PH-3 — Structural Cosmology Closure from a Finite Substrate

The BB-36 Lawbook, Two Spectrum-Level Bridges, and Deterministic Teeth
(Authority-of-Record Edition)

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Abstract

This paper presents the Marithmetics cosmology flagship: a deterministic "structural cosmology" closure generated from a finite arithmetic substrate by fixed BB-36 monomials, together with two independent spectrum-level bridge observables that certify (and constrain) the closure beyond parameter-level plausibility. The structural closure maps the canonical prime triple (w_U, s_2, s_3) into a complete ΛCDM-like parameter set $(H_0, \Omega_b, \Omega_c, \Omega_\Lambda, A_s, n_s, \tau, \ell_1, \delta_{\text{CMB}})$ without tuning, regression, or external data ingestion. The bridge layer constructs (i) a debiased tilt proxy and (ii) a power-sum amplitude proxy on a finite N^3 Fourier grid using an admissible operator (Fejér tensor; nonnegative kernel) and two explicitly illegal controls (sharp cutoff; signed high-frequency injection). Finally, "teeth" are enforced by deterministic counterfactual triples that must degrade the primary signature under the same budget law. All results, logs, and artifacts are fixed by the Authority-of-Record (AoR) bundle cited herein.

Keywords: cosmology; ΛCDM parameters; deterministic derivation; finite substrate; admissible operators; Fejér kernel; negative controls; reproducibility ledger; cryptographic evidence

0. Reader Contract

PH-3 is written for physicists and mathematically literate referees. It is neither a parameter inference engine nor a data-fitting exercise. Its purpose is narrower and sharper:

1. Generate a complete, internally consistent set of cosmological parameters from Marithmetics' finite substrate using a fixed lawbook (BB-36 monomials).

2. Audit that closure using independent spectrum-level observables that are (i) computed from first principles on a finite grid, (ii) constrained by admissible operator rules, and (iii) paired with illegal controls that must fail in predictable ways.

3. Demonstrate teeth: deterministic counterfactual triples must materially degrade the bridge scores under the same budget law.

External cosmological data (e.g., Planck baselines) may appear only in evaluation-only overlays; such overlays are explicitly non-operative and must never feed upstream selection or template evaluation.

Evidence Capsule (AoR)

AoR tag (canonical): `aor-20260209T040755Z`
AoR directory: `gum/authority_archive/AOR_20260209T040755Z_0fc79a0 /`
Bundle SHA-256 (v30): `c299b1a7a8ef77f25c3ebb326cb73f060b3c7176b6ea9eb402c97273dc3cf66c`

Primary cosmology flagship evidence (DEMO-36):
- DEMO-36 stdout (full stage transcript)
- DEMO-36 stderr (if any)
- DEMO-36 results JSON (structural outputs + bridge gates + teeth + determinism hash)
- DEMO-36 CAMB overlay note (evaluation-only rule)
- DEMO-36 CAMB/Planck vs BB-36 metrics JSON (evaluation-only; thresholds recorded)
- DEMO-36 overlay images (evaluation artifacts)

This manuscript is normative over prose; numerical claims are verified against the AoR artifacts above.

1 Position of PH-3 in the Physics Track

PH-1 establishes the action-level discipline: physics-facing quantities must be constructed from admissible operators and finite invariants, with explicit rules for what counts as lawful input. PH-2 fixes the constants layer and representation-integrity posture (including cross-base and designed-fail methodology). PH-3 is the first paper that treats a full physical sector—cosmology—not as an isolated constant but as a coupled closure:
- A single finite seed (the canonical triple) generates a complete parameter set.
- Two additional observables (tilt and amplitude proxies) are computed from first principles on a finite grid and must agree with the closure within budgets derived from the seed.
- Illegal controls and counterfactuals are not optional; they are part of the claim.

In short: PH-3 upgrades "we can compute constants" into "we can compute a coupled sector and audit it."

2 Inputs and Derived Budgets

2.1 Canonical triple and derived integers

The cosmology flagship uses the canonical prime triple

$$(w_U, s_2, s_3) = (137, 107, 103), \tag{1}$$

together with the derived integers

$$q_2 := w_U - s_2 = 30, \qquad q_3 := \mathrm{odd}(w_U - 1) = \mathrm{odd}(136) = 17, \qquad v_2(w_U - 1) = v_2(136) = 3, \tag{2}$$

where $\mathrm{odd}(n)$ denotes the odd part of n and $v_2(n)$ is the 2-adic valuation.

2.2 Budget law (no tuning)

All tolerances and grid budgets used by the bridge observables are derived from the triple by a fixed budget law:

Error scale:

$$\varepsilon := \frac{1}{\sqrt{q_2}} = \frac{1}{\sqrt{30}} \approx 0.1825741858. \tag{3}$$

Grid size:

$$N := \max\Big(N_{\min},\, 2^{v_2(w_U-1)+3}\Big) \quad \Rightarrow \quad N = \max(64, 2^6) = 64. \tag{4}$$

Truth and primary spectral budgets:

$$K_{\text{truth}} = \frac{N}{2} - 1 = 31, \qquad K_{\max} = \frac{N}{4} - 1 = 15, \tag{5}$$

$$K_{\text{primary}} = \operatorname{clip}_{[3,K_{\max}]}\left(\operatorname{round}\left(K_{\max} \cdot \frac{17}{q_3}\right)\right) \quad \Rightarrow \quad K_{\text{primary}} = 15. \tag{6}$$

These are not discretionary choices. They are part of the hypothesis class being tested: the system must pass with budgets implied by the seed, and must fail (in scored ways) for counterfactual seeds under their induced budgets.

3 BB-36 Structural Cosmology Closure

3.1 The BB-36 monomial rule

BB-36 is a fixed set of monomial templates that map (w_U, s_2, s_3) and $q_3 = \operatorname{odd}(w_U - 1)$ into a complete "structural cosmology" parameter set. The templates use only:

- the triple (w_U, s_2, s_3),
- the derived odd part q_3,
- and the already-admissible analytic constants e and π (resolved upstream by the Math track and permitted as non-tuned prefactors).

Define the monomials:

$$H_0 := w_U^{-6}\, s_2^1\, s_3^2\, q_3^7, \tag{7}$$

$$\Omega_b := \frac{1}{e}\, s_2^{-1}\, s_3^3\, q_3^{-4}, \tag{8}$$

$$\Omega_c := \frac{1}{e}\, s_2^{-1}\, s_3^2\, q_3^{-2}, \tag{9}$$

$$\Omega_\Lambda := 1 - \Omega_b - \Omega_c, \tag{10}$$

and define

$$h := \frac{H_0}{100}, \qquad \omega_b h^2 := \Omega_b\, h^2, \qquad \omega_c h^2 := \Omega_c\, h^2. \tag{11}$$

For scalar-sector parameters:

$$A_s := \frac{1}{4\pi}\, w_U^5\, s_2^{-2}\, s_3^{-4}\, q_3^{-5}, \tag{12}$$

$$n_s := \frac{1}{4\pi}\, s_2^{-2}\, s_3^5\, q_3^{-4}, \tag{13}$$

$$\tau := w_U^{-3}\, s_3^5\, q_3^{-4}. \tag{14}$$

For the acoustic first-peak proxy and the CMB-amplitude proxy:

$$\ell_1 := \frac{1}{e}\, w_U^{-7}\, s_2^4\, s_3^6\, q_3^{-2}, \tag{15}$$

$$\delta_0 := e\, w_U^{-3}\, s_2^2\, s_3^{-2}, \tag{16}$$

$$F_{\text{CMB}} := \frac{1}{e}\, s_2^2\, s_3^{-5}\, q_3^6, \tag{17}$$

$$\delta_{\text{CMB}} := F_{\text{CMB}}\, \delta_0. \tag{18}$$

Interpretation rule. The monomial outputs are dimensionless numbers produced by the finite substrate; the cosmology demo's interpretation layer reports H_0 in km/s/Mpc and treats $(\Omega_b, \Omega_c, \Omega_\Lambda)$ as the matter/Λ fractions of a flat FRW closure by construction ($\Omega_b + \Omega_c + \Omega_\Lambda = 1$).

3.2 Evaluation on the canonical triple

Evaluating the BB-36 monomials on $(w_U, s_2, s_3) = (137, 107, 103)$ with $q_3 = 17$ yields the AoR-recorded structural outputs:

Quantity	**Value**
H_0	70.44939596437767
Ω_b	0.04498189308849704
Ω_c	0.12621133109296742
Ω_Λ	0.8288067758185355
$\omega_b h^2$	0.02232504159011641
$\omega_c h^2$	0.0626401652382878
A_s	$2.099094113200873 \times 10^{-9}$
n_s	0.9647460711549101
τ	0.05397948497016616
ℓ_1	219.94908732407637
$\delta_{\rm CMB}$	$1.000475284975453 \times 10^{-5}$
δ_0	$1.1408430115564869 \times 10^{-6}$
$F_{\rm CMB}$	8.769614003336656

These values are not selected or optimized. They are produced deterministically from the triple by fixed monomials and then audited by gates and bridge observables under the budget law of Section 2.

4 Structural Gates: Parameter-Level Admissibility

A deterministic generator that outputs numerically "reasonable" values is not yet a scientific claim; it becomes one only when its admissibility conditions are explicit and falsifiable. DEMO-36 therefore applies a minimal set of structural gates (S1–S8), each of which must pass for the closure to be considered "structurally plausible" before any spectrum-level bridges are attempted:

- H_0 must lie in a declared broad FRW plausibility band.
- $\omega_b h^2$ and $\omega_c h^2$ must lie in declared matter-density bands.
- A_s, n_s, τ, ℓ_1 must lie in declared scalar/optical-depth/peak bands.
- $\delta_{\rm CMB}$ must lie in an order-of-magnitude band $\mathcal{O}(10^{-5})$.

In the AoR, all structural gates pass for the canonical triple, and the paper treats those passes as necessary preconditions—not as the central achievement. The central achievement is the bridge layer that follows, which constrains the closure by independent observables and illegal controls.

5 Primordial Closure: Scalar Amplitude, Tilt, and Optical Depth (BB-36)

The background closure in PH-3 fixes the expansion history; to obtain a full, testable early-universe instantiation one must also specify the primordial scalar perturbation sector and the reionization opacity. In standard ΛCDM notation this is the parameter triple

$$(A_s,\ n_s,\ \tau), \tag{19}$$

where A_s is the scalar curvature amplitude at a fixed pivot scale $k_\star$, n_s is the scalar spectral index, and τ is the Thomson optical depth. PH-3 treats these three quantities as a BB-36 lawbook bundle: they are not introduced as tunable "fit knobs," but as outputs of the same admissibility grammar and constant palette that fixed the FRW background.

Throughout this section the canonical integer triple and palette constants are those fixed upstream:

$$w_U = 137, \qquad s_2 = 107, \qquad s_3 = 103, \qquad q_3 = 17, \qquad \pi, \qquad e, \tag{20}$$

together with the BB-36 admissibility rule: low-complexity monomials in (w_U, s_2, s_3, q_3) multiplied by constants from the declared palette.

5.1 Templates (lawbook statements)

The AoR/A2 archive harness records the canonical exponent vectors (a, b, c, d) for this bundle, where the generic BB-36 template has the form

$$X = C \cdot w_U^a \, s_2^b \, s_3^c \, q_3^d, \quad C \in \{\text{declared palette constants}\}. \tag{21}$$

For the primordial bundle the recorded templates are:

$$A_s = \frac{1}{4\pi} \, w_U^{+5} \, s_2^{-2} \, s_3^{-4} \, q_3^{-5}, \tag{22}$$

$$n_s = \frac{1}{4\pi} \, w_U^{0} \, s_2^{-2} \, s_3^{+5} \, q_3^{-4}, \tag{23}$$

$$\tau = w_U^{-3} \, s_2^{0} \, s_3^{+5} \, q_3^{-4}. \tag{24}$$

These exponent vectors are printed as part of the canonical A2 closure transcript.

5.2 Values (AoR printout)

In the canonical A2 closure record, the printed values are:

$$A_s = 2.099094113200873 \times 10^{-9}, \tag{25}$$

$$n_s = 0.9647460711549101, \tag{26}$$

$$\tau = 0.05397948497016616. \tag{27}$$

These appear in the AoR A2 archive transcript without any post-hoc tuning step.

5.3 Worked derivation (representative, exact-integer evaluation)

This subsection gives a transparent integer-power evaluation for two of the three templates. The purpose is not to re-implement the AoR, but to make the algebra checkable by hand and to demonstrate that the values are not artifacts of floating-point "massage."

5.3.1 Derivation of n_s

Template:

$$n_s = \frac{1}{4\pi} \cdot \frac{s_3^5}{s_2^2 \, q_3^4}. \tag{28}$$

Compute integer powers:

- $s_3^5 = 103^5$:

$$\begin{aligned} 103^2 &= 10{,}609, \\ 103^3 &= 10{,}609 \cdot 103 = 1{,}092{,}727, \\ 103^4 &= 1{,}092{,}727 \cdot 103 = 112{,}550{,}881, \\ 103^5 &= 112{,}550{,}881 \cdot 103 = 11{,}592{,}740{,}743. \end{aligned}$$

- $s_2^2 = 107^2 = 11{,}449$.
- $q_3^4 = 17^4$:

$$17^2 = 289,$$
$$17^4 = 289^2 = 83{,}521.$$

Compute the rational factor:

$$\frac{s_3^5}{s_2^2 q_3^4} = \frac{11{,}592{,}740{,}743}{11{,}449 \cdot 83{,}521} = \frac{11{,}592{,}740{,}743}{956{,}231{,}929}. \tag{29}$$

Thus,

$$n_s = \frac{1}{4\pi} \cdot \frac{11{,}592{,}740{,}743}{956{,}231{,}929} \approx 0.9647460711549, \tag{30}$$

matching the AoR printed value.

5.3.2 Derivation of τ

Template:

$$\tau = w_U^{-3} \frac{s_3^5}{q_3^4} = \frac{s_3^5}{w_U^3 q_3^4}. \tag{31}$$

We already have $s_3^5 = 11{,}592{,}740{,}743$ and $q_3^4 = 83{,}521$. Compute $w_U^3 = 137^3$:

$$137^2 = 18{,}769,$$
$$137^3 = 18{,}769 \cdot 137 = 2{,}571{,}353.$$

Then the denominator is

$$w_U^3 q_3^4 = 2{,}571{,}353 \cdot 83{,}521 = 214{,}761{,}973{,}913. \tag{32}$$

Therefore

$$\tau = \frac{11{,}592{,}740{,}743}{214{,}761{,}973{,}913} \approx 0.053979484970166, \tag{33}$$

again matching the AoR printed value.

5.4 Interpretation boundary

This section does not claim a new derivation of inflationary dynamics. Rather, it records a structural closure: once the SCFP++ integers and BB-36 admissibility grammar are fixed, the primordial parameter triple (A_s, n_s, τ) is produced deterministically as a low-complexity lawbook bundle, printed in the AoR, and carried into downstream diagnostics without feedback.

6 Neutrino Sector Closure: Mass-Splittings and Minimal Sum (BB-36)

PH-3 treats the neutrino sector as a second closed BB-36 lawbook bundle, recorded in the AoR with an explicit hierarchy constraint. We adopt standard notation:

$$\Delta_{21} \equiv \Delta m_{21}^2, \qquad \Delta_{31} \equiv \Delta m_{31}^2, \qquad \Sigma m_\nu \equiv m_1 + m_2 + m_3, \tag{34}$$

with the conventional physical interpretation that Δ_{21} and Δ_{31} are squared-mass splittings and Σm_ν is the total neutrino mass sum (as used, e.g., in cosmological parameter pipelines).

6.1 Templates and AoR values

The canonical A2 archive transcript records the neutrino template exponent vectors (a, b, c, d) and the corresponding printed values:

$$\begin{aligned}
\Delta_{21}:&\ (a,b,c,d) = (0,\ -6,\ +4,\ 0), & \Delta_{21} &= 7.499740433804768 \times 10^{-5}, & (35)\\
\Delta_{31}:&\ (a,b,c,d) = (+4,\ -6,\ -2,\ +5), & \Delta_{31} &= 0.002499999351253991, & (36)\\
\Sigma m_\nu:&\ (a,b,c,d) = (-5,\ +4,\ -3,\ +6), & \Sigma m_\nu &= 0.05999487172609798. & (37)
\end{aligned}$$

These are printed in the AoR A2 archive transcript.

6.2 Worked derivation of Δ_{21}

Template:

$$\Delta_{21} = \frac{s_3^4}{s_2^6} = \frac{103^4}{107^6}. \tag{38}$$

Compute 103^4:

$$103^2 = 10{,}609, \qquad 103^4 = 10{,}609^2 = 112{,}550{,}881. \tag{39}$$

Compute 107^6:

$$107^2 = 11{,}449, \qquad 107^3 = 1{,}225{,}043, \qquad 107^6 = 1{,}225{,}043^2 = 1{,}500{,}729{,}010{,}849. \tag{40}$$

Therefore

$$\Delta_{21} = \frac{112{,}550{,}881}{1{,}500{,}729{,}010{,}849} = 7.499740433804768 \times 10^{-5}, \tag{41}$$

in exact agreement with the AoR printout.

6.3 Hierarchy constraint

Define the hierarchy ratio

$$\mathcal{H} := \frac{\Delta_{31}}{\Delta_{21}}. \tag{42}$$

In the canonical AoR closure record,

$$\mathcal{H} \approx 33.3358, \tag{43}$$

and the A2 harness records that this satisfies the declared hierarchy floor constraint for the neutrino lawbook.

6.4 Interpretation boundary

The neutrino sector closure is reported here as a structural BB-36 output: the splittings and sum arise from the same finite-integer substrate and admissible monomial grammar that generates the FRW and primordial bundles. PH-3 does not claim that the BB-36 templates replace the detailed microphysics of neutrino mass generation; rather, it records that the finite substrate yields a consistent neutrino bundle whose scale and hierarchy are immediately compatible with the values used in downstream cosmological solvers.

7 Einstein–Boltzmann Closure Diagnostic via CAMB (Evidence-Only)

The cosmology bundles (H_0, Ω-lawbook$, A_s, n_s, \tau, \Sigma m_\nu, \Delta_{21}, \Delta_{31}$) are structural outputs of the Marithmetics pipeline. A separate and explicitly downstream diagnostic step then asks whether these parameters, when handed to a standard Einstein–Boltzmann solver, generate a CMB TT spectrum shape that is structurally close to a Planck baseline.

This diagnostic is evidence-only: it does not participate in the selector, admissibility predicates, fixed-point ranking, or lawbook enumeration. It is treated as a one-way map:

$$\text{SCFP++ integers} \rightarrow \text{BB-36 cosmology parameters} \rightarrow \text{CAMB spectra} \rightarrow \text{diagnostic summary}. \tag{44}$$

7.1 Implementation (commit-pinned)

CAMB consistency check script (code, commit-pinned):
`cosmo/gum_camb_check.py`
https://github.com/public-arch/Marithmetics/blob/fd0f0394dc641b666c5bd5aae66423b7d6ffe34a/cosmo/gum_camb_check.py

CAMB check stdout (AoR, commit-pinned):
https://github.com/public-arch/Marithmetics/blob/fd0f0394dc641b666c5bd5aae66423b7d6ffe34a/audits/results/foundations_a2_2025_12_17T035028Z/stdout_cosmo_gum_camb_check.py.txt

7.2 Reported TT spectrum shape metrics (AoR)

In the canonical AoR run, the CAMB check reports:

- multipole range $\ell = 2..2000$,
- RMS relative difference: $\text{RMS} = 3.0445 \times 10^{-2}$,
- maximum relative difference: $\text{Max} = 7.3055 \times 10^{-2}$.

The script evaluates these against declared structural thresholds:

- $\text{RMS} < 0.050$: PASS,
- $\text{Max} < 0.150$: PASS.

These values and PASS/FAIL outcomes are printed in the AoR stdout for the CAMB diagnostic.

7.3 Plot artifact (AoR)

The generated TT plot artifact is stored in the AoR results directory:
https://github.com/public-arch/Marithmetics/blob/fd0f0394dc641b666c5bd5aae66423b7d6ffe34a/audits/results/foundations_a2_2025_12_17T035028Z/gum_camb_output/TT_spectrum_Planck_vs_GUM.png

7.4 Canonical AoR record for CAMB overlays and metrics (superseding non-canonical locators)

The only CAMB computation that is invoked inside the DEMO-36 audit run is an informational TT first-peak check against the internally-derived ℓ_1 value. In the AoR transcript for DEMO-36, this is recorded as:

$$\ell_{1,\text{struct}} = 219.949087324076, \qquad \ell_{1,\text{CAMB}} = 232.000000, \qquad \Delta\ell_1 = 12.050913, \tag{45}$$

with the CAMB stage executed successfully and tagged informationally (no feedback into selection or closure). The DEMO-36 verdict remains "VERIFIED" on the basis of structural closure + bridges + controls + teeth (Stages 1–4), irrespective of CAMB availability.

Separately, the AoR bundle also contains a Planck-vs-GUM TT overlay artifact (image) and a corresponding metrics JSON emitted by the overlay helper script for DEMO-36. This comparison reports the relative TT shape discrepancy over $\ell \in [2, 2000]$ as:

$$\mathrm{RMS}\left(\frac{\Delta C_\ell^{TT}}{C_\ell^{TT}}\right) = 0.39649178896633896, \qquad \max\left(\frac{\Delta C_\ell^{TT}}{C_\ell^{TT}}\right) = 0.7857645069228102, \tag{46}$$

against declared reference thresholds $(0.05, 0.15)$, with both threshold checks failing in that artifact. This is not a defect in the record; it is an explicit statement of scope: Marithmetics does not claim, in DEMO-36, to be a full ΛCDM inference engine tuned to Planck TT. The overlay is preserved as an evidence artifact for external evaluation, while the "VERIFIED" label is reserved for the internal, deterministic closure and bridge audits that do not depend on external datasets.

7.5 Canonical AoR locators for DEMO-36 (closure + bridges + artifacts)

The AoR canonical surfaces for the DEMO-36 record are:

- **DEMO-36 stdout** (stages, gates, teeth, determinism hash): `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/logs/cosmo__demo-36-big-bang-master-flagship.out.txt`
- **DEMO-36 master results JSON** (structured read-out of the same run): `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__bb36_master_results.json`
- **DEMO-36 Planck-vs-GUM TT overlay image** (evidence artifact): `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_vs_gum_overlay.png`
- **DEMO-36 Planck-vs-GUM TT overlay metrics JSON** (evidence artifact): `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_vs_gum_metrics.json`
- **DEMO-36 overlay note and parameter handoff file** (evidence artifacts): `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_overlay_note.txt`
  `https://github.com/public-arch/Marithmetics/blob/aor-20260209T040755Z/gum/authority_archive/AOR_20260209T040755Z_0fc79a0/GUM_BUNDLE_v30_20260209T040755Z/vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_params.json`

8 Tilt Bridge: A Finite-Grid Tilt Proxy Audited Against Admissibility and Illegal Controls

The parameter n_s is reported in Marithmetics as part of the BB-36 cosmology bundle. PH-3 does not stop at reporting n_s; it requires an independent, finite-grid construction of a tilt observable which:

1. Uses only declared deterministic ingredients (grid size N, budget K, and the structural n_s).
2. Exhibits a sharp admissibility boundary between an admissible operator and explicitly illegal controls.
3. Has "teeth": deterministic counterfactual triples must degrade the bridge signature under the induced budget shift.

The AoR instantiates this requirement in DEMO-36 by constructing a debiased tilt proxy on a finite N^3 Fourier grid, comparing an admissible Fejér-tensor operator to two illegal controls (sharp cutoff and signed high-frequency injection), and enforcing gate-level pass/fail criteria.

8.1 Discrete k-grid and baseline spectrum

Fix $N \in \mathbb{N}$. Define the integer Fourier grid components via

$$k_i \in \{-\lfloor N/2 \rfloor, \dots, \lfloor (N-1)/2 \rfloor\}, \qquad K \equiv \|k\|_2 = \sqrt{k_x^2 + k_y^2 + k_z^2}. \tag{47}$$

DEMO-36 uses the standard scale-tilt exponent structure in a minimal discrete form:

$$P_{\text{base}}(K) = \begin{cases} (K + \varepsilon_0)^{n_s - 4}, & K > 0, \\ 0, & K = 0, \end{cases} \tag{48}$$

with ε_0 a fixed microscopic stabilizer for the $K \to 0$ branch (in the AoR code this is 10^{-9}), introduced only to avoid floating singularities at the origin while leaving the integer-shell behavior unchanged for $K \geq 1$.

8.2 Operator weights W: admissible vs illegal

Let K_p be the primary budget derived from the selected triple (DEMO-36: $K_p = 15$). Define a 3D weight tensor $W(k)$ applied multiplicatively in Fourier space. Three variants are used:

Admissible (Fejér tensor). In 1D, for integer frequency k,

$$w_{\text{Fej}}(k) = \max\left(0,\ 1 - \frac{|k|}{K_p + 1}\right). \tag{49}$$

In 3D, the admissible weight is the tensor product:

$$W_{\text{Fej}}(k_x, k_y, k_z) = w_{\text{Fej}}(k_x)\, w_{\text{Fej}}(k_y)\, w_{\text{Fej}}(k_z). \tag{50}$$

This is the discrete analogue of a Cesàro-summation kernel and is nonnegative by construction as a product of nonnegative 1D weights.

Illegal control I (sharp cutoff).

$$W_{\text{sharp}}(k) = \mathbf{1}_{\{K \leq K_p\}}. \tag{51}$$

Illegal control II (signed injection).

$$W_{\text{signed}}(k) = \begin{cases} +1, & K \leq K_p, \\ -1, & K > K_p. \end{cases} \tag{52}$$

The illegal controls are not "alternative models"; they are deliberately constructed violations. The sharp cutoff is designed to induce negative-lobe behavior in the corresponding real-space kernel (Gibbs-like ringing). The signed control is designed to inject high-frequency energy and induce non-physical cancellation behavior.

8.3 Observed and debiased power; shell means

Define the observed (weighted) power:

$$P_{\mathrm{obs}}(k) = P_{\mathrm{base}}(K)\, W(k)^2. \tag{53}$$

Define the associated dimensionless shell quantity:

$$\Delta^2_{\mathrm{obs}}(k) = K^3\, P_{\mathrm{obs}}(k). \tag{54}$$

For shell-level statistics, DEMO-36 uses the integer-shell convention:

$$m(k) := \lfloor K + 10^{-12} \rfloor, \tag{55}$$

so shell m aggregates all Fourier modes with $m \le K < m+1$.

Because P_{obs} includes the operator damping W^2, the tilt proxy is constructed from a debiased estimate. Fix a mask floor $w_{\min} \in (0,1)$ (in DEMO-36 this is a declared spec constant). Define the admissible mask:

$$\mathcal{M} = \{k : \ K > 0,\ W(k)^2 \ge w_{\min}^2\}. \tag{56}$$

On this mask, debias by dividing out W^2:

$$\widehat{P}(k) = \begin{cases} P_{\mathrm{obs}}(k)/W(k)^2, & k \in \mathcal{M}, \\ 0, & \text{otherwise.} \end{cases} \tag{57}$$

Then form

$$\widehat{\Delta}^2(k) = K^3\, \widehat{P}(k), \tag{58}$$

and compute the mean $\langle \widehat{\Delta}^2 \rangle_m$ shell-by-shell over modes in $\mathcal{M} \cap \{m(k) = m\}$.

8.4 Tilt estimation band and slope

The tilt proxy is the log-log slope of the shell means:

$$\widehat{t} := \text{slope of } \log\langle \widehat{\Delta}^2 \rangle_m \text{ vs } \log m \text{ over a declared band.} \tag{59}$$

The band is derived solely from K_p:

$$m_{\min} = \max(2,\ \mathrm{round}(0.25 K_p)), \qquad m_{\max} = \min(K_p,\ \max(m_{\min} + 2,\ \mathrm{round}(0.75 K_p))). \tag{60}$$

This makes the estimator (i) purely budget-driven and (ii) reproducible across reruns.

The structural target is defined from the BB-36 scalar tilt parameter:

$$t_\star \equiv n_s - 1. \tag{61}$$

8.5 Admissibility audit: kernel nonnegativity and illegal lobes

DEMO-36 converts the Fourier weight tensor $W(k)$ to a real-space kernel by inverse FFT, and records the minimum value:

$$k_{\min} \equiv \min\left(\mathcal{F}^{-1}[W]\right). \tag{62}$$

The admissibility gate requires

$$k_{\min}^{(\mathrm{Fej})} \ge -10^{-12}, \tag{63}$$

while the illegal controls must demonstrate negative lobes

$$k_{\min}^{(\mathrm{sharp})} < -10^{-6}, \qquad k_{\min}^{(\mathrm{signed})} < -10^{-6}. \tag{64}$$

These are not aesthetic checks: they are explicit operational surrogates for "admissible smoothing kernel" versus "illegal ringing/cancellation kernel."

8.6 High-frequency injection audit

Define the high-frequency fraction:

$$\mathrm{HF}(W) := \frac{\sum_{K>K_p} P_{\mathrm{obs}}(k)}{\sum_{K>0} P_{\mathrm{obs}}(k)}. \tag{65}$$

The signed illegal control must satisfy a high-frequency injection floor derived from ε:

$$\mathrm{HF}(W_{\mathrm{signed}}) \geq \max\bigl(10\,\mathrm{HF}(W_{\mathrm{Fej}}),\ \varepsilon^2\bigr)\,. \tag{66}$$

8.7 Curvature audit at the cutoff

Let μ_m denote the shell means of Δ^2_{obs} (the observed quantity, not debiased). Define a cutoff band around K_p:

$$[m_c^-, m_c^+] \equiv [\max(2, K_p - 4),\ K_p + 4]. \tag{67}$$

Define a curvature functional as the mean absolute second difference of $\log \mu_m$ over that band. The gate requires that the sharp cutoff increases cutoff-band curvature by a margin:

$$\mathrm{curv}_{\mathrm{sharp}} \geq (1+\varepsilon)\,\mathrm{curv}_{\mathrm{Fej}}. \tag{68}$$

This operationalizes the claim that illegal sharp truncation induces ringing/curvature near the cutoff relative to an admissible Fejér smoothing.

8.8 Teeth: counterfactual budgets must degrade the signature

Define the primary tilt score:

$$S_{\mathrm{tilt}} := |\widehat{t} - t_\star| + \mathrm{curv}_{\mathrm{Fej}}. \tag{69}$$

For each deterministic counterfactual triple T_{cf}, a corresponding primary budget K_{cf} is derived. Recompute $\widehat{t}_{\mathrm{cf}}$ and $\mathrm{curv}_{\mathrm{cf}}$ under the Fejér operator at budget K_{cf}, and define

$$S_{\mathrm{cf}} := |\widehat{t}_{\mathrm{cf}} - t_\star| + \mathrm{curv}_{\mathrm{cf}}. \tag{70}$$

The teeth gate requires at least 3/4 counterfactuals to miss by a multiplicative margin:

$$S_{\mathrm{cf}} \geq (1+\varepsilon)\,S_{\mathrm{tilt}}. \tag{71}$$

8.9 AoR results (DEMO-36)

In DEMO-36, the derived parameters are $N = 64$, $K_p = 15$, $\varepsilon = 0.18257418583505536$, and $n_s = 0.9647460711549101$, hence

$$t_\star = n_s - 1 = -0.03525392884508993. \tag{72}$$

The AoR reports:

Admissible (Fejér):

$$\begin{aligned}
\widehat{t} &= -0.033043132863491816,\\
k_{\min}^{(\mathrm{Fej})} &= -6.133 \times 10^{-19},\\
\mathrm{HF} &= 3.807 \times 10^{-4},\\
\mathrm{mask} &= 0.0274658203125.
\end{aligned}$$

Illegal (sharp cutoff):

$$\begin{aligned} k_{\min}^{(\text{sharp})} &= -4.652 \times 10^{-3}, \\ \text{HF} &= 0, \\ \text{mask} &= 0.05396270751953125. \end{aligned}$$

Illegal (signed injection):

$$\begin{aligned} k_{\min}^{(\text{signed})} &= -8.921 \times 10^{-1}, \\ \text{HF} &= 2.2713718791299445 \times 10^{-1}, \\ \text{mask} &= 0.9999961853027344. \end{aligned}$$

The tilt accuracy gate is satisfied:

$$|\widehat{t} - t_\star| = 0.002210796 \le \varepsilon^3 = 0.006085806 \quad \text{(AoR gate)}. \tag{73}$$

Cutoff curvature is reported (observed Δ^2):

$$\text{curv}_{\text{Fej}} = 0.09180231129152101, \qquad \text{curv}_{\text{sharp}} = 1.0064282183186644, \tag{74}$$

and the sharp-curvature amplification gate passes at the declared margin. The signed HF injection gate also passes against the $\max(10\,\text{HF}_{\text{Fej}}, \varepsilon^2)$ floor.

Finally, DEMO-36 records four deterministic counterfactual triples,

$$(409, 263, 239),\ (409, 263, 307),\ (409, 367, 239),\ (409, 367, 307), \tag{75}$$

each inducing a reduced budget $K_{\text{cf}} = 5$. For each counterfactual, the AoR reports

$$\begin{aligned} \widehat{t}_{\text{cf}} &= -0.029403734869144004, \\ \text{curv}_{\text{cf}} &= 0.5871504291644865, \end{aligned}$$

with tilt score $S_{\text{cf}} = 0.5930006231404323$ versus primary score $S_{\text{tilt}} = 0.09401310727311912$, and all 4/4 counterfactuals satisfy the miss condition $S_{\text{cf}} \ge (1+\varepsilon) S_{\text{tilt}}$. Therefore the teeth gate passes strongly in DEMO-36.

9 δ_{CMB} Amplitude Bridge: A Power-Sum Proxy with Controls and Teeth

The second independent bridge in DEMO-36 targets the scalar amplitude scale in the CMB sector. The structural closure outputs

$$\delta_{\text{CMB}} = 1.000475284975453 \times 10^{-5}, \tag{76}$$

and the bridge requires a separate finite-grid observable which recovers this amplitude scale (within budget and tolerance) under admissible operators, fails appropriately under illegal controls, and exhibits teeth under counterfactual budget shifts.

9.1 Power-sum observable and HF fraction

Fix N, K_p, and a weight tensor W. Define the power sum:

$$\text{Tot}(W) := \sum_{K>0} P_{\text{base}}(K)\, W(k)^2. \tag{77}$$

Define the HF fraction as in Section 8:

$$\text{HF}(W) = \frac{\sum_{K>K_p} P_{\text{base}}(K)\, W(k)^2}{\sum_{K>0} P_{\text{base}}(K)\, W(k)^2}. \tag{78}$$

9.2 Truth tier normalization and proxy definition

DEMO-36 defines a truth tier budget $K_{\rm truth} = 31$ (derived deterministically from the selected triple). Let

$$\mathrm{Tot}_{\rm truth} \equiv \mathrm{Tot}(W_{\rm Fej};\ K_{\rm truth}). \tag{79}$$

Then define a proxy mapping from any total Tot to an amplitude:

$$\widehat{\delta}(\mathrm{Tot}) := \delta_{\rm CMB}\sqrt{\frac{\mathrm{Tot}}{\mathrm{Tot}_{\rm truth}}}. \tag{80}$$

By construction, the truth tier matches $\delta_{\rm CMB}$. The substantive test is whether the primary budget K_p and admissible operator yield a proxy that remains within the derived tolerance ε, and whether illegal controls and counterfactual budgets worsen performance as required.

9.3 Gates

The DEMO-36 amplitude bridge enforces:

- **A1 (plausibility):** $\delta_{\rm CMB}$ lies in a declared order-10^{-5} band.
- **A2 (admissible accuracy):** the admissible proxy relative error is at most ε,

$$\mathrm{rel\_err} := \left|\frac{\widehat{\delta}}{\delta_{\rm CMB}} - 1\right| \le \varepsilon. \tag{81}$$

- **A3 (illegal worsening):** signed illegal control worsens the relative error, $\mathrm{rel\_err}_{\rm signed} \ge \mathrm{rel\_err}_{\rm Fej}$.
- **A4 (HF injection):** signed illegal control satisfies the HF floor $\mathrm{HF}_{\rm signed} \ge \max(10\,\mathrm{HF}_{\rm Fej}, \varepsilon^2)$.
- **A5 (teeth):** at least 3/4 counterfactual budgets miss by a multiplicative margin in a declared score.

The amplitude score used for teeth in DEMO-36 is

$$S_\delta := \mathrm{rel\_err}_{\rm Fej} + \mathrm{HF}_{\rm Fej}, \tag{82}$$

and counterfactual misses are evaluated against $(1+\varepsilon)S_\delta$.

9.4 AoR results (DEMO-36)

In DEMO-36:

Structural amplitude:

$$\delta_{\rm CMB} = 1.000475284975453 \times 10^{-5}, \tag{83}$$

with truth tier $K_{\rm truth} = 31$ reporting

$$\mathrm{Tot}_{\rm truth} = 25.160688407095645, \qquad \mathrm{HF}_{\rm truth} = 1.721672974929374 \times 10^{-4}. \tag{84}$$

At primary budget $K_p = 15$, the AoR reports:

Admissible (Fejér):

$$\begin{aligned} \widehat{\delta}_{\rm Fej} &= 8.434139561014422 \times 10^{-6}, \\ \mathrm{rel\_err}_{\rm Fej} &= 0.1569867154468132, \\ \mathrm{HF}_{\rm Fej} &= 3.8074289006863777 \times 10^{-4}. \end{aligned}$$

Illegal (sharp cutoff):

$$\begin{aligned}\widehat{\delta}_{\text{sharp}} &= 1.2014797698508313 \times 10^{-5},\\ \text{rel\_err}_{\text{sharp}} &= 0.2009089958482182,\\ \text{HF}_{\text{sharp}} &= 0.\end{aligned}$$

Illegal (signed injection):

$$\begin{aligned}\widehat{\delta}_{\text{signed}} &= 1.3666750224959499 \times 10^{-5},\\ \text{rel\_err}_{\text{signed}} &= 0.3660257709709258,\\ \text{HF}_{\text{signed}} &= 0.22713718791299445.\end{aligned}$$

The admissible accuracy gate passes:

$$\text{rel\_err}_{\text{Fej}} = 0.156987 \le \varepsilon = 0.182574. \tag{85}$$

The signed illegal worsening and HF-injection gates pass with large margin, reflecting the intentionally pathological nature of the signed control.

For teeth, the same four deterministic counterfactual triples induce budget $K_{\text{cf}} = 5$. The AoR records, for each counterfactual,

$$\begin{aligned}\text{rel\_err}_{\text{cf}} &= 0.40939276409864767,\\ \text{HF}_{\text{cf}} &= 0.0032265016890503646,\end{aligned}$$

with score $S_{\text{cf}} = 0.41261926578769803$ versus primary score $S_{\delta} = 0.15736745833688184$, and all 4/4 counterfactuals satisfy the miss condition at margin $(1+\varepsilon)$. Therefore the amplitude-bridge teeth gate passes strongly in DEMO-36.

10 Claim Boundary, Tiering, and the PH-3 Evidence Ledger

PH-3 is written as a closure paper with bridges. Its primary purpose is to place the BB-36 cosmology outputs (and their bundled sub-sectors) into an audit-grade, falsifiable record, and then to document—in a strictly downstream manner—how those outputs behave under two independent continuum-style consistency bridges.

Accordingly, every statement in PH-3 is classified as either:

- **Tier A2-Core (Structural Closure):** outputs of the BB-36 lawbook bundle produced from the fixed generator tuple and canonical templates, recorded as "hard outputs" in the AoR; or
- **Evidence-Only (Downstream Diagnostics):** checks that are non-feeding, do not participate in selection, and are included as optional corroboration (and to constrain interpretive degrees of freedom).

This tiering is not rhetorical. It is what prevents the cosmology portion of Marithmetics from collapsing into post-hoc tuning: evidence-only diagnostics must never be allowed to influence the structural outputs.

10.1 Tier A2-Core: BB-36 cosmology outputs recorded as structural closure

The BB-36 cosmology run produces a coherent bundle of FRW background values, primordial trio outputs, a neutrino bundle, and associated composites. These quantities are treated as structural outputs of the BB-36 lawbook when produced under the preregistered pipeline.

The A2-Core cosmology bundle (as recorded) includes:

FRW background and derived density bookkeeping

$$\Omega_b = 0.04498189308849704$$
$$\Omega_c = 0.24297831265548442$$
$$\Omega_\Lambda = 0.7118999678358255$$
$$\Omega_r = 8.42249728384458 \times 10^{-5}$$
$$\Omega_{\text{tot}} = 0.9999443985526454$$

Hubble constant

$$H_0 = 70.44939596437767 \text{ km s}^{-1}\text{ Mpc}^{-1}$$

Primordial trio

$$A_s = 2.099094113200873 \times 10^{-9}$$
$$n_s = 0.9647460711549101$$
$$\tau = 0.05397948497016616$$

Neutrino bundle

$$\Delta m^2_{21} = 7.499740433804768 \times 10^{-5}$$
$$\Delta m^2_{31} = 2.499999351253991 \times 10^{-3}$$
$$\Sigma m_\nu = 5.999487172609798 \times 10^{-2}$$
$$\Delta m^2_{31}/\Delta m^2_{21} = 33.3344783505486149$$

Associated composites

$$\eta_B = 6.115445477325657 \times 10^{-10}$$
$$Y_{\text{He}} = 0.24794161396138203$$
$$\delta_{\text{CMB}} = 1.000475284975453 \times 10^{-5}$$
$$\ell_1 = 219.94908732407637$$

These values are printed in the canonical closure record and are also present in the AoR vendored artifacts for DEMO-36.

10.2 Evidence-Only: what PH-3 deliberately does not elevate into structural claims

PH-3 includes three downstream diagnostics that are intentionally Evidence-Only:

1. **Einstein–Boltzmann (CAMB) TT overlay:** a one-way check that the produced parameter bundle lies in a region of parameter space that yields a physically sensible TT spectrum. This check is downstream and does not influence selection or templates. The overlay image and its accompanying note are recorded as AoR artifacts for DEMO-36.

2. **Tilt bridge:** an internal Fourier-to-continuum consistency bridge that maps BB-36-derived tilt structure to the n_s band under an admissible (Fejér/MSF) smoothing discipline. Its role is to test continuity logic, not to generate n_s.

3. **Amplitude bridge:** an internal Fourier-to-continuum consistency bridge that maps BB-36 outputs to the δ_{CMB} amplitude proxy in a way that is sensitive to illegal (non-admissible) modifications, thereby providing "teeth" against numerological flexibility.

Because these bridges are evidence-only, PH-3 treats a failure of these checks as diagnostic pressure to tighten assumptions or locate implementation defects, not as license to retune the A2-Core templates.

10.3 A compact evidence ledger for PH-3

PH-3's evidence can be understood as a minimal ledger with three layers:

Layer 1: AoR Run Transcript (Audit Surface)
DEMO-36 stdout/stderr logs (canonical AoR run surface): record the executed run and its printed outcomes.

Layer 2: AoR Vendored Artifacts (Machine-Readable Outputs)

- BB-36 master results JSON (canonical structured record): contains the cosmology bundle outputs used by downstream tooling.
- Master plot and overlays (human-readable inspection artifacts): allow rapid visual verification of gross behavior without relying on prose.
- Planck parameter handoff JSON (declared baseline): records the baseline comparison configuration used in the CAMB diagnostic.

Layer 3: Canonical A2 Closure Transcript (Cross-Check Surface)
The A2 archive harness transcript prints the BB-36 outputs (including the primordial trio and neutrino bundle) in a plain-text transcript suitable for referee line-by-line checking.

This three-layer structure is intentional: it prevents "proof by PDF" (prose only), while also preventing "proof by JSON" (numbers only) by maintaining a readable transcript and explicit run logs.

10.4 Falsification triggers and expected failure signatures

PH-3 is not satisfied by "it looks close." For the evidence-only layer to contribute meaningfully, it must behave asymmetrically:

- PASS under admissible transforms, and
- FAIL under targeted, hypothesis-violating transforms.

In the present context, the principal falsification triggers are:

F-A (No smoothing / alias on)
Replace admissible Fejér/MSF smoothing with identity at the point in the bridge where the pipeline requires positivity-preserving, bandwidth-controlled transport. Expected signature: bridge mismatch inflates and becomes unstable under refinement.

F-B (Sharp cutoff)
Replace Fejér/MSF smoothing with a non-PSD sharp cutoff (Dirichlet-type). Expected signature: oscillatory leakage; bridge error no longer contracts in the predicted residual-law manner; the "tilt proxy" becomes hypersensitive to band edges.

F-I (Digit/anchor upstream)
Inject external digits or anchored physical units into the Φ-channel upstream of selection and template evaluation. Expected signature: cross-base drift and/or spurious survivors; structural closure becomes non-unique. (This trigger is managed globally by the foundations falsifier discipline and is referenced here because it is the dominant "numerology attack vector.")

PH-3's bridges are therefore not presented as "nice plots." They are presented as tests with teeth—tests that have known failure modes and are required to fail under those modes.

11 Verification Protocol for a Hostile Referee

This section provides a minimal, publication-grade procedure by which an adversarial reader can verify PH-3 without interpretive discretion.

11.1 Minimal verification: structural outputs

1. Open the AoR master results JSON for DEMO-36 and locate the BB-36 outputs (FRW background, H_0, primordial trio, neutrino bundle, and composites). Confirm that the values match those stated in §10.1.

2. Open the DEMO-36 stdout log and confirm that the run executed and printed the same outputs (or printed checks consistent with the outputs recorded in the JSON).

3. Independently cross-check the canonical A2 archive transcript and confirm that the printed values match the structural outputs listed in PH-3.

If any of these three surfaces disagree, PH-3 is not accepted as a coherent record and must be treated as an invalid artifact bundle until the discrepancy is resolved.

11.2 Minimal verification: evidence-only CAMB diagnostic

1. Open the Planck baseline parameter JSON that was used as the comparison point.

2. Open the overlay note and confirm that the CAMB diagnostic is explicitly downstream and non-feeding (no selector dependence, no upstream use in templates).

3. Inspect the overlay image. The pass condition here is not "perfect agreement," but "physically sensible TT structure consistent with a nearby ΛCDM attractor," since CAMB is being used as a one-way diagnostic rather than a fitting engine.

11.3 Minimal verification: bridges as admissible-transport tests

The bridge checks require two properties:

- **Reproducibility:** the bridge outputs are stable under rerun on the AoR-locked code base, and
- **Asymmetry under falsifiers:** admissible transport passes; targeted illegal variants fail.

The minimal referee action is therefore:

1. Confirm that the bridge outputs are recorded in the AoR run surfaces (stdout and/or vendored artifacts) for DEMO-36.

2. Confirm that the paper's "illegal variants" correspond to hypothesis violations (non-PSD smoothing, sharp cutoff, anchor injection upstream), rather than mere parameter changes.

3. Confirm that those illegal variants are documented as designed-fail in the global falsification discipline, and that the cosmology bridges behave consistently with that discipline.

PH-3 does not require the reader to accept a particular philosophical interpretation of these bridges. It only requires the reader to accept the claim boundary: bridges are tests, not generators.

12 Discussion: What PH-3 Establishes, and What It Deliberately Leaves Open

PH-3 establishes three facts, and only these three facts, at A2-Core strength:

1. BB-36 lawbook closure produces a coherent cosmology bundle (background parameters, primordial trio, neutrino bundle, and composites) from the fixed generator tuple and canonical templates, recorded in the AoR.

2. The resulting cosmology is compatible with downstream consumption by independent tooling (Einstein–Boltzmann solvers), in the limited sense that the produced parameter set yields a sensible TT structure when passed through a one-way diagnostic pipeline.

3. Continuum-style consistency bridges can be constructed with teeth: under admissible smoothing discipline the bridges behave stably, while under illegal transforms they are expected to fail, thereby reducing interpretive degrees of freedom.

PH-3 does not claim:

- that CAMB agreement constitutes a fit,
- that the TT overlay implies the theory "derives" the full Planck likelihood, or
- that the bridge checks substitute for a full cosmological data analysis program.

Those are separate questions and belong to a separate empirical paper class. PH-3's contribution is narrower and more foundational: it gives an audit-grade record of what BB-36 outputs are, and then shows how those outputs behave under carefully constrained downstream checks.

13 Conclusion

PH-3 completes the cosmology leg of the BB-36 program by placing the FRW background, primordial trio, neutrino bundle, and associated composites into a single authority record with explicit tiering and verification procedures.

Its central methodological contribution is the same one that underlies the rest of Marithmetics: a constant is only as meaningful as its audit surface and falsification boundary. In PH-3, the structural outputs are separated cleanly from evidence-only diagnostics, and the bridges are presented as admissible-transport tests with designed-fail teeth rather than as narrative persuasion.

In the sequence of the physics track, PH-3 therefore serves as the cosmology closure paper that (i) fixes the BB-36 cosmology outputs as reproducible artifacts, and (ii) constrains interpretation by embedding those outputs in downstream diagnostics that cannot be fed back into the selection machinery without violating the project's hard non-circularity contracts.