The κ_2 Dormancy Proposition: Observability-Gated Selection in the UNNS Substrate

Abstract

We formalize and validate a phenomenon observed in the UNNS Substrate: the systematic dormancy of the conditional selection operator κ_2 under generic symmetry-selected ensembles. We show that κ_2 is not universally active, but is instead gated by an observability condition Ω_2 that depends on the empirical variance of a parity classifier Σ_2^p. This leads to the central result of the paper: selection may exist structurally, yet remain operationally unobservable. We state this as the κ_2 Dormancy Proposition and discuss its implications for selection theory, symmetry narratives, and physical law emergence.

1 Introduction

Selection mechanisms are commonly assumed to act whenever structural distinctions exist. In many mathematical and physical frameworks, the presence of a distinguishable feature is taken to imply its influence on observable outcomes. The UNNS Substrate challenges this assumption by separating three notions:

1. the existence of structure,
2. the ranking of structure,
3. the observability of selection.

This paper formalizes the first experimentally validated instance of this separation, occurring at the level of the conditional selection operator κ_2.

2 Background and Operator Hierarchy

Within the UNNS Substrate, operators are organized hierarchically:

$$\Sigma \to E \to \Omega \to \kappa \to \tau$$

Here:

- Σ denotes structural descriptors,
- E is the ensemble of admissible states,
- Ω denotes observability gates,
- κ denotes selection operators,

- τ denotes stabilization dynamics.

The operator κ_1 performs universal symmetry-based selection using continuous symmetry metrics Σ_1. The operator κ_2 is fundamentally different: it is conditional and lives entirely within the observability layer Ω.

3 Parity Classifier Σ_2^p

We define a parity classifier:

$$\Sigma_2^p : E \to \{\text{EVEN}, \text{ODD}, \text{NULL}\}$$

The classifier assigns a discrete parity label to each state based on topological or boundary features (e.g., domain-wall parity). Crucially, Σ_2^p is *not* a magnitude and does not admit ordering. It encodes structural distinction without ranking.

4 Observability Gate Ω_2

The activation of κ_2 is controlled by an observability gate Ω_2, defined empirically.

Let $E_{\text{active}} \subset E$ be the subset of states with $\Sigma_2^p \in \{\text{EVEN}, \text{ODD}\}$. Define

$$p_{\text{EVEN}} = \frac{|E_{\text{EVEN}}|}{|E_{\text{active}}|}, \quad p_{\text{ODD}} = \frac{|E_{\text{ODD}}|}{|E_{\text{active}}|}$$

The parity variance is

$$\text{Var}(\Sigma_2^p) = p_{\text{EVEN}}(1 - p_{\text{EVEN}}) + p_{\text{ODD}}(1 - p_{\text{ODD}})$$

The observability gate is defined as:

$$\Omega_2 = \begin{cases} \text{active} & \text{if } \text{Var}(\Sigma_2^p) > \varepsilon \text{ and } |E_{\text{active}}| \geq 2 \\ \text{inactive} & \text{otherwise} \end{cases}$$

5 Definition of κ_2

The operator κ_2 is a conditional selector:

$$\kappa_2 : E \to E'$$

subject to the constraint:

$$\kappa_2(E) = \begin{cases} \text{select}(E) & \text{if } \Omega_2 \text{ is active} \\ E & \text{if } \Omega_2 \text{ is inactive} \end{cases}$$

When inactive, κ_2 performs no selection and leaves the ensemble unchanged.

6 Formal Results: κ_2 Dormancy

We now state the empirical findings of the previous section in formal form. The following theorem and corollary elevate the observed behavior of κ_2 from a descriptive outcome to a structural result of the UNNS Substrate.

6.1 Theorem: κ_2 Dormancy

Theorem 1 (Dormancy Theorem).

Let E be an ensemble obtained as the output of κ_1 selection. If the induced parity classifier Σ_2^p is degenerate on E, i.e.,

$$\mathrm{Var}(\Sigma_2^p) = 0,$$

then the observability gate Ω_2 is inactive and the conditional selection operator κ_2 acts as the identity on E:

$$\kappa_2(E) = E.$$

Proof

By definition, Ω_2 is active if and only if:

$$\mathrm{Var}(\Sigma_2^p) > \varepsilon \quad \text{and} \quad |E_{\text{active}}| \geq 2.$$

If $\mathrm{Var}(\Sigma_2^p) = 0$, then all parity-bearing states in E belong to a single parity class. Hence $\mathrm{Var}(\Sigma_2^p) \leq \varepsilon$ for any $\varepsilon > 0$, and Ω_2 is inactive.

By definition of κ_2, inactivity of Ω_2 implies that no conditional selection is performed and the ensemble passes through unchanged. Therefore,

$$\kappa_2(E) = E.$$

□

6.2 Corollary: Generic Dormancy of κ_2 under κ_1

Corollary 1 (Generic Dormancy).

For ensembles produced by κ_1 symmetry-based selection, κ_2 is generically dormant.

Justification

Empirical evaluation of multiple independent κ_1 runs demonstrates that κ_1 selection consistently collapses Σ_2^p variance, producing parity-degenerate ensembles. By Theorem 1, this implies Ω_2 inactivity and hence κ_2 dormancy.

Thus, dormancy of κ_2 is not an exceptional or fine-tuned case, but the dominant regime for symmetry-selected ensembles.

6.3 Interpretive Consequence

The theorem and corollary together establish that:

> Selection at higher structural layers may exist in principle yet remain operationally silent due to observability constraints imposed by lower-order selection.

This demonstrates that observability is a necessary intermediate condition between structure and selection, rather than a passive epistemic limitation.

6.4 Structural Significance

The κ_2 Dormancy Theorem formally separates three notions:

1. the existence of structural distinctions,
2. the ability to rank such distinctions,
3. the ability of a selector to observe and act upon them.

Within the UNNS Substrate, these notions are realized at distinct operator layers. The dormancy of κ_2 provides the first explicit demonstration that these layers do not collapse into one another.

6.5 Counterexample Theorem: Forced Activation of κ_2

The dormancy result does not imply that κ_2 is vacuous. We now state a counterexample demonstrating that κ_2 activates deterministically when its observability conditions are satisfied.

Theorem 2 (Forced Activation of).

There exist ensembles E for which Ω_2 is active and κ_2 performs non-trivial, deterministic selection.

Proof

Construct an ensemble E such that:

1. E contains at least one state s_{EVEN} with $\Sigma_2^p(s_{\text{EVEN}}) = \text{EVEN}$,
2. E contains at least one state s_{ODD} with $\Sigma_2^p(s_{\text{ODD}}) = \text{ODD}$,
3. all other structural descriptors (including Σ_1–Σ_4) are held fixed or remain admissible.

Then the active parity subset satisfies:

$$|E_{\text{active}}| \geq 2, \quad p_{\text{EVEN}} > 0, \quad p_{\text{ODD}} > 0.$$

Hence the parity variance satisfies:

$$\text{Var}(\Sigma_2^p) = p_{\text{EVEN}}(1 - p_{\text{EVEN}}) + p_{\text{ODD}}(1 - p_{\text{ODD}}) > 0.$$

For any fixed $\varepsilon < \text{Var}(\Sigma_2^p)$, the observability gate Ω_2 is active.

By definition of κ_2, activation of Ω_2 implies that conditional selection is executed. Empirical evaluation shows that the resulting selection is deterministic and reproducible under all admissible κ_2 policies.

Therefore, κ_2 is non-trivial and activates whenever its observability conditions are met. □

7 Motivation for κ_3: Nested Observability and Higher-Order Selection

The Forced Activation Theorem establishes that κ_2 is a non-trivial conditional selector whose dormancy arises from structural projection rather than definitional weakness. This result, however, immediately exposes a deeper limitation: κ_2 can only act on distinctions that survive lower-order selection.

This motivates the introduction of a higher-order operator, κ_3, whose role is not to strengthen selection, but to reason about *observability itself.*

7.1 Limitation of κ_2

Theorem 2 shows that κ_2 activates whenever observable parity variance exists. However, Theorem 1 and its corollary show that such variance is generically erased by κ_1. Thus, κ_2 is structurally constrained by the projection effects of lower-order selection.

In particular:

- κ_2 cannot recover distinctions eliminated by κ_1,
- κ_2 cannot alter the conditions of its own observability,
- κ_2 cannot act on dormant structural layers.

Therefore, conditional selection alone is insufficient to explain the emergence or persistence of higher-order structure.

7.2 Observability as a Structural Object

The behavior of Ω_2 demonstrates that observability is not a passive filter, but a structural condition with measurable consequences. The activation or dormancy of Ω_2 determines whether selection occurs at all.

This suggests that observability itself must become an object of analysis. Rather than asking which states are selected, one must ask:

> Under what conditions do distinctions remain observable across selection layers?

7.3 Conceptual Role of κ_3

The operator κ_3 is motivated as a selector acting on *families of observability gates*. Its purpose is to evaluate whether distinctions suppressed at one layer may re-emerge, persist, or compound across nested structures.

Formally, κ_3 is not defined as:

$$\kappa_3 : E \to E',$$

but instead as an operator over structured selection contexts:

$$\kappa_3 : (\Omega_1, \Omega_2, \ldots) \to \Omega'.$$

In this sense, κ_3 is a meta-selector: it acts on the conditions under which selection itself becomes possible.

7.4 From Conditional Selection to Nested Observability

The necessity of κ_3 arises directly from the coexistence of Theorem 1 and Theorem 2:

- Theorem 1 shows that higher-order selection can be dormant even when structure exists.
- Theorem 2 shows that dormancy can be lifted only by restoring observability.

Together, these results imply that the persistence of structure depends not only on selection strength, but on the stability of observability conditions across layers.

κ_3 is thus motivated as the operator responsible for:

- tracking observability across nested selection layers,
- identifying regimes where distinctions re-enter visibility,
- characterizing structural resilience against projection-induced dormancy.

7.5 Implications

The introduction of κ_3 marks a transition from selection theory to observability theory. Rather than asking why particular states survive, the focus shifts to why certain distinctions remain actionable at all.

This reframing is not optional. It is logically forced by the existence of conditional dormancy at the κ_2 level.

7.6 Summary

The results of this paper establish that:

1. Selection may exist without being observable.
2. Conditional selection activates only under strict observability conditions.
3. Higher-order structure requires stability of observability across layers.

The operator κ_3 is therefore not an extension by complexity, but a structural necessity implied by the behavior of κ_2.

7.7 Corollary: Dormancy Is Structural, Not Degenerate

Corollary 2 (Non-Vacuity of).
The dormancy of κ_2 under κ_1-generated ensembles is not due to an inherent inability of κ_2 to select, but due to the absence of observable parity variance.

Interpretation

The existence of forced-activation ensembles establishes that:

- κ_2 is a well-defined and operative selector,
- its inactivity in real κ_1 data is not a failure mode,
- observability, rather than structural existence, determines whether selection occurs.

Taken together with Theorem 1, this result demonstrates that κ_2 dormancy is a consequence of lower-order projection effects, not an artifact of construction or threshold choice.

8 The κ_2 Dormancy Proposition

Proposition (Dormancy).
Let E be an ensemble produced by κ_1 selection. If the induced parity classifier Σ_2^p has zero variance over E, then Ω_2 is inactive and κ_2 is dormant. In this case, no conditional selection occurs, despite the existence of structural distinctions.

Proof Sketch

Empirical evaluation of κ_1-selected ensembles shows:

- Σ_1 symmetry is strongly minimized,
- parity-bearing states collapse into a single Σ_2^p class,
- $\mathrm{Var}(\Sigma_2^p) = 0$.

By definition of Ω_2, this implies Ω_2 is inactive. By definition of κ_2, inactivity implies identity action. Hence κ_2 is dormant.

□

9 Empirical Validation

The proposition is validated by:

- repeated runs on real output ensembles,
- zero false activations of Ω_2,
- exact pass-through behavior of κ_2,
- deterministic outcomes under forced parity contrast.

Synthetic activation tests confirm that κ_2 becomes active only when parity variance is intentionally introduced.

10 Data Analysis: Empirical Structure of κ_2 Dormancy

This section analyzes the empirical results obtained from extensive κ_2 executions on ensembles produced by κ_1. The goal is not to re-establish correctness of implementation, but to characterize the structural regime in which κ_2 operates.

10.1 Dataset Overview

The analyzed datasets consist of multiple κ_2 runs with:

- ensemble size $|E| = 20$,
- parity modes including domain-wall and winding parity,
- selection policies κ_2^a (dominant), κ_2^b (balanced), and κ_2^c (lexicographic),
- observability threshold $\varepsilon = 0.1$.

All runs were executed on real κ_1 output ensembles without synthetic perturbation, unless explicitly stated.

10.2 Observed Parity Distribution

Across all real κ_1-derived ensembles, the observed parity classifier distribution was:

$$\Sigma_2^p(E) = \begin{cases} \text{EVEN}: & |E| \\ \text{ODD}: & 0 \\ \text{NULL}: & 0 \end{cases}$$

This result is invariant across:

- parity computation modes,
- ensemble seeds,
- selection policies.

Consequently, the empirical parity variance satisfies:

$$\mathrm{Var}(\Sigma_2^p) = 0$$

10.3 Activation Statistics

Given the activation condition:

$$\Omega_2 = \text{active} \iff \mathrm{Var}(\Sigma_2^p) > \varepsilon \ \wedge \ |E_{\text{active}}| \geq 2,$$

all real-data runs resulted in:

$$\Omega_2 = \text{inactive}.$$

No false activations were observed. No near-threshold cases were detected. Dormancy was binary and unambiguous.

10.4 Behavioral Outcomes

Because Ω_2 was inactive in all real-data cases, the following held identically:

- the selected ensemble equaled the input ensemble,
- no states were discarded,
- determinism was exactly 1.0,
- results were reproducible across repeated runs.

Formally:

$$\kappa_2(E) = E \quad \text{for all observed real-data ensembles.}$$

This confirms that κ_2 does not degrade, perturb, or reinterpret ensembles when inactive.

10.5 Forced Activation Control Experiments

To verify that dormancy was not an artifact, controlled parity contrast was introduced by modifying a minimal subset of states to produce both EVEN and ODD parity classes.

In these cases:

- $\mathrm{Var}(\Sigma_2^p) > \varepsilon$,
- Ω_2 activated immediately,
- κ_2 selection executed deterministically,
- all three κ_2 policies produced stable and reproducible outputs.

This confirms that dormancy arises from ensemble structure, not implementation constraints.

10.6 Emergent Pattern

The data reveals a consistent and non-trivial pattern:

> κ_1 selection generically projects ensembles into a Σ_2^p-degenerate subspace, rendering κ_2 dormant.

Thus, κ_2 inactivity is not exceptional; it is the dominant regime for symmetry-selected ensembles.

10.7 Interpretation

The empirical findings demonstrate that:

- parity distinctions may exist in principle,
- yet be erased by lower-order selection,
- preventing higher-order conditional selection from becoming observable.

This establishes dormancy as a structural outcome, not a failure mode.

10.8 Summary of Empirical Findings

1. κ_2 dormancy is empirically dominant under real κ_1 outputs.
2. Ω_2 exhibits zero false activations.
3. Conditional selection activates only under explicit parity variance.
4. Observability is a stricter condition than structural existence.

These findings directly support the κ_2 Dormancy Proposition.

11 Conceptual Significance

The κ_2 Dormancy Proposition establishes a new principle:

> Structural distinctions may exist without being operationally observable.

This invalidates the common assumption that all existing distinctions must influence selection. Instead, observability itself becomes a structural condition.

12 Implications

- Selection is not universal.
- Dormancy is a generic regime, not a failure mode.
- Observability gates are required to explain saturation and stability of laws.
- Symmetry breaking is conditional, not inevitable.

13 Conclusion

The κ_2 Dormancy Proposition demonstrates that the UNNS Substrate supports selection mechanisms that may exist structurally yet remain silent. This marks a transition from unconditional selection narratives to observability-aware structural theory. Future work will explore higher-order observability gates and nested selection operators.