The Origin Axiom:
A Non-Cancelling Principle for Physical Configuration Space

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Abstract

This paper motivates and formulates the *Origin Axiom*, a proposed structural constraint on the configuration space of the universe. The basic intuition is that absolute nothingness—a state with no fields, no degrees of freedom and no possibility of change—is not a coherent element of physical reality. More generally, global configurations that cancel in such a way as to be indistinguishable from nothing should not be dynamically realised.

We express this idea in terms of global complex amplitudes $A(C)$ assigned to configurations C, and propose the Origin Axiom as the requirement that physically realised configurations avoid a small neighbourhood of a special value A_*. In the simplest case $A_* = 0$, this excludes states with perfect global cancellation. The axiom is agnostic about the microscopic details of fields and interactions; it is intended as an extra structural layer atop otherwise standard dynamics.

The present paper is conceptual and programmatic. We: (i) analyse the incoherence of absolute nothingness and the ubiquity of cancellation in physics; (ii) define a general framework for global amplitudes and the associated non–cancelling rule; (iii) discuss consistency requirements with known physics; and (iv) outline concrete realisations in simple toy models. Companion work implements the axiom in a minimal scalar toy universe and studies the behaviour of global non–cancelling constraints in explicit simulations.

1 Motivation: why absolute nothingness is unstable

Attempts to imagine "nothing" often smuggle in more structure than they intend: an empty space, a dark void, a blank state. All of these already assume the existence of a background stage with geometric and causal properties. By contrast, *absolute nothingness* would have to be a state without space, time, laws, fields or even potentiality. It is not clear that such an object can be coherently described.

Even if one could write down a candidate "nothing" configuration, treating it as a member of configuration space immediately promotes it to *something*—an element that can be compared with others and assigned probabilities. This suggests a tension: the very act of including absolute nothingness as a possible state undermines its intended role.

We take a strong stance:

Principle. *Absolute nothingness is not a coherent member of physical configuration space; existence in some form is the default.*

This principle does not tell us which specific universe is realised, but it rules out the idea that the universe could ever evolve to or from a state that is in every sense "no universe at all". The Origin Axiom builds on this by sharpening what is meant by "nothingness" in terms of global cancellations.

2 Cancellation systems and global neutrality

Many familiar physical systems exhibit cancellations:

- electric charge neutrality in macroscopic matter,
- destructive interference of waves,
- cancellation of positive and negative contributions in path integrals,
- gravitationally bound systems with zero total momentum.

These are examples of what we call *cancellation systems*: arrangements in which local degrees of freedom are nontrivial, but some global quantity (e.g. total charge, total field amplitude) vanishes.

In conventional treatments, global neutrality is often benign. A neutral atom is not "nothing"; it still has nonzero energy, structure and dynamics. However, certain theoretical constructions—especially in quantum field theory and cosmology—lean heavily on the idea that vacuum contributions might cancel "exactly enough" to leave no trace. For example, naive estimates of vacuum energy can exceed observed values by many orders of magnitude, and one sometimes appeals to cancellations between sectors.

The Origin Axiom does *not* deny ordinary neutrality. Instead, it singles out a stricter notion of *global cancellation* in terms of a chosen complex amplitude $A(C)$. When $A(C)$ vanishes exactly, or lies in a sufficiently small neighbourhood of a distinguished point A_*, the configuration is regarded as suspect: it is too close to the forbidden "nothing" state.

The key hypothesis is that there exists at least one such global amplitude whose near–vanishing is structurally forbidden, in the same sense that some systems forbid certain topological configurations.

3 Global amplitudes and configuration space

Let $\mathcal{C}$ denote the configuration space of some class of physical systems, for instance the set of field configurations on a Cauchy surface. A *global amplitude* is a complex–valued functional

$$A : \mathcal{C} \to \mathbb{C} \tag{1}$$

with the following properties:

- **Linearity or quasi–linearity.** For many examples, A is linear in the fields, e.g. an integral or sum of a local function. More general quasi–linear forms are also possible.
- **Sensitivity to cancellation.** When local degrees of freedom arrange themselves into symmetric or antisymmetric patterns, the resulting contributions to A can cancel.
- **Globality.** A is not a local density; it depends on the configuration as a whole and cannot be inferred from any finite patch.

The simplest example, used in our toy models, is the volume sum of a complex scalar field:

$$A(C) = \sum_{\mathbf{n}} \Phi_{\mathbf{n}}, \tag{2}$$

which vanishes when the field configuration is perfectly balanced between positive and negative contributions.

In general, we allow for a family of possible amplitudes, some of which may be physically distinguished. We assume there exists at least one such functional A for which exact cancellation is forbidden by the Origin Axiom.

4 Statement of the Origin Axiom

We now formulate the axiom in abstract terms. Let $\mathcal{C}$ be a configuration space and $A : \mathcal{C} \to \mathbb{C}$ a chosen global amplitude. Let $A_* \in \mathbb{C}$ denote a distinguished reference value, and let $\epsilon > 0$ be a small tolerance.

Origin Axiom (informal). *Physical reality does not realise configurations whose global amplitude $A(C)$ lies in a forbidden neighbourhood of A_*.*

Formally, we define the forbidden region

$$\mathcal{D}_\epsilon(A_*) = \{A \in \mathbb{C} \mid |A - A_*| < \epsilon\}. \tag{3}$$

The Origin Axiom then asserts that the physically realised subset $\mathcal{C}_{\text{phys}} \subseteq \mathcal{C}$ satisfies

$$\forall C \in \mathcal{C}_{\text{phys}} : \quad A(C) \notin \mathcal{D}_\epsilon(A_*). \tag{4}$$

The simplest and most natural choice is $A_* = 0$, in which case configurations with perfect global cancellation of the chosen amplitude are excluded. The tolerance ϵ expresses the idea that even extremely small neighbourhoods of the origin are structurally disfavoured.

Several remarks are in order:

- The axiom is intentionally agnostic about the microscopic dynamics. Local equations of motion may be standard; the restriction acts at the level of admissible global configurations.
- The axiom is also compatible with other conservation laws. The amplitude A need not be conserved; only its near–vanishing is forbidden.
- The magnitude of ϵ is not fixed here. In concrete models it plays the role of a tunable scale of non–cancellation.

In companion work, the axiom is implemented by modifying the dynamics so that whenever the system attempts to enter $\mathcal{D}_\epsilon(A_*)$, it is projected back to the boundary. This is a convenient numerical realisation; conceptually, the axiom is a statement about which configurations occur at all, not about how they are dynamically enforced.

5 Consistency with known physics

A structural rule that forbids certain global cancellations must be compatible with the wealth of empirical evidence for systems that are locally and globally neutral. We highlight a few consistency requirements.

5.1 Ordinary neutrality is allowed

Neutral atoms, neutral plasmas and globally neutral cosmologies must remain permitted. The Origin Axiom therefore cannot simply outlaw all configurations with vanishing conserved charges. Rather, it focuses on a particular global amplitude A which need not coincide with any familiar conserved quantity.

For example, in the scalar toy universe the amplitude is the volume sum of a complex field. A neutral atom has zero net electric charge, but its corresponding scalar amplitude (if such a field exists) may be nonzero. The axiom leaves all ordinary neutral systems untouched as long as they are not exactly cancelling with respect to the selected amplitude.

5.2 Small but nonzero amplitudes

Observations suggest that many global quantities in our universe are small but not exactly zero. For instance, the cosmological constant is tiny but nonvanishing in natural units. The Origin Axiom naturally favours this sort of situation: global amplitudes are generically pushed away from exact zero into small but finite values. In concrete models, the parameter ϵ can be thought of as setting such a non–cancellation scale.

5.3 Symmetry and gauge invariance

Any proposed amplitude A must respect relevant symmetries. For example, if a theory is invariant under gauge transformations or global phase rotations, the definition of A should either be gauge invariant or explicitly tied to a gauge–fixed description. In the toy models, we use a simple complex scalar with no gauge redundancy, so this issue does not arise. In more realistic theories, construction of a meaningful A would require care.

6 Toy models and concrete realisations

The abstract formulation above becomes more tangible in explicit models. The companion paper on the scalar toy universe studies a complex field on a discrete three–torus where the global amplitude is simply the lattice sum of the field values. There the axiom is implemented as a constraint $|A| \geq \epsilon$, enforced dynamically as a projection step when needed.

The main lessons from those simulations can be summarised as follows:

- In both linear and nonlinear regimes, the constraint successfully keeps the universe away from global cancellation. The typical amplitude scale is set by ϵ.
- The energy evolution of the system is largely insensitive to the presence or absence of the constraint. This suggests that the axiom can be treated as a structural selection rule rather than a new local interaction.
- In simple one–dimensional twisted scalar models, the total vacuum energy is independent of a global twist angle. These cases act as null results, indicating that more structure is needed for global phase–like parameters to have observable energetic consequences.

From the perspective of the Origin Axiom programme, these toy models play two roles. First, they test whether the non–cancelling rule can be implemented without leading to obvious instabilities or contradictions. Second, they provide a sandbox in which different choices of amplitude A, reference value A_* and tolerance ϵ can be explored systematically.

7 Outlook

The Origin Axiom is deliberately modest in its formal content: it does not specify a particular field content, interaction Lagrangian or cosmological history. Instead, it proposes that the set of physically realised configurations is a proper subset of the kinematically allowed ones, selected by the requirement that an appropriate global amplitude never vanishes.

Several open questions and directions follow:

- **Which amplitude?** Identifying physically natural candidates for A in realistic field theories is a central task. Possibilities include weighted integrals over fields, currents or curvature scalars.
- **Relation to vacuum energy.** In what sense could a non–cancelling constraint help explain why certain contributions to vacuum energy do not cancel exactly? The toy models suggest qualitative parallels but no quantitative prediction yet.

- **Quantum formulation.** The present discussion is largely classical or semiclassical. A full quantum version of the Origin Axiom would require specifying how the forbidden region in amplitude space is represented in Hilbert space or path integrals.
- **Observational signatures.** Ultimately, the axiom is only interesting if it leads to testable deviations from standard expectations. Identifying such signatures—for instance, small residuals that cannot be tuned away by conventional symmetries—is an important part of future work.

In summary, the Origin Axiom is proposed as a structural principle: a simple but nontrivial restriction on the global structure of physical configuration space motivated by the incoherence of absolute nothingness. The scalar toy universe and related models show that such a rule can be implemented in concrete systems without immediate contradiction. Whether it plays a role in our actual universe remains an open and intriguing question.