Constrained Universe
(derivative–suppressed, positive $\mu(k)$ with $\mu\to 1$ on linear scales)

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Abstract

We formalise the linear–cosmology limit of the Janus/PLI mid–band portal and show that if $\mu(a,k)$ obeys $\mu(k\to 0)=1$ with derivative–suppressed tails, then primary CMB acoustic physics and linear growth remain effectively ΛCDM–like, with sub–percent shifts in $\mathcal{C}_\ell$ over $100\lesssim\ell\lesssim 1000$ and in $f\sigma_8$ at $z\lesssim 1$. Our parameterisation and the safety thesis follow the notation and motivation of Paper A and the foundations note (v14), where PLI, strong positivity, and the hidden–time sector are laid out; see §§ 2–6 of Paper A and §§ 1–5, 8–11 of v14 for context and the positivity/Born machinery. We use standard cosmological perturbation theory and Boltzmann codes as benchmarks [3, 4, 5, 6].

1 Set–up and references in context

The Janus/PLI programme (Paper A; v14) motivates a positive, derivative–suppressed $\mu(a,k)$ that opens a mid–band in the gravitational response while returning to GR at both low and high k. On linear cosmological scales we require $\mu\to 1$ so that the Poisson equation reduces to its GR form and the Sachs–Wolfe/early–ISW driving and matter growth remain ΛCDM–like [1, 2]. We adopt the usual conformal–Newtonian conventions for linear perturbations [3]. Mapping multipoles to wavenumbers by $k\sim\ell/\chi_\star$ with $\chi_\star\simeq 14\,\mathrm{Gpc}$ puts the acoustic range $100\lesssim\ell\lesssim 1000$ at $k\in[7\times10^{-3}, 7\times10^{-2}]\,\mathrm{Mpc}^{-1}$ [6].

2 Kernel and linear safety criteria

We use the minimal positive family

$$\mu(a,k)=1+\varepsilon(a)\,\mathcal{B}(k;k_{\rm mb},w,n),\qquad \mathcal{B}=\frac{(k/k_{\rm mb})^{2n}}{\left[1+(k/k_{\rm mb})^{2n}\right]\left[1+(k_{\rm mb}e^{-w}/k)^{2n}\right]},\tag{1}$$

with $n\geq 2$ enforcing derivative suppression. In the linear regime $k\ll k_{\rm mb}$ one has $\mu-1=\mathcal{O}\big((k/k_{\rm mb})^{2n}\big)$; hence the CMB and growth responses are power–law suppressed. Departures propagate to observables through the Poisson rescaling and the growth equation [3]

$$D''+\left(2+\frac{\mathcal{H}'}{\mathcal{H}}\right)D'-\frac{3}{2}\,\Omega_{\rm m}(a)\,\mu(a,k)\,D=0\,.\tag{2}$$

3 Analytic envelopes and numerical scaffolding

An order–of–magnitude CMB estimate follows

$$\frac{\Delta C_\ell}{C_\ell}\;\approx\;\alpha_\ell\,\overline{\delta\mu}_\ell\,,\qquad \overline{\delta\mu}_\ell\simeq\varepsilon\left(\frac{\ell/\chi_\star}{k_{\rm mb}}\right)^{2n},\tag{3}$$

with $\alpha_\ell = \mathcal{O}(1)$ as a conservative envelope in the acoustic range [3, 6]. Linear growth responds similarly:

$$\left|\frac{\delta(f\sigma_8)}{f\sigma_8}\right| \lesssim c_0\,\varepsilon \left(\frac{k_{\rm lin}}{k_{\rm mb}}\right)^{2n}, \tag{4}$$

where $k_{\rm lin} \lesssim 0.1\,{\rm Mpc}^{-1}$ is representative of the linear regime today. To confront data one implements $\mu(a,k)$ in a Boltzmann code; both `CAMB` and `CLASS` admit a minimal hook in the Einstein sector [4, 5].

4 Figures and parameters (reproducible PDFs)

Figures 1, 2, 3 are generated by the accompanying Python script (see repository listing) with the parameter set $(\varepsilon, k_{\rm mb}, w, n) = (0.03, 0.30, 1.0, 2)$ and $\chi_\star = 14\,000\,{\rm Mpc}$. These are conservative envelopes meant to visualise the sub–percent regime advocated above and to provide a verifiable template for a Boltzmann fork study [6, 7, 8, 9, 10].

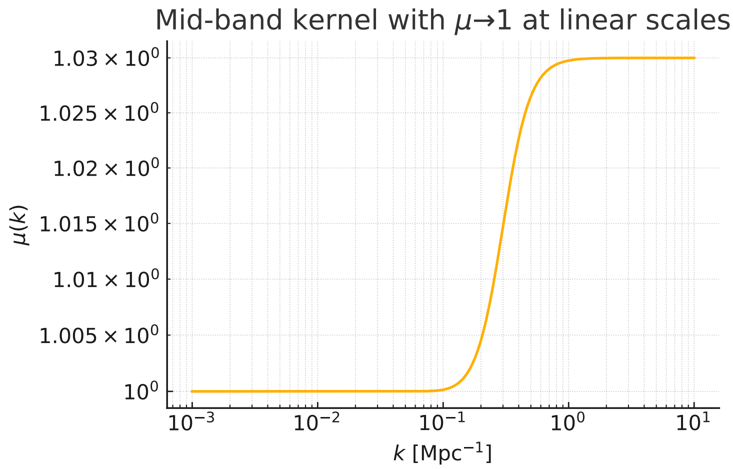

Figure 1: Mid–band kernel $\mu(k)$ with $\mu \to 1$ at linear scales. Parameters as stated in the text.

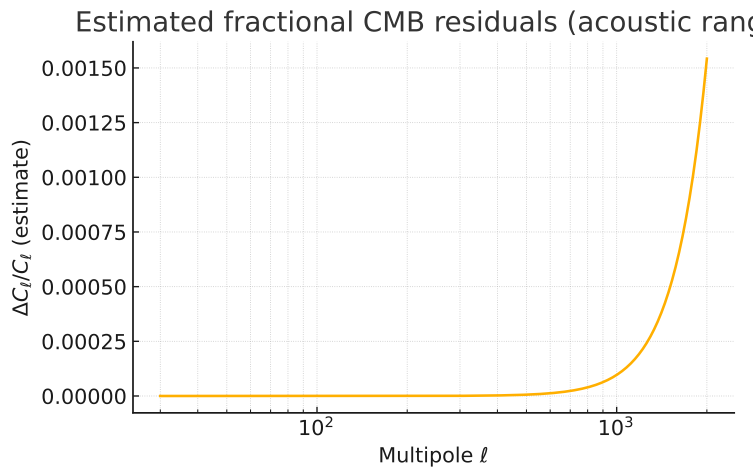

Figure 2: Estimated fractional CMB residuals $\Delta C_\ell / C_\ell$ using the analytic envelope $\propto \varepsilon(\ell/\chi_\star k_{\rm mb}^{-1})^{2n}$ in the acoustic range.

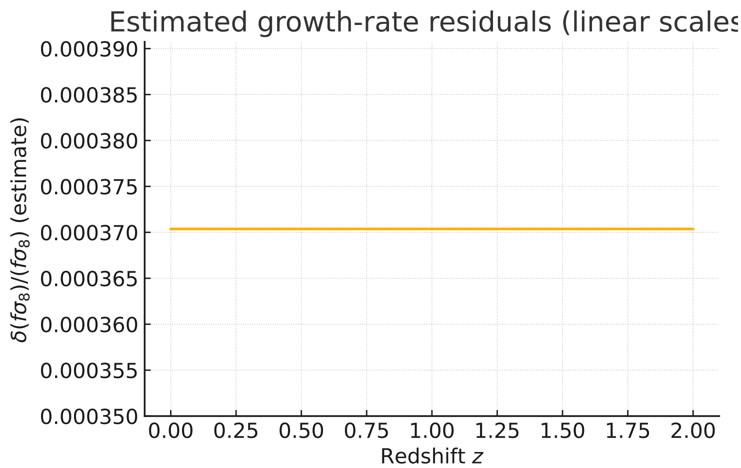

Figure 3: Estimated growth–rate residuals $\delta(f\sigma_8)/(f\sigma_8)$ vs redshift using a linear–scale envelope at fixed $k_{\rm lin} = 0.1\,{\rm Mpc}^{-1}$.

5 Falsifiers and outlook

A coherent $> 1\%$ deviation in $\mathcal{C}_\ell$ across $100 \lesssim \ell \lesssim 1000$ or a $> 1\%$ shift in $f\sigma_8$ at $z \lesssim 1$ not attributable to standard systematics would falsify the mid–band portal in its linear–safe guise. The next step is a public Boltzmann–code fork and Stage–IV Fisher forecasts [7, 8, 9, 10].

Provenance (internal). Conceptual foundations, positivity, and Born rule are summarised in v14 (Secs. 1–5, 8–11); the cosmology and compactification context is given in Paper A (Secs. 3–6, 8–10).

References

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