Origin Axiom — Phase 3 (Exploratory Add-on): Flavor Phase Integration

Origin Axiom Collaboration

Abstract

Phase 3 integrates an empirically fitted phase parameter θ (from CKM+PMNS within a declared ansatz) into the Phase 2 vacuum residue mechanism, and documents the resulting correlation under strict under-claiming.

1 Scope and Non-Claims

1.1 Role of Phase 3 in the program

Phase 3 is a *ledger-compatible add-on*: it extracts a candidate value and uncertainty interval for θ by fitting a fixed, explicitly stated ansatz to frozen external flavor-sector targets (CKM and PMNS CP-phase information). The Phase 3 deliverable is not the internal fit machinery; it is the exported, schema-stable artifact `phase_03_theta_filter.json`, designed to be consumable by the Phase 0 corridor/ledger aggregation without requiring Phase 3 internals.

Concretely:

- **Inputs**: external target snapshot encoded in `phase3/fit/targets.yaml` (treated as frozen for this Phase 3 run) and the fixed ansatz implementation.
- **Outputs**: (i) fit summary and diagnostics tables, (ii) figures, (iii) this PDF report, and (iv) the ledger artifact `phase_03_theta_filter.json`.

1.2 What Phase 3 does and does not establish

Phase 3 establishes only the following narrow fact: under the Phase 3 baseline ansatz and frozen targets, there exists a best-fit θ and an uncertainty interval produced by an explicit, reproducible scan.

Non-claims (explicit). Phase 3 does *not* claim:

- a derivation of a unique fundamental constant $\theta_\star$;
- a proof that the Origin Axiom is correct, complete, or uniquely determined;
- a reduction of Standard Model free parameters, or a predictive theory of the CKM/PMNS structures;
- a measurement-level global fit (this is not a replacement for PDG/NuFIT analyses);
- robustness to arbitrary re-parameterizations or model classes beyond the declared ansatz family.

1.3 Success criteria (Phase 1/2 style contract)

A Phase 3 run is considered successful iff:

- the workflow gate reproduces all declared artifacts end-to-end;
- the bundle manifest lists exactly the declared inputs/outputs with hashes and sizes;
- the paper claims remain within the narrow scope above (no implied derivation or discovery).

Ledger-level outcome. At the level of the Phase 0 corridor ledger, Phase 3 contributes only a filter: it may further narrow the corridor defined by earlier phases or, in some configurations, eliminate it entirely. In the baseline configuration documented here (ansatz locked in `phase3/fit/targets.yaml` with the stated CKM/PMNS snapshot), the Phase 0 ledger reports that the combined corridor is empty once the Phase 3 filter is applied. We interpret this as a negative result for that specific ansatz/target combination, not as a proof that no Origin-Axiom-compatible corridor exists.

2 Fit Pipeline: CKM+PMNS $\to \theta$

We define an explicit mapping (ansatz) from a single phase parameter θ to a set of target observables and perform a grid-based χ^2 scan. We report the best-fit θ, an uncertainty interval, and diagnostics. External CKM/PMNS targets are treated as frozen inputs for this Phase 3 add-on, sourced from standard references (PDG and NuFIT snapshots) and encoded in `phase3/fit/targets.yaml` [1, 2].

2.1 Objective function

Let the ansatz predict a set of phase-like targets $\{\varphi_i(\theta)\}$ to be compared against frozen targets $\{\varphi_i^{\mathrm{tgt}}\}$ with uncertainties $\{\sigma_i\}$. Because phases are defined modulo 2π, we use a wrapped distance

$$\Delta(\alpha, \beta) = \mathrm{wrap}(\alpha - \beta) \in (-\pi, \pi], \qquad \chi^2(\theta) = \sum_i \left(\frac{\Delta(\varphi_i(\theta), \varphi_i^{\mathrm{tgt}})}{\sigma_i} \right)^2 .$$

The implementation details (grid bounds, step size, and target keys) are recorded in the accompanying metadata JSON produced by the workflow.

2.2 Discrete offset sweep and baseline choice

To avoid hidden parameter fitting, the Phase 3 baseline fixes all offset choices a priori and fits only θ. We nevertheless test a small discrete set of candidate fixed offsets for the PMNS phase mapping, $b_{\mathrm{PMNS}} \in \{0,\ \pi,\ -\pi/2,\ +\pi/2\}$, holding the rest of the ansatz fixed. For each hypothesis we run the same grid scan over θ and compare the minimum χ^2 values. The results are reported in Appendix 1.

We adopt as the Phase 3 baseline the discrete hypothesis with the lowest minimum χ^2 under the frozen targets. For the current run this selects $b_{\mathrm{PMNS}} = \pi$.

3 Injection Pipeline: $\theta \to$ Phase 2 diagnostic

The injection stage is a *downstream diagnostic* that consumes the fitted `theta_fit_summary.csv` artifact and evaluates the Phase 2 injection observable (vacuum-residue response) as a function of θ. This stage does *not* participate in the Phase 3 fit objective and therefore cannot retroactively improve the CKM/PMNS fit. Its role is purely cross-phase: it allows the Phase 3 best-fit interval to be visualized against the Phase 2 diagnostic curve, producing Figure 2 and associated provenance metadata.

All injection outputs are packaged in the Phase 3 paper bundle and listed in the manifest. The workflow records the exact inputs, hashes, and run environment so the diagnostic can be regenerated verbatim.

4 Falsifiability and Failure Modes

Phase 3 is falsifiable in the narrow sense appropriate to an exploratory fit: the mapping from θ to the frozen flavor targets can fail to produce a stable, interpretable interval.

4.1 Explicit failure conditions

We treat the Phase 3 extraction as *invalid* if any of the following occur:

- **Non-identifiability:** multiple disjoint θ regions yield indistinguishably good minima (flat or multi-modal χ^2 without a defensible interval).
- **Offset ambiguity:** the discrete offset sweep yields competing hypotheses with comparable minima, preventing a pre-registered baseline choice from being meaningful.
- **Target drift collapse:** a reasonable update of the external targets (future PDG/NuFIT releases) removes the minimum or shifts it outside any stable corridor overlap with other phases.
- **Ansatz fragility:** small, clearly stated modifications to the mapping family (within the declared ansatz class) destroy the existence of a stable minimum, indicating the result is an artifact of parameterization rather than a durable extraction.
- **Ledger incompatibility:** when the Phase 3 θ-filter is injected into the Phase 0 corridor ledger, the resulting combined corridor becomes empty (no θ survives simultaneous application of the Phase 0–2 and Phase 3 filters). This is treated as evidence against the locked Phase 3 ansatz/target combination until the ansatz or external targets are revised.

4.2 What Phase 3 can support downstream

If Phase 3 passes the checks above, it supports only this downstream use: the exported `phase_03_theta_filter.json` interval can be compared by Phase 0 ledger tooling to other phase constraints to test whether a corridor overlap emerges. No stronger inference is warranted.

5 Limitations

- **External-target dependence:** results are conditional on frozen PDG/NuFIT-style targets encoded in `phase3/fit/targets.yaml`. Updates to those targets may shift or erase the extracted interval.
- **Ansatz dependence:** the extraction is conditional on the declared mapping family. Phase 3 does not claim this family is unique or theoretically preferred.
- **Not a global fit:** this is not a full oscillation-data reanalysis or a replacement for PDG or NuFIT methodologies; it is a single-parameter exploratory scan.
- **Interpretation bound:** the only supported downstream interpretation is ledger comparison (corridor overlap) with other phases; no discovery claim is implied.

A Claims Table (Phase 3)

See `phase3/CLAIMS_TABLE.md` for the live evidence map.

B Reproducibility

Phase 3 follows the same gate structure as Phases 0–2, with explicit levels and a single Snakemake entry point. The authoritative, machine-readable reproducibility contract is documented in `phase3/REPRODUCIBILITY.md`, but we summarize the structure here.

Levels.

- **Level A (repo snapshot):** verify the paper and bundle from an existing repository snapshot. This level checks that the committed artifacts and the bundle manifest are internally consistent. Entry point: `bash scripts/phase3_gate.sh --level A`.
- **Level B (regenerate artifacts):** rebuild all tables, figures, the paper, and the paper bundle from source using Snakemake, then verify the bundle. This is the default reproducibility target for external readers: `snakemake -s phase3/workflow/Snakefile -c 1 all`, followed by `bash scripts/phase3_gate.sh --level B`.

Table 1: Discrete fixed-offset sweep for b_{PMNS} with a single fitted parameter θ. Lower χ^2 is better; $\Delta\chi^2$ is relative to the best row.

b_{PMNS} (deg)	θ^* (deg)	χ^2	$\Delta\chi^2$	$\theta^{\mathrm{lo}}_{68\%}$ (rad)	$\theta^{\mathrm{hi}}_{68\%}$ (rad)
180	65.682	0.675474	0.000000	1.120292	1.172128
90	65.790	1.881895	1.206421	1.122491	1.174013
-90	65.556	9.093410	8.417936	1.118407	1.169929
0	65.916	12.712767	12.037293	1.124690	1.176212

- **Level C (heavy runs):** optional developer mode that can populate `phase3/outputs/runs/` (git-ignored) with additional scans or diagnostics. This mode is not required to reproduce any claims in this paper, and is intended only for extended exploration: `bash scripts/phase3_gate.sh --level C`.

Bundle and evidence location. All artifacts used as evidence for the Phase 3 claims are collected under `phase3/outputs/paper_bundle/`, with a `run_index.json` and `bundle_manifest.json` that enumerate inputs and outputs with hashes and sizes. The canonical PDF for this phase is `phase3/artifacts/origin-axiom-p` built by the Phase 3 Snakemake workflow.

References

[1] Particle Data Group. Review of particle physics. *Phys. Rev. D*, 110:030001, 2024.

[2] I. Esteban, M. C. Gonzalez-Garcia, M. Maltoni, I. Martinez-Soler, and T. Schwetz. The fate of hints: updated global analysis of three-flavor neutrino oscillations. *JHEP*, 09:178, 2020. NuFIT 5.2 (online update; see nu-fit.org).

C Phase 3 θ-filter artifact (Phase 0 ledger interface)

Phase 3 emits a machine-readable θ-filter artifact: `phase3/outputs/theta_filter/phase_03_theta_filter.json`. This file is the Phase 3 contribution to the Phase 0 corridor method: it reports an admissible set of θ values under an explicitly declared Phase 3 test suite, along with provenance sufficient for audit and reproduction.

C.1 Declared test suite

Phase 3 is an empirical calibration filter (not an OA-binding demonstration). We therefore define a single test:

- **fit_compat_interval:** θ is admissible if it lies within the declared fit interval reported in `theta_fit_summary.csv`.

This choice is intentionally conservative: it makes the corridor definition explicit and reproducible, and it avoids parameter proliferation or implicit re-optimization beyond the one-parameter scan.

C.2 Schema compliance

The JSON conforms to the Phase 0 ledger interface: it declares a θ domain on $[0, 2\pi)$, provides an interval-form corridor representation, and includes a deterministic grid+pass array representation, plus provenance bindings (commit/config/environment hashes when available).

C.3 Ledger outcome in the current configuration

The Phase 0 ledger applies the Phase 3 θ-filter on top of the existing Phase 0–2 filters and records the resulting combined corridor in `phase0/phase_outputs/theta_corridor_history.jsonl`. In the baseline configuration documented here, the ledger reports that the combined corridor is empty once the Phase 3 filter is applied. This is logged as a negative test for the present Phase 3 ansatz/target combination, and it is intentionally encoded so that future runs with alternative ansatz choices or updated external targets can be compared against this outcome.