Phase 0: Contracts for a Reproducible Non-Cancellation Program

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January 2, 2026

Abstract

We present Phase 0 of the Origin Axiom program: a foundations and provenance layer that makes subsequent phases auditable, falsifiable, and resistant to accidental numerology. The program begins from a simple methodological postulate—*global perfect cancellation is forbidden*—and explores its consequences through controlled implementations and domain-to-domain transfers.

Phase 0 contributes four deliverables. First, we formalize the non-cancellation postulate as a constraint on a specified global complex amplitude A and a strictly positive floor $\varepsilon > 0$, and we define *binding* versus *non-binding* regimes to prevent misinterpretation of inert constraints. Second, we introduce a corridor-based inference protocol for the universal phase parameter $\theta \in [0, 2\pi)$: rather than fixing a single $\theta^\star$ early, each phase produces an admissible set (a corridor, possibly disconnected) via explicit pass/fail tests, and the program advances by intersecting these admissible sets across independent layers. Third, we state phase-by-phase contracts (assumptions, claims permitted, required artifacts, and non-claims) so that each phase can be locked only when its claims are tied to reproducible run manifests and ablation controls. Fourth, we define a minimal, deterministic "Phase 0 ledger" mechanism: future phases emit standardized JSON filter artifacts over θ, which the ledger intersects to produce a versioned corridor history and a human-auditable dashboard after each phase or subphase.

Phase 0 makes no physical claim that the postulate is true in nature, nor does it attempt to derive ε or a unique $\theta^\star$. Its purpose is to establish a rigorous scaffold in which later phases can test whether a single phase-like control parameter can coherently survive multiple independent constraints, and whether the corridor narrows toward a discrete or unique value as layers are added.

1 Introduction

1.1 Euler cancellation as a reference ideal

A useful reference point for what we mean by *cancellation* is Euler's identity,

$$e^{i\pi} + 1 = 0, \tag{1}$$

which expresses a precise and global destructive balance between two terms. As a mathematical statement it is exact; as a metaphor it captures a broader notion of *perfect cancellation*: a structured combination of contributions can sum to identically nothing. The Origin Axiom program begins by asking a constrained question: *what changes if global perfect cancellation is forbidden as an attainable outcome of the universe's bookkeeping?*

We emphasize that this is not an argument from aesthetics. The point of beginning from Eq. (1) is to make the null state concrete: if a theory permits exact global cancellation, then it admits a sharply defined "nothing" benchmark. The program explores the alternative posture: treat "nothing" as a boundary that cannot be crossed, and study the remainder forced by that boundary.

1.2 From philosophical premise to operational postulate

To move from intuition to science, the program adopts a minimal operational postulate. We define a specified global complex amplitude A constructed from the state of a model system (the precise construction is phase-dependent and must be stated explicitly). The Origin Axiom is then expressed as the constraint

$$|A| \geq \varepsilon, \qquad \varepsilon > 0, \tag{2}$$

where ε is a strictly positive floor. The intent is not to claim that Eq. (2) is already derived from a known fundamental action. Rather, Eq. (2) is treated as a *postulate to be tested by consequences.*

A crucial distinction follows immediately: a constraint can exist in code yet be irrelevant in a given regime. We therefore separate *non-binding* regimes (the raw evolution satisfies $|A| > \varepsilon$ and the constraint never activates) from *binding* regimes (the raw evolution would dip below ε, requiring intervention). This distinction is mandatory for intellectual honesty: any claim that "the axiom matters" must be accompanied by binding-regime evidence and ablations against a constraint-off baseline.

1.3 Why we introduce a universal phase parameter

The program's second organizing motif is the exploration of whether a single phase-like control parameter can coherently thread multiple domains. We denote this parameter by $\theta \in [0, 2\pi)$. The role of θ is not to serve as a numerological constant, but to act as a candidate *carrier* of a universal "twist" that could modulate: (i) flavor-sector structure (mixings and phases), (ii) the behavior of vacuum-like residuals under non-cancellation enforcement, and (iii) the stability and character of downstream cosmological embeddings.

This immediately raises a methodological hazard: if we fix a specific number $\theta^\star$ too early, later successes can appear to be engineered around a chosen value. Phase 0 therefore formalizes a corridor-based protocol in which $\theta^\star$ is treated, at most, as a *fiducial representative* within a larger admissible set.

1.4 Corridors instead of imposed constants

The key idea is to treat each phase as a filter on θ. We begin from an initial prior corridor $\Theta_0 \subset [0, 2\pi)$ (possibly broad). Each phase i defines explicit pass/fail tests $\mathcal{T}_i(\theta)$ that depend on reproducible artifacts (binding certificates, stability bounds, scaling checks, and transfer viability). The phase outputs an admissible set

$$\Theta_{i+1} = \{\theta \in \Theta_i : \mathcal{T}_i(\theta) \text{ passes}\}, \tag{3}$$

possibly disconnected, and the program advances by intersecting admissible sets across independent layers. In this framing, a single $\theta^\star$ is *earned* only if the intersection of independent constraints collapses the corridor toward a unique value (or a small discrete set), rather than being assumed at the outset.

1.5 What Phase 0 contributes

Phase 0 locks the epistemic and reproducibility scaffolding required for later phases to be meaningful:

- clear definitions of postulate versus implementation versus model versus consequence;
- a binding/non-binding regime distinction and the requirement of ablation evidence for causal claims;

- the corridor method for propagating admissible θ sets across phases;
- phase-by-phase contracts specifying what each phase is permitted to claim and what it must not claim;
- a minimal deterministic ledger mechanism that aggregates standardized per-phase θ-filter artifacts into a versioned corridor history and dashboard.

This paper therefore serves as the series' "contract layer": it does not attempt unification or parameter prediction. It establishes the rules by which subsequent claims will be stated, tested, audited, and either locked or rejected.

2 Axioms and definitions

This section fixes the minimal objects and terms that all subsequent phases must use consistently. Phase 0 is intentionally conservative: we define only what we must, and we label where later phases may refine or replace definitions.

2.1 Cancellation and the choice of a global amplitude

By *global cancellation* we mean the possibility that a specified aggregate complex quantity A constructed from the instantaneous state of a system can approach zero in magnitude,

$$|A| \to 0. \tag{4}$$

The program does not assume a unique universal definition of A across all domains. Instead, each phase must:

1. define A explicitly in terms of the phase's model variables, and
2. justify why that A is a relevant bookkeeping object for that phase.

Invariance requirement. To avoid purely representational artifacts, a phase must state what transformations leave its A invariant (or covariant) and why the constraint is meaningful under those transformations. Examples include invariance under basis changes, rephasing symmetries, coordinate transformations, or coarse-graining procedures. If a phase cannot provide an invariance statement, it must explicitly label its A as a *toy diagnostic* rather than a physically invariant observable.

2.2 The Origin Axiom (non-cancellation floor)

Postulate (OA). Given a specified global complex amplitude A for a given phase/model, the Origin Axiom asserts the existence of a strictly positive floor $\varepsilon > 0$ such that

$$|A| \geq \varepsilon. \tag{5}$$

In Phase 0 we treat Eq. (5) as a postulate; no derivation from an action, symmetry principle, or microphysical mechanism is claimed.

Interpretation. Equation (5) is a "no-perfect-nothing" constraint: it forbids A from entering an arbitrarily small neighborhood of the origin in the complex plane. The scientific question is not whether such a rule is aesthetically appealing, but whether implementing it produces controlled, falsifiable consequences in a chain of models.

2.3 Implementation: the minimal intervention rule

A postulate becomes testable only when implemented. We therefore define a minimal implementation hypothesis.

Implementation hypothesis (MI). When the raw evolution of the model would yield $|A_{\text{raw}}| < \varepsilon$, the constraint is enforced by applying the smallest correction (according to a phase-specified norm) needed to satisfy Eq. (5). We denote the enforced amplitude by A_{con}.

The exact definition of "smallest" is implementation-dependent and must be specified in each phase. Common choices include:

- radial projection in the complex plane: $A_{\text{con}} = \varepsilon\, A_{\text{raw}}/|A_{\text{raw}}|$ (when $A_{\text{raw}} \neq 0$),
- additive correction with minimal norm in a parameterized subspace,
- constrained optimization over model degrees of freedom.

Regardless of choice, the implementation must log sufficient diagnostics to audit whether and how enforcement occurred.

2.4 Binding vs non-binding regimes

We define two regimes:

Non-binding regime. A run is non-binding if the raw evolution satisfies $|A_{\text{raw}}(t)| > \varepsilon$ for the entire run. In this regime the implementation must be *non-invasive*: constrained and unconstrained runs should coincide up to numerical tolerance.

Binding regime. A run is binding if there exists at least one time (or step) at which $|A_{\text{raw}}| < \varepsilon$ and the enforcement rule is applied. Binding is therefore an objective event that can be certified by logged artifacts.

Binding certificate (required). Any phase that claims the axiom has a causal effect must provide, for at least one representative configuration, a binding certificate containing:

- `constraint_applied = true` (or equivalent),
- a quantitative measure of intervention (`n_hits`, `hit_fraction`, or `min_raw_minus_eps`),
- a paired ablation showing the divergence between constrained and unconstrained trajectories for a diagnostic of interest.

2.5 Residual, remainder, and diagnostic outputs

When enforcement occurs, the program focuses on what cannot be cancelled: the *remainder*. We use "residual" to denote a scalar diagnostic extracted from the system that is intended to track that remainder.

Each phase must define:

- the raw residual R_{raw},
- the constrained residual R_{con} (under OA enforcement),
- and the difference $\Delta R = R_{\text{con}} - R_{\text{raw}}$ (or a ratio) used to quantify axiom impact.

The residual is not assumed to be a physical observable in Phase 0; it is an operational diagnostic whose meaning and invariance must be argued phase-by-phase.

2.6 The universal phase parameter and its domain

We define a universal phase-like control parameter

$$\theta \in [0, 2\pi), \tag{6}$$

with the understanding that phases differing by integer multiples of 2π are equivalent in any dependence that enters only through $e^{i\theta}$ or other 2π-periodic functions.

We distinguish:

- **Fiducial representative** $\theta^\star$: a convenient point chosen for illustration or for a single-run benchmark within an admissible corridor.
- **Admissible corridor** Θ: a set of θ values that pass a phase's explicit test suite.

Phase 0 prohibits treating $\theta^\star$ as a derived constant unless the corridor-intersection protocol collapses Θ toward a unique value (or a small discrete set) under independent constraints.

2.7 Ablation principle (causal isolation)

Whenever a phase claims that OA enforcement causes an effect, it must include a paired ablation:

- Run A (control): constraint OFF (or $\varepsilon = 0$ / enforcement disabled),
- Run B (treatment): constraint ON with specified $\varepsilon > 0$,

with identical initialization, seed, and numerical parameters. Only then can differences be attributed to the axiom implementation rather than to confounders.

2.8 Phase locking criteria (definition)

A phase is considered *locked* only when:

1. its claims are explicitly stated;
2. every claim is tied to regenerable artifacts (figures/tables) and run manifests;
3. binding certificates are provided wherever causal axiom impact is asserted;
4. non-claims and limitations are explicitly listed;
5. provenance (git commit, config hash, environment) is recorded for all headline runs.

Phases that do not satisfy these conditions may be explored, but they may not be used as authoritative inputs for later phases.

3 The corridor method

The corridor method is the program's mechanism for avoiding premature fixation on a single numerical phase value and for converting multi-domain consistency into a quantitative narrowing of admissible parameter space. It is a disciplined alternative to "choose $\theta^\star$ and build around it": each phase contributes a filter, and the surviving set is the intersection of independent filters.

3.1 Admissible sets and phase filters

Let $\Theta_0 \subset [0, 2\pi)$ denote an initial prior corridor for the universal phase parameter θ. Phase 0 permits Θ_0 to be broad (including $\Theta_0 = [0, 2\pi)$) provided later phases define tests that are sufficiently θ-informative to narrow it.

Each phase i defines:

- a model family and an implementation of OA enforcement;
- a test suite $\mathcal{T}_i(\theta)$ composed of explicit pass/fail criteria;
- a scan or evaluation strategy over $\theta \in \Theta_i$ (grid scan, adaptive scan, or analytic characterization).

The phase outputs an admissible set

$$\Theta_{i+1} \;=\; \{\theta \in \Theta_i : \mathcal{T}_i(\theta) \text{ passes}\}. \tag{7}$$

The corridor Θ_{i+1} may be a single interval, a union of intervals, or a discrete set of isolated points.

3.2 What belongs in a test suite

A test suite $\mathcal{T}_i$ should be: *explicit*, *artifact-backed*, and, when possible, *independent* of tests used in other phases. Typical elements include:

Binding test (if the phase claims OA impact). There must exist a regime within the phase's explored parameter space where enforcement activates (binding certificate), and the constrained run differs from the constraint-off ablation.

Non-invasiveness test. In non-binding regimes, constrained and unconstrained runs must coincide up to numerical tolerance.

Stability test. The dynamics must remain bounded (no runaway) and numerically stable under specified sweeps (step size, resolution, cutoff).

Robustness test. Headline behavior must persist under a defined set of controlled perturbations (e.g., small parameter changes, discretization changes).

Transfer viability test. If the phase exports a derived object to a downstream module (e.g. mapping a residual into an FRW term), the exported object must keep the downstream solver stable and within a predeclared envelope.

3.3 Corridor narrowing and the role of thresholds

Corridors narrow only if tests are θ-informative. Phase 0 highlights three common failure modes:

1. **Weak dependence:** the diagnostic is nearly flat in θ, so $\mathcal{T}_i$ does not discriminate.
2. **Always non-binding:** the floor never activates for any θ in the explored regime, so OA impact is not tested.
3. **Always binding:** enforcement activates for all θ in the explored regime and saturates outputs, erasing θ-structure.

Threshold-driven tests are particularly valuable because they can create sharp boundaries in θ-space. For example, if a binding condition is expressed as $R_{\mathrm{raw}}(\theta) < \varepsilon$, then the set of θ values for which binding occurs is naturally separated from those for which it does not, producing a "kink" structure. Stacking multiple such thresholds across independent layers is one realistic route by which an initially broad corridor can collapse to a narrow interval or a discrete set.

3.4 Fiducial representatives and avoiding numerology

The corridor method permits the use of a fiducial representative $\theta^\star$ for:

- illustrative plots,
- benchmarking runtime and numerical stability,
- pinning a single run for detailed diagnostics.

However, $\theta^\star$ must be labeled as *fiducial* unless and until the corridor-intersection protocol collapses the admissible set to a unique value (or a small discrete set) under independent constraints. This labeling rule is the program's primary defense against accidental numerology.

3.5 From corridors to a point: when is a unique $\theta^\star$ earned?

A unique $\theta^\star$ is earned only if:

- the admissible corridor narrows monotonically (or nearly so) as independent constraints are added, and
- the final intersection Θ_{final} is either a single sufficiently small interval or a discrete set with a single element after accounting for symmetries (e.g. $\theta \sim \theta + 2\pi$ and other model-specific equivalences).

Phase 0 does not assume that such collapse must occur. If the corridor remains broad, the program interprets this as information: either θ is not uniquely fixed by the considered constraints, or the current phases do not supply sufficiently independent θ-informative tests.

3.6 The Phase 0 ledger mechanism (deterministic corridor tracking)

To prevent drift and to make corridor evolution auditable, Phase 0 introduces a minimal deterministic ledger mechanism. Each phase emits a standardized `theta_filter` artifact (JSON) encoding:

- the prior corridor used by the phase,
- the θ values evaluated (grid or intervals),
- pass/fail per θ under $\mathcal{T}_i$,
- optional scores ranking admissible θ values,
- and full provenance (git commit, config hash, run identifiers).

The ledger consumes the ordered list of phase artifacts and produces:

- the current corridor Θ as a union of intervals on $[0, 2\pi)$,
- an append-only corridor history log,
- and a human-readable dashboard summarizing which phases narrowed the corridor and why.

The ledger is strictly functional: given the same phase artifacts, it deterministically reproduces the same corridor history.

4 Phase contracts (I–V)

This section defines the series as a sequence of contracts. Each phase must state (i) its assumptions, (ii) its permitted claims, (iii) the artifacts required to support those claims, and (iv) explicit non-claims. The purpose is to ensure continuity: later phases inherit prior outputs without inheriting ambiguity.

4.1 Common contract clauses

All phases share the following mandatory clauses:

Causal isolation. Any claim that OA enforcement causes an effect must include a constraint-off vs constraint-on ablation with identical initialization and seed (Sec. 2.7).

Binding honesty. Any claim that OA enforcement matters must include at least one binding certificate (Sec. 2.4). Non-binding plots may be included as sanity checks, but they may not be used as evidence of axiom impact.

Provenance. Headline runs must log git commit, config hash, environment snapshot, and run identifiers sufficient to reproduce figures and tables.

Corridor output. Each phase must produce a standardized `theta_filter` artifact that encodes its admissible set Θ_{i+1} and the test suite outcomes.

4.2 Phase I: implementation sanity and minimal non-cancellation behavior

Objective. Demonstrate a stable implementation of OA enforcement in a controlled toy setting and verify the basic binding vs non-binding behavior.

Assumptions. A specific definition of the global amplitude A is chosen for the toy system, along with a concrete minimal-intervention enforcement rule.

Permitted claims.

- **Existence:** the implementation runs stably and is reproducible.
- **Binding behavior:** in binding regimes, constrained trajectories respect $|A| \geq \varepsilon$ while constraint-off trajectories can dip below ε.
- **Non-invasiveness:** in non-binding regimes, constrained and unconstrained runs agree up to tolerance.
- **Basic scaling:** within tested sweeps (resolution/volume/time step), the qualitative behavior is stable and does not trivially disappear.

Required artifacts.

- at least one binding certificate (time-series diagnostic showing pinning at ε),
- at least one non-binding certificate (agreement constrained vs unconstrained),
- at least one scaling/robustness sweep figure,
- run manifest mapping each artifact to run directories and configurations,
- a `phase_01_theta_filter.json` artifact (even if Phase I does not strongly narrow θ).

Non-claims. Phase I does not claim physical identification of ε, does not claim cosmological relevance, and does not claim derivation of $\theta^{\star}$.

4.3 Phase II: pipeline closure (residual → cosmological embedding)

Objective. Close an end-to-end toy pipeline in which a residual diagnostic produced under OA enforcement is mapped into a minimal cosmological embedding (e.g. an FRW background term), and verify stability and controlled dependence on θ.

Assumptions. A toy vacuum-like model produces a residual $R(\theta)$, and a specified mapping f produces an effective cosmological contribution (e.g. $\Omega_\Lambda(\theta) = f(R(\theta))$) in a normalized FRW solver.

Permitted claims.

- **End-to-end viability:** the pipeline runs reproducibly from residual extraction to FRW integration.
- **OA impact in binding regimes:** in at least one binding corridor, OA enforcement measurably changes $R(\theta)$ relative to ablation baselines.
- **Robustness:** key behaviors persist under declared sweeps (floor scale, discretization/UV controls, solver tolerances).
- **Controlled transfer:** the mapped term does not induce numerical instability or runaway behavior in the downstream FRW solver within the declared envelope.

Required artifacts.

- at least one *binding-regime* residual plot with ablation,
- sweeps showing stability/robustness of the residual diagnostic,
- FRW comparison diagnostics that demonstrate stable integration and bounded deviation,
- a complete run manifest,
- `phase_02_theta_filter.json` encoding admissible θ values under Phase II tests.

Non-claims. Phase II does not claim to match the observed cosmological constant, does not claim EFT matching to the Standard Model + GR, and does not claim a first-principles derivation of OA or of a unique $\theta^{\star}$.

4.4 Phase III: principled mechanism (beyond an algorithmic floor)

Objective. Replace or justify the OA enforcement rule by a principled mechanism (action-level constraint, symmetry, topological condition, or emergent selection principle) and test whether Phase I/II behaviors persist or are modified.

Permitted claims.

- derivation or motivated embedding of a non-cancellation mechanism within a declared framework,
- identification of invariants and transformation properties that reduce definition dependence of A and R,
- new quantitative predictions or sharper constraints on θ arising from the principled mechanism.

Required artifacts.

- explicit statement of framework assumptions and limitations,
- tests demonstrating that Phase I/II-style binding behavior is reproduced or replaced in a controlled way,
- `phase_03_theta_filter.json` capturing Phase III admissibility.

Non-claims. Phase III does not claim final unification unless independently constrained cross-domain predictions are produced and survive ablations.

4.5 Phase IV: cross-domain predictive tests

Objective. Confront the program with multiple independent empirical targets (flavor observables, cosmological observables, microstructure/defect signatures, or other measurable proxies) and test whether a consistent corridor survives.

Permitted claims.

- nontrivial predictions or narrowed admissible regions arising from independent datasets or constraints,
- identification of signatures capable of falsifying the program.

Required artifacts.

- explicit definition of datasets/proxies used,
- independent test suites and clear uncertainty handling,
- `phase_04_theta_filter.json`.

4.6 Phase V: consolidation and synthesis

Objective. Synthesize the surviving corridor and mechanisms into a consolidated framework *only if* the intersection of independent constraints becomes narrow and stable.

Permitted claims. Phase V may claim a derived $\theta^\star$ (unique or discrete) only if the corridor-intersection history demonstrates robust collapse under independent constraints and if the resulting framework produces additional testable predictions.

Required artifacts.

- consolidated corridor history and justification of collapse,
- full provenance for all contributing phases,
- explicit list of remaining assumptions and open problems.

5 Reproducibility contract

Reproducibility is treated here not as an aspirational virtue but as a formal requirement for phase locking. This section defines the minimum artifact, logging, and provenance standards that each phase must meet. Any result that does not satisfy these standards may be explored, but it may not be used as an authoritative input for later phases.

5.1 Artifact-first claims

Every technical claim in the series must be reducible to a finite set of regenerable artifacts: figures, tables, and machine-readable summaries produced by logged runs. A claim is considered *valid* only if it is accompanied by:

- the artifact identifier (figure/table label),
- the generating run identifier (run directory or run ID),
- the configuration snapshot used by the run,
- and the exact code revision (git commit hash).

Statements that are not tied to artifacts must be explicitly labeled as motivation, conjecture, or future work.

5.2 Run manifests

Each phase must provide a run manifest mapping every headline figure/table to its provenance. At minimum, a manifest entry includes:

- the script or module entrypoint used to generate the artifact,
- the configuration file(s) and the resolved parameter snapshot,
- the run directory containing raw outputs and summaries,
- the canonical staged artifact included in the paper build,
- hashes/signatures sufficient to detect drift (config hash, artifact hash).

The manifest may be presented as an appendix table or as a machine-readable file referenced by the paper.

5.3 Ablation discipline

Causal attribution requires ablation. Any claim of the form "OA enforcement produces effect X" must be supported by paired runs:

1. **Control (OFF):** enforcement disabled (or $\varepsilon = 0$), producing $(A_{\text{raw}}, R_{\text{raw}})$.
2. **Treatment (ON):** enforcement enabled with specified $\varepsilon > 0$, producing $(A_{\text{con}}, R_{\text{con}})$.

All other parameters and random seeds must be identical. If seeds are not applicable, the phase must explain what replaces stochastic reproducibility (e.g. deterministic integrators with fixed tolerances).

5.4 Binding certificates: the non-negotiable gate

Because the series centers on non-cancellation enforcement, any phase that claims OA relevance must include binding evidence. A *binding certificate* consists of:

- an explicit `constraint_applied` flag (true/false),
- a quantitative measure of binding intensity (e.g. `n_hits`, `hit_fraction`, or $\min_t(|A_{\mathrm{raw}}(t)|-\varepsilon)$),
- at least one overlay diagnostic comparing constraint-off vs constraint-on behavior in the binding regime.

Phases may include non-binding results as sanity checks, but non-binding results cannot be used to support causal claims about OA impact.

5.5 Logging requirements

Each run that contributes to a headline artifact must log:

Configuration. A complete configuration snapshot and a fully resolved parameter file (including defaults expanded and derived values recorded).

Provenance.

- git commit hash,
- dirty state indicator (whether uncommitted changes were present),
- run timestamp in UTC,
- platform information (OS, CPU/GPU if relevant).

Numerics.

- step sizes, solver tolerances, discretization parameters,
- random seeds and RNG algorithms when applicable,
- run length (steps/time), and any termination criteria.

Environment. A package/environment snapshot sufficient to recreate the runtime (e.g. `pip freeze` or equivalent).

Summaries. A machine-readable `summary.json` containing the scalar quantities used by captions and tables, and pointers to raw arrays when needed.

5.6 Deterministic phase ledger artifacts

To ensure the corridor method is not merely narrative, each phase must emit a standardized `theta_filter` artifact. At minimum, the artifact includes:

- the prior corridor used by the phase,
- the evaluated θ grid or interval representation,
- pass/fail outcomes for each θ under the declared test suite,

- optional scores ranking admissible θ values,
- full provenance linking each evaluated θ to run identifiers.

The Phase 0 ledger consumes these artifacts in order and deterministically reproduces the corridor history. A phase is not lockable unless its `theta_filter` artifact can be processed by the ledger without manual intervention.

5.7 Versioning and drift control

A common failure mode in long projects is silent drift: figures are regenerated under different assumptions without traceability. The series therefore adopts the following drift controls:

- headline artifacts are staged in canonical locations with signature/hash files;
- paper builds are reproducible from a clean checkout at the referenced commit;
- any change to configuration defaults or model definitions that could affect results must trigger regeneration of affected artifacts and an explicit changelog entry.

These controls are treated as part of the scientific method of the program, not as auxiliary engineering.

6 Falsifiability and failure modes

A constraint-based research program can fail in ways that are subtle: it may remain internally consistent while producing no discriminating predictions. Phase 0 therefore makes falsifiability explicit. We define what would count as failure at multiple levels: implementation failure, inference failure, and cross-domain coherence failure.

6.1 What would falsify the program (within its own scope)

The Origin Axiom program makes a set of internal commitments. The following outcomes would falsify those commitments:

F1: OA enforcement cannot be made stable. If, across reasonable numerical choices, enforcing $|A| \geq \varepsilon$ systematically produces numerical instability, runaway corrections, or irreproducible behavior, then the program fails at the implementation level. In that case, later phases cannot inherit results because the postulate cannot be operationalized reliably.

F2: OA enforcement is either inert everywhere or dominates everywhere. If, for all explored regimes and for all $\theta \in \Theta_i$, runs are always non-binding (the axiom never activates), then OA impact is untested and the phase cannot support causal claims. Conversely, if runs are always binding and enforcement saturates all outputs, then θ-structure is erased and the corridor method cannot narrow. Either outcome indicates that the phase's test suite is not informative as a filter layer.

F3: Corridor method produces no narrowing under independent constraints. If successive phases add genuinely independent tests and yet the corridor intersection remains effectively unchanged, the program must conclude either: (i) θ is not meaningfully constrained by the tested layers, or (ii) the chosen diagnostics and mappings are too weakly θ-dependent to carry information. A persistent lack of narrowing is not necessarily a refutation of OA as a postulate, but it refutes the specific unification aim that a single θ can be empirically earned by cross-layer consistency.

F4: Inconsistent intersections (empty corridor). If two or more phases, each stable and internally consistent, yield admissible sets whose intersection is empty,

$$\Theta_i \cap \Theta_j = \emptyset, \tag{8}$$

then the program's cross-domain stitching fails at the current level of modeling assumptions. This is a decisive signal: either one phase's model/diagnostic is mis-specified, or the notion that a single θ threads those layers is incorrect. In either case, the correct response is not to "pick a number," but to revisit assumptions, invariances, and mappings.

F5: Lack of ablation separation. If purported OA-driven effects persist even when enforcement is disabled, or if constrained and unconstrained runs agree in claimed binding regimes, then the evidence does not support causal attribution. This is a failure of scientific hygiene and invalidates the corresponding claim set.

6.2 Expected failure modes and how we detect them early

E1: Definition dependence of A and R. A common failure is that the chosen amplitude A or residual R is not invariant under relevant transformations, making the constraint an artifact of representation. Mitigation: each phase must state invariance properties (Sec. 2.1) and include ablations that demonstrate that headline behavior is not a gauge/basis accident within the model.

E2: Parameter degeneracy masquerading as a corridor. A wide corridor can reflect a real degeneracy (multiple θ values genuinely equivalent) or a weak diagnostic (the phase does not bite on θ). Mitigation: report not only pass/fail but also θ-dependence of key observables and optional scores that quantify preference within the corridor.

E3: Overfitting the mapping between layers. When a residual is mapped into a downstream module (e.g. FRW), ad hoc mappings can absorb discrepancies and make almost any θ appear viable. Mitigation: declare mapping form and constraints explicitly; include mapping ablations; require that at least one downstream viability criterion is not trivially satisfied by rescaling.

E4: Drift in "canonical" outputs. As the program evolves, canonical figures and claims can drift without explicit acknowledgement. Mitigation: artifact hashes, run manifests, and explicit phase locking criteria (Sec. 2.8) prevent silent drift.

6.3 Locking criteria revisited as falsifiability gates

We restate phase locking as an operational falsifiability gate: a phase may be considered locked only if its claims survive ablations, its OA-relevance claims include binding certificates, and its admissible θ set is recorded in ledger-compatible form. If a phase cannot meet these gates, the appropriate scientific outcome is to treat it as exploratory and to refrain from using it as an authoritative layer in the corridor intersection.

7 Discussion: candidate origins and interpretations of non-cancellation

Phase 0 treats the Origin Axiom as a postulate tested by consequences. Nevertheless, it is useful to catalogue plausible ways in which non-cancellation-like behavior could arise in established scientific language. This section is intentionally framed as *candidate interpretations* rather than as claims; it is a map of mechanistic hypotheses to be evaluated in later phases.

7.1 Constraint as a consistency condition

Many physical principles are best understood as consistency constraints: requirements that exclude pathological states rather than constructive dynamical laws. Examples include positivity of probabilities, unitarity constraints, anomaly cancellation conditions, and stability bounds. In this spirit, the non-cancellation floor may be interpreted as a consistency requirement on an aggregate quantity A: the theory does not permit trajectories that enter an arbitrarily small neighborhood of $A = 0$.

Under this interpretation, the primary scientific tasks are: (i) to identify a suitable invariant definition of A in realistic settings, (ii) to demonstrate that enforcing the constraint does not introduce contradictions, and (iii) to determine whether the constraint yields nontrivial predictions.

7.2 Selection principle: minimal intervention and extremality

If enforcement is framed by a minimal-intervention rule (Sec. 2.3), one may reinterpret the program as exploring an extremal selection principle: among all evolutions compatible with the model, the realized evolution minimizes a cost functional associated with approaching perfect cancellation.

Concretely, one might define an intervention cost

$$C(\theta) = \int dt \; \mathcal{L}_{\mathrm{int}}(A_{\mathrm{raw}}(t;\theta), \varepsilon)\,, \tag{9}$$

with $\mathcal{L}_{\mathrm{int}}$ penalizing excursions below ε. Later phases could examine whether the corridor method effectively selects θ values that minimize such costs while satisfying stability and transfer constraints. Phase 0 does not commit to this interpretation; it is presented as a viable formalization route.

7.3 Topological and holonomy-like interpretations

Phase-like parameters that survive across domains are often associated with holonomy, winding, or Berry-phase structures. In such settings, certain values can become preferred or quantized due to topological consistency conditions. A non-cancellation constraint could plausibly arise as a statement that a global phase defect (or holonomy) cannot be gauged away and therefore enforces an irreducible remainder.

This class of interpretations is attractive because it offers a route to: (i) invariance under local redefinitions, (ii) robustness to perturbations, and (iii) discrete candidate values for θ through quantization. Whether the Origin Axiom can be embedded in such a structure is a Phase III-level question.

7.4 Information-theoretic perspectives

Another broad interpretation treats cancellation as erasure. In information-theoretic language, perfect global cancellation would correspond to a lossless compression of structure into null output. A non-cancellation postulate can be viewed as forbidding complete erasure of structured information in the system's global bookkeeping.

This perspective is speculative but potentially productive: it suggests defining A as an information-carrying functional and interpreting ε as a lower bound on retained distinguishability. Phase 0 does not assert such a mapping; it notes it as a conceptual lane that may later yield invariance principles or scaling expectations.

7.5 Caution: avoiding "anything can be enforced"

A central scientific concern is that an arbitrary floor ε can be imposed on almost any quantity, making the program vacuous. The corridor method and the reproducibility gates exist to prevent this failure mode. To remain nontrivial, later phases must show:

- binding regimes where OA enforcement demonstrably changes outcomes,
- robustness and scaling properties that restrict ε and implementation choices,
- and independent constraints that meaningfully narrow θ rather than leaving it free.

If these conditions are not met, the correct conclusion is not that the axiom is "true," but that the current definitions do not produce discriminating science.

8 Conclusion

Phase 0 establishes the canonical scaffold for the Origin Axiom program. We have formalized the non-cancellation postulate as a floor constraint on a phase-specified global complex amplitude A with $\varepsilon > 0$, and we have separated binding from non-binding regimes to prevent misinterpretation of inert constraints. We introduced the corridor method as the program's inference protocol for a universal phase parameter $\theta \in [0, 2\pi)$: each phase is required to define explicit pass/fail tests, output an admissible set of θ values, and propagate progress by intersecting admissible sets across independent layers rather than by fixing $\theta^\star$ prematurely.

We also defined the reproducibility contract that governs the entire series. Causal claims require ablations; OA-relevance claims require binding certificates; and all headline results require run manifests and full provenance. Finally, we specified a minimal deterministic ledger mechanism that ingests standardized per-phase JSON filter artifacts to produce a versioned corridor history and a human-auditable dashboard after each phase or subphase.

Phase 0 makes no claim that the Origin Axiom is true in nature, nor does it attempt to derive ε or a unique $\theta^\star$. Its purpose is to make the subsequent phases reviewable: if later phases succeed, the program will have earned the right to claim that a single phase-like parameter can survive multiple independent constraints and potentially collapse from a corridor to a discrete or unique value. If later phases fail, the failure will be legible: it will be attributable to explicit assumptions, invariance limitations, or insufficiently informative tests rather than to hidden drift or untracked choices.

With this scaffold locked, Phase I and Phase II can be read as disciplined experiments: Phase I validates the implementation and basic binding behavior of OA enforcement, and Phase II tests whether a constrained residual can be transferred into a stable downstream embedding with controlled dependence on θ. Subsequent phases may then attempt principled mechanisms, cross-domain predictions, and consolidation only to the extent that the corridor-intersection history supports such claims.

A Notation and glossary

This appendix defines notation and terms used throughout Phase 0 and inherited by subsequent phases. Where later phases introduce specialized variants, they must either reuse these symbols consistently or explicitly declare deviations.

A.1 Core symbols

- $\theta \in [0, 2\pi)$: universal phase-like control parameter (defined modulo 2π).

- $\theta^\star$: a *fiducial representative* value of θ used for benchmark runs or illustrative plots; not a derived constant unless corridor collapse is demonstrated.
- $\Theta \subset [0, 2\pi)$: an admissible set (corridor) of θ values; may be a union of intervals or a discrete set.
- Θ_0: initial prior corridor.
- Θ_i: corridor after applying filters from phases $1, \ldots, i-1$.
- $\mathcal{T}_i(\theta)$: Phase-i test suite (explicit pass/fail criteria) evaluated at θ.
- A: a phase-specified global complex amplitude used to define "cancellation" and the OA floor.
- A_{raw}: the amplitude produced by the unconstrained (constraint-off) evolution.
- A_{con}: the amplitude after enforcement of the OA floor.
- $\varepsilon > 0$: the strictly positive floor in the Origin Axiom constraint.
- R: a phase-specified scalar residual diagnostic associated with non-cancellation / remainder.
- R_{raw}: residual from the unconstrained run.
- R_{con}: residual from the constrained run.
- ΔR: difference between constrained and unconstrained residual (definition must be stated; additive or multiplicative).

A.2 Key terms (glossary)

Cancellation. The approach of the chosen global amplitude toward zero magnitude, $|A| \to 0$, within a specified model/phase definition.

Non-cancellation (Origin Axiom). The postulate that $|A|$ is bounded below by a strictly positive floor ε (Eq. (5)).

Implementation. A concrete algorithm or rule that enforces the postulate within a chosen model, including how corrections are applied and how minimality is defined.

Minimal intervention (MI). An implementation hypothesis stating that when enforcement is required, the smallest correction (according to a declared norm or cost) is applied to satisfy $|A| \geq \varepsilon$.

Non-binding regime. A run/regime in which the raw evolution never violates the floor: $|A_{\text{raw}}(t)| > \varepsilon$ for all times/steps. In this regime the constraint should be non-invasive.

Binding regime. A run/regime in which the raw evolution would violate the floor at least once: $\exists t$ such that $|A_{\text{raw}}(t)| < \varepsilon$. In this regime enforcement must activate, and constrained and unconstrained runs may differ.

Binding certificate. A logged artifact demonstrating that enforcement occurred (e.g. a boolean flag plus a quantitative measure of hits) and that the constrained trajectory differs from the constraint-off ablation in a diagnostically relevant way.

Ablation. A controlled comparison where a single factor is changed (here: constraint OFF vs ON), holding all other settings fixed (seed, configuration, numerics). Required for causal attribution.

Test suite. A set of explicit criteria used to define admissibility of θ values in a phase, including binding evidence (when required), stability, robustness, and transfer viability.

Admissible set / corridor. The subset of θ values that pass a phase's test suite; represented as a union of intervals on $[0, 2\pi)$ or as a discrete set of points.

Corridor method. The protocol that advances the program by intersecting admissible sets across phases:

$$\Theta_{i+1} = \{\theta \in \Theta_i : \mathcal{T}_i(\theta) \text{ passes}\}.$$

Ledger. A deterministic mechanism that ingests per-phase `theta_filter` artifacts and produces a versioned corridor history and dashboard, enabling audit-grade tracking of corridor narrowing over time.

Phase locking. A phase is "locked" only when its claims are explicitly stated, tied to regenerable artifacts, supported by required ablations and binding certificates, and accompanied by full provenance and ledger-compatible corridor outputs (Sec. 2.8).

B Phase θ-filter artifact schema (ledger interface)

This appendix defines the minimal machine-readable interface by which each phase reports its admissible θ set to the Phase 0 ledger. The goal is to make corridor evolution deterministic and auditable.

B.1 Design goals

The `theta_filter` artifact must:

- be sufficient to reconstruct the phase's admissible set Θ_{i+1};
- record the phase's declared test suite and the pass/fail outcome for each evaluated θ;
- contain provenance linking each evaluated θ (or interval) to reproducible run identifiers;
- be stable under minor refactors (schema versioned; backwards compatible when possible).

B.2 Minimal required fields

Each phase must emit a JSON file named

$$\texttt{phase\_XX\_theta\_filter.json}, \tag{10}$$

where `XX` is a zero-padded phase number.

The minimal schema is:

```
{
  "schema_version": "1.0",
  "phase": 2,
  "subphase": "optional-string",
```

```
  "theta_domain": [0.0, 6.283185307179586],

  "theta_prior": {
    "type": "intervals",
    "intervals": [[2.18, 5.54]]
  },

  "theta_grid": [2.18, 2.20, 2.22, ...],

  "tests": ["binds", "stable", "robust", "transfer_viable"],

  "pass": [true, false, true, ...],

  "fail_reasons": [
    [],
    ["binds=false", "stable=false"],
    []
  ],

  "provenance": {
    "git_commit": "abcdef123456",
    "config_hash": "sha256:...",
    "environment": "pip-freeze-or-env-hash",
    "run_ids": {
      "theta=2.18": "outputs/runs/<run_id>/",
      "theta=2.20": "outputs/runs/<run_id>/"
    }
  }
}
```

B.3 Optional fields (recommended)

The following fields are optional but recommended for diagnostics and ranking:

Scores. A phase may provide one or more score arrays aligned with `theta_grid`:

```
"score": {
  "intervention_cost": [...],
  "stability_margin": [...],
  "transfer_penalty": [...],
  "total": [...]
}
```

Scores should be documented in the phase paper and interpreted cautiously. Scores do not replace pass/fail; they rank within the admissible set.

Interval representation. If a phase analytically characterizes admissibility as intervals rather than by grid scan, it may omit `theta_grid` and instead provide:

```
"theta_pass": {
  "type": "intervals",
  "intervals": [[a1, b1], [a2, b2]]
}
```

The ledger will accept either representation. If both are present, `theta_pass` takes precedence.

Binding metrics. When OA impact is claimed, phases should include binding metrics per θ:

```
"binding": {
  "epsilon": 1e-6,
  "hit_fraction": [...],
  "n_hits": [...],
  "min_raw_minus_eps": [...]
}
```

B.4 Ledger interpretation rules

To ensure determinism, the ledger applies the following rules:

1. The admissible set Θ_{i+1} is reconstructed from either:
   - `theta_pass.intervals` (if present), or
   - the subset of `theta_grid` entries where `pass=true`, grouped into contiguous intervals using a declared grid spacing tolerance.
2. Corridors are represented internally as unions of intervals on $[0, 2\pi)$. Any wrap-around interval is represented as two intervals.
3. The new corridor is computed by intersection:
$$\Theta \leftarrow \Theta \cap \Theta_{i+1}.$$
4. If the intersection is empty, the ledger must emit an error state and record which phase artifact caused the empty intersection.

B.5 Schema evolution

Future schema versions must:

- bump `schema_version`,
- preserve required fields or provide an explicit compatibility layer in the ledger,
- document changes in Phase 0 and in the ledger README.

C Toy example: corridor shrinking by intersecting independent thresholds

This appendix provides a minimal illustrative example of the corridor method. The goal is not to model physics, but to show how independent constraints can narrow an initially broad Θ_0 toward a small interval or isolated point(s).

C.1 Setup

Let $\theta \in [0, 2\pi)$ and begin with a broad prior corridor:

$$\Theta_0 = [0, 2\pi). \tag{11}$$

Assume three independent layers (phases) each supplies a pass/fail test based on a threshold condition.

C.2 Layer 1: a smooth preference window

Suppose Phase I admits θ values that satisfy

$$\mathcal{T}_1(\theta): \quad |\sin(\theta - \alpha)| \le c_1, \tag{12}$$

for some α and $0 < c_1 < 1$. This yields an admissible set Θ_1 consisting of two intervals per 2π period centered near $\theta \approx \alpha$ and $\theta \approx \alpha + \pi$.

C.3 Layer 2: a binding "kink" constraint

Suppose Phase II includes a binding condition where enforcement activates only when a diagnostic dips below a floor:

$$R_{\text{raw}}(\theta) < \varepsilon. \tag{13}$$

If, for illustration, $R_{\text{raw}}(\theta)$ crosses ε near a specific phase offset, then the admissible set Θ_2 may be defined as:

$$\mathcal{T}_2(\theta): \quad R_{\text{raw}}(\theta) < \varepsilon \quad \text{and} \quad \Delta R(\theta) > 0, \tag{14}$$

where ΔR measures a detectable OA impact relative to a constraint-off ablation. This constraint can produce sharp boundaries (a "kink") separating binding from non-binding regions and can therefore shrink Θ_1 substantially when intersected.

C.4 Layer 3: a stability window

Suppose Phase III admits only θ values for which a downstream solver remains stable:

$$\mathcal{T}_3(\theta): \quad \text{solution exists and remains bounded for } t \in [0, T]. \tag{15}$$

In many dynamical systems, stability occurs only in windows, producing disconnected admissible sets.

C.5 Intersection and outcomes

The corridor method advances by intersection:

$$\Theta_{\text{final}} = \Theta_1 \cap \Theta_2 \cap \Theta_3. \tag{16}$$

Depending on the relative placement of windows and thresholds, three typical outcomes occur:

Outcome A: narrow interval. If the three admissible sets overlap in a single small window, the final corridor is a short interval. In this case θ is constrained but not uniquely determined.

Outcome B: discrete candidates. If overlaps occur only at isolated points (e.g. where a binding kink boundary intersects a stability boundary), the final admissible set can become a discrete set. This is common when constraints impose threshold-like behavior or when symmetry is partially broken.

Outcome C: no narrowing. If one or more tests are weakly θ-dependent, the corresponding admissible set is nearly all of $[0, 2\pi)$ and the intersection remains broad. This indicates that the phase is not informative as a filter layer and motivates revisiting its diagnostics or regimes to ensure binding and θ sensitivity.

C.6 Why this matters for the series

The toy example highlights why Phase 0 insists on:

- explicit binding evidence (to ensure OA is actually tested),
- independence of constraints across phases (to avoid redundant filters),
- and ledger-tracked corridor evolution (to make narrowing quantitative).

If later phases succeed, the corridor history will provide transparent evidence for whether a unique $\theta^\star$ is earned, whether multiple discrete candidates remain, or whether θ remains effectively unconstrained by the explored layers.

D Claims checklist (arXiv honesty and auditability)

This appendix is a practical checklist used to prevent overclaiming and to keep the paper series intellectually honest. Each phase must satisfy the relevant items before it can be considered "locked."

D.1 Claim classification

For each statement in the paper, label it as one of:

1. **Definition / postulate** (declared, not derived),
2. **Implementation hypothesis** (algorithmic rule),
3. **Model assumption** (toy environment choices),
4. **Consequence / result** (artifact-backed),
5. **Conjecture / future work** (explicitly non-validated).

If a statement cannot be classified, rewrite it.

D.2 Artifact linkage

For each *result* statement:

- Does the paper cite a figure/table label?
- Does the run manifest identify the exact run ID and config snapshot?
- Is the generating script/path identified?
- Is the git commit hash recorded?

If any answer is "no," the statement is not a result.

D.3 Ablation requirements

For any claim of causal influence of OA enforcement:

- Is there a constraint-off vs constraint-on paired run?
- Are seeds/initial conditions identical?
- Is the only difference the enforcement setting (or ε)?
- Is the effect quantified (difference or ratio)?

If not, the claim must be downgraded to observation or conjecture.

D.4 Binding certificate requirements

For any claim that "the axiom matters":

- Is there at least one binding certificate?
- Is `constraint_applied` explicitly true?
- Is binding intensity recorded (`n_hits`, `hit_fraction`, or equivalent)?
- Is there an overlay diagnostic showing divergence from the ablation baseline?

If not, the claim must be rewritten as "in the explored regime, enforcement did not bind" (non-binding), or removed.

D.5 Invariance and definition dependence

For the chosen A and R:

- Are relevant invariances stated (basis/gauge/coordinate/coarse-graining)?
- If not invariant, is the diagnostic explicitly labeled as a toy quantity?

If not, add the invariance statement or downgrade scope.

D.6 $\theta^\star$ and corridor honesty

- Is $\theta^\star$ labeled as fiducial unless collapse is demonstrated?
- Is the admissible corridor Θ reported for the phase?
- Is the corridor produced by explicit tests and recorded in a ledger-compatible artifact?
- Is any "derived $\theta^\star$" claim supported by corridor-intersection history across independent phases?

If not, remove "derived" language.

D.7 Phase locking gate

Before labeling a phase "locked," confirm:

1. claims are explicit and scoped;
2. artifacts regenerate from a clean checkout at the stated commit;
3. run manifest is complete;
4. ablations and binding certificates exist where required;
5. the phase emits its `theta_filter` JSON and the ledger updates without manual edits.

If any item fails, the phase remains exploratory.

References