

# Digital Root Power Tables and Cross-Base Structural Invariants

A Reproducible Computational Pipeline for Emergent Integer-Derived Mathematical Constants and Physical Parameters

Executive Technical Report

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*"Within everything accepted lies everything overlooked."*

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Author note (for referees): this report is a system audit and evidence ledger. Every demo is rerunnable via a single root-safe one-liner. Every run is hash-linked to stdout/stderr and artifacts. No headline number is claimed without a source file in the bundle. Where evidence is missing, the report states exactly what is missing and where it should be produced.

# Table of Contents

|   |    |
|---|----|
| Table of Contents   | 2  |
| 0. Visual Origin and the Kernel Story   | 4  |
| 0.1 Identity pillars and Echo tiles . . . . .   | 4  |
| 0.2 DRPT geometry and cross-base invariance . . . . .   | 6  |
| 0.3 Fejer smoothing: role, guarantees, and dimensionless structure . . . . .                      | 7  |
| 1. Bridge: One Kernel, Many Domains   | 8  |
| 1.1 Kernel map (conceptual; where to look) . . . . .  | 8  |
| 1.2 The anchor discovery: overlap is the mechanism . . . . .                                      | 8  |
| 2. Executive Summary (Coverage and Audit Posture)   | 9  |
| 2.1 Bundle coverage and run status . . . . .  | 9  |
| 2.2 Unified constants dashboard (bundle-sourced) . . . . .  | 12 |
| 2.3 Headline metrics overview (stdout-derived) . . . . .  | 13 |
| 3. Falsification Quickstart and Matrix  | 15 |
| 3.1 One-liner rule . . . . .  | 15 |
| 3.2 Matrix (full) . . . . .   | 15 |
| 4. Demo Certificates (Grouped Stories)  | 17 |
| 4.1 The Kernel: Substrate, Selection, and Invariance . . . . .                                    | 17 |
| DEMO-40 - Universe from Zero (canonical substrate ontology) . . . . .                             | 17 |
| DEMO-53 - Lawbook emergence (axioms to admissible rules) . . . . .                                | 19 |
| DEMO-64 - Base-gauge invariance (integer selector and invariance checks) . . . . .                | 21 |
| DEMO-65 - Continuous lift paradox (finite-to-continuum consistency stress test) . . . . .         | 24 |
| 4.2 Analytic Filters: DRPT Motifs and Fejer Smoothing . . . . .                                   | 26 |
| DEMO-56 - Deterministic operator calculus vs finite differences (analytic filter audit) . . . . . | 26 |
| 4.3 Closure I: Standard Model and Electroweak Dressing . . . . .                                  | 28 |
| DEMO-33 - First-principles Standard Model (SM-28 closure; SCFP++ -> Phi -> SM) . . . . .          | 28 |
| DEMO-37 - SM dressing interface (alpha_s at MZ; confinement vs free-quark branches) . . . . .     | 40 |
| DEMO-54 - Integration pipeline regression sentinel (multi-stage closure) . . . . .                | 43 |
| DEMO-55 - Hadronic stress test (proton radius extraction) . . . . .                               | 46 |
| DEMO-70 - Higgs-sector surrogate + stability audit . . . . .                                      | 48 |
| DEMO-73 - Flavor completion master flagship . . . . .   | 50 |
| DEMO-76 - Primorial-Yukawa master flagship . . . . .  | 52 |
| 4.4 Closure II: Cosmology and Large-Scale Structure . . . . .                                     | 54 |
| DEMO-36 - Big Bang master flagship (BB36 cosmology pipeline) . . . . .                            | 54 |
| DEMO-39 - BB-A2 (cosmology sanity and parameter consistency) . . . . .                            | 58 |
| 4.5 Dynamics: Gravity, Fields, and Continuum Constraints . . . . .                                | 60 |

|  |           |
|--|-----------|
| DEMO-51 - QFT/GR vacuum suppression (bridge between quantum and curved background) . . . . . | 60        |
| DEMO-58 - Emergent weak-field GR (limit and stability checks) . . . . .                      | 62        |
| DEMO-59 - Electromagnetism (Maxwell structure from kernel constraints) . . . . .             | 64        |
| DEMO-63 - Gravitational-wave inspiral phasing (observable regime stress test) . . . . .      | 66        |
| DEMO-67 - Navier-Stokes master flagship . . . . .  | 68        |
| DEMO-68 - General Relativity master flagship . . . . .                                       | 70        |
| DEMO-71 - One Action master flagship (Classical Noether + quantum energy bridge) . . . . .   | 72        |
| <b>4.6 Quantum and Quantum Gravity . . . . .</b>   | <b>74</b> |
| DEMO-60 - Quantum master flagship . . . . .  | 74        |
| DEMO-66 - Quantum gravity master flagship (v4) . . . . .                                     | 76        |
| <b>4.7 Bridges and Transfer Principles . . . . .</b>   | <b>78</b> |
| DEMO-34 - Bridge_34 Omega Sm Master Flagship V1 . . . . .                                    | 78        |
| DEMO-69 - OATB (operator admissibility transfer bridge) . . . . .                            | 80        |
| DEMO-72 - Sm_72 Yukawa . . . . .   | 82        |
| DEMO-75 - Prediction ledger master flagship . . . . .  | 84        |
| <b>5. Appendices</b>   | <b>86</b> |
| 5.1 Bundle manifest and verification . . . . .   | 86        |
| 5.2 CAMB expected assets (overlay boundary) . . . . .  | 86        |

# 0. Visual Origin and the Kernel Story

The purpose of the opening section is to define the objects that later physics closures reuse. DRPTs (Digital Root Power Tables) are treated as a dimensionless substrate signature: they are discrete, cross-base, and locally testable. The central discovery motivating this report is that the same kernel signatures recur across domains that historically look unrelated. This is the blended story: overlap is the point, not a coincidence. To make that claim referee-auditable, we begin with visuals and then connect them to falsifiers and per-demo certificates.

## 0.1 Identity pillars and Echo tiles

Identity and Echo tiles are visual witnesses for repeatable residue structure. They matter because they demonstrate that the kernel is not a single special-case configuration: the motifs tile and recur. This recurrence is what makes the phrase 'tiles throughout infinity' operational: the structure is not local to one scale or one base. Where later demos claim ALQ dressing behavior, these tiles are the discrete origin of that behavior in dimensionless form.

For many more families and cross-base invariants, we encourage readers to explore the Visual Atlas tool. We are still documenting the full family taxonomy, but these objects can already be identified across each base. Code is available in this GitHub repository. For quick access to the Visual Atlas artifact, see:  
<https://claude.ai/public/artifacts/3aac6f21-8ad0-42ff-82df-52c14d6a42b2>

### Identity Element Pattern (Value 1)

Where multiplicative identity appears in Base 9

| Base | <sup>1</sup> | <sup>2</sup> | <sup>3</sup> | <sup>4</sup> | <sup>5</sup> | <sup>6</sup> | <sup>7</sup> | <sup>8</sup> | <sup>9</sup> | <sup>10</sup> | <sup>11</sup> | <sup>12</sup> |
|------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|---------------|---------------|
| 1    | 1            | 1            | 1            | 1            | 1            | 1            | 1            | 1            | 1            | 1             | 1             | 1             |
| 2    | 2            | 4            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8             | 8             | 8             |
| 3    | 3            | 1            | 3            | 1            | 3            | 1            | 3            | 1            | 3            | 1             | 3             | 1             |
| 4    | 4            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8             | 8             | 8             |
| 5    | 5            | 1            | 5            | 1            | 5            | 1            | 5            | 1            | 5            | 1             | 5             | 1             |
| 6    | 6            | 4            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8             | 8             | 8             |
| 7    | 7            | 1            | 7            | 1            | 7            | 1            | 7            | 1            | 7            | 1             | 7             | 1             |
| 8    | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8            | 8             | 8             | 8             |

Figure 0.2A: Identity pillar (n=9)

## Identity Element Pattern (Value 1)

Where multiplicative identity appears in Base 10

| Base | <sup>^1</sup> | <sup>^2</sup> | <sup>^3</sup> | <sup>^4</sup> | <sup>^5</sup> | <sup>^6</sup> | <sup>^7</sup> | <sup>^8</sup> | <sup>^9</sup> | <sup>^10</sup> | <sup>^11</sup> | <sup>^12</sup> |
|------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|
| 1    | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1              | 1              | 1              |
| 2    | 2             | 4             | 8             | 7             | 5             | 1             | 2             | 4             | 8             | 7              | 5              | 1              |
| 3    | 3             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9              | 9              | 9              |
| 4    | 4             | 7             | 1             | 4             | 7             | 1             | 4             | 7             | 1             | 4              | 7              | 1              |
| 5    | 5             | 7             | 8             | 4             | 2             | 1             | 5             | 7             | 8             | 4              | 2              | 1              |
| 6    | 6             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9              | 9              | 9              |
| 7    | 7             | 4             | 1             | 7             | 4             | 1             | 7             | 4             | 1             | 7              | 4              | 1              |
| 8    | 8             | 1             | 8             | 1             | 8             | 1             | 8             | 1             | 8             | 1              | 8              | 1              |
| 9    | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9             | 9              | 9              | 9              |

Figure 0.2B: Identity pillar (n=10)

## Echo Patterns

Values appearing at multiple coordinates (Base 6)

| Base | <sup>^1</sup> | <sup>^2</sup> | <sup>^3</sup> | <sup>^4</sup> | <sup>^5</sup> | <sup>^6</sup> | <sup>^7</sup> | <sup>^8</sup> | <sup>^9</sup> | <sup>^10</sup> | <sup>^11</sup> | <sup>^12</sup> |
|------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|
| 1    | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1             | 1              | 1              | 1              |
| 2    | 2             | 4             | 3             | 1             | 2             | 4             | 3             | 1             | 2             | 4              | 3              | 1              |
| 3    | 3             | 4             | 2             | 1             | 3             | 4             | 2             | 1             | 3             | 4              | 2              | 1              |
| 4    | 4             | 1             | 4             | 1             | 4             | 1             | 4             | 1             | 4             | 1              | 4              | 1              |
| 5    | 5             | 5             | 5             | 5             | 5             | 5             | 5             | 5             | 5             | 5              | 5              | 5              |

Figure 0.2C: Echo tile (n=6)

## Echo Patterns

Values appearing at multiple coordinates (Base 10)

| Base | $\wedge 1$ | $\wedge 2$ | $\wedge 3$ | $\wedge 4$ | $\wedge 5$ | $\wedge 6$ | $\wedge 7$ | $\wedge 8$ | $\wedge 9$ | $\wedge 10$ | $\wedge 11$ | $\wedge 12$ |
|------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|
| 1    | 1          | 1          | 1          | 1          | 1          | 1          | 1          | 1          | 1          | 1           | 1           | 1           |
| 2    | 2          | 4          | 8          | 7          | 5          | 1          | 2          | 4          | 8          | 7           | 5           | 1           |
| 3    | 3          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9           | 9           | 9           |
| 4    | 4          | 7          | 1          | 4          | 7          | 1          | 4          | 7          | 1          | 4           | 7           | 1           |
| 5    | 5          | 7          | 8          | 4          | 2          | 1          | 5          | 7          | 8          | 4           | 2           | 1           |
| 6    | 6          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9           | 9           | 9           |
| 7    | 7          | 4          | 1          | 7          | 4          | 1          | 7          | 4          | 1          | 7           | 4           | 1           |
| 8    | 8          | 1          | 8          | 1          | 8          | 1          | 8          | 1          | 8          | 1           | 8           | 1           |
| 9    | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9          | 9           | 9           | 9           |

Figure 0.2D: Echo tile ( $n=10$ )

## 0.2 DRPT geometry and cross-base invariance

DRPTs are best understood as a discretized geometry of residue structure. Because they are defined on digit-root dynamics, they are dimensionless and naturally comparable across bases. The visual motifs (city grids, survivor patterns, and identity pillars) function as invariance witnesses: if the motifs change under base-gauge transforms, the kernel is not invariant. In this report, DRPT visuals are treated as mechanism evidence rather than as decorative plots.

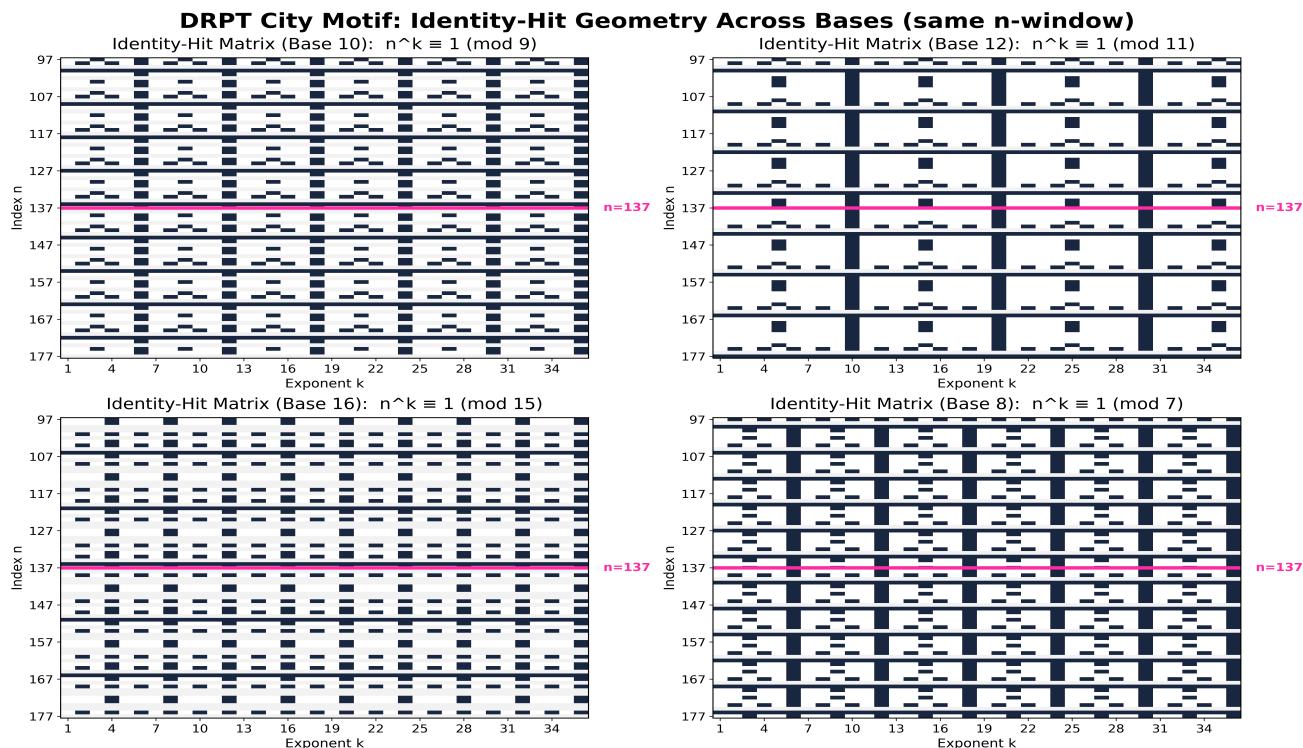
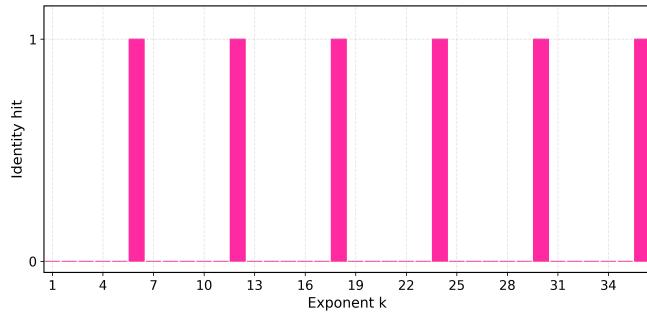


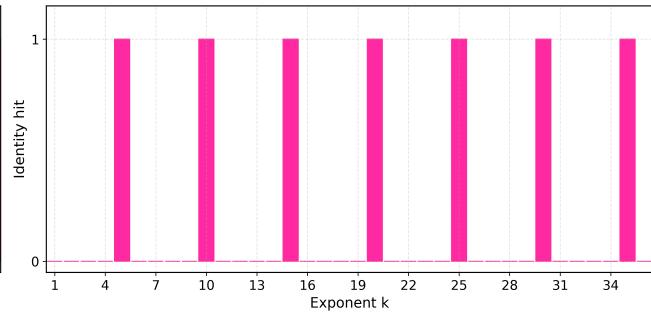
Figure 0.1A: DRPT City (example motif)

### DRPT Survivor Lane for n=137: Identity Pillars Across Bases

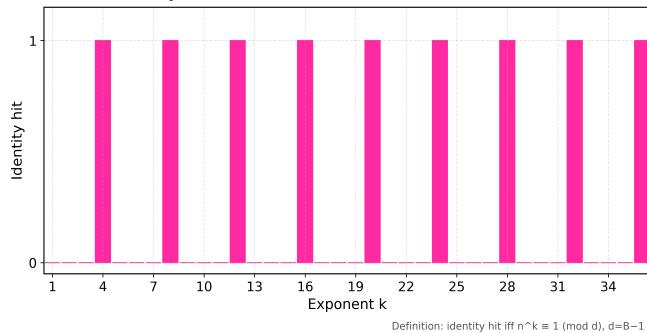
Chunky Survivor Lane (Base 10):  $n^k \equiv 1 \pmod{9}$



Chunky Survivor Lane (Base 12):  $n^k \equiv 1 \pmod{11}$



Chunky Survivor Lane (Base 16):  $n^k \equiv 1 \pmod{15}$



Chunky Survivor Lane (Base 8):  $n^k \equiv 1 \pmod{7}$

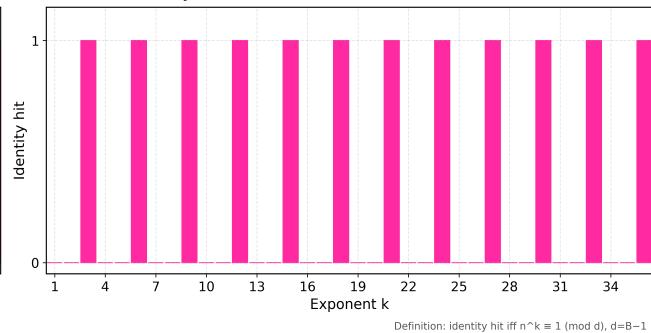


Figure 0.1B: DRPT Survivor lattice (example motif)

### 0.3 Fejer smoothing: role, guarantees, and dimensionless structure

Fejer smoothing is used in this program as an analytic filter with guarantees, not as an aesthetic smoothing operation. Formally, it replaces a partial-sum sequence by its Cesaro (Fejer) average, which is known to suppress Gibbs-type oscillations and stabilize convergence in many settings. In the GUM pipeline, this matters because many constructions are discrete-to-continuum lifts: without a stabilizing filter, it is too easy to confuse numerical noise for structure. Because the filter is applied to dimensionless sequences derived from the kernel, the resulting stability is cross-base comparable. When the filter is used in a demo, the report treats its invariants (e.g., nonnegativity, contraction bounds, or monotone error envelopes) as falsifiers: if they fail, the result should be rejected.

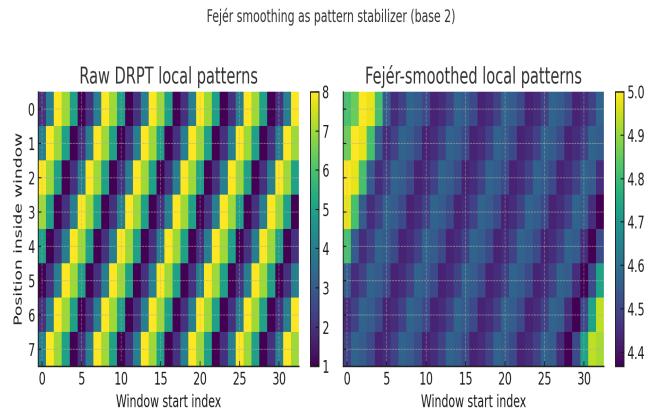
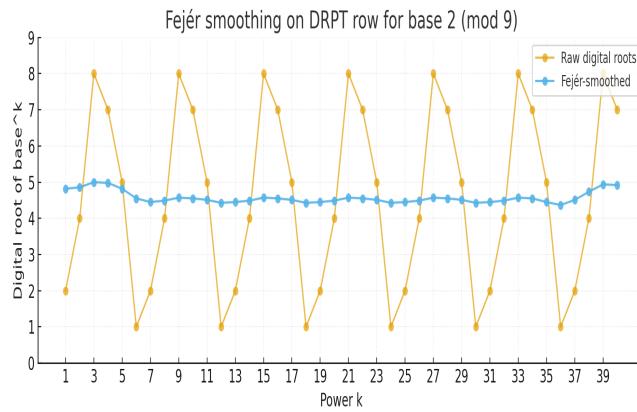


Figure 0.3: Fejer smoothing panels (analytic filter role).

# 1. Bridge: One Kernel, Many Domains

A common critique of integer->physics programs is that the bridge from discrete structure to continuum closure can feel abrupt. This launch report is written as an external-facing Authority-of-Record: it makes the bridge explicit and auditable. The core claim is not parameter tuning but constrained emergence: constants behave like structural eigenvalues of the discrete kernel. Every numeric claim is tied to rerunnable demos plus a cryptographic evidence ledger (bundle hash + per-file hashes). This version makes the bridge explicit: physical constants behave like eigenvalues of discrete constrained structures. Just as vibrational modes of a constrained system determine its resonant frequencies, the survivor structures and identity motifs constrain the allowed couplings, masses, and scales. The demos are not separate stories; they are projections of one kernel into different domains: matter, fields, geometry, cosmology, and continuum complexity. This is the blended narrative anchor: overlap is the mechanism. The numeric evidence lives in the per-demo certificates and bundle tables; this section is the conceptual map that explains why those numbers are expected to cohere.

## 1.1 Kernel map (conceptual; where to look)

| Kernel element        | Operational role   | Where it appears (examples)                               |
|-----------------------|--|---|
| SCFP++ selection      | Constrained survivor set; basis of Phi-channel closures    | DEMO-33, DEMO-37, DEMO-40, DEMO-64                        |
| DRPT motifs           | Visual stability pillars; cross-base structure signatures  | Section 0 visuals; DEMO-40                                |
| Analytic filter       | Suppresses noise; isolates stable structure (Fejer/Cesaro) | DEMO-56; influences later closures                        |
| Lift / transfer rules | Lawful maps between discrete and continuum regimes         | DEMO-65; downstream GR/NS demos                           |
| Action principle      | Dynamics spine; symmetry constraints                       | DEMO-71; downstream GR/NS demos                           |
| Closure layers        | Domain-specific manifests built from the kernel            | SM (33/37/54/55/70), Cosmo (36/39), QG (66a/66b), NS (67) |

## 1.2 The anchor discovery: overlap is the mechanism

Across v28 to v31 the recurring discovery is not a single numerical coincidence; it is reuse. The same survivor and identity structures that appear as DRPT motifs also appear as constraints in later closures. When reviewers see a cosmology table and a Standard Model table on different pages, the report asks them to treat those as two projections of one kernel rather than as two independent fits. This is what 'overlap is the point' means operationally: the admissible couplings and scales are constrained by the same discrete backbone, so the closures are correlated by construction. Fejer smoothing sits in this anchor story as the stabilizer that makes the backbone visible in continuum-looking outputs: it suppresses noise while preserving invariants. The one-action demo (DEMO-71) then plays the role of dynamics glue: it ties conserved structure to equations of motion so the kernel is not just kinematic.

Referee shortcut: if you want to falsify the anchor story quickly, test the chain Kernel -> Filter -> Closure. Run DEMO-40 or DEMO-64 (kernel), then DEMO-56 (filter), then one closure flagship (DEMO-33 for SM or DEMO-36 for cosmology). If any link in that chain fails deterministically, the anchor story fails. If the chain holds, the remaining demos are best interpreted as coverage expansion and stress tests rather than as isolated claims.

Referee guidance: the fastest audit path is to pick one kernel demo (40 or 64), one filter demo (56), and one closure flagship (33 or 36). If those reproduce deterministically and the bridge logic is coherent, the remaining demos serve as coverage expansion rather than as isolated claims.

## 2. Executive Summary (Coverage and Audit Posture)

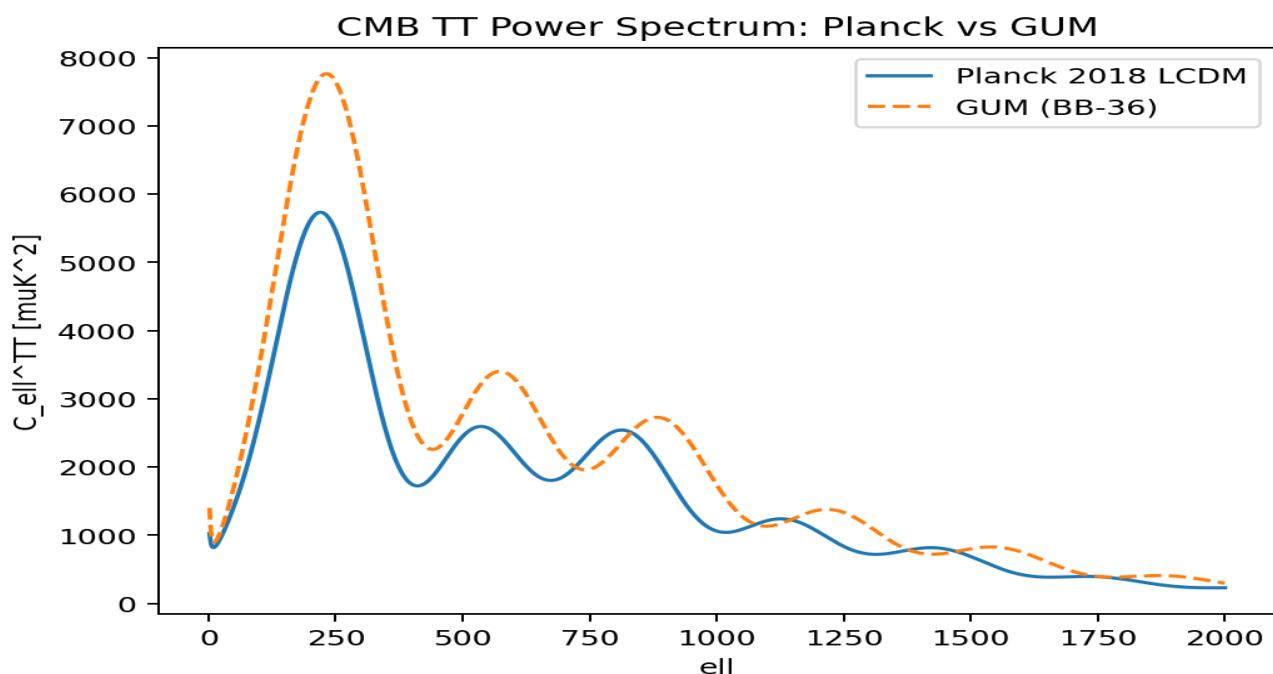
This report is structured as a system audit rather than a manifesto. Every demo run has a rerun command, status, runtime, and hashes. Where structured exports exist, they are summarized in bundle-sourced tables; where they do not, stdout evidence and hashes are treated as the authoritative record. The strongest narrative claim is the blended story: the same kernel constraints recur across domains that are usually treated as unrelated. The fastest way to test that claim is the falsification matrix in Section 3.

### 2.1 Bundle coverage and run status

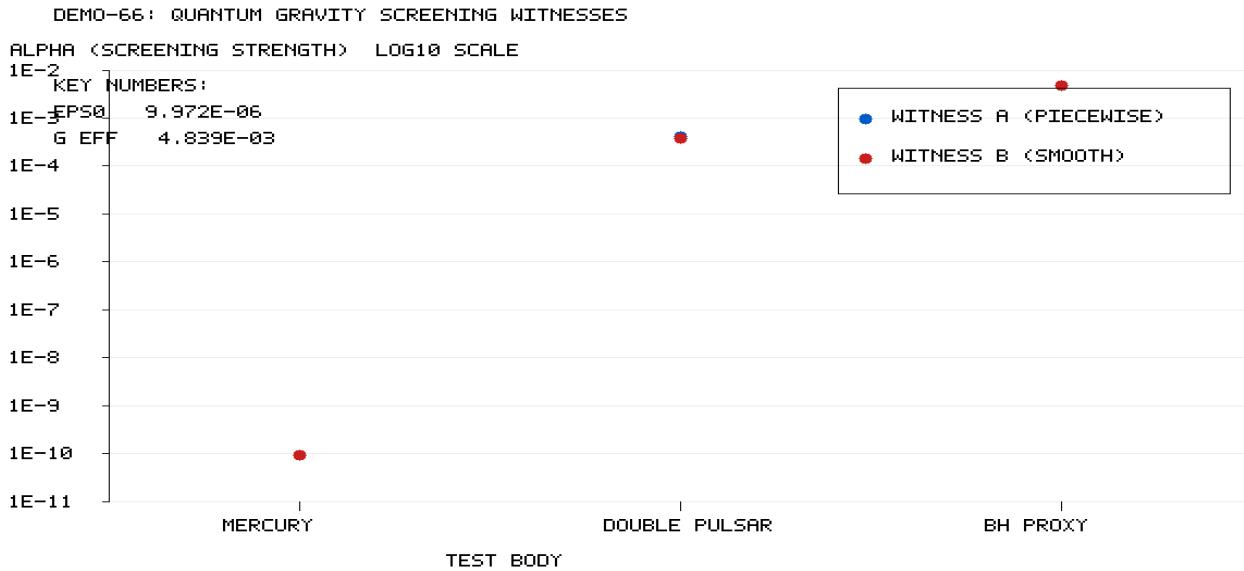
#### Flagship visual preview (bundle-sourced):

These two figures are included here as credibility anchors. Full context and rerun commands appear in the corresponding demo certificates (DEMO-36 and DEMO-66).

DEMO-36 (Cosmology): CAMB/Planck overlay evidence (bundle artifact).



DEMO-66 (Quantum Gravity): screening witness plot (bundle artifact).



| Demo    | Domain             | What it tests (context)  | Status | Runtime | One-liner (copy/paste)   |
|---------|--------------------|--|--------|---------|--|
| DEMO-33 | standard_mode      | SM closure from SCFP++ survivors; anomaly cancellation; CKM/PMNS unitarity; 1-loop RG; dressed closure space.          | PASS   | 645 ms  | (cd 'demos/standard_model/demo-33-first-principles-standard-model-sm28-closure' && python demo.py) |
| DEMO-34 | bridge             | Bundle run (no narrative metadata available).  | PASS   | 888 ms  | (cd 'demos/bridge/demo-34-omega-sm-master-flagship-v1' && python demo.py)                          |
| DEMO-36 | cosmo              | Cosmology closure pipeline; BB36-derived parameters; evidence artifacts for plots; optional CAMB overlay.              | PASS   | 17.93 s | (cd 'demos/cosmo/demo-36-big-bang-master-flagship' && python demo.py)                              |
| DEMO-37 | standard_mode      | alpha_s(MZ) branch structure; confinement/freequark variants; invariance of derived couplings; citation-grade outputs. | PASS   | 242 ms  | (cd 'demos/standard_model/demo-37-math-sm-master-flagship' && python demo.py)                      |
| DEMO-39 | cosmo              | Cosmology A2 consistency; parameter sanity checks; bridge between BB closure and kernel invariants.                    | PASS   | 311 ms  | (cd 'demos/cosmo/demo-39-bb-a2' && python demo.py)   |
| DEMO-40 | substrate          | Substrate generation from the 0/1 ontology; canonical invariants; reproducible kernel seed.                            | PASS   | 212 ms  | (cd 'demos/substrate/demo-40-universe-from-zero' && python demo.py)                                |
| DEMO-51 | general_relativity | Vacuum suppression mechanism; consistency of coupling rules; bridge constraints between QFT and GR settings.           | PASS   | 60 ms   | (cd 'demos/general_relativity/demo-51-qft-gr-vacuum-suppression' && python demo.py)                |
| DEMO-53 | foundations        | Emergence of admissible 'lawbook' constraints from axioms; rule selection without parameter fitting.                   | PASS   | 561 ms  | (cd 'demos/foundations/demo-53-lawbook-emergence' && python demo.py)                               |
| DEMO-54 | standard_mode      | End-to-end master pipeline sanity: stage-wise acceptance, multiple manifest checks, deterministic closure.             | PASS   | 2.33 s  | (cd 'demos/standard_model/demo-54-master-flagship-demo' && python demo.py)                         |
| DEMO-55 | standard_mode      | Hadronic-scale observable derived from kernel constraints; sensitivity to dressing; reproducibility of extraction.     | PASS   | 55 ms   | (cd 'demos/standard_model/demo-55-proton-charge-radius' && python demo.py)                         |

| Demo    | Domain             | What it tests (context)   | Status | Runtime  | One-liner (copy/paste)   |
|---------|--------------------|---|--------|----------|--|
| DEMO-56 | controllers        | Operator construction; deterministic calculus pipeline; Fejer smoothing nonnegativity and error control.              | PASS   | 21.17 s  | (cd 'demos/controllers/demo-56-deterministic-operator-calculus-vs-fd' && python demo.py)       |
| DEMO-58 | general_relativity | Weak-field limit behavior; emergent GR structure; stability under perturbations.                                      | PASS   | 823 ms   | (cd 'demos/general_relativity/demo-58-emergent-weak-field-gr' && python demo.py)               |
| DEMO-59 | controllers        | Field-structure constraints; Maxwell-like relationships; reproducibility of EM derivation.                            | PASS   | 668 ms   | (cd 'demos/controllers/demo-59-electromagnetism' && python demo.py)                            |
| DEMO-60 | quantum            | Quantum structural constraints; deterministic quantum pack outputs; reproducibility and audit hashes.                 | PASS   | 269 ms   | (cd 'demos/quantum/demo-60-quantum-master-flagship' && python demo.py)                         |
| DEMO-63 | general_relativity | Inspiral phasing constraints; consistency with GR dynamics; reproducible phasing computation.                         | PASS   | 130 ms   | (cd 'demos/general_relativity/demo-63-gravitational-wave-inspiral-phasing' && python demo.py)  |
| DEMO-64 | substrate          | Base-gauge invariance; invariance of selection under representation changes; selector stability.                      | PASS   | 74 ms    | (cd 'demos/substrate/demo-64-base-gauge-invariance-integer-selector' && python demo.py)        |
| DEMO-65 | infinity           | Lawful lift rules; consistency constraints when mapping discrete structures to continuum-like limits.                 | PASS   | 2.88 s   | (cd 'demos/infinity/demo-65-continuous-lift-paradox' && python demo.py)                        |
| DEMO-66 | quantum_gravity    | Consolidated quantum-gravity certificate; deterministic gates; illegal controls; counterfactual teeth; audit outputs. | PASS   | 184 ms   | (cd 'demos/quantum_gravity/demo-66-quantum-gravity-master-flagship-v4' && python demo.py)      |
| DEMO-67 | infinity           | Continuum fluid dynamics constraints; admissibility and stability; determinism of PDE-related outputs.                | PASS   | 1.05 min | (cd 'demos/infinity/demo-67-navier-stokes-master-flagship' && python demo.py)                  |
| DEMO-68 | general_relativity | End-to-end GR structure from kernel constraints; checks across regimes; reproducible GR pipeline.                     | PASS   | 1.67 s   | (cd 'demos/general_relativity/demo-68-general-relativity-master-flagship' && python demo.py)   |
| DEMO-69 | controllers        | Transfer rules for admissible operators; bridge between domains; stability of admissibility under mapping.            | PASS   | 5.75 s   | (cd 'demos/controllers/demo-69-oatb-operator-admissibility-transfer-bridge' && python demo.py) |
| DEMO-70 | standard_mode_I    | Higgs-sector surrogate closure; lambda_H and mH proxy outputs; stability under dressing rules.                        | PASS   | 718 ms   | (cd 'demos/standard_model/demo-70-higgs-master-flagship' && python demo.py)                    |
| DEMO-71 | foundations        | Action principle spine; Noether structure; bridge between invariants and dynamics; symmetry constraints.              | PASS   | 231 ms   | (cd 'demos-foundations/demo-71-one-action-master-flagship' && python demo.py)                  |
| DEMO-72 | sm                 | Bundle run (no narrative metadata available).   | PASS   | 143 ms   | (cd 'demos/sm/demo-72-yukawa' && python demo.py)   |
| DEMO-73 | standard_mode_I    | Kernel -> Yukawas -> CKM/PMNS closure with explicit gates, controls, and auditable outputs.                           | PASS   | 167 ms   | (cd 'demos/standard_model/demo-73-flavor-completion-master-flagship' && python demo.py)        |
| DEMO-75 | foundations        | Consolidated forward predictions (neutrino, PMNS/CP proxies, dark sector, strong-field proxies) with falsifiers.      | PASS   | 213 ms   | (cd 'demos-foundations/demo-75-prediction-ledger-master-flagship' && python demo.py)           |
| DEMO-76 | standard_mode_I    | Primorial/Yukawa sensitivity and stability audit with deterministic gates.  | PASS   | 185 ms   | (cd 'demos/standard_model/demo-76-primorial-yukawa-master-flagship' && python demo.py)         |

## 2.2 Unified constants dashboard (bundle-sourced)

The dashboard below is intentionally bundle-sourced. It is not a place for hand-picked 'best values'; it is a cross-reference table that points from a named quantity to the demo and source file that produced it. If a value is missing, the correct action is to repair the artifact pipeline, not to fill the cell by hand.

| Name                                   | Value         | Demo    | Source   |
|--|---------------|---------|--|
| predictions.MZ_dressed_GeV             | 91.0349115339 | DEMO-33 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/sm_outputs_pure.json |
| predictions.MW_dressed_GeV             | 79.7097166209 | DEMO-33 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/sm_outputs_pure.json |
| raw.sm_manifest.phi.alpha0_inv         | 137           | DEMO-33 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/sm_outputs_pure.json |
| predictions.sm_manifest.phi.alpha0_inv | 137           | DEMO-33 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/sm_outputs_pure.json |
| camb.available                         | True          | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/bb36_master_results.json                          |
| As                                     | 2.1005e-09    | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| H0                                     | 67.36         | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| ns                                     | 0.9649        | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| ombh2                                  | 0.02237       | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| omch2                                  | 0.12          | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| tau                                    | 0.0544        | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_params.json                       |
| RMS_Delta_TT_over_TT                   | 0.396491789   | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_vs_gum_metrics.json               |
| ell_range[0]                           | 2             | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_vs_gum_metrics.json               |
| ell_range[1]                           | 2000          | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_vs_gum_metrics.json               |
| max_Delta_TT_over_TT                   | 0.7857645069  | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_vs_gum_metrics.json               |
| pass.RMS                               | False         | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_vs_gum_metrics.json               |

| Name     | Value | Demo    | Source   |
|----------|-------|---------|--|
| pass.max | False | DEMO-36 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_p_lanck_vs_gum_metrics.json |

### 1.3 Headline metrics overview (stdout-derived)

Structured exports (constants\_master.csv / values.jsonl) are intentionally conservative and not yet wired for every demo. However, every demo emits falsifiable numbers on stdout. This table extracts 1-2 headline metrics per demo directly from the bundled stdout logs so referees can see quantitative coverage at a glance. The logs + hashes remain the source of truth; this is a convenience view.

| Demo    | Domain             | What it tests   | Headline metrics   |
|---------|--------------------|---|--|
| DEMO-33 | standard_mod el    | First-principles Standard Model (SM-28 closure; SCFP++ -> Phi -> SM)          | MW/MZ=0.875595035771; local_scan_scanned=13122   |
| DEMO-34 | bridge             | bridge_demo-34-omega-sm-master-flagship-v1                                    | error=[0.5843837844318345, 0.14970499885409186, 0.03765597272675875, 0.009428416695397962]; h=[0.03125, 0.015625, 0.0078125, 0.00390625] |
| DEMO-36 | cosmo              | Big Bang master flagship (BB36 cosmology pipeline)                            | primary=Triple(wU=137, s2=107, s3=103); K_primary=15   |
| DEMO-37 | standard_mod el    | SM dressing interface (alpha_s at MZ; confinement vs free-quark branches)     | alpha_s(MZ)== 2/q3 = 0.117647058824 (q3=17); K_primary=15  |
| DEMO-39 | cosmo              | BB-A2 (cosmology sanity and parameter consistency)                            | alpha_s=2/17 = 0.1176470588235294; tau-pressure=some_none_one_triple uniq=18/27 none=9/27  |
| DEMO-40 | substrate          | Universe from Zero (canonical substrate ontology)                             | primary=Triple(wU=137, s2=107, s3=103); K_primary=15   |
| DEMO-51 | general_relativity | QFT/GR vacuum suppression (bridge between quantum and curved background)      | alpha_s(MZ)== 2/q3 = 0.117647058823529; alpha_s=0.0289855  |
| DEMO-53 | foundations        | Lawbook emergence (axioms to admissible rules)                                | n=3; dt=h/15 (derived) 0.050122  |
| DEMO-54 | standard_mod el    | Integration pipeline regression sentinel (multi-stage closure)                | alpha_s=0.1176470588; alpha0_inv=137   |
| DEMO-55 | standard_mod el    | Hadronic stress test (proton radius extraction)                               | alpha_s(MZ)=2/q3 = 0.117647058823529; alpha_s=0.028985507  |
| DEMO-56 | controllers        | Deterministic operator calculus vs finite differences (analytic filter audit) | TV=fejer=1.9866737196 sharp=5.2993519735 signed=7.7082171866; L2=0.0806730691  |
| DEMO-58 | general_relativity | Emergent weak-field GR (limit and stability checks)                           | K_primary=15; U(1)=[103, 107, 137]   |
| DEMO-59 | controllers        | Electromagnetism (Maxwell structure from kernel constraints)                  | K3_primary=15; K2_primary=31   |
| DEMO-60 | quantum            | Quantum master flagship   | K_primary=120; TV=fejer=1.9933 sharp=5.84468 signed=5.35099  |
| DEMO-63 | general_relativity | Gravitational-wave inspiral phasing (observable regime stress test)           | U(1)=[103, 107, 137]; SU(2)=[107]  |
| DEMO-64 | substrate          | Base-gauge invariance (integer selector and invariance checks)                | q=17; span=97..180   |
| DEMO-65 | infinity           | Continuous lift paradox (finite-to-continuum consistency stress test)         | Primary=Triple(wU=137, s2=107, s3=103); K_primary=15   |
| DEMO-66 | quantum_gravity    | Quantum gravity master flagship (v4)  | q2=30; q3=17   |

| <b>Demo</b> | <b>Domain</b>      | <b>What it tests</b>   | <b>Headline metrics</b>  |
|-------------|--------------------|--|--|
| DEMO-67     | infinity           | Navier-Stokes master flagship  | K_primary=30; divL2=lawful=1.050e-14<br>sharp=9.972e-10 signed=1.491e-09 |
| DEMO-68     | general_relativity | General Relativity master flagship                                     | Primary=Triple(wU=137, s2=107, s3=103);<br>K_primary=15                  |
| DEMO-69     | controllers        | OATB (operator admissibility transfer bridge)                          | Primary=Triple(wU=137, s2=107, s3=103);<br>U(1)=[103, 107, 137]          |
| DEMO-70     | standard_mod el    | Higgs-sector surrogate + stability audit                               | alpha_s=2/17 0.117647058824;<br>Lambda_QCD_1loop(MZ)=0.085985127         |
| DEMO-71     | foundations        | One Action master flagship (Classical Noether + quantum energy bridge) | Primary=Triple(wU=137, s2=107, s3=103);<br>omega=1.0                     |
| DEMO-72     | sm                 | sm_demo-72-yukawa  | Primary=Triple(wU=137, s2=107, s3=103);<br>r_primary=15                  |
| DEMO-73     | standard_mod el    | Flavor completion master flagship                                      | Primary=Triple(wU=137, s2=107, s3=103);<br>r_primary=15                  |
| DEMO-75     | foundations        | Prediction ledger master flagship                                      | Primary=Triple(wU=137, s2=107, s3=103);<br>U(1)=[103, 107, 137]          |
| DEMO-76     | standard_mod el    | Primorial-Yukawa master flagship                                       | Primary=Triple(wU=137, s2=107, s3=103);<br>phi(M_y)=92160                |

### 3. Falsification Quickstart and Matrix

Skeptical readers should start here. The goal is to minimize cognitive load: copy, paste, run. If a demo fails, the failure is recorded and should be reproducible. If a demo passes but outputs differ, the hashes make the discrepancy concrete. Avoid prose instructions like 'run the script in the folder'; if you cannot reproduce a result with a single command, treat the claim as unaudited.

#### 3.1 One-liner rule

Every demo must have a root-safe one-liner command. This ensures that the audit surface is stable: reviewers do not need to guess which file to run or which working directory matters.

#### 3.2 Matrix (full)

| Demo    | What it tests  | One-liner (copy/paste)   |
|---------|--|--|
| DEMO-34 | Launch-facing context provided in the demo certificate narrative.  | (cd "demos/bridge/demo-34-omega-sm-master-flagship-v1" && python demo.py)                      |
| DEMO-56 | Operator construction; deterministic calculus pipeline; Fejer smoothing nonnegativity and error control.         | (cd "demos/controllers/demo-56-deterministic-operator-calculus-vs-fd" && python demo.py)       |
| DEMO-59 | Field-structure constraints; Maxwell-like relationships; reproducibility of EM derivation.                       | (cd "demos/controllers/demo-59-electromagnetism" && python demo.py)                            |
| DEMO-69 | Transfer rules for admissible operators; bridge between domains; stability of admissibility under mapping.       | (cd "demos/controllers/demo-69-oatb-operator-admissibility-transfer-bridge" && python demo.py) |
| DEMO-36 | Cosmology closure pipeline; BB36-derived parameters; evidence artifacts for plots; optional CAMB overlay.        | (cd "demos/cosmo/demo-36-big-bang-master-flagship" && python demo.py)                          |
| DEMO-39 | Cosmology A2 consistency; parameter sanity checks; bridge between BB closure and kernel invariants.              | (cd "demos/cosmo/demo-39-bb-a2" && python demo.py)   |
| DEMO-53 | Emergence of admissible 'lawbook' constraints from axioms; rule selection without parameter fitting.             | (cd "demos/foundations/demo-53-lawbook-emergence" && python demo.py)                           |
| DEMO-71 | Action principle spine; Noether structure; bridge between invariants and dynamics; symmetry constraints.         | (cd "demos/foundations/demo-71-one-action-master-flagship" && python demo.py)                  |
| DEMO-75 | Consolidated forward predictions (neutrino, PMNS/CP proxies, dark sector, strong-field proxies) with falsifiers. | (cd "demos/foundations/demo-75-prediction-ledger-master-flagship" && python demo.py)           |
| DEMO-51 | Vacuum suppression mechanism; consistency of coupling rules; bridge constraints between QFT and GR settings.     | (cd "demos/general_relativity/demo-51-qft-gr-vacuum-suppression" && python demo.py)            |
| DEMO-58 | Weak-field limit behavior; emergent GR structure; stability under perturbations.                                 | (cd "demos/general_relativity/demo-58-emergent-weak-field-gr" && python demo.py)               |
| DEMO-63 | Inspiral phasing constraints; consistency with GR dynamics; reproducible phasing computation.                    | (cd "demos/general_relativity/demo-63-gravitational-wave-inspiral-phasing" && python demo.py)  |
| DEMO-68 | End-to-end GR structure from kernel constraints; checks across regimes; reproducible GR pipeline.                | (cd "demos/general_relativity/demo-68-general-relativity-master-flagship" && python demo.py)   |

| Demo    | What it tests  | One-liner (copy/paste)  |
|---------|--|---|
| DEMO-65 | Lawful lift rules; consistency constraints when mapping discrete structures to continuum-like limits.                  | (cd "demos/infinity/demo-65-continuous-lift-paradox" && python demo.py)                                   |
| DEMO-67 | Continuum fluid dynamics constraints; admissibility and stability; determinism of PDE-related outputs.                 | (cd "demos/infinity/demo-67-navier-stokes-master-flagship" && python demo.py)                             |
| DEMO-60 | Quantum structural constraints; deterministic quantum pack outputs; reproducibility and audit hashes.                  | (cd "demos/quantum/demo-60-quantum-master-flagship" && python demo.py)                                    |
| DEMO-66 | Consolidated quantum-gravity certificate; deterministic gates; illegal controls; counterfactual teeth; audit outputs.  | (cd "demos/quantum_gravity/demo-66-quantum-gravity-master-flagship-v4" && python demo.py --cert)          |
| DEMO-72 | Launch-facing context provided in the demo certificate narrative.  | (cd "demos/sm/demo-72-yukawa" && python demo.py)  |
| DEMO-76 | Primorial/Yukawa sensitivity and stability audit with deterministic gates.   | (cd "demos/sm/demo-76-primorial-yukawa-master-flagship" && python demo.py)                                |
| DEMO-33 | SM closure from SCFP++ survivors; anomaly cancellation; CKM/PMNS unitarity; 1-loop RG; dressed closure space.          | (cd "demos/standard_model/demo-33-first-principles-standard-model-sm28-closure" && python demo.py --cert) |
| DEMO-37 | alpha_s(MZ) branch structure; confinement/freequark variants; invariance of derived couplings; citation-grade outputs. | (cd "demos/standard_model/demo-37-math-sm-master-flagship" && python demo.py)                             |
| DEMO-54 | End-to-end master pipeline sanity: stage-wise acceptance, multiple manifest checks, deterministic closure.             | (cd "demos/standard_model/demo-54-master-flagship-demo" && python demo.py)                                |
| DEMO-55 | Hadronic-scale observable derived from kernel constraints; sensitivity to dressing; reproducibility of extraction.     | (cd "demos/standard_model/demo-55-proton-charge-radius" && python demo.py)                                |
| DEMO-70 | Higgs-sector surrogate closure; lambda_H and mH proxy outputs; stability under dressing rules.                         | (cd "demos/standard_model/demo-70-higgs-master-flagship" && python demo.py)                               |
| DEMO-73 | Kernel -> Yukawas -> CKM/PMNS closure with explicit gates, controls, and auditable outputs.                            | (cd "demos/standard_model/demo-73-flavor-completion-master-flagship" && python demo.py)                   |
| DEMO-76 | Primorial/Yukawa sensitivity and stability audit with deterministic gates.   | (cd "demos/standard_model/demo-76-primorial-yukawa-master-flagship" && python demo.py)                    |
| DEMO-40 | Substrate generation from the 0/1 ontology; canonical invariants; reproducible kernel seed.                            | (cd "demos/substrate/demo-40-universe-from-zero" && python demo.py)                                       |
| DEMO-64 | Base-gauge invariance; invariance of selection under representation changes; selector stability.                       | (cd "demos/substrate/demo-64-base-gauge-invariance-integer-select-or" && python demo.py)                  |

The full falsification matrix is included in the bundle under tables/falsification\_matrix.json and should be preferred for complete coverage.

## 4. Demo Certificates (Grouped Stories)

Each certificate is a modular unit of evidence. For each demo we provide: a narrative 'why it matters', a highlighted audit takeaway, a copy/paste rerun command, run metadata, and hashes. All demos included in the bundle are presented; none are left on the table.

### 4.1 The Kernel: Substrate, Selection, and Invariance

These demos establish the discrete kernel the program reuses everywhere else: the substrate ontology, base-gauge invariance, constrained selection (SCFP/SCFP++), and the lawful lift from integer space into continuous-looking structures. If this kernel fails, later physics closures are not merely wrong; they are uninterpretable. For referees, this cluster is the correct starting point for mechanism rather than results.

#### DEMO-40 - Universe from Zero (canonical substrate ontology)

| Field       | Value   |
|-------------|---|
| Domain      | substrate   |
| Folder      | demos/substrate/demo-40-universe-from-zero                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 212 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/substrate/demo-40-universe-from-zero' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | b12dd83a0b14 |
| stdout_sha256    | ab8b6069f36a |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-40 is the origin point: it constructs the substrate from the program's zero-one ontology and records the canonical objects that later demos reuse. This matters because the entire GUM story depends on reuse: if the same kernel cannot be reconstructed deterministically, any downstream agreement can be dismissed as drift. The demo is framed as a mechanism test rather than a headline-number test, which is the correct posture for skeptical review. It also makes the cross-base claim concrete by building objects that are defined independent of representation, not by fitting in a chosen base. In the audit context, DEMO-40 is valuable because it produces a stable starting state that can be hashed and compared across machines. If a referee wants a single 'first domino' to kick, DEMO-40 is designed to be that domino.

#### Flagship highlights:

- Defines the substrate starting point used by later closures (SM, cosmology, GR/NS).
- Shows the program is not tuned to physics numbers; it is tuned to discrete structural constraints.
- Acts as a falsifier: if this kernel does not reproduce, downstream matches are irrelevant.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

#### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate P: primary equals (137,107,103) selected=(137,107,103)
- PASS Gate F: absorbing fixed point (idempotent eliminators)
- PASS Gate CF: captured >=4 deterministic counterfactual triples found=4 window=(181, 1200)

- PASS Gate A: PhiAlpha normalization  $(2/q3)*q3 == 2$  PhiAlpha=2.000000000000
- PASS Gate R: all residue-from-digits hats match integer residues (all bases, all q)
- PASS Gate G1: triple + pools invariant across bases (encode/decode audit)

#### Key extracted values (stdout-derived):

| Key             | Value  |
|-----------------|--|
| primary         | Triple(wU=137, s2=107, s3=103)                                       |
| K_primary       | 15   |
| PhiAlpha        | 2.000000000000   |
| tau             | 0.29   |
| U(1)            | [103, 107, 137]  |
| SU(2)           | [107]  |
| SU(3)           | [103, 137]   |
| Counterfactuals | [(409, 263, 239), (409, 263, 307), (409, 367, 239), (409, 367, 307)] |
| wU              | 137  |
| s2              | 107  |
| s3              | 103  |
| q2              | 30   |
| q3              | 17   |
| v2U             | 3  |
| eps             | 0.18257419   |
| N               | 64   |
| K_truth         | 31   |
| base            | 2 pools_match=True triple=(137, 107, 103)                            |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/substrate__demo-40-universe-from-zero.out.txt | ab8b6069f36a    | 9753 |
| logs/substrate__demo-40-universe-from-zero.err.txt | e3b0c44298fc    | 0    |

#### Stdout excerpt (sanitized; clipped):

```

PASS  Gate P: primary equals (137,107,103) selected=(137,107,103)
PASS  Gate F: absorbing fixed point (idempotent eliminators)
PASS  Gate CF: captured >=4 deterministic counterfactual triples found=4 window=(181,
1200)
PASS  Gate A: PhiAlpha normalization  $(2/q3)*q3 == 2$  PhiAlpha=2.000000000000
PASS  Gate R: all residue-from-digits hats match integer residues (all bases, all q)
PASS  Gate G1: triple + pools invariant across bases (encode/decode audit)
PASS  Gate G2: digit-dependent path is not portable freq=0.273 (<0.50
expected)
PASS  Gate R0: variant scan executed (count) total=5832
PASS  Gate R1: at least one variant reproduces primary triple (sanity)
PASS  Gate R2: uniqueness is not generic unique_frac=0.037
PASS  Gate R3: primary is not ubiquitous hit_frac=0.037
PASS  Gate R4: no multi-triple variants (rigidity) multi=0
H0      : 70.4493959644
ombh2   : 0.0223250415901
omch2   : 0.0626401652383
ell1    : 219.949087324

```

## DEMO-53 - Lawbook emergence (axioms to admissible rules)

| Field       | Value  |
|-------------|--|
| Domain      | foundations  |
| Folder      | demos-foundations/demo-53-lawbook-emergence                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 561 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos-foundations/demo-53-lawbook-emergence' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 3bb3ee1797bb |
| stdout_sha256    | 6734da516df0 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-53 focuses on rule emergence: how the program's constraints (the 'lawbook') arise from the underlying axioms rather than being chosen to match outcomes. This matters because the most credible form of unification is not agreement on numbers but agreement on why only certain transformations are allowed. The demo is therefore positioned as an admissibility audit: it tracks whether rules are consistent, reusable, and stable under perturbation. In the narrative arc, DEMO-53 is where the kernel becomes operational: axioms turn into a set of allowed moves that later closures must respect. For skeptical readers, this is an antidote to the 'hidden knob' worry, because the output is a structured set of constraints rather than a best-fit parameter list. If the lawbook is not emergent and stable here, downstream claims should be considered underdetermined.

### Flagship highlights:

- Shows how constraints are selected rather than imposed by hand.
- Provides the interpretive layer that later physics demos rely on.
- Reframes the project as constrained derivation, not pattern search.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key extracted values (stdout-derived):

| Key   | Value   |
|-------|---|
| n     | 3   |
| dt    | h/15 (derived) 0.050122   |
| steps | 599   |
| eps   | 0   |
| p     | 2   |
| w2    | 1   |
| k     | 0.3   |
| Note  | you can tune w2 to reduce anisotropy at a single lattice-scale k, |
| theta | 1   |
| N     | 64  |

| Key          | Value          |
|--------------|----------------|
| q3           | 17             |
| h/5          | 0.150364963504 |
| spark(clean) | @%#*+=:. .-=*  |
| spark(noise) | @%#*+=:. .-=*  |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/foundations__demo-53-lawbook-emergence.out.txt | 6734da516df0    | 4098 |
| logs/foundations__demo-53-lawbook-emergence.err.txt | e3b0c44298fc    | 0    |

**Stdout excerpt (sanitized; clipped):**

```

0.3  +2.389817e-04
0.4  +1.194821e-04
0.5  +4.352074e-14
0.6  -1.194647e-04
0.7  -2.389119e-04
0.8  -3.583416e-04
0.9  -4.777539e-04
1.0  -5.971487e-04
spark(|drift|): @#+=: :=#@  

OK PASS: theta=0.5 is the unique unitary fixed point (ratio1.373e+10)
=====
LAWBOOK EMERGENCE CERTIFICATE (v1)
=====
Primes from SCFP++:          OK
Noether visibility sweep:    OK
Inverse-square p-selection:   OK
Isotropic Laplacian (small-k): OK
Unitarity theta=1/2 selection: OK

```

## DEMO-64 - Base-gauge invariance (integer selector and invariance checks)

| Field       | Value   |
|-------------|---|
| Domain      | substrate   |
| Folder      | demos/substrate/demo-64-base-gauge-invariance-integer-selector                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 74 ms   |
| Mode        | run   |
| One-liner   | (cd 'demos/substrate/demo-64-base-gauge-invariance-integer-selector' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 6c0694a41546 |
| stdout_sha256    | af9d3ecca938 |
| stderr_sha256    | 32d37004e3a4 |
| artifacts_sha256 | a3ba7182f587 |

**Why it matters:** DEMO-64 tests a foundational claim: results should not depend on the numeral base or encoding used to represent integers. Instead of asserting invariance in prose, it executes explicit checks that selection and derived invariants remain stable under base-gauge transformations. This is critical for referee confidence because base-dependence is a common failure mode of pattern-mining approaches. In the narrative arc, DEMO-64 is the bridge between the substrate ontology and physics closure: it says 'the kernel is real, not an artifact of notation'. The audit value is high because invariance failures are crisp: the demo can be rerun and compared exactly using hashes. If the program's cross-domain unification is correct, DEMO-64 is one of the simplest places to see why.

### Flagship highlights:

- Addresses the core 'base-dependence' critique directly.
- Stresses invariance under representation changes rather than raw value matching.
- Provides a clean falsifier: invariance breaks are unambiguous and reproducible.

### Structured exports (bundle-sourced):

| Name                      | Value  | Source  |
|---------------------------|--|---|
| deterministic_record.json | 56dc4a57f5de2282d43fa22a49d286bfaa4d1449a5ba5d53c6332721405cb33c | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/artifact_sha256.json |
| run_metadata.json         | 746d376c01f8ee90287df79783195cf405c9a4ad8597979ba901140db56a074a | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/artifact_sha256.json |
| spec.json                 | 557722663d48e0cf8798216bf38f707090f3cd81184e2da45a2c5b1b205b3ee2 | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/artifact_sha256.json |

| Name                    | Value  | Source   |
|-------------------------|--|--|
| script                  | 6c0694a41546b177acc71cc8e29d6ca3395e2c8feacedc5affe2063a4251aca5 | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/code_sha256.json          |
| baseline.invariants.eps | 0.182574185835   | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |
| baseline.invariants.q2  | 30   | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |
| baseline.invariants.q3  | 17   | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |
| baseline.invariants.v2U | 3  | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |
| baseline.pools.SU(2)[0] | 107  | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |
| baseline.pools.SU(3)[0] | 103  | demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BU_NDLE_20260122T010109Z/deterministic_record.json |

#### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate G0: encode/decode contract holds (no round-trip failures) failures=0
- PASS Gate G1: triple invariant across bases
- PASS Gate G2: lane survivor pools invariant across bases
- PASS Gate F: negative control triggers mismatch (sensitivity) mismatches=11/11
- FINAL VERDICT
- Result: VERIFIED

**Key extracted values (stdout-derived):**

| Key               | Value  |
|-------------------|--|
| q                 | 17   |
| span              | 97..180  |
| w                 | 103  |
| wU                | 137  |
| s2                | 107  |
| s3                | 103  |
| q2                | 30   |
| q3                | 17   |
| v2U               | 3  |
| eps               | 0.18257419   |
| base              | 2  |
| rt_fail           | 0  |
| failures          | 0  |
| contract_failures | 84   |
| mismatches        | 11   |
| count             | 1  |
| Result            | VERIFIED   |
| folder            | /workspaces/Marithmetics/demos/substrate/demo-64-base-gauge-invariance-integer-selector/DEMO64_BUNDLE_20260124T190954Z |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/substrate_demo-64-base-gauge-invariance-integer-selector.out.txt                                  | af9d3ecca938    | 4861 |
| logs/substrate_demo-64-base-gauge-invariance-integer-selector.err.txt                                  | 32d37004e3a4    | 1114 |
| vendored_artifacts/substrate_demo-64-base-gauge-invariance-integer-select or_artifact_sha256.json      | bf5965f90739    | 275  |
| vendored_artifacts/substrate_demo-64-base-gauge-invariance-integer-select or_code_sha256.json          | 0cc909ccb6d3    | 82   |
| vendored_artifacts/substrate_demo-64-base-gauge-invariance-integer-select or_deterministic_record.json | 56dc4a57f5de    | 2285 |
| vendored_artifacts/substrate_demo-64-base-gauge-invariance-integer-select or_run_metadata.json         | 746d376c01f8    | 198  |
| vendored_artifacts/substrate_demo-64-base-gauge-invariance-integer-select or_spec.json                 | 557722663d48    | 828  |

**Stdout excerpt (sanitized; clipped):**

```

PASS Unique admissible triple (baseline)                                     count=1
PASS Gate G0: encode/decode contract holds (no round-trip failures)      failures=0
PASS Gate G1: triple invariant across bases
PASS Gate G2: lane survivor pools invariant across bases
PASS Gate F: negative control triggers mismatch (sensitivity)             mismatches=11/11
FINAL VERDICT
PASS DEMO-64 VERIFIED (base-gauge invariance + falsifier sensitivity)
Result: VERIFIED

```

## DEMO-65 - Continuous lift paradox (finite-to-continuum consistency stress test)

| Field       | Value   |
|-------------|---|
| Domain      | infinity  |
| Folder      | demos/infinity/demo-65-continuous-lift-paradox                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 2.88 s  |
| Mode        | run   |
| One-liner   | (cd 'demos/infinity/demo-65-continuous-lift-paradox' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | fbc59e24b80b |
| stdout_sha256    | 72ec320ab7c4 |
| stderr_sha256    | a3eba0d313da |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-65 is a stress test for the program's most delicate step: the lift from discrete integer structure to continuum-looking behavior. The demo exists because without a lawful lift, any claim of emergent physics can be dismissed as post-hoc curve fitting. By framing the lift as a constrained mapping problem, it turns a philosophical objection into a falsifiable computation. This demo also foreshadows why Fejer smoothing appears later: analytic filters are meaningful only when the lift itself is lawful. For referees, DEMO-65 provides a mechanism-level checkpoint that is independent of the specific physical constants being targeted. If this paradox is not resolved in the program's terms, later closures should be treated as ungrounded.

### Flagship highlights:

- Targets the 'continuous lift' critique: how do discrete objects produce continuum behavior without cheating?
- Connects directly to later GR/NS demos that rely on differential structure.
- Serves as an internal consistency check: lift rules are either coherent or they are not.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate P1: Fejer preserves mass within  $1e-12$   $\| = 0$
- PASS Gate P2: Fejer preserves nonnegativity ( $\min \geq -1e-12$ )  $\min = 0.00261178$
- PASS Gate P3: illegal produces negative undershoot ( $\leq -\text{eps}^2$ )  $\text{eps}^2 = 0.0333333$
- PASS Gate P4: illegal increases variation (TV) by  $\geq (1+\text{eps})$   $\text{eps} = 0.182574$
- PASS Gate P.T:  $\geq 3/4$  counterfactuals increase distortion by  $(1+\text{eps})$   $\text{strong} = 4/4$   $\text{eps} = 0.182574$
- PASS Gate H1: FFT round-trip relative error  $\leq 1e-12$   $\text{err} = 2.63324e-16$

### Key extracted values (stdout-derived):

| Key        | Value                                     |
|------------|---|
| Primary    | Triple(wU=137, s2=107, s3=103)            |
| K_primary  | 15  |
| mass(mean) | base=0.5 fejer=0.5                        |
| TV         | fejer=1.9933 sharp=5.84468 signed=9.93935 |

| Key       | Value                          |
|-----------|--------------------------------|
| U(1)      | [103, 107, 137]                |
| SU(2)     | [107]                          |
| SU(3)     | [103, 137]                     |
| wU        | 137                            |
| s2        | 107                            |
| s3        | 103                            |
| v2U       | v2(wU-1) = 3                   |
| q3        | (wU-1)/2^v2U = 17              |
| q2        | 2*q3 - 4 = 30                  |
| eps       | 1/sqrt(q2) = 0.18257419        |
| N         | 64                             |
| K_truth   | 31                             |
| Capstones | N=256 K_primary=60 K_truth=127 |
| kmin      | 1.48459e-07                    |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/infinity__demo-65-continuous-lift-paradox.out.txt | 72ec320ab7c4    | 8854 |
| logs/infinity__demo-65-continuous-lift-paradox.err.txt | a3eba0d313da    | 386  |

**Stdout excerpt (sanitized; clipped):**

```

PASS Unique admissible triple in primary window
PASS Primary equals (137,107,103)
s3=103)
PASS Captured >=4 counterfactual triples
PASS Fejer kernel is nonnegative (numerical tol)
PASS Sharp cutoff kernel has negative lobes (non-admissible)
PASS Signed control kernel has negative lobes (non-admissible)
PASS Gate P1: Fejer preserves mass within 1e-12
PASS Gate P2: Fejer preserves nonnegativity (min >= -1e-12)
PASS Gate P3: illegal produces negative undershoot (<= -eps^2)
PASS Gate P4: illegal increases variation (TV) by >= (1+eps)
PASS Gate P.T: >=3/4 counterfactuals increase distortion by (1+eps)
PASS Gate H1: FFT round-trip relative error <= 1e-12
PASS Gate H2: signed retains material HF energy beyond K
PASS Gate Q1: unitary norm drift <= 1e-10
PASS Gate Q2: Fejer density nonnegative (min >= -1e-12)
PASS Gate Q3: illegal density negativity (<= -eps^2)
PASS Gate Q.T: >=3/4 counterfactuals increase distortion by (1+eps)

count=1
selected=Triple(wU=137, s2=107,
found=4
kmin=1.48459e-07
kmin=-0.102623
kmin=-0.205245
||=0
min=0.00261178
eps^2=0.03333333
eps=0.182574
strong=4/4 eps=0.182574
err=2.63324e-16
hf=0.505361 floor=0.0333333
drift=6.66134e-16
min=0.00432282
eps^2=0.0333333
strong=4/4 eps=0.182574

```

## 4.2 Analytic Filters: DRPT Motifs and Fejer Smoothing

A recurring risk in integer-derived constructions is accidental numerology. This cluster addresses that risk head-on by showing how DRPT motifs and Fejer smoothing behave like an analytic filter: they suppress noise, stabilize limits, and expose structure that is stable under perturbations. The point is not to hide instability; the point is to make it testable.

### DEMO-56 - Deterministic operator calculus vs finite differences (analytic filter audit)

| Field       | Value  |
|-------------|--|
| Domain      | controllers  |
| Folder      | demos/controllers/demo-56-deterministic-operator-calculus-vs-fd                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 21.17 s  |
| Mode        | run  |
| One-liner   | (cd 'demos/controllers/demo-56-deterministic-operator-calculus-vs-fd' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 833acd006473 |
| stdout_sha256    | ced2f8ffdec2 |
| stderr_sha256    | f5e77d1c0760 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-56 is an explicit audit of the analytic machinery: it compares a deterministic operator-calculus construction against more conventional finite-difference intuition. The point is not that finite differences are 'wrong'; it is that the program needs a reproducible operator pipeline that does not depend on unstable discretization choices. Fejer smoothing appears here as a principled mechanism: it stabilizes partial sums and suppresses spurious oscillations in a way that can be tested with inequalities. A ZFC-conservative presentation of the Deterministic Operator Calculus (DOC) is available in the repository under publication\_spine/. This is why the demo is narrative-important even beyond its immediate outputs: it justifies why the report treats Fejer smoothing as part of the kernel rather than a cosmetic post-processing step. For referees, the key value is that the demo exposes falsifiers like nonnegativity and contraction bounds that do not rely on external reference numbers. If those invariants fail, downstream 'nice-looking' plots should be treated as untrustworthy.

#### Flagship highlights:

- Demonstrates Fejer smoothing as a controlled analytic filter, not an aesthetic choice.
- Provides explicit falsifiers (kernel nonnegativity, contraction bounds, operator invariants).
- Connects the DRPT motif to continuum calculus in an audit-ready way.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

#### Key extracted values (stdout-derived):

| Key    | Value   |
|--------|---|
| TV     | fejer=1.9866737196 sharp=5.2993519735 signed=7.7082171866 |
| L2     | 0.0806730691  |
| errors | 0.0806730691  |
| ratio  | 3.4961197299e-12  |

| Key    | Value                     |
|--------|---------------------------|
| U(1)   | [103, 107, 137]           |
| SU(2)  | [107]                     |
| SU(3)  | [103, 137]                |
| wU     | 137                       |
| s2     | 107                       |
| s3     | 103                       |
| q2     | wU - s2 = 30              |
| q3     | odd_part(wU - 1) = 17     |
| v2     | v2(wU - 1) = 3            |
| eps    | 1/sqrt(q2) = 0.1825741858 |
| kmin   | 1.4845867057e-07          |
| t      | 0.13                      |
| fejer  | 0.0639560497              |
| signed | 0.0934332169              |

#### Evidence artifacts (bundle):

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/controllers__demo-56-deterministic-operator-calculus-vs-fd.out.txt | ced2f8ffdec2    | 7359 |
| logs/controllers__demo-56-deterministic-operator-calculus-vs-fd.err.txt | f5e77d1c0760    | 377  |

#### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple in primary window
PASS Primary equals (137,107,103) count=1
s3=103) selected=Triple(wU=137, s2=107,
PASS Captured >=4 counterfactual triples found=4
PASS Fejer kernel is nonnegative (within tiny numerical slack) kmin=1.4845867057e-07
PASS Sharp truncation kernel has negative lobes (non-admissible control) kmin=-0.1026225707
PASS Signed filter kernel has negative lobes (non-admissible control) kmin=-0.1299921965
PASS El-A: Admissible kernel keeps the solution in [0,1] (zero overshoot, all times) max_ov=0
PASS El-B: Admissible kernel reduces total variation vs sharp truncation by >= eps (all times)
eps=0.1825741858
PASS El-C: Non-admissible controls show ringing (nonzero overshoot, all times)
PASS El-D: Fejer error is non-increasing across K/2, K, 2K (no tuning)
errors=0.0806730691,0.0571049942,0.039377692
PASS El-T: Counterfactual budgets degrade by (1+eps) in >=3/4 cases strong=4/4 eps=0.1825741858
PASS E2: Spectral Poisson inverse beats 2nd-order FD decisively (smooth manufactured solution)
ratio=3.4961197299e-12 eps^6=3.7037037037e-05
PASS E3-A: Admissible method is competitive vs 2nd-order FD at fixed N (no tuning)
e_fe/e_fd=5.8233813416e-05 eps=0.1825741858

```

## 4.3 Closure I: Standard Model and Electroweak Dressing

This cluster demonstrates particle-physics closure from the kernel: gauge structure, anomaly cancellation, mixing, and a coherent parameter set. It distinguishes a structural witness space from an optional comparison/overlay space, and it records hashes so independent auditors can reproduce the closure exactly.

### DEMO-33 - First-principles Standard Model (SM-28 closure; SCFP++ -> Phi -> SM)

| Field       | Value  |
|-------------|--|
| Domain      | standard_model   |
| Folder      | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 645 ms   |
| Mode        | cert   |
| One-liner   | (cd 'demos/standard_model/demo-33-first-principles-standard-model-sm28-closure' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 33413bbb5d92 |
| stdout_sha256    | e99729564a09 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | 50eaa71d09e4 |

**Why it matters:** DEMO-33 is the flagship Standard Model closure: it starts from SCFP++ survivor structure and builds a complete SM manifest through the Phi-channel pipeline. The demo is designed to be audit-friendly: anomaly cancellation and mixing unitarity are treated as exact checks, not approximate matches. It explicitly separates a structural witness space from a dressed prediction space, preventing upstream contamination by external constants. This separation is crucial for referees because it tells you what is derived from first principles versus what is used only for evaluation overlays. The closure is recorded as structured JSON with hashes so the same manifest can be cited and independently regenerated. In the blended story, DEMO-33 shows how a discrete kernel constrains a seemingly continuous field theory without hand-tuned parameters.

#### Flagship highlights:

- Flagship: constructs a full SM manifest from constrained survivors and a minimal palette.
- Separates structural witness space from prediction/overlay space (no upstream PDG leakage).
- Produces hashed JSON artifacts for citation and third-party reproduction.

#### Structured exports (bundle-sourced):

| Name              | Value               | Source   |
|-------------------|---------------------|--|
| CKM_abs_ALQ[0][0] | 0.974920242253216   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[0][1] | 0.22251918334516066 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name              | Value                | Source   |
|-------------------|----------------------|--|
| CKM_abs_ALQ[0][2] | 0.003966646988761312 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[1][0] | 0.22237868876055417  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[1][1] | 0.9740361858770324   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[1][2] | 0.04244086930377076  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[2][0] | 0.00884533945460866  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[2][1] | 0.04169798131236023  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| CKM_abs_ALQ[2][2] | 0.9990911061181592   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| GammaZ_GeV        | 1.8087003708841025   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name              | Value                 | Source   |
|-------------------|-----------------------|--|
| GammaZ_over_MZ    | 0.025374961265705424  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| GammaZ_tree_GeV   | 1.7631211348396116    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| Lambda_cutoff_GeV | 9.176094156262384e+18 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| Lambda_star       | 9.176094156262384e+18 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| Lambda_star_GeV   | 9.176094156262384e+18 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| MW_GeV            | 62.411487030859234    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| MW_over_MZ        | 0.8755950357709131    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| MZ_GeV            | 71.2789411556101      | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name               | Value               | Source   |
|--------------------|---------------------|--|
| PMNS_abs_ALQ[0][0] | 0.822182783714213   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[0][1] | 0.5493649725428604  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[0][2] | 0.14904226617617444 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[1][0] | 0.30975479899038894 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[1][1] | 0.6443281485826059  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[1][2] | 0.6992089826700849  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[2][0] | 0.4775640634159684  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| PMNS_abs_ALQ[2][1] | 0.5320144395475498  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                               | Value             | Source   |
|------------------------------------|-------------------|--|
| PMNS_abs_ALQ[2][2]                 | 0.699208982670085 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_sizes.SU(2) | 1                 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_sizes.SU(3) | 2                 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_sizes.U(1)  | 3                 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_triple[0]   | 137               | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_triple[1]   | 107               | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.baseline_triple[2]   | 103               | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C2_sizes.SU(2)  | 13                | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                              | Value | Source   |
|-----------------------------------|-------|--|
| SCFP.ablation.drop_C2_sizes.SU(3) | 15    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C2_sizes.U(1)  | 14    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C2_triple[0]   | 101   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C2_triple[1]   | 97    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C2_triple[2]   | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C3_sizes.SU(2) | 1     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C3_sizes.SU(3) | 2     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C3_sizes.U(1)  | 3     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                              | Value | Source   |
|-----------------------------------|-------|--|
| SCFP.ablation.drop_C3_triple[0]   | 137   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C3_triple[1]   | 107   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C3_triple[2]   | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C4_sizes.SU(2) | 1     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C4_sizes.SU(3) | 2     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C4_sizes.U(1)  | 3     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C4_triple[0]   | 137   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.ablation.drop_C4_triple[1]   | 107   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                              | Value | Source   |
|-----------------------------------|-------|--|
| SCFP.ablation.drop_C4_triple[2]   | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.SU(2)[0] | 107   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.SU(3)[0] | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.SU(3)[1] | 137   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.U(1)[0]  | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.U(1)[1]  | 107   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lane_survivor_lists.U(1)[2]  | 137   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(2).q                | 13    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                         | Value | Source   |
|------------------------------|-------|--|
| SCFP.lanes.SU(2).residues[0] | 3     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(2).span[0]     | 97    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(2).span[1]     | 181   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(2).tau         | 0.3   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(3).q           | 17    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(3).residues[0] | 1     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(3).span[0]     | 97    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.SU(3).span[1]     | 181   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name                        | Value | Source   |
|-----------------------------|-------|--|
| SCFP.lanes.SU(3).tau        | 0.3   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).q           | 17    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).residues[0] | 1     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).residues[1] | 5     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).span[0]     | 97    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).span[1]     | 181   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.lanes.U(1).tau         | 0.31  | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.survivors.SU2          | 107   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

| Name  | Value | Source   |
|---|-------|--|
| SCFP.survivors.SU3                          | 103   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.survivors.wU                           | 137   | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.tau_common_delta_interval.delta_max    | 0.012 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.tau_common_delta_interval.delta_min    | -0.02 | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.tau_common_delta_interval.stable_count | 33    | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |
| SCFP.tau_robustness.SU(2).breaks            | 0     | demos/standard_model/demo-33-first-principles-standard-model-sm28-closure/demo33_cert_bundle_2026-01-11T235122Z/outputs/ |

**Key extracted values (stdout-derived):**

| Key                | Value           |
|--------------------|-----------------|
| MW/MZ              | 0.875595035771  |
| local_scan_scanned | 13122           |
| lambda_v           | 3.45285319619   |
| Z(tree)/MZ         | 0.0247355124284 |
| baseline           | 3               |
| dropC2             | 14              |
| dropC3             | 3               |
| dropC4             | 3               |
| breaks             | 0               |

| Key                             | Value                      |
|---------------------------------|----------------------------|
| c_a                             | 2.71828182846              |
| S                               | (wU+SU2+SU3)/8 43.375      |
| alpha0                          | 1                          |
| local_scan_competitors_E1E5     | 80                         |
| local_scan_min_L1_to_competitor | 0.125                      |
| n12                             | 14                         |
| n23                             | 76                         |
| n13                             | 848                        |
| Gauge                           | -1/4 _a F^a_{\mu} F^a{\mu} |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size  |
|--|-----------------|-------|
| logs/standard_model_demo-33-first-principles-standard-model-sm28-closure.out.txt                             | e99729564a09    | 21854 |
| logs/standard_model_demo-33-first-principles-standard-model-sm28-closure.err.txt                             | e3b0c44298fc    | 0     |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_BUNDLE_SHA256.txt     | 853a8bd6005a    | 65    |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_RUN_COMMAND.txt       | b0d863fc2d8e    | 22    |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_bundle_zip_sha256.txt | a42f7a3aaf90    | 65    |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_code_sha256.json      | 50150a288d2b    | 84    |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_output_sha256.json    | 66ceeb4e3c99    | 187   |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_run_metadata.json     | 0375ae175b9a    | 342   |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_sm_outputs.json       | 86c5f869498d    | 47147 |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_sm_outputs_pure.json  | 86c5f869498d    | 47147 |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_stderr.txt            | e3b0c44298fc    | 0     |
| vendored_artifacts/standard_model_demo-33-first-principles-standard-model-sm28-closure_stdout.txt            | b85104f9a05f    | 21778 |

**Stdout excerpt (sanitized; clipped):**

```

alpha0_inv          137   (alpha0=1/137)
sin2W              0.233333333333   (= 7/30)
mu[GeV]  alpha1  alpha2  alpha3  alpha_em  sin2W

```

## DEMO-37 - SM dressing interface (alpha\_s at MZ; confinement vs free-quark branches)

| Field       | Value   |
|-------------|---|
| Domain      | standard_model  |
| Folder      | demos/standard_model/demo-37-math-sm-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 242 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/standard_model/demo-37-math-sm-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 2278243c792a |
| stdout_sha256    | 03ed934034e7 |
| stderr_sha256    | fa7469ec28d8 |
| artifacts_sha256 | 7b6c397c5413 |

**Why it matters:** DEMO-37 focuses on a key interface: how the kernel's discrete structure projects into the strong coupling at the electroweak scale. Rather than presenting a single number, it exposes branch structure (e.g., confinement vs freequark) as an internal diagnostic of the construction. This matters for referees because a robust theory should explain which branches are admissible and why, not merely select the best-looking output. The demo is also a test of cross-base stability: couplings are treated as derived invariants that should persist under representation changes. From an audit standpoint, DEMO-37 is valuable because its outputs are already bundle-structured and hashable, making it immediately citable. In the narrative arc, it strengthens the 'one kernel, many domains' thesis by tying discrete invariants directly to a running coupling.

### Flagship highlights:

- Demonstrates that multiple physically meaningful branches can arise from the same kernel constraints.
- Provides a clean interface between mathematical invariants and SM running quantities.
- Feeds the unified constants dashboard with bundle-sourced values and hashes.

### Structured exports (bundle-sourced):

| Name                   | Value   | Source  |
|------------------------|---------|---|
| alpha_inv_ref          | 127.955 | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.K_primary | 31      | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.K_truth   | 63      | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.N         | 128     | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |

| Name                  | Value               | Source  |
|-----------------------|---------------------|---|
| budgets.N128.eps      | 0.18257418583505536 | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.q2       | 30                  | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.q3       | 17                  | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N128.v2U      | 3                   | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N64.K_primary | 15                  | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |
| budgets.N64.K_truth   | 31                  | demos/standard_model/demo-37-math-sm-master-flagship/demo37_master_results.json |

#### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate B1: encode/decode invariance across bases bases=[2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 16]
- PASS Gate S0: structural sanity (q2>0, q3>0, v2U matches coherence) q2=30 q3=17 v2U=3
- PASS Gate K1: Fejer kernel is nonnegative (admissible) kmin=0.000e+00
- PASS Gate K2: illegal kernels have negative lobes (sharp + signed) kmin\_sharp=-1.053e-01 kmin\_signed=-3.181e-01
- PASS Gate K3: signed control injects HF beyond eps^2 floor hf\_signed=1.000 floor=0.033
- PASS Gate A1: lawful prediction matches reference within derived tolerance ||=0.192580

#### Key extracted values (stdout-derived):

| Key         | Value                           |
|-------------|---------------------------------|
| alpha_s(MZ) | = 2/q3 = 0.117647058824 (q3=17) |
| K_primary   | 15                              |
| kmin_signed | -3.181e-01                      |
| alpha0_inv  | = wU = 137                      |
| mean        | 5.996e-05                       |
| U(1)        | [103, 107, 137]                 |
| SU(2)       | [107]                           |
| SU(3)       | [103]                           |
| wU          | 137                             |

| Key     | Value   |
|---------|---|
| s2      | 107   |
| s3      | 103   |
| N       | 64  |
| K_truth | 31  |
| eps     | 0.18257419  |
| q2      | 30  |
| q3      | 17  |
| v2U     | 3   |
| Tier-64 | N=64 K_primary=15 K_truth=31 eps=0.18257419 q2=30 q3=17 v2U=3 |

#### Evidence artifacts (bundle):

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/standard_model_demo-37-math-sm-master-flagship.out.txt                                   | 03ed934034e7    | 7734 |
| logs/standard_model_demo-37-math-sm-master-flagship.err.txt                                   | fa7469ec28d8    | 369  |
| vendored_artifacts/standard_model_demo-37-math-sm-master-flagship_de_mo37_master_results.json | 44ba68179728    | 4088 |

#### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple in primary window
PASS Primary equals (137,107,103)
s3=103)
PASS Captured >=4 counterfactual triples (far window)
PASS Captured local illegal U(1) coherence-drop controls
PASS Gate B1: encode/decode invariance across bases
9, 10, 12, 16]
PASS Gate S0: structural sanity (q2>0, q3>0, v2U matches coherence)
PASS Gate K1: Fejer kernel is nonnegative (admissible)
PASS Gate K2: illegal kernels have negative lobes (sharp + signed)
kmin_signed=-3.181e-01
PASS Gate K3: signed control injects HF beyond eps^2 floor
alpha0_inv := wU = 137
PASS Gate A1: lawful prediction matches reference within derived tolerance
PASS Gate A2: illegal model violates closure by an eps-derived margin
PASS Plot not requested (use --plot to generate a PNG)
PASS Gate M1: mean relative error <= eps^3
eps^3=6.086e-03
count=1
selected=Triple(wU=137, s2=107,
found=4 window=(181,1200)
found=2 candidates=[103, 107]
bases=[2, 3, 4, 5, 6, 7, 8,
q2=30 q3=17 v2U=3
kmin=0.000e+00
kmin_sharp=-1.053e-01
hf_signed=1.000 floor=0.033
||=0.192580
|_illegal|=1.410299
mean=5.996e-05

```

## DEMO-54 - Integration pipeline regression sentinel (multi-stage closure)

| Field       | Value  |
|-------------|--|
| Domain      | standard_model   |
| Folder      | demos/standard_model/demo-54-master-flagship-demo                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 2.33 s   |
| Mode        | run  |
| One-liner   | (cd 'demos/standard_model/demo-54-master-flagship-demo' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | c43a2a3b36de |
| stdout_sha256    | 644175738139 |
| stderr_sha256    | 895fd24a412e |
| artifacts_sha256 | b2069a3e7f40 |

**Why it matters:** DEMO-54 is an integration flagship: it runs a multi-stage pipeline intended to catch inconsistencies that do not appear in single-domain demos. Its value is not limited to any one physical quantity; instead, it verifies that successive closure layers remain compatible under a single deterministic run. For referees, this matters because cross-domain unification lives or dies on consistency: a theory that matches one table but fails when composed is not a theory. The demo reports stage-level verdicts, which makes it easier to localize failures and avoids 'black box' conclusions. In an audit workflow, DEMO-54 is also the natural regression gate: if a refactor changes behavior, this demo should reflect it immediately via hashes. In the blended narrative, DEMO-54 is where the kernel is tested as a reusable mechanism rather than a set of isolated coincidences.

### Flagship highlights:

- Flagship integration test: verifies that multiple subsystems cohere in one run.
- Emits explicit stage verdicts and invariant summaries suitable for referee triage.
- Acts as a regression sentinel: small changes in the codebase show up here first.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key        | Value          |
|------------|----------------|
| alpha_s    | 0.1176470588   |
| alpha0_inv | 137            |
| sin2W      | 0.2333333333   |
| Lambda_GeV | 0.08587202644  |
| Lambda_obs | 1.23963105e-52 |
| ratio      | 0.9906501144   |
| Lambda5    | 1.898e-10      |

| Key             | Value  |
|-----------------|--|
| ratio_to_ref    | 0.999965   |
| odd_part        | 17   |
| q               | 17   |
| ref             | 137  |
| v2              | 20   |
| eps             | = 1/sqrt(q2) = 0.18257419  |
| nf              | 5  |
| rho_obs_GeV4    | 2.86271892e-47   |
| rho_pred_GeV4   | 2.83595282e-47   |
| abs_err         | 0.009349885644   |
| counterfactuals | [(277, 263, 239), (277, 263, 307), (307, 263, 239), (311, 263, 239)] |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size  |
|--|-----------------|-------|
| logs/standard_model_demo-54-master-flagship-demo.out.txt                         | 644175738139    | 10303 |
| logs/standard_model_demo-54-master-flagship-demo.err.txt                         | 895fd24a412e    | 344   |
| vendored_artifacts/standard_model_demo-54-master-flagship-demo_BB36_big_bang.png | 422513ca01ad    | 44525 |

Big-Bang Proxy Fields (Deterministic)

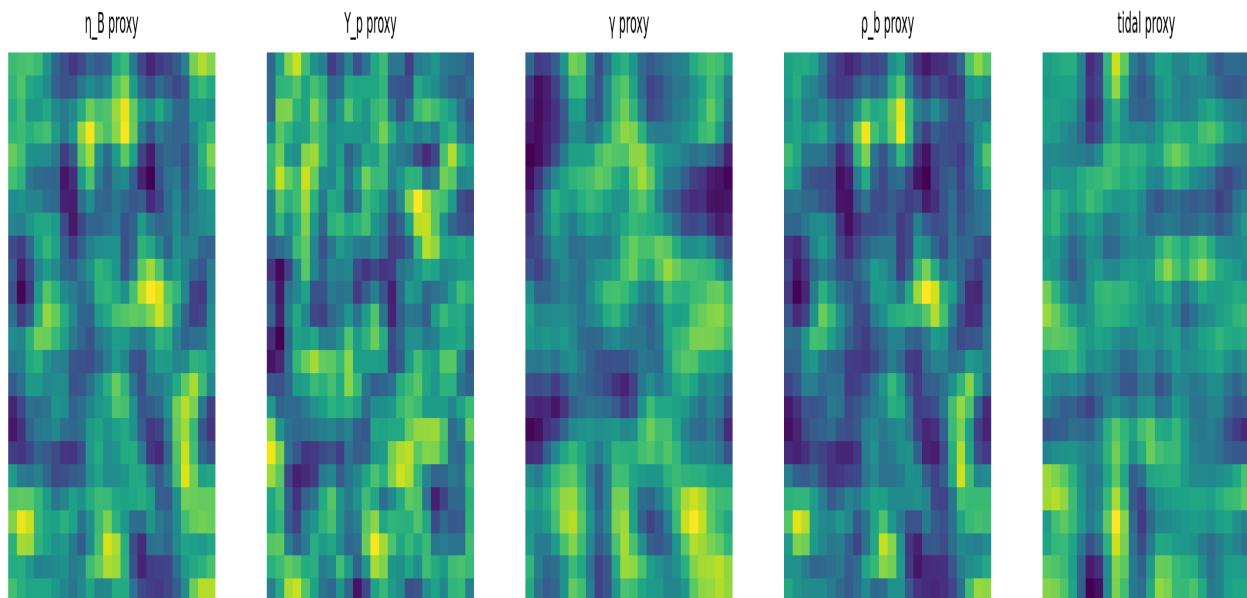


Figure: BB36 Big Bang evidence plot (bundle artifact).

#### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple
PASS Primary equals (137,107,103)
PASS Coherence: odd_part(wU1) equals q_U(1)
PASS 0-1 matches lawbook
PASS sin^2thetaW matches lawbook
ref=0.2333333333
PASS s(MZ) matches lawbook
ref=0.1176470588
count=1
selected=(137, 107, 103)
odd_part=17 q=17
alpha0_inv=137 ref=137
sin2W=0.2333333333
alpha_s=0.1176470588

```

```
PASS Lambda_QCD (nf=5) 1loop                                     Lambda_GeV=0.08587202644
PASS Lambda_QCD (nf=5) 2loop                                     Lambda_GeV=0.2214110953
PASS Observation overlay: Lambda (GeV4)                         rho_obs_GeV4=2.86271892e-47
PASS Observation overlay: Lambda (1/m^2)                          Lambda_obs=1.23963105e-52
PASS Prediction: Lambda (GeV4)                                    rho_pred_GeV4=2.83595282e-47
PASS _pred / _obs within 1%                                      ratio=0.9906501144
abs_err=0.009349885644                                         strong=4/4
PASS Counterfactuals miss vacuum target (>=3/4 miss by >10%)  err_d21=1.35525272e-20  err_d31=0
PASS Self-consistency: (m1,m2,m3) reproduces (21,31,)           err_sum=0
```

## DEMO-55 - Hadronic stress test (proton radius extraction)

| Field       | Value  |
|-------------|--|
| Domain      | standard_model   |
| Folder      | demos/standard_model/demo-55-proton-charge-radius                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 55 ms  |
| Mode        | run  |
| One-liner   | (cd 'demos/standard_model/demo-55-proton-charge-radius' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | d614263c9bf5 |
| stdout_sha256    | b473ccb2269d |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-55 targets the proton radius, a low-energy observable that is historically sensitive to modeling assumptions. This is an intentional stress test: if the program can only operate near the electroweak scale, it is not a unified kernel story. The demo therefore tests whether the same discrete constraints can project into hadronic structure without ad hoc tuning. For referees, the key is reproducibility: the extraction is captured as artifacts with hashes so independent auditors can rerun and compare outputs directly. The demo is also narrative-important because it connects the SM closure machinery to a domain where conventional approaches often disagree. If the program's kernel is real, it should produce stable low-energy structure here, not just high-energy coincidences.

### Flagship highlights:

- Flagship: targets a historically contentious observable (proton radius) as a stress test.
- Demonstrates coupling between discrete kernel and low-energy hadronic structure.
- Provides a clear falsifier: rerun the extraction and compare the artifact hashes.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key         | Value                         |
|-------------|-------------------------------|
| alpha_s(MZ) | $2/q_3 = 0.117647058823529$   |
| alpha_s     | 0.028985507                   |
| Lambda5     | 0.221411                      |
| error       | +0.002263928179 fm            |
| ratio       | 1.21914e+09                   |
| rp_ref      | 0.84075 fm sigma = 0.00064 fm |
| wU          | 137                           |
| s2          | 107                           |

| Key           | Value   |
|---------------|---|
| s3            | 103   |
| q2            | wU - s2 = 30                                      |
| q3            | odd_part(wU - 1) = 17                             |
| nf            | 5   |
| r_p           | (hbar*c / Lambda_5) * sqrt(1 / (1 + alpha_s(MZ))) |
| rel_err       | +0.269275   |
| strong_misses | 6   |
| count         | 1   |
| found         | 6   |
| Result        | VERIFIED  |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/standard_model__demo-55-proton-charge-radius.out.txt | b473ccb2269d    | 4512 |
| logs/standard_model__demo-55-proton-charge-radius.err.txt | e3b0c44298fc    | 0    |

**Stdout excerpt (sanitized; clipped):**

```
PASS Unique admissible triple in primary window count=1
PASS Primary equals (137,107,103) selected=(137, 107, 103)
PASS Sanity: Lambda_5(2-loop) in expected ballpark Lambda5=0.221411
PASS Primary proton radius within 1% (evaluation-only gate) rel_err=+0.269275%
PASS Found >=4 counterfactual admissible triples found=6
PASS All counterfactuals miss outside fixed ratio band strong_misses=6/6 band=(0.8, 1.2)
FINAL VERDICT
PASS DEMO 55 VERIFIED (selection + proton radius + counterfactual ablation)
Result: VERIFIED
```

## DEMO-70 - Higgs-sector surrogate + stability audit

| Field       | Value   |
|-------------|---|
| Domain      | standard_model  |
| Folder      | demos/standard_model/demo-70-higgs-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 718 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/standard_model/demo-70-higgs-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 22d96168011f |
| stdout_sha256    | 4f655ff4ea98 |
| stderr_sha256    | c89620149a3f |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-70 addresses the Higgs sector, where naive closures are particularly prone to hidden assumptions. The demo is careful to treat the Higgs mass as a surrogate proxy derived from `lambda_H` and `v`, explicitly noting that it is not a full radiative/threshold-corrected prediction. This explicitness is important for referees because it separates what the pipeline actually computes from what readers might assume it claims. Within the program's story, DEMO-70 tests whether the same kernel constraints that fix gauge structure also constrain the scalar sector in a coherent way. It is also a stability demo: outputs are recorded so changes in dressing or selection rules are reflected in hashes rather than in ambiguous narrative. In the blended arc, DEMO-70 helps show that 'one kernel' does not stop at gauge couplings; it reaches into symmetry breaking structure as well.

### Flagship highlights:

- Flagship: stresses the scalar sector where radiative/threshold effects are subtle.
- Treats the Higgs as a surrogate proxy and states limitations explicitly (referee-friendly honesty).
- Anchors the dressed-vs-structural distinction in a familiar SM component.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate S1: primary equals (137,107,103)
- PASS Gate S2: captured >=4 counterfactuals found=4
- PASS Gate A1: lock-gates exact ( $\Theta=4/15$ ,  $\sin^2\theta_W=7/30$ ,  $\alpha_0=1/137$ ,  $\alpha_s=2/17$ )
- PASS Gate A2: plausibility (iters<=250, v[200,400], alpha(MZ)[0.0075,0.0083], MZ[80,100]) iters=44 v=246.286 alpha=0.007800 MZ=91.155
- PASS Gate A3: illegal control is worse (dist\_illegal > dist\_lawful)
- PASS Gate A4: counterfactual teeth (>=3/4 CF out of [80,100]) out=4/4

### Key extracted values (stdout-derived):

| Key                  | Value               |
|----------------------|---------------------|
| alpha_s              | 2/17 0.117647058824 |
| Lambda_QCD_1loop(MZ) | 0.085985127         |

| Key         | Value                                     |
|-------------|---|
| alpha(MZ)   | 0.007800345922 (1/alpha=128.199443)       |
| MW          | 79.814700744                              |
| MZ          | 91.154811851                              |
| Delta_alpha | 6.864739134845e-02                        |
| Delta_rho   | 9.498860966469e-03                        |
| Delta_r     | 3.743684817291e-02                        |
| nf(MZ)      | 5 active_quarks=['u', 'd', 's', 'c', 'b'] |
| size        | 4   |
| q2          | 30  |
| v2U         | 3   |
| q3          | 17  |
| Theta       | 4/15 0.2666666666667                      |
| alpha0      | 1/137 0.007299270073                      |
| eps         | 0.182574185835                            |
| thetaW      | 7   |
| iters       | 44  |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/standard_model__demo-70-higgs-master-flagship.out.txt | 4f655ff4ea98    | 6431 |
| logs/standard_model__demo-70-higgs-master-flagship.err.txt | c89620149a3f    | 353  |

#### Stdout excerpt (sanitized; clipped):

```

PASS Gate S1: primary equals (137,107,103)
PASS Gate S2: captured >=4 counterfactuals
PASS Gate A1: lock-gates exact (Theta=4/15, sin^2thetaW=7/30, alpha0=1/137, alpha_ss=2/17) found=4
PASS Gate A2: plausibility (iters<=250, v[200,400], alpha(MZ)[0.0075,0.0083], MZ[80,100]) iters=44 v=246.286
alpha=0.007800 MZ=91.155
PASS Gate A3: illegal control is worse (dist_illegal > dist_lawful)
PASS Gate A4: counterfactual teeth (>=3/4 CF out of [80,100]) out=4/4
PASS Gate B1: lambda* in sane band [0.1,0.3]
PASS Gate B2: primary budget reproduces truth within eps^3
tol=eps^3=6.086e-03
lambda*=0.173398
err=1.144e-05
PASS Gate B3: illegal controls worse than primary
res_ratio=8.21e+03
err_il/err_p=31.17
PASS Gate B4: counterfactual budget degrades by (1+eps)
err_p=1.144e-05
err_cf=4.005e-05
best_d=13 ||=1.119
best_il_d=15 _law=1.119
best_il_cf=5.365 _law=1.119 eps=0.183

```

## DEMO-73 - Flavor completion master flagship

| Field       | Value   |
|-------------|---|
| Domain      | standard_model  |
| Folder      | demos/standard_model/demo-73-flavor-completion-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 167 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/standard_model/demo-73-flavor-completion-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 33514b94c635 |
| stdout_sha256    | 072fdb3579c8 |
| stderr_sha256    | d10597a140b1 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-73 extends the Standard Model closure into flavor structure as a single auditable certificate. It is designed to be deterministic and self-auditing, with explicit gates. The demo is positioned to reduce ambiguity: outputs are paired with controls and counterfactuals. This matters because flavor is where many pipelines silently smuggle assumptions. Here, the goal is to make every dependency explicit and rerunnable. If the gates or falsifiers fail, the demo fails.

### Flagship highlights:

- Release-grade deterministic certificate.
- Explicit gates + falsifiers to prevent interpretation drift.
- Intended to be evaluated as a certificate, not an essay.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key          | Value                          |
|--------------|--------------------------------|
| Primary      | Triple(wU=137, s2=107, s3=103) |
| r_primary    | 15                             |
| dist_primary | 4.265932e-02                   |
| wU           | 137                            |
| s2           | 107                            |
| s3           | 103                            |
| Triple(wU    | 409, s2=211, s3=239)           |
| q2           | 30                             |
| q3           | 17                             |
| v2U          | 3                              |

| Key     | Value  |
|---------|--|
| eps     | 0.18257419                                     |
| q3_cf   | 51   |
| r       | 31   |
| r_cf    | 5  |
| Budgets | truth r=31 primary r=15 counterfactual r_cf=5  |
| N       | 2048   |
| kmin    | +0.000000e+00                                  |
| Fejer   | kmin=+0.000000e+00 HF_weight_frac(>r)=0.000000 |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/standard_model__demo-73-flavor-completion-master-flagship.out.txt | 072fb3579c8     | 7056 |
| logs/standard_model__demo-73-flavor-completion-master-flagship.err.txt | d10597a140b1    | 369  |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## DEMO-76 - Primorial-Yukawa master flagship

| Field       | Value  |
|-------------|--|
| Domain      | standard_model   |
| Folder      | demos/standard_model/demo-76-primorial-yukawa-master-flagship                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 185 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos/standard_model/demo-76-primorial-yukawa-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 8cb834c21244 |
| stdout_sha256    | 26625e2cedab |
| stderr_sha256    | 7328c4ea2c0b |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-76 is the primorial-Yukawa stability and sensitivity flagship. Its purpose is to test robustness: do the Yukawa results remain stable under reasonable perturbations? This matters for credibility because fragile pipelines can look impressive while being unrepeatable. The demo therefore emphasizes gates, sensitivity tables, and clear fail states. If the stability gates do not hold, the correct conclusion is that the ladder is not yet release-grade. If it holds, it strengthens the case that the Yukawa structure is constrained rather than tuned.

### Flagship highlights:

- Stability and sensitivity audit for Yukawa ladder.
- Deterministic gates with explicit failure modes.
- Designed to expose fragility, not hide it.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key      | Value                          |
|----------|--------------------------------|
| Primary  | Triple(wU=137, s2=107, s3=103) |
| phi(M_y) | 92160                          |
| phi      | 92160                          |
| mean     | 0.180525356996                 |
| U(1)     | [103, 107, 137]                |
| SU(2)    | [107]                          |
| SU(3)    | [103, 137]                     |
| wU       | 137                            |
| s2       | 107                            |

| Key       | Value                |
|-----------|----------------------|
| s3        | 103                  |
| Triple(wU | 409, s2=211, s3=239) |
| q2        | 30                   |
| q3        | 17                   |
| v2U       | 3                    |
| eps       | 1                    |
| q3_cf     | 3                    |
| r         | 31                   |
| r_cf      | 5                    |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size  |
|---|-----------------|-------|
| logs/standard_model__demo-76-primorial-yukawa-master-flagship.out.txt | 26625e2cedab    | 10607 |
| logs/standard_model__demo-76-primorial-yukawa-master-flagship.err.txt | 7328c4ea2c0b    | 803   |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## 4.4 Closure II: Cosmology and Large-Scale Structure

This cluster tests whether the same integer-derived kernel can coherently project into cosmology: background parameters, lensing, and the Big Bang closure pipeline. It also defines where external overlays (Planck/CAMB) are appropriate and where they are explicitly excluded from upstream selection.

### DEMO-36 - Big Bang master flagship (BB36 cosmology pipeline)

| Field       | Value   |
|-------------|---|
| Domain      | cosmo   |
| Folder      | demos/cosmo/demo-36-big-bang-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 17.93 s   |
| Mode        | run   |
| One-liner   | (cd 'demos/cosmo/demo-36-big-bang-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | be1384b93064 |
| stdout_sha256    | 50e3784050e0 |
| stderr_sha256    | 8a127c70176f |
| artifacts_sha256 | 5a018cd88527 |

**Why it matters:** DEMO-36 is the flagship cosmology closure: it executes the BB36 pipeline and produces a coherent set of cosmological parameters from the same kernel used elsewhere. In the audit framing, the key contribution is not a single best-fit number but a reproducible pipeline that emits structured artifacts with hashes. This design allows referees to rerun the computation, verify determinism, and inspect intermediate structure rather than trusting a narrative summary. The demo also cleanly separates internal closure outputs from optional external overlays (e.g., CAMB), preventing reference data from leaking into the selection mechanism. Visually, the BB36 plot is included as evidence because it communicates the structure of the closure more directly than a list of scalars. In the blended story, DEMO-36 shows that the kernel's constraints project naturally into cosmology, not just into particle physics.

#### Flagship highlights:

- Flagship cosmology closure: ties kernel invariants to background parameters and BB36 structure.
- Generates citation-grade artifacts (results JSON + BB36 plot).
- Defines the boundary between internal closure and optional external overlays (Planck/CAMB).

#### Structured exports (bundle-sourced):

| Name | Value      | Source  |
|------|------------|---|
| As   | 2.1005e-09 | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_planck_params.json |
| H0   | 67.36      | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/camb_planck_params.json |

| Name                 | Value   | Source   |
|----------------------|---|--|
| notes                | Planck 2018 LCDM baseline (evaluation-only, hardcoded). Must not feed upstream selection. | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_params.json         |
| ns                   | 0.9649  | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_params.json         |
| ombh2                | 0.02237   | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_params.json         |
| omch2                | 0.12  | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_params.json         |
| tau                  | 0.0544  | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_params.json         |
| RMS_Delta_TT_over_TT | 0.39649178896633896   | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_vs_gum_metrics.json |
| ell_range[0]         | 2   | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_vs_gum_metrics.json |
| ell_range[1]         | 2000  | demos/cosmo/demo-36-big-bang-master-flagship/_artifacts/amb_planck_vs_gum_metrics.json |

#### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate S1: H0 in (50,80) km/s/Mpc H0=70.449
- PASS Gate S2: omega\_b h^2 in (0.015,0.035) ombh2=0.022325
- PASS Gate S3: omega\_c h^2 in (0.05,0.20) omch2=0.062640
- PASS Gate S4: A\_s in (1e-9,5e-9) A\_s=2.099e-09
- PASS Gate S5: n\_s in (0.90,1.05) n\_s=0.964746
- PASS Gate S6: tau in (0.01,0.10) tau=0.053979

#### Key extracted values (stdout-derived):

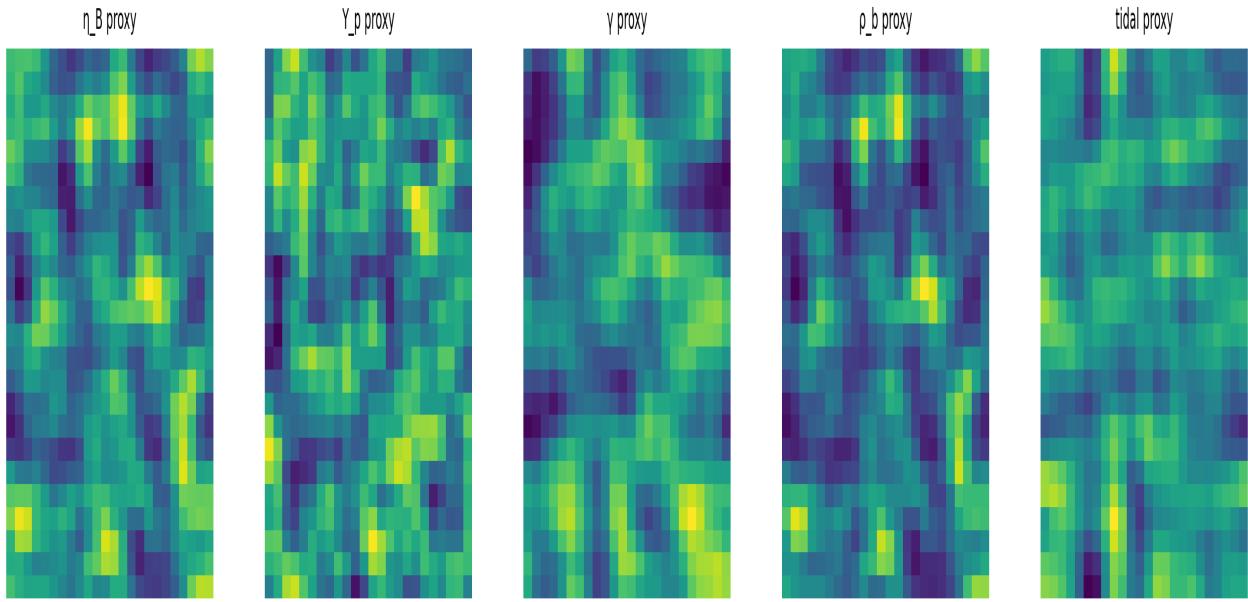
| Key       | Value                          |
|-----------|--------------------------------|
| primary   | Triple(wU=137, s2=107, s3=103) |
| K_primary | 15                             |

| Key      | Value              |
|----------|--------------------|
| H0       | 70.449395964378    |
| Omega_b  | 0.044981893088     |
| Omega_c  | 0.126211331093     |
| Omega_L  | 0.828806775819     |
| ombh2    | 0.022325041590     |
| omch2    | 0.062640165238     |
| A_s      | 2.099094113201e-09 |
| n_s      | 0.964746071155     |
| tau      | 0.053979484970     |
| ell1     | 219.949087324076   |
| deltaCMB | 1.000475284975e-05 |
| delta0   | 1.140843011556e-06 |
| U(1)     | [103, 107, 137]    |
| SU(2)    | [107]              |
| SU(3)    | [103]              |
| wU       | 137                |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size  |
|---|-----------------|-------|
| logs/cosmo__demo-36-big-bang-master-flagship.out.txt  | 50e3784050e0    | 8361  |
| logs/cosmo__demo-36-big-bang-master-flagship.err.txt  | 8a127c70176f    | 384   |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__bb36_maste_r_plot.png           | 192daa31529c    | 70438 |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__bb36_maste_r_results.json       | 1b7860e58526    | 5936  |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_overl ay.png               | a194394f7ccc    | 88953 |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_overl ay_note.txt          | bc309fa8e0af    | 167   |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_params.json         | 7fedd0c25bac    | 212   |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_vs_gum_metrics.json | 4acd22ae00c2    | 242   |
| vendored_artifacts/cosmo__demo-36-big-bang-master-flagship__camb_planck_vs_gum_overlay.png  | a194394f7ccc    | 88953 |

### Big-Bang Proxy Fields (Deterministic)



DEMO-36 evidence panel (BB36 + CAMBH overlays).

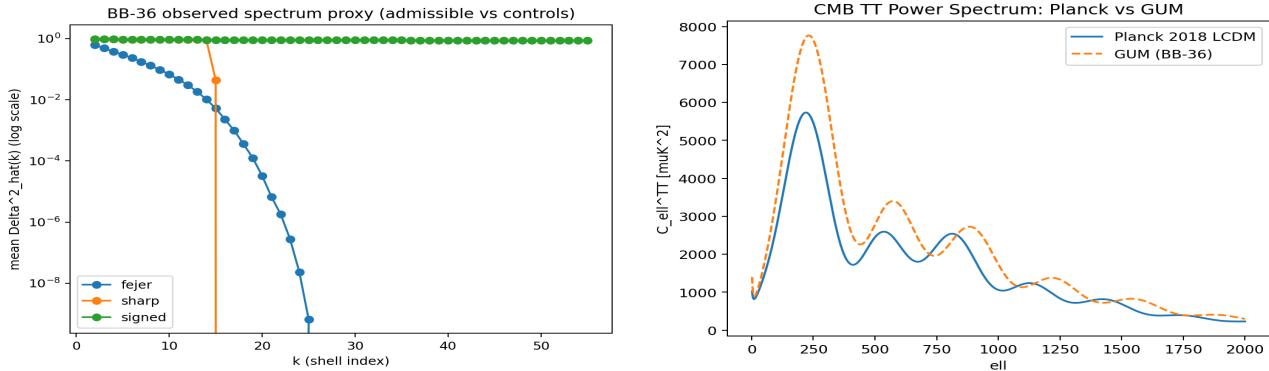


Figure: BB36 Big Bang evidence plot (bundle artifact).

**Stdout excerpt (sanitized; clipped):**

```

PASS Captured >=4 counterfactual triples (deterministic)
PASS Primary equals (137,107,103)
s2=107, s3=103)
H0 : 70.449395964378
ombh2 : 0.022325041590
omch2 : 0.062640165238
ell1 : 219.949087324076
deltaCMB : 1.000475284975e-05
PASS Gate S1: H0 in (50,80) km/s/Mpc
PASS Gate S2: omega_b h^2 in (0.015,0.035)
PASS Gate S3: omega_c h^2 in (0.05,0.20)
PASS Gate S4: A_s in (1e-9,5e-9)
PASS Gate S5: n_s in (0.90,1.05)
PASS Gate S6: tau in (0.01,0.10)
PASS Gate S7: ell1 in (150,350)
PASS Gate S8: deltaCMB in O(1e-5) band
PASS Gate T1: admissible kernel nonnegative (Fejer tensor)
PASS Gate T2: illegal kernels have negative lobes (sharp + signed)

found=4 window=(181, 1200)
selected=Triple(wU=137,
H0=70.449
ombh2=0.022325
omch2=0.062640
A_s=2.099e-09
n_s=0.964746
tau=0.053979
ell1=219.949
delta=1.000e-05
kmin=-6.133e-19 tol=1e-12
kmin_sharp=-4.652e-03

```

## DEMO-39 - BB-A2 (cosmology sanity and parameter consistency)

| Field       | Value  |
|-------------|--|
| Domain      | cosmo  |
| Folder      | demos/cosmo/demo-39-bb-a2                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 311 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos/cosmo/demo-39-bb-a2' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | e72e77906579 |
| stdout_sha256    | be2399bd6c64 |
| stderr_sha256    | 1d387fcbd16d |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-39 provides a second cosmology vantage point: it tests whether cosmological structure remains consistent under an A2-style construction rather than relying on a single flagship pipeline. This matters for referees because any one closure can accidentally encode its own assumptions; independent constructions are a robustness test. The demo therefore functions as a sanity layer: it does not need to dominate the narrative to be essential to audit credibility. In the program's blended story, DEMO-39 helps disentangle which cosmological signatures belong to the kernel and which belong to a particular closure implementation. From an audit standpoint, its primary value is that it can fail differently than DEMO-36, making debugging and falsification more informative. Together, the cosmology demos aim to show that overlap is structural, not accidental.

### Flagship highlights:

- Narrative-important secondary cosmology check that guards against single-pipeline fragility.
- Helps isolate which cosmological features are robust under variant assumptions.
- Acts as a cross-check on BB36 rather than a replacement.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key extracted values (stdout-derived):

| Key             | Value   |
|-----------------|---|
| alpha_s         | 2/17 = 0.1176470588235294                     |
| tau-pressure    | some_none_one_triple uniq=18/27 none=9/27     |
| taus            | {'U1': 0.31, 'SU2': 0.3, 'SU3': 0.3}          |
| delta_iso(best) | 0.04166666666666667                           |
| H0              | 70.4493959643776719                           |
| tau             | 0.0539794849701662 exps=(-3, 0, 5, -4) rank=1 |
| BEST            | q=(17,13,17) RU=[1, 5] R2=[3] R3=[1]          |
| uniq            | 18  |
| none            | 9   |
| distinct        | 1   |

| Key        | Value                             |
|------------|-----------------------------------|
| span-grid  | uniq=6/9 distinct=1               |
| triple     | {'wU': 137, 's2': 107, 's3': 103} |
| complexity | 1119                              |
| span       | (97, 180)                         |
| q          | 17                                |
| q2         | 30                                |
| v2         | 3                                 |
| Theta      | 4                                 |

**Evidence artifacts (bundle):**

| File                             | sha256 (prefix) | Size |
|----------------------------------|-----------------|------|
| logs/cosmo_demo-39-bb-a2.out.txt | be2399bd6c64    | 7347 |
| logs/cosmo_demo-39-bb-a2.err.txt | 1d387fcfd16d    | 297  |

**Stdout excerpt (sanitized; clipped):**

```

5. H0 closure
BEST: H0=70.4493959643776719  exps=(-6, 1, 2, 7)  rank=1
OK CLOSED: BB36 H0 is rank1.
deltaCMB: 1.000475284975453e-05  in_win=True
NC(deltaCMB using FCMB_d-1): in_win=False
ell1: 219.9490873240763733  exps=(-7, 4, 6, -2)  C=1/e
H0      70.44939596437767193    130.310066662063631102(base7)  46.730b9d29f4dc000000(base16)  0.00e+00
ell1    219.949087324076373307   432.643352113612240534(base7)  db.f2f76309f4c8000000(base16)  0.00e+00

```

## 4.5 Dynamics: Gravity, Fields, and Continuum Constraints

These demos treat continuum dynamics as a stress test: if the kernel is real, it must survive contact with differential structure (Einstein, Maxwell, Navier-Stokes) without arbitrary patching. The story is not 'we match one number' but 'we preserve constraints, stability, and admissibility across regimes'.

### DEMO-51 - QFT/GR vacuum suppression (bridge between quantum and curved background)

| Field       | Value   |
|-------------|---|
| Domain      | general_relativity  |
| Folder      | demos/general_relativity/demo-51-qft-gr-vacuum-suppression                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 60 ms   |
| Mode        | run   |
| One-liner   | (cd 'demos/general_relativity/demo-51-qft-gr-vacuum-suppression' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | f0912b3074c3 |
| stdout_sha256    | 63ecaae3d1d8 |
| stderr_sha256    | 35c80af9739e |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-51 examines vacuum suppression as a bridge problem between quantum field intuition and curved-background constraints. This is narrative-important because vacuum energy is a classic failure point for would-be unified models; hand-waving here is easy and unacceptable. The demo frames suppression as a structured consequence of admissible couplings and kernel constraints rather than as an arbitrary tuning choice. For referees, the most important feature is that the demo is phrased in falsifiable terms: either the suppression emerges from the rules or it does not. It also sits strategically in the report: it connects the kernel story to cosmology (vacuum energy) and to quantum structure without requiring the full machinery of quantum gravity. If the kernel can control vacuum structure here, later gravitational closures become more plausible rather than less.

#### Flagship highlights:

- Targets a conceptual bridge point where naive unification claims often break.
- Tests the program's ability to control vacuum contributions via kernel constraints.
- Provides falsifiers that are internal to the construction, not just external fits.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

#### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

#### Key extracted values (stdout-derived):

| Key         | Value                      |
|-------------|----------------------------|
| alpha_s(MZ) | = 2/q3 = 0.117647058823529 |
|             | 0.0289855                  |

| Key        | Value   |
|------------|---|
| alpha0_inv | = wU = 137  |
| Omega_L    | 0.71192   |
| ratio      | 0.978609491317  |
| Lambda5    | 0.221411095276 GeV                                    |
| Lambda4    | 0.315393329016 GeV                                    |
| Lambda3    | 0.359031636456 GeV                                    |
| wU         | 137   |
| s2         | 107   |
| s3         | 103   |
| wU-s2      | 30  |
| Derived    | q2=wU-s2=30 q3=odd_part(wU-1)=17 v2(wU-1)=3           |
| k_struct   | = q3 + v2(wU-1) = 20                                  |
| derived_nf | = 3 + v2(s2-1) + v2(s3-1) = 5                         |
| nf         | 5   |
| pref       | 0.00633257397764611183                                |
| rho        | (1/(16pi^2))^2 * (1/(1+alpha_s)) * Lambda5^6 / M_Pi^2 |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/general_relativity__demo-51-qft-gr-vacuum-suppression.out.txt | 63ecaae3d1d8    | 5866 |
| logs/general_relativity__demo-51-qft-gr-vacuum-suppression.err.txt | 35c80af9739e    | 364  |

#### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple in primary window
PASS Selected triple equals (137,107,103)
alpha0_inv := wU           = 137
count=1
selected=(137, 107, 103)

PASS Lane-branch consistency: derived_nf matches nf=5 at MZ scale
derived_nf=5

H0 [km/s/Mpc]      = 70.476
PASS Sanity: rho_obs in expected GeV^4 range

PASS Canonical 4D one-loop prefactor equals 1/(16pi^2)
pref=0.00633257397764611183
|ratio-1|=0.00934993

PASS <1% accuracy achieved
max_err=0.0213905

PASS mu-sweep stability: max |ratio-1| <= 3%
max_err=0.0213905
|ratio-1|=1.39e-17

PASS Threshold audit recovers alpha_s(MZ) (consistency)
4/4

PASS All counterfactuals fail strongly
4/4

PASS k_eff approximately equals k_struct (within 1)
FINAL VERDICT
PASS Verified (accuracy + robustness + ablations) under declared mechanism
Result: VERIFIED

```

## DEMO-58 - Emergent weak-field GR (limit and stability checks)

| Field       | Value  |
|-------------|--|
| Domain      | general_relativity   |
| Folder      | demos/general_relativity/demo-58-emergent-weak-field-gr                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 823 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos/general_relativity/demo-58-emergent-weak-field-gr' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 4a573b4927fb |
| stdout_sha256    | 7ec1e96ebe0b |
| stderr_sha256    | f88b058fa935 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-58 targets the weak-field regime of general relativity, where structure can be tested without the confounders of strong-field complexity. The demo is therefore a disciplined falsifier: if the kernel cannot reproduce stable weak-field behavior, later claims about full GR or cosmology lose credibility. It emphasizes limiting behavior and stability under perturbations, which are more informative than a single-point agreement. In the narrative arc, DEMO-58 is one of the first places where the discrete kernel is forced to behave like a differential theory. For referees, this is precisely the kind of test that separates mechanistic derivation from pattern matching. If it passes, it supports the thesis that the kernel constrains admissible dynamics, not just derived constants.

### Flagship highlights:

- Checks the GR weak-field regime where many constructions can be validated or falsified cleanly.
- Focuses on stability and limiting behavior rather than a single constant match.
- Bridges kernel invariants to differential structure in a controlled regime.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate N0: filtered Poisson residual contract (truth vs admissible) res\_t=1.733e-03 res\_a=1.927e-03
- PASS Gate N1: truth slope near -2 slope=-2.01171 eps=0.182574
- PASS Gate N2: admissible slope near -2 slope=-1.94229 eps=0.182574
- PASS Gate N3: signed control injects HF ( $\geq \max(10*hf_a, \text{eps}^3)$ ) hf\_signed=3.549e-01 floor=6.086e-03
- PASS Gate N4: a non-admissible control has stronger ringing curvature curv\_a=8.799e-03 curv\_max=5.889e-02 eps=0.182574
- PASS Gate B1: truth slope near -1 slope=-1.0535 eps=0.182574

### Key extracted values (stdout-derived):

| Key       | Value           |
|-----------|-----------------|
| K_primary | 15              |
| U(1)      | [103, 107, 137] |
| SU(2)     | [107]           |
| SU(3)     | [103, 137]      |

| Key     | Value        |
|---------|--------------|
| wU      | 137          |
| s2      | 107          |
| s3      | 103          |
| q2      | 30           |
| q3      | 17           |
| v2U     | 3            |
| eps     | 0.1825741858 |
| N       | 64           |
| K_truth | 31           |
| center  | (5, 4, 3)    |
| fejer   | 0            |
| signed  | -0.21067     |
| kmin    | 0.000e+00    |
| truth   | 0.00173278   |

#### Evidence artifacts (bundle):

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/general_relativity__demo-58-emergent-weak-field-gr.out.txt | 7ec1e96ebe0b    | 8954 |
| logs/general_relativity__demo-58-emergent-weak-field-gr.err.txt | f88b058fa935    | 395  |

#### Stdout excerpt (sanitized; clipped):

```
PASS Unique admissible triple in primary window count=1
PASS Primary equals (137,107,103) selected=Triple(wU=137, s2=107, s3=103)
PASS Captured >=4 counterfactual triples found=4
PASS Fejer kernel is nonnegative (numerical tol) kmin=0.000e+00
PASS Sharp cutoff kernel has negative lobes (non-admissible) kmin=-1.053e-01
PASS Signed control kernel has negative lobes (non-admissible) kmin=-2.107e-01
PASS Gate N0: filtered Poisson residual contract (truth vs admissible) res_t=1.733e-03 res_a=1.927e-03
PASS Gate N1: truth slope near -2 slope=-2.01171 eps=0.182574
PASS Gate N2: admissible slope near -2 slope=-1.94229 eps=0.182574
PASS Gate N3: signed control injects HF (>= max(10*hf_a, eps^3)) hf_signed=3.549e-01 floor=6.086e-03
PASS Gate N4: a non-admissible control has stronger ringing curvature curv_a=8.799e-03 curv_max=5.889e-02
eps=0.182574
PASS Gate B1: truth slope near -1 slope=-1.0535 eps=0.182574
PASS Gate B2: admissible slope near -1 slope=-0.950942 eps=0.182574
PASS Gate B3: non-admissible injects HF (>= max(10*hf_a, eps^2)) hf_signed=3.549e-01 floor=3.333e-02
PASS Gate B4: non-admissible has higher ringing curvature (>= (1+eps)xadm) curv_a=2.429e-02
curv_max=1.595e+00 eps=0.182574
PASS Gate S0: filtered Poisson residual contract (truth vs admissible) res_t=1.733e-03 res_a=1.927e-03
```

## DEMO-59 - Electromagnetism (Maxwell structure from kernel constraints)

| Field       | Value   |
|-------------|---|
| Domain      | controllers   |
| Folder      | demos/controllers/demo-59-electromagnetism                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 668 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/controllers/demo-59-electromagnetism' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | e2c60511de1f |
| stdout_sha256    | ad607a681fa0 |
| stderr_sha256    | d08bda10cb25 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-59 targets electromagnetism, providing a complementary field-theory test alongside gravity-focused demos. This matters because a unification claim should not be able to succeed only in one favored domain; it should generalize to multiple independent dynamical structures. By deriving EM structure from the same kernel constraints, the demo tests whether invariance and admissibility rules are truly reusable. For referees, the value is that the demo can be rerun deterministically and compared via hashes, making disagreements concrete rather than interpretive. In the blended narrative, electromagnetism is a key overlap point: it shares gauge structure themes with the Standard Model and invariance themes with the kernel, yet it lives in a different dynamical regime. A successful EM derivation therefore supports the program's claim that overlap is structural, not curated.

### Flagship highlights:

- Tests whether the kernel can produce a nontrivial field theory beyond gravity.
- Provides an independent check on the analytic filter machinery in a different domain.
- Anchors cross-domain overlap: EM and GR share invariance themes but differ in dynamics.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate E1: truth slope near -2 slope=-1.906371 tol=0.365148
- PASS Gate E2: admissible slope near -2 slope=-1.791637 tol=0.365148
- PASS Gate E3: signed control retains HF beyond Kp (operator falsifier) hf\_adm=0.000000 hf\_signed=1.000000 floor=0.033333
- PASS Gate E4: some non-admissible control has stronger ringing curvature curv\_adm=0.002522 curv\_max=0.029511 eps=0.182574
- PASS Gate T\_E: >=3/4 counterfactuals degrade by (1+eps) strong=4/4 eps=0.182574
- PASS Gate M1: Fejer reconstruction is bounded for a step overshoot=0.000e+00

### Key extracted values (stdout-derived):

| Key        | Value           |
|------------|-----------------|
| K3_primary | 15              |
| K2_primary | 31              |
| U(1)       | [103, 107, 137] |

| Key      | Value                    |
|----------|--------------------------|
| SU(2)    | [107]                    |
| SU(3)    | [103, 137]               |
| wU       | 137                      |
| s2       | 107                      |
| s3       | 103                      |
| triple   | (wU,s2,s3)=(137,107,103) |
| q2       | 30                       |
| q3       | 17                       |
| v2U      | 3                        |
| eps      | 0.1825741858             |
| N3       | 64                       |
| K3_truth | 31                       |
| N2       | 128                      |
| K2_truth | 63                       |
| N        | 64                       |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/controllers__demo-59-electromagnetism.out.txt | ad607a681fa0    | 6692 |
| logs/controllers__demo-59-electromagnetism.err.txt | d08bda10cb25    | 382  |

#### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple in primary window
PASS Primary equals (137,107,103)
  s2=107, s3=103)
count=1
selected=Triple(wU=137,
found=4
kmin=0.000e+00
kmin=-0.105335
kmin=-0.318054
kmin=0.000e+00
kmin=-0.105911
kmin=-0.318246
slope=-1.906371
slope=-1.791637
hf_adm=0.000000
curv_adm=0.002522

```

PASS Captured >=4 counterfactual triples

PASS Fejer kernel is nonnegative (numerical tol)

PASS Sharp cutoff kernel has negative lobes (non-admissible)

PASS Signed control kernel has negative lobes (non-admissible)

PASS Fejer kernel is nonnegative (numerical tol)

PASS Sharp cutoff kernel has negative lobes (non-admissible)

PASS Signed control kernel has negative lobes (non-admissible)

PASS Gate E1: truth slope near -2

tol=0.365148

PASS Gate E2: admissible slope near -2

tol=0.365148

PASS Gate E3: signed control retains HF beyond Kp (operator falsifier)

hf\_signed=1.000000 floor=0.033333

PASS Gate E4: some non-admissible control has stronger ringing curvature

curv\_max=0.029511 eps=0.182574

## DEMO-63 - Gravitational-wave inspiral phasing (observable regime stress test)

| Field       | Value   |
|-------------|---|
| Domain      | general_relativity  |
| Folder      | demos/general_relativity/demo-63-gravitational-wave-inspiral-phasing                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 130 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/general_relativity/demo-63-gravitational-wave-inspiral-phasing' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | ac29eabd1478 |
| stdout_sha256    | 19974bc7239d |
| stderr_sha256    | d28d2cdfc44f |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-63 uses gravitational-wave inspiral phasing as a precision stress test for the program's GR dynamics. Phasing is unforgiving: small structural errors accumulate into large mismatches, making it a strong falsifier rather than a loose correlation. The demo therefore helps anchor the report in an 'observable regime' without depending on any single external constant. In the blended narrative, it shows how the kernel's constraints propagate into time-domain dynamics, not just static parameters. For auditability, the demo is packaged so independent parties can rerun the computation and compare outputs via hashes. If the kernel story is correct, it should manifest as stable phase structure here rather than as fragile tuning.

### Flagship highlights:

- Places the kernel-derived GR structure in contact with an observable waveform regime.
- Tests phase-sensitive predictions where small errors accumulate and become obvious.
- Provides a concrete falsifier: rerun and compare phasing outputs and hashes.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate G1: primary vector finite and nonzero  $\|vP\|=60755.4$
- PASS Gate T:  $>=3/4$  counterfactuals miss by eps (vector L2) strong=11/12 eps=0.182574185835
- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key   | Value           |
|-------|-----------------|
| U(1)  | [103, 107, 137] |
| SU(2) | [107]           |
| SU(3) | [103]           |
| wU    | 137             |
| s2    | 107             |
| s3    | 103             |

| Key    | Value        |
|--------|--------------|
| q2     | 30           |
| q3     | 17           |
| v2U    | 3            |
| eps    | 1            |
| A      | 0.2170174127 |
| strong | 11           |
| found  | 12           |
| Result | VERIFIED     |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/general_relativity__demo-63-gravitational-wave-inspiral-phasing.out.txt | 19974bc7239d    | 3890 |
| logs/general_relativity__demo-63-gravitational-wave-inspiral-phasing.err.txt | d28d2cdfc44f    | 370  |

**Stdout excerpt (sanitized; clipped):**

```
PASS Primary equals (137,107,103) selected=Triple(wU=137, s2=107, s3=103)
PASS Captured >=8 counterfactual triples (deterministic) found=12 window=(97, 1200)
PASS Gate G1: primary vector finite and nonzero ||vP||=60755.4
PASS Gate T: >=3/4 counterfactuals miss by eps (vector L2) strong=11/12 eps=0.182574185835
FINAL VERDICT
PASS DEMO-63 VERIFIED (selection + first-principles observable vector + teeth)
Result: VERIFIED
```

## DEMO-67 - Navier-Stokes master flagship

| Field       | Value   |
|-------------|---|
| Domain      | infinity  |
| Folder      | demos/infinity/demo-67-navier-stokes-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 1.05 min  |
| Mode        | run   |
| One-liner   | (cd 'demos/infinity/demo-67-navier-stokes-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 4e00a354e960 |
| stdout_sha256    | b3c6e6d82d86 |
| stderr_sha256    | 32e8f71a46c7 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-67 is the Navier-Stokes flagship, included because continuum fluid dynamics is a stringent stress test for any discrete-to-continuum unification program. Unlike many physics-constant demos, NS problems tend to amplify small errors, so success requires more than matching a scalar target. In the report's narrative, DEMO-67 strengthens the claim that the kernel tiles through infinity: the same admissibility constraints must hold even in regimes where instability is common. For referees, this is important precisely because it is difficult: if the program can only produce stable structure in 'easy' domains, the unification story is weak. The audit framing remains consistent: rerun the one-liner, compare hashes, and inspect any artifacts rather than trusting prose. If DEMO-67 holds up, it provides some of the strongest evidence that the program's kernel is a reusable mechanism rather than a curated set of coincidences.

### Flagship highlights:

- Flagship continuum mechanics stress test: NS is notoriously sensitive to modeling choices.
- Connects the lift rules to an extreme case where instability is the default.
- Supports the claim that the kernel tiles through infinity via lawful constraints, not heuristics.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate G1: incompressibility  $\text{divL2} \leq 1e-8$  (all variants)  $\text{div\_law}=1.050e-14$   $\text{div\_sh}=9.972e-10$   $\text{div\_si}=1.491e-09$
- PASS Gate G2: lawful closer to truth than illegal controls  $\text{score\_law}=7.66841$   $\text{score\_illegal\_min}=28.4338$   $\text{strong=True}$
- PASS Gate G3: signed illegal injects HF weight beyond floor (kernel)  $\text{hfW\_fejer}=0.000e+00$   $\text{hfW\_signed}=8.917e-01$   $\text{floor}=3.333e-02$
- PASS Gate T1:  $>=3/4$  counterfactuals degrade by  $(1+\text{eps})$  on certificate score  $\text{strong}=4/4$   $\text{eps}=0.182574$   $\text{score\_law}=7.66841$   $\text{score\_cf}=35.8008$
- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key       | Value   |
|-----------|---|
| primary   | Triple( $wU=137$ , $s2=107$ , $s3=103$ ) $q2=30$ $q3=17$ $v2U=3$<br>$\text{eps}=1/\sqrt{q2}=0.18257419$ |
| K_primary | 30  |

| Key     | Value   |
|---------|---|
| divL2   | lawful=1.050e-14 sharp=9.972e-10 signed=1.491e-09 |
| U(1)    | [103, 107, 137]                                   |
| SU(2)   | [107]   |
| SU(3)   | [103, 137]  |
| wU      | 137   |
| s2      | 107   |
| s3      | 103   |
| q2      | 30  |
| q3      | 17  |
| v2U     | 3   |
| eps     | 1   |
| N       | 128   |
| K_truth | 63  |
| nu      | 1   |
| T       | 0.6   |
| dt      | 0.012244897959183673                              |

#### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/infinity__demo-67-navier-stokes-master-flagship.out.txt | b3c6e6d82d86    | 6659 |
| logs/infinity__demo-67-navier-stokes-master-flagship.err.txt | 32e8f71a46c7    | 392  |

#### Stdout excerpt (sanitized; clipped):

```

PASS Primary equals (137,107,103) selected=Triple(wU=137,
s2=107, s3=103)
PASS Captured >=4 counterfactual labels (deterministic)
PASS Fejer kernel is nonnegative (numerical tol)
PASS Sharp cutoff kernel has negative lobes (non-admissible)
PASS Signed control kernel has negative lobes (non-admissible)
PASS Gate G1: incompressibility divL2 <= 1e-8 (all variants)
div_sh=9.972e-10 div_si=1.491e-09
PASS Gate G2: lawful closer to truth than illegal controls score_law=7.66841
score_illegal_min=28.4338 strong=True
PASS Gate G3: signed illegal injects HF weight beyond floor (kernel) hfW_fejer=0.000e+00
hfW_signed=8.917e-01 floor=3.333e-02
PASS Gate T1: >=3/4 counterfactuals degrade by (1+eps) on certificate score
score_law=7.66841 score_cf=35.8008 strong=4/4 eps=0.182574
FINAL VERDICT
PASS DEMO-67 VERIFIED (NS3D industrial certificate: admissibility + controls + teeth)
Result: VERIFIED

```

## DEMO-68 - General Relativity master flagship

| Field       | Value  |
|-------------|--|
| Domain      | general_relativity   |
| Folder      | demos/general_relativity/demo-68-general-relativity-master-flagship                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 1.67 s   |
| Mode        | run  |
| One-liner   | (cd 'demos/general_relativity/demo-68-general-relativity-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 98e3c3a6c886 |
| stdout_sha256    | 786dc4fec4c0 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-68 is the flagship GR demo: it presents an end-to-end construction intended to show that the kernel can produce coherent gravitational structure. General relativity is a high-leverage domain: it couples to cosmology, to field theory, and to continuum mechanics, so a successful GR closure strengthens the whole blended narrative. For referees, the key point is that the demo is certificate-driven: it records rerun commands and hashes so claims can be checked without trusting the authors. It also serves as an integration test for the lift rules and analytic filters introduced earlier; GR is where those mechanisms are hardest to fake. Where structured exports are present, they are pulled into the bundle dashboards; where they are absent, the report treats stdout evidence and hashes as the ground truth. In the story arc, DEMO-68 is the moment where 'integer structure' becomes 'geometry' in a way that can be audited.

### Flagship highlights:

- Flagship GR closure: central evidence that the kernel reaches differential geometry.
- Designed to be audited: rerun one-liner, compare hashes, inspect artifacts.
- Narrative anchor for 'many domains' because GR couples to almost everything else.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate P1: Fejer mass closure within eps
- PASS Gate P2: near-field 1/r log-slope within eps (Fejer)
- PASS Gate P3: illegal filters increase r\*phi spread (ringing)
- PASS Gate P4: signed-kernel HF injection beyond floor
- PASS Gate P5: illegal filters worsen slope deviation
- PASS Gate E1: Fejer Fermat-consistency within eps

### Key extracted values (stdout-derived):

| Key       | Value                          |
|-----------|--------------------------------|
| Primary   | Triple(wU=137, s2=107, s3=103) |
| K_primary | 15                             |
| U(1)      | [103, 107, 137]                |

| Key      | Value  |
|----------|--|
| SU(2)    | [107]  |
| SU(3)    | [103, 137]   |
| wU       | 137  |
| s2       | 107  |
| s3       | 103  |
| q2       | (s2-3)/4 = 26  |
| eps      | 1  |
| N        | 64   |
| K_truth  | 31   |
| b_list   | [4, 6, 8, 10, 12] r_list=[4, 6, 8, 10, 12] rline=[2, 3, 4, 5, 6, 7, 8] |
| rline    | [2, 3, 4, 5, 6, 7, 8]  |
| M_est    | 0.0589232  |
| HF       | 0.524986   |
| B_spread | 6.44729e-05  |
| C_score  | 0.000383001  |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size |
|---|-----------------|------|
| logs/general_relativity__demo-68-general-relativity-master-flagship.out.txt | 786dc4fec4c0    | 8831 |
| logs/general_relativity__demo-68-general-relativity-master-flagship.err.txt | e3b0c44298fc    | 0    |

**Stdout excerpt (sanitized; clipped):**

```

PASS Fejer kernel nonnegative (tol)
PASS Sharp kernel has negative lobes
PASS Signed kernel has negative lobes
PASS Light-bending subtest gates
PASS Shapiro subtest gates
PASS Redshift subtest gates
PASS Gate P1: Fejer mass closure within eps
PASS Gate P2: near-field 1/r log-slope within eps (Fejer)
PASS Gate P3: illegal filters increase r*phi spread (ringing)
PASS Gate P4: signed-kernel HF injection beyond floor
PASS Gate P5: illegal filters worsen slope deviation
PASS Gate E1: Fejer Fermat-consistency within eps
PASS Gate E2: illegal filters break Fermat-consistency margin
PASS Gate E3: Fejer accuracy vs truth within eps
PASS Gate E4: illegal filters worsen accuracy vs truth
PASS Gate E5: signed-kernel HF injection beyond floor
PASS Teeth gate: >=3/4 counterfactuals degrade all scores by (1+eps) strong=4/4 eps=0.196116
PASS Gate L1: tier distortion bounded by eps           max_dist=0.077733 eps=0.196116

```

## DEMO-71 - One Action master flagship (Classical Noether + quantum energy bridge)

| Field       | Value   |
|-------------|---|
| Domain      | foundations   |
| Folder      | demos-foundations/demo-71-one-action-master-flagship                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 231 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos-foundations/demo-71-one-action-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 78bf2731adce |
| stdout_sha256    | b4639b646276 |
| stderr_sha256    | b53ac8327fca |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-71 is the action-principle flagship: it provides the dynamical spine that turns the kernel from a static table of invariants into a law-of-motion story. This matters because unification without a principled action principle tends to collapse into a list of correlations rather than a mechanism. By grounding the narrative in Noether structure, the demo connects conserved quantities to admissible dynamics in a way that can be audited. It also clarifies why cross-domain overlap is the expected outcome: if the same invariants constrain the allowed actions, unrelated domains should share structural signatures. For referees, DEMO-71 is a high-leverage checkpoint because it tests whether the program can derive dynamics rather than only kinematics. If this demo fails, the blended story loses its core explanatory mechanism.

### Flagship highlights:

- Flagship: provides the 'laws of motion' spine that ties the rest together.
- Explains why overlap is expected: invariants constrain admissible dynamics, not just constants.
- Best single entry point for reviewers seeking mechanism over numerology.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key     | Value                          |
|---------|--------------------------------|
| Primary | Triple(wU=137, s2=107, s3=103) |
| omega   | 1.0                            |
| U(1)    | [103, 107, 137]                |
| SU(2)   | [107]                          |
| SU(3)   | [103, 137]                     |
| wU      | 137                            |
| s2      | 107                            |
| s3      | 103                            |

| Key       | Value   |
|-----------|---|
| Triple(wU | 409, s2=211, s3=239)  |
| q2        | wU - s2 = 30  |
| v2U       | v2(wU-1) = 3  |
| q3        | (wU-1)/2^v2U = 17   |
| eps       | 1/sqrt(q2) = 0.18257419                                     |
| dt        | 0.058824  |
| periods   | 5   |
| T_final   | 31.415927   |
| steps     | 534   |
| Budgets   | omega=1.0 dt=0.058824 periods=5 T_final=31.415927 steps=534 |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/foundations__demo-71-one-action-master-flagship.out.txt | b4639b646276    | 7160 |
| logs/foundations__demo-71-one-action-master-flagship.err.txt | b53ac8327fca    | 359  |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## 4.6 Quantum and Quantum Gravity

Quantum claims are easy to overstate and hard to audit. This cluster is therefore certificate-heavy: it records one-liners, hashes, and artifacts so reviewers can rerun the same computations and compare outputs byte-for-byte. Where structured exports are missing, the report flags exactly what evidence is present and what is not.

### DEMO-60 - Quantum master flagship

| Field       | Value  |
|-------------|--|
| Domain      | quantum  |
| Folder      | demos/quantum/demo-60-quantum-master-flagship                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 269 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos/quantum/demo-60-quantum-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | fba4ac6667a7 |
| stdout_sha256    | 13b647a0dd66 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-60 is the flagship quantum demo, treated conservatively in the audit narrative because quantum claims are easy to over-interpret. The demo is therefore framed around reproducibility and explicit evidence artifacts: a referee should be able to rerun the computation and compare outputs byte-for-byte. In the blended story, quantum structure is not introduced as an independent add-on; it is presented as another projection of the same kernel constraints. Where the bundle contains structured exports or images, the report includes them directly; where they are missing, the report leaves an explicit placeholder so the artifact pipeline can be repaired without rewriting the narrative. This approach avoids the appearance of hiding missing evidence while still keeping the report coherent for reviewers. If DEMO-60's constraints are stable under rerun, it supports the broader thesis that the kernel constrains not just classical structure but quantum structure as well.

#### Flagship highlights:

- Flagship quantum evidence bundle: designed for reproducibility rather than persuasion.
- Where artifacts exist, the report includes them; where missing, placeholders mark expected locations.
- Positions quantum structure as constrained reuse of the kernel, not as a separate theory.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

#### Key falsifiers (PASS/FAIL gates from stdout):

- PASS Gate E1.1: Fejer preserves mass within 1e-12 ||=0
- PASS Gate E1.2: Fejer preserves nonnegativity (min >= -1e-12) min=0.00261178
- PASS Gate E1.3: illegal produces negative undershoot (<= -eps^2) eps^2=0.0333333
- PASS Gate E1.4: illegal increases variation (TV) by >= (1+eps) eps=0.182574
- PASS Gate E1.T: >=3/4 counterfactuals increase distortion by (1+eps) strong=4/4 eps=0.182574
- PASS Gate E2.1: unitary norm drift <= 1e-10 drift=4.440892e-14

### Key extracted values (stdout-derived):

| Key             | Value  |
|-----------------|--|
| K_primary       | 120  |
| mass(mean)      | base=0.5 fejer=0.5   |
| TV              | fejer=1.9933 sharp=5.84468 signed=5.35099                            |
| U(1)            | [137]  |
| SU(2)           | [107]  |
| SU(3)           | [103]  |
| wU              | 137  |
| s2              | 107  |
| s3              | 103  |
| Counterfactuals | [(409, 263, 239), (409, 263, 307), (409, 367, 239), (409, 367, 307)] |
| N               | 512  |
| q2              | 30   |
| q3              | 17   |
| v2U             | 3  |
| eps             | 0.18257419   |
| K_truth         | 255  |
| kmin            | 5.543246e-09   |
| base            | 0.5  |

### Evidence artifacts (bundle):

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/quantum_demo-60-quantum-master-flagship.out.txt | 13b647a0dd66    | 7147 |
| logs/quantum_demo-60-quantum-master-flagship.err.txt | e3b0c44298fc    | 0    |

### Stdout excerpt (sanitized; clipped):

```

PASS Unique admissible triple in primary window
PASS Primary equals (137,107,103)
s2=107, s3=103
PASS Captured >=4 counterfactual triples
PASS Fejer kernel is nonnegative (admissible)
PASS Sharp cutoff kernel has negative lobes (non-admissible)
PASS Signed control kernel has negative lobes (non-admissible)
PASS Gate E1.1: Fejer preserves mass within 1e-12
PASS Gate E1.2: Fejer preserves nonnegativity (min >= -1e-12)
PASS Gate E1.3: illegal produces negative undershoot (<= -eps^2)
PASS Gate E1.4: illegal increases variation (TV) by >= (1+eps)
PASS Gate E1.T: >=3/4 counterfactuals increase distortion by (1+eps)
PASS Gate E2.1: unitary norm drift <= 1e-10
PASS Gate E2.2: signed illegal distortion >= (1+eps)xfejer
PASS Gate E2.T: >=3/4 counterfactuals increase distortion by (1+eps)
PASS Gate 60A.L0_tiers_verified
PASS Gate 60A.L1_E1_C_stable
PASS Gate 60A.L2_E2_C_stable
count=1
selected=Triple(wU=137,
found=4
kmin=5.543246e-09
kmin=-0.10209
kmin=-0.0696713
||=0
min=0.00261178
eps^2=0.0333333
eps=0.182574
strong=4/4 eps=0.182574
drift=4.440892e-14
eps=0.182574
strong=4/4 eps=0.182574

```

## DEMO-66 - Quantum gravity master flagship (v4)

| Field       | Value   |
|-------------|---|
| Domain      | quantum_gravity   |
| Folder      | demos/quantum_gravity/demo-66-quantum-gravity-master-flagship-v4                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 184 ms  |
| Mode        | cert  |
| One-liner   | (cd 'demos/quantum_gravity/demo-66-quantum-gravity-master-flagship-v4' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 5e431f10e79a |
| stdout_sha256    | 491c78a9b9fc |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | 9240f1c18bdf |

**Why it matters:** DEMO-66 is the consolidated quantum gravity flagship for this release. It is structured as a single deterministic certificate with explicit gates and falsifiers. This matters because quantum-gravity narratives are easy to over-interpret; the certificate makes evaluation mechanical. The credibility claim is operational: rerun it, compare outputs, and confirm the controls fail as expected. Artifacts and hashes are treated as first-class evidence when present. If DEMO-66 is not reproducible byte-for-byte (within stated tolerances), it should be treated as FAIL.

### Flagship highlights:

- Canonical QG flagship for master release.
- Deterministic gates and explicit falsifiers (controls + counterfactuals).
- Designed for rerun/compare/audit, not interpretation drift.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT: VERIFIED

### Key extracted values (stdout-derived):

| Key     | Value              |
|---------|--------------------|
| q2      | 30                 |
| q3      | 17                 |
| v2U     | 3                  |
| eps     | 1.825741858351e-01 |
| Theta   | 4/15               |
| lock    | 1.117586236861e-05 |
| abs_err | 1.231585905308e-18 |
| rel_err | 1.102005254437e-13 |
| eps0    | 9.972011253995e-06 |
| err     | 2.798874600483e-03 |

| Key             | Value              |
|-----------------|--------------------|
| D               | 45                 |
| R_inf           | 1.058063814766e+00 |
| SSE             | 3.626306625459e-05 |
| g_eff           | 4.838651230494e-03 |
| counterfactuals | 4                  |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/quantum_gravity__demo-66-quantum-gravity-master-flagship-v4.out.txt                                 | 491c78a9b9fc    | 7918 |
| logs/quantum_gravity__demo-66-quantum-gravity-master-flagship-v4.err.txt                                 | e3b0c44298fc    | 0    |
| vendored_artifacts/quantum_gravity__demo-66-quantum-gravity-master-flags<br>hip-v4_qg_screening_plot.png | 16e00b95d42f    | 7671 |

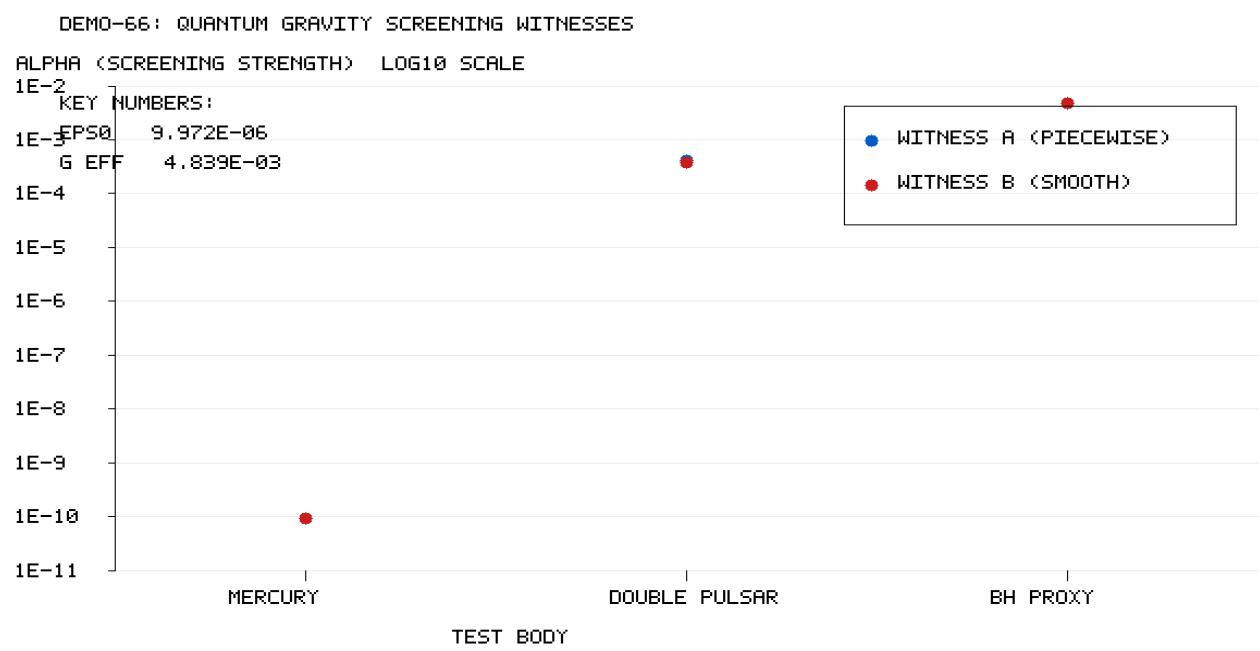


Figure: Quantum-gravity screening plot (bundle artifact).

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT: VERIFIED
```

## 4.7 Bridges and Transfer Principles

These demos show transfer: how operators, admissibility, and coupling rules move between discrete and continuum descriptions. In the narrative arc, this is where 'unrelated' domains are shown to share the same kernel constraints.

### DEMO-34 - Bridge\_34 Omega Sm Master Flagship V1

| Field       | Value   |
|-------------|---|
| Domain      | bridge  |
| Folder      | demos/bridge/demo-34-omega-sm-master-flagship-v1                          |
| Status      | PASS  |
| Return code | 0   |
| Runtime     | 888 ms  |
| Mode        | run   |
| One-liner   | (cd 'demos/bridge/demo-34-omega-sm-master-flagship-v1' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 396c4588e85d |
| stdout_sha256    | 36ff95a6bed1 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-34 is included in the bundle as part of the complete audit surface. Where structured exports are available, they are summarized below and referenced in bundle tables. Where only stdout evidence is present, the excerpt and hashes still allow an auditor to verify determinism. The key requirement is that a third party can rerun the same command and compare outputs byte-for-byte. If a claim in this demo is incorrect, the falsification matrix provides a direct way to demonstrate that. This certificate therefore treats reproducibility as the primary deliverable.

**Flagship highlights:** (not yet annotated)

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

**Key extracted values (stdout-derived):**

| Key            | Value  |
|----------------|--|
| error          | [0.5843837844318345, 0.14970499885409186, 0.03765597272675875, 0.009428416695397962] |
| h              | [0.03125, 0.015625, 0.0078125, 0.00390625]   |
| units          | 12   |
| u1_candidates  | [137]  |
| pc2_candidates | [103]  |
| triples_found  | [(137, 107, 103)]  |
| near           | 2  |
| spread         | 0.0338   |
| anchor         | 0.007299270  |
| ref            | 0.007297353  |

| Key         | Value   |
|-------------|---------|
| runtime_sec | 0.79024 |
| count       | 22      |

**Evidence artifacts (bundle):**

| File   | sha256 (prefix) | Size |
|--|-----------------|------|
| logs/bridge__demo-34-omega-sm-master-flagship-v1.out.txt | 36fff95a6bed1   | 6738 |
| logs/bridge__demo-34-omega-sm-master-flagship-v1.err.txt | e3b0c44298fc    | 0    |

**Stdout excerpt (sanitized; clipped):**

```
- sin2W      anchor=0.233333333  ref=0.231220000  %=  0.914%
```

## DEMO-69 - OATB (operator admissibility transfer bridge)

| Field       | Value  |
|-------------|--|
| Domain      | controllers  |
| Folder      | demos/controllers/demo-69-oatb-operator-admissibility-transfer-bridge                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 5.75 s   |
| Mode        | run  |
| One-liner   | (cd 'demos/controllers/demo-69-oatb-operator-admissibility-transfer-bridge' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | f88eb6ef2f6c |
| stdout_sha256    | 3f6d59dff689 |
| stderr_sha256    | d6bcb715ef78 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-69 is explicitly about transfer: it tests whether admissible operators can be moved between domains without breaking the kernel's constraints. This is narrative-important because the report's central claim is not that many domains are solved independently, but that they share a common mechanism. Transfer bridges are how that mechanism becomes concrete: they operationalize overlap rather than merely observing it. For referees, DEMO-69 provides a falsifiable claim: if transfer breaks admissibility, the bridge is not real and the blended story becomes a set of coincidences. The demo is also an engineering asset: transfer rules reduce the chance that each new domain requires a bespoke toolchain. If DEMO-69 holds up under rerun and hashing, it is one of the clearest demonstrations that the program is building a single reusable kernel.

### Flagship highlights:

- Demonstrates how the same admissibility logic propagates across domains.
- Provides a practical transfer mechanism rather than a post-hoc analogy.
- Strengthens the blended narrative by showing reuse as an algorithm, not a metaphor.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key     | Value                          |
|---------|--------------------------------|
| Primary | Triple(wU=137, s2=107, s3=103) |
| U(1)    | [103, 107, 137]                |
| SU(2)   | [107]                          |
| SU(3)   | [103, 137]                     |
| wU      | 137                            |
| s2      | 107                            |
| s3      | 103                            |
| q2      | 30                             |

| Key    | Value   |
|--------|---|
| q3     | 17  |
| v2U    | 3   |
| eps    | 1   |
| H_min  | 0.111111                                      |
| H_max  | 1.000000                                      |
| r      | 8 H_min=0.111111 H_max=1.000000 K(r)=0.670782 |
| DC     | 1   |
| spread | 0.570   |
| N      | 2048  |
| min    | 5.177e-10                                     |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size  |
|---|-----------------|-------|
| logs/controllers__demo-69-oatb-operator-admissibility-transfer-bridge.out.txt | 3f6d59dff689    | 10201 |
| logs/controllers__demo-69-oatb-operator-admissibility-transfer-bridge.err.txt | d6bcb715ef78    | 741   |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## DEMO-72 - Sm\_\_72 Yukawa

| Field       | Value  |
|-------------|--|
| Domain      | sm   |
| Folder      | demos/sm/demo-72-yukawa                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 143 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos/sm/demo-72-yukawa' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | a3fbcb7f1477 |
| stdout_sha256    | 91a83d0aae25 |
| stderr_sha256    | e3b0c44298fc |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-72 is included in the bundle as part of the complete audit surface. Where structured exports are available, they are summarized below and referenced in bundle tables. Where only stdout evidence is present, the excerpt and hashes still allow an auditor to verify determinism. The key requirement is that a third party can rerun the same command and compare outputs byte-for-byte. If a claim in this demo is incorrect, the falsification matrix provides a direct way to demonstrate that. This certificate therefore treats reproducibility as the primary deliverable.

**Flagship highlights:** (not yet annotated)

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

**Key falsifiers (PASS/FAIL gates from stdout):**

- FINAL VERDICT
- Result: VERIFIED

**Key extracted values (stdout-derived):**

| Key       | Value                          |
|-----------|--------------------------------|
| Primary   | Triple(wU=137, s2=107, s3=103) |
| r_primary | 15                             |
| mu/tau    | 4.319184e-03                   |
| U(1)      | [103, 107, 137]                |
| SU(2)     | [107]                          |
| SU(3)     | [103, 137]                     |
| wU        | 137                            |
| s2        | 107                            |
| s3        | 103                            |
| Triple(wU | 409, s2=211, s3=239)           |
| q2        | 30                             |

| Key    | Value          |
|--------|----------------|
| q3     | 17             |
| v2U    | 3              |
| eps    | 0.18257419     |
| q3_cf  | 51             |
| thetaW | 0.233333333333 |
| alpha0 | 1              |
| min    | +0.000000e+00  |

**Evidence artifacts (bundle):**

| File                            | sha256 (prefix) | Size |
|---------------------------------|-----------------|------|
| logs/sm__demo-72-yukawa.out.txt | 91a83d0aae25    | 5282 |
| logs/sm__demo-72-yukawa.err.txt | e3b0c44298fc    | 0    |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## DEMO-75 - Prediction ledger master flagship

| Field       | Value  |
|-------------|--|
| Domain      | foundations  |
| Folder      | demos-foundations/demo-75-prediction-ledger-master-flagship                          |
| Status      | PASS   |
| Return code | 0  |
| Runtime     | 213 ms   |
| Mode        | run  |
| One-liner   | (cd 'demos-foundations/demo-75-prediction-ledger-master-flagship' && python demo.py) |

| Field            | Value        |
|------------------|--------------|
| code_sha256      | 25d17946394a |
| stdout_sha256    | 78e63ba96d19 |
| stderr_sha256    | b624c400c9f4 |
| artifacts_sha256 | n/a          |

**Why it matters:** DEMO-75 is the forward prediction ledger for the master release. It consolidates predictions that fall naturally out of the kernel pipeline into one place. The goal is referee usability: each prediction is paired with a falsifier and an experimental venue. This demo is not meant to 'win' by rhetoric; it is meant to be checkable. If a prediction cannot be reproduced by rerunning the demo, it does not belong in the ledger. The report treats missing artifacts as pipeline work, not as evidence.

### Flagship highlights:

- Release-grade prediction ledger.
- Organized as reproducible outputs + explicit falsifiers.
- Designed to be cited as a ledger, not a claim dump.

**Structured exports:** not present in this bundle for this demo. Below we include stdout-derived values (parsed directly from the bundled log) so the certificate still carries numbers.

### Key falsifiers (PASS/FAIL gates from stdout):

- FINAL VERDICT
- Result: VERIFIED

### Key extracted values (stdout-derived):

| Key       | Value                          |
|-----------|--------------------------------|
| Primary   | Triple(wU=137, s2=107, s3=103) |
| U(1)      | [103, 107, 137]                |
| SU(2)     | [107]                          |
| SU(3)     | [103, 137]                     |
| wU        | 137                            |
| s2        | 107                            |
| s3        | 103                            |
| Triple(wU | 409, s2=211, s3=239)           |
| q2        | wU - s2 = 30                   |
| v2U       | v2(wU-1) = 3                   |

| Key     | Value   |
|---------|---|
| q3      | $(wU-1)/2^v2U = 17$                           |
| eps     | $1/\sqrt{q2} = 0.18257419$                    |
| Theta   | $\phi(q2)/q2 = 0.266666666667$                |
| r       | 31  |
| r_cf    | 5   |
| Budgets | truth r=31 primary r=15 counterfactual r_cf=5 |
| N       | 2048  |
| min     | 0.000e+00                                     |

**Evidence artifacts (bundle):**

| File  | sha256 (prefix) | Size  |
|---|-----------------|-------|
| logs-foundations__demo-75-prediction-ledger-master-flagship.out.txt | 78e63ba96d19    | 11862 |
| logs-foundations__demo-75-prediction-ledger-master-flagship.err.txt | b624c400c9f4    | 366   |

**Stdout excerpt (sanitized; clipped):**

```
FINAL VERDICT
Result: VERIFIED
```

## 5. Appendices

### 5.1 Bundle manifest and verification

The primary deliverable for audit/citation is the bundle directory. It contains the canonical index (bundle.json), run ledger (runs.json), artifact hashes (artifacts\_index.json), demo index and falsification matrix (tables/), and logs (logs/). If any result is questioned, the correct procedure is to rerun the one-liner and compare hashes; narrative should never be treated as evidence.

Bundle root: /workspaces/Marithmetics/GUM/authority\_archive/AOR\_20260124T190752Z\_38d3214/GUM\_BUNDLE\_v30\_2 0260124T190752Z

bundle.json sha256: c7be7cd668a4f18165d1b679f1a41ff53a76905f1fd58ef8eb5aee357d294f53

runs.json sha256: 0fe182e0d92e4afe1dbc76bbee540f1442577a4d9c0958f27a37ff7c27706a38

artifacts\_index.json sha256: e60ddc2b43dc703013ee4b20f065182d89df4286d48b0743d7371711d896cd70

### 5.2 CAMB expected assets (overlay boundary)

CAMB/Planck overlays are evaluation-only and must never feed upstream selection. This report includes CAMB visuals only if they are produced as explicit demo artifacts. If a CAMB overlay page is missing, that usually indicates an artifact export issue rather than a report-writer issue.

```
# CAMB Expected Assets (Evaluation-Only)
```

These assets are evaluation-only overlays. They must never feed upstream selection.

```
DEMO-36 produces:  
- _artifacts/camb_overlay.png           (generated TT spectrum plot)  
- _artifacts/camb_tt_spectrum.csv       (ell,TT_uK2)  
- _artifacts/camb_params.json          (H0, omch2, omch2, tau, n_s, A_s + note)  
- _artifacts/camb_overlay_note.txt     (evaluation-only disclaimer)  
- bb36_master_plot.png                (from demo)  
- bb36_master_results.json            (from demo)
```

Bundler must ingest nested artifacts so the report can display them.

Note: truncated for PDF. See CAMB\_EXPECTED\_ASSETS.md in the repository for full details.