A THEORY OF ASPECTUALITY

A Minimal Structural Framework for the Simulation of Physical Regimes

and the Emergence of Invariants Without Fundamental Laws

Abstract

We present the Theory of Aspectuality, a minimal structural framework intended to investigate the emergence, simultaneous structural admissibility, and stability of physical regimes through computational simulation. Rather than postulating fundamental laws, forces, or constants, the framework constrains the conditions under which regimes may arise and persist, treating physical laws as emergent invariants rather than primitives.

Within this approach, familiar physical notions (such as space, time, mass, fields, particles, and quantum phenomena) are not assumed a priori, but are examined as possible aspects of regimes that remain structurally consistent under perturbation. The framework is designed to confront whether multiple such properties can coexist within a single regime without fine tuning or independent foundations.

A key motivation of this work is the structural reinterpretation of gravitation, approached not as a force or interaction, but as a global constraint associated with regime closure. This interpretation is investigated within the same minimal framework, without presupposing specific dynamics, metrics, or physical substrates.

The Theory of Aspectuality is not proposed as a replacement for existing physical theories, nor does it introduce new experimental predictions at this stage. Its aim is to define a testable structural arena in which questions of emergence, coexistence, and collapse admit non-trivial outcomes. The framework is intentionally simple: if inadequate, structural inconsistencies or counterexamples should arise rapidly through simulation. We therefore present this work as an open invitation to collaborative testing, falsification, and refinement.

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1. Introduction

Modern physics is extraordinarily successful, yet conceptually fragmented. Classical mechanics, quantum mechanics, general relativity, and cosmology rely on distinct primitives and postulates, giving rise to persistent foundational tension. These tensions do not arise from experimental failure, but from ambiguity at the level of structure: why these laws, why these constants, and why such regimes remain stable at all.

This fragmentation is mirrored in contemporary computational studies of emergence. Despite decades of increasingly sophisticated simulations, the field remains methodologically unstable. Individual models reproduce isolated behaviors, patterns, or transitions, but fail to coexist coherently within a single framework capable of sustaining multiple structurally admissible properties simultaneously. The dominant approach relies on rich state spaces fixed in advance, dynamics introduced for convenience, and observables selected early to ensure interpretability. What is often described as emergence is therefore the direct consequence of assumptions embedded in the chosen substrate, dynamics, or observational frame. The failure is not accidental, nor merely technical, but methodological.

The Theory of Aspectuality does not attempt to unify known theories at the level of equations. Instead, it addresses a more basic question: under what minimal structural conditions can physical laws coexist and remain stable? From this perspective, laws are not treated as fundamental objects, but as invariants of regimes: patterns that persist only while underlying structural constraints are satisfied. Physics, in this view, concerns the structural admissibility of regimes and their capacity to sustain multiple properties without internal contradiction, rather than the postulation of laws in isolation.

Early attempts to study emergence computationally, particularly the coexistence of multiple emergent phenomena within a single model, revealed a deeper limitation. Refinements of existing simulation techniques consistently led to increased parameterization, fragmentation into isolated studies, or the silent introduction of structural commitments that could not be justified. Rather than converging toward clarity, the investigation fractured. This indicated that the difficulty did not lie in insufficient computational power or numerical sophistication, but in the absence of an adequate structural framework.

The Theory of Aspectuality therefore proceeds by identifying the minimal relational form capable of supporting coherent joint admissibility. Such a form must jointly sustain three inseparable sectors: a domain of admissible configurations, a constraint that enforces relational consistency, and a mode through which the resulting structure becomes manifest. None of these are meaningful in isolation; each exists only through its relation to the others. This organization is introduced neither as an analogy nor as a physical model, but as the minimal relational condition under which stable regimes (and thus coexisting laws) can arise without presupposing specific dynamics, metrics, or physical substrates.

Within this framework, the emergence of physical invariants, their coexistence and persistence, and the admissibility of emergent, globally inferred regularities are confronted simultaneously under the same minimal structural constraints. These questions are not posed as sequential objectives or independent goals, but as structurally coupled conditions whose outcome is non-degenerate. The framework is constructed so that the confrontation necessarily yields a result: either the sustained joint admissibility of such regimes, or their structural collapse. Both outcomes are treated as equally informative, as the work aims not to guarantee success, but to render the question of coexistence structurally decidable. Throughout this work, emergence refers strictly to inferential inevitability under structural constraints, not to dynamical generation or causal production.

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2. Primitive Structural Assumptions

2.1. Operational Starting Point

$$S = \emptyset$$

As this work proposes a minimal structural framework intended to connect mathematics and physics through computational experimentation without introducing surplus ontological commitments, the guiding constraint is epistemic honesty: The starting point must be fully independent, free of implicit structure, and equally valid in both the physical and virtual domains. Under this criterion, the only legitimate initial condition is the empty abstract state space, $S = \emptyset$. Any finitude that appears thereafter is treated strictly as a passive limitation of implementation, never as a fundamental property of reality. At the foundational level, the statement is not an algebraic claim about a populated set, but an epistemic constraint: the model refuses any privileged initial structure, metric, identity, or observable. This choice enforces total independence of the starting point and prevents the silent importation of physical or mathematical assumptions. No algebra is required to operate at this level.

2.2. Primitive Concepts

2.2.1. Indistinctness

Absence of any distinction. From the starting point, the first unavoidable concept is **indistinction**, understood as the absence of any differentiation. Indistinctness alone does not yet constrain any relational structure. In order to admit differentiation within the framework, a complementary concept of distinction is introduced.

2.2.2. Distinctness

Complementarily, **distinction**, defined here as differentiation that is stable under conditions. Crucially, neither concept is meaningful in isolation. Indistinction and distinction are mutually implicative, forming the minimal conceptual pair required for any consistent structural description.

2.2.3. Correlation

From the mutual implications of indistinction and distinction, **correlation** is defined as the minimal condition that allows relational morphisms to compose in a non-trivial manner. It does not represent interaction, causation, or influence, but simply the existence of a consistent relational linkage between distinctions that makes composition possible. Correlation is therefore a purely structural notion: it marks the threshold at which distinctions can coexist and be jointly mediated without collapsing into indistinction.

2.2.4. Ternary Relational Mediation, Structural Admissibility and Global Closure

The primitive notions introduced previously: “indistinctness, distinction, and correlation” are sufficient to express the *possibility* of relational structure, but they do not yet determine when such structure is *admissible* within a single inferential frame. Admissibility requires a constraint preventing distinctions from persisting as absolute or uncorrected residues. This constraint is realized through **ternary relational mediation**, understood not as a dynamics but as a **closed structural coupling** between the state space, the relational form, and the inferential view, enforced under global closure.

(i) Mediation (S–D–V Coupling)

Let

S denote the state space,
D a set of ternary relational morphisms,
V an inferential view space.

Mediation is defined as a relation

$$M \subseteq S \times D \times V$$

A triple $(s, d, v) \in M$ signifies that the state s is **inferentially admissible** under morphism d within view v.

Mediation is not an operation, does not generate transitions, and does not prescribe evolution. It serves exclusively to delimit admissibility.

(ii) View-Induced Structural Equivalence (No In-Frame Residue)

Structural equivalence is defined by invariance of mediation membership:

$$s \simeq s' \quad \Leftrightarrow \quad \forall d \in D,\ \forall v \in V\colon\ (s, d, v) \in M \quad \Leftrightarrow \quad (s', d, v) \in M$$

This expresses the **neutrality requirement** in its correct structural form: within a fixed inferential frame (d, v), no admissible mediation may introduce a detectable distinction.

Throughout this work, *residue* refers strictly to detectability under M; no ontological surplus is implied.

(iii) Closure Under Ternary Relational Form

To represent distinction without introducing an absolute origin, identity, or reference point, the admissible relational form is taken to be a ternary morphism

$$d: S \times S \times S \to S$$

satisfying the torsor (heap) axioms:

$$d(x, x, y) = y, \; d(x, y, y) = x$$

$$d(x, y, d(u, v, w)) = d(d(x, y, u), v, w)$$

These axioms encode cancellation and associativity without identity elements.

Mediation is required to be closed under this form in the following admissibility sense:

$$(s, d, v) \in M \quad \Longrightarrow \quad (d(x, y, s), d, v) \in M \qquad \forall x, y \in S$$

We impose a **strong global neutrality condition**, requiring admissibility to be invariant under *all* ternary mediations:

$$(s, d, v) \in M \quad \Longleftrightarrow \quad (d(x, y, s), d, v) \in M \qquad \forall x, y \in S$$

This is the precise formal expression of *no residue within a frame*. No auxiliary functionals or external criteria are introduced.

(iv) Structural Cost as the Signature of Operational Failure

At the abstract level, exact closure introduces no deviation.

Deviations arise **only** at the level of realization: through discretization, projection, bounded representation, or restricted admissibility windows.

Such deviations are not treated as truncation errors but as **structural mismatches** that must be corrected *globally*. The magnitude of this correction constitutes a **structural closure cost**.

Within the Theory of Aspectuality, this cost:

a. does not indicate algebraic inconsistency,
b. does not introduce new ontology,
c. and does not represent loss of information.

It is the operational signature of failure to sustain exact neutrality and admits a precise interpretation as **non-ontological gravitation**.

(v) Global Projection and Conservation of Information

Let an operational realization induce, at a given inferential frame, a deviation field

$$\Delta \in A^{s}$$

where A denotes the representational algebra.

Global neutrality requires that no net distinguishability accumulate within a frame. Deviations are therefore corrected by **projection**, not restriction:

$$\Delta_{\text{eff}}(s) = \Delta(s) - \frac{1}{|S|} \sum_{u \in S} \Delta(u)$$

This removes only the globally inadmissible component while preserving all relational variation. No information is destroyed; the correction is fully reversible within the admissible subspace.

The norm of the removed component defines the **structural closure cost**.

(vi) Correlation Order, Admissibility Window, and Complexity Limit

Iterated mediation induces **layers of correlation**, each corresponding to higher-order relational constraints. These layers do not extend indefinitely. As correlation order increases, distinguishability decreases, until the structure collapses back into **indistinguishability**.

This establishes a **finite stratification of correlation**, terminating at a complexity boundary where further relational refinement is inferentially inaccessible.

Within this stratification, the admissible regime is not arbitrary. The effective window of admissibility corresponds to a **linearized band** around neutrality, analogous to a Conway-style linear neighborhood: not as a dynamics, but as a **structural admissibility window**. Outside this window, closure cost increases, signaling impending violation.

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3. Identity and the Inferential Emergence of Spatiality

3.1. Continuity from Chapter 2

Chapter 2 established the primitive structural assumptions of the Theory of Aspectuality: the empty origin $S = \emptyset$, ternary relational mediation as the minimal expression of distinction, and global neutrality as a closure constraint. No physical observables, regimes, or dynamics were introduced. The framework remained strictly pre-phenomenal.

The present chapter proceeds necessarily from this foundation. Once distinction, correlation, and admissibility are admitted under global neutrality, a question becomes unavoidable:

What is the first identity that can exist without violating the structure?

No new primitives are introduced. We examine only what follows.

3.2. Identity as Inferential Invariant

Identity cannot be assumed. It cannot attach to elements, states, or trajectories. It must be inferred. Under global neutrality, admissible realizations are restricted to structural equivalence:

$$S' \simeq S$$

Any deviation $S' \neq S$ would introduce a privileged distinction and is prohibited.

We define the minimal identity invariant as:

$$I = \{S' \mid S' \simeq S \ \ under\, fixed\ (d, v)\}$$

This yields:

$$S = \emptyset \quad \Rightarrow \quad I = \emptyset$$

$$S \neq \emptyset \quad \Rightarrow \quad \exists!\, I$$

Identity is thus **absent at the origin** and **inevitable thereafter**.

3.3. Structural Dependence and Content Independence

The identity invariant I is:

a. independent of the contents of S,
b. necessarily dependent on its admissible relational structure.

Any identity detached from structure would violate neutrality. Therefore, identity can encode **only** what remains invariant across all admissible realizations: pure relational separability.

3.4. Inferential Projection

The view V operates solely on invariants. Identity becomes manifest only through projection:

$$\pi: I \rightarrow X$$

subject to:

1. Preservation of structural equivalence,
2. Absence of privileged origin, orientation, scale, or metric.

The projected object X encodes nothing but separability.

3.5. Spatiality as the First Phenomenon

Spatiality is proposed as the minimal interpretation of $\pi(I)$.

It is not postulated. It is the **inevitable inferential manifestation** of the unique admissible identity invariant.

Spatiality:

a. does not reside in S,
b. requires no time, energy, particles, or dynamics,
c. exists entirely within V as an inferential structure.

Coordinates and geometries are representational conveniences, not defining features.

3.6. Dimensionality as Relational Degree

If the admissible relational structure supports nnn independent degrees of distinction, then:

$$dim(X) = deg_{rel}(S)$$

One degree yields a line, two a plane, three a volume. No dimensionality is privileged.

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4. Computational Realization of Aspectuality

At this point, the Theory of Aspectuality is **structurally complete** at the inferential level. Phenomena, identity, spatiality, admissibility, and closure cost have been defined without operational assumptions.

The following chapter does not extend the theory. It demonstrates how this closed structure can be **realized computationally**, how structural cost manifests numerically, and how admissible regimes emerge under finite representation: without violating information conservation or introducing external laws.

4.1. A State-Field Implementation with Plug-In Ternary Mediation, Global Closure Audits, and Continuous Admissibility

This chapter describes a GPU implementation of the Theory of Aspectuality (ToA) designed to *instantiate the theory's structural commitments without importing physical primitives*. The implementation is not a "physics engine." It is a **finite, auditable realization of the aspectual cycle**: ternary relational mediation, redistribution under closure, and the emergence of stable invariants under perturbation: while keeping *all observational quantities strictly observational*.

The design principle is strict: **the state is never overwritten by views**, and no view becomes a "law." Views may diagnose, audit, and optionally drive an explicitly enabled correction pathway, but the core dynamics remain mediated only by the ternary operator.

4.2. Purpose and Scope

This chapter targets three goals:

1. **Minimal state substrate**: a finite substitute S' for the conceptual S, implementing "state" as raw information with no metric meaning.
2. **Explicit ternary mediation**: a plug-in mediator $D(x, y, z)$ that performs the only structurally privileged operation.
3. **Global closure auditing**: continuous measurement of regime coherence (closure) from local views, without feeding those views back into state unless an experiment toggle is enabled.

In ToA terms:

- **State** is the implemented carrier of "distinction potential," not a physical quantity.
- **Mediation** is the only primitive "structural action."
- **Admissibility** is the computational analogue of closure constraints: not a law, but a selection rule for redistribution stability.
- **Cost** is represented as a view derived from state (and from differences under mediation), not as a physical energy.

4.3. The Finite Substrate S': State as `float3`

The implemented state space is:

$$S' = \{s \in R^3\} \quad (stored\ as\ `float3`)$$

Each element of S' is a **pure information token**:

- It is not a position vector.
- It has no physical magnitude.
- It has no metric significance.

Its only privileged role is: it is the argument type of the ternary mediator D.

4.3.1. Grid and Slot

The simulation uses a finite 2D grid of **cells**, with one **SlotPerCell** independent state elements per cell.

Indexing:

- `cellIdx = id.x + id.y * GridWidth`
- `idx = cellIdx * SlotPerCell + slot`

Total elements:

$N = GridWidth \cdot GridHeight \cdot SlotsPerCell$

This implements the finite constraint explicitly: the theory allows conceptual infinitude; the implementation does not. The substitution is honest and explicit:

$S \rightsquigarrow S'(finite,\ explicit,\ auditable)$

4.3.2. Boundary Conditions: Auditable Wrap Without Machine Contamination

Because ToA disallows “hidden identity from machine artifacts,” coordinate wrapping is implemented in `int`:

$w(c) = ((c\ mod\ d) + d)\ mod\ d$

This prevents accidental conversion of negative indices into huge `uint` values (a silent injection of machine identity into the structural substrate). Any compiler warning about integer modulus is accepted by design because **auditability dominates micro-performance** in this theory’s implementation.

4.4. Numerical Integrity as a Structural Constraint (NaN/Inf Policy)

ToA demands that *structure be preserved*, and that errors be explicit rather than silently normalized away. Accordingly, the implementation bans implicit `isnan`/`isinf` and uses **bit-level IEEE-754 checks**:

- `exp = 0xff` indicates NaN/Inf.
- invalid results do not propagate.

Policy:

- If mediator output is invalid, **preserve the prior state** and **mark health**.

This implements a strict rule consistent with ToA's stance on closure: do not let a local violation corrupt the global regime invisibly.

4.5. The Ternary Relational Mediator $D(x, y, z)$

The ToA primitive is a ternary operation:

$$D\colon S' \times S' \times S' \quad \to \quad S'$$

In code, this is `Mediator(float3 x, float3 y, float3 z, ...)`.

The mediator:

1. forms a neighbor blend $(y + z)/2$,
2. computes a drift toward the blend,
3. updates x with a damped step,
4. optionally injects explicit "vibration" (controlled perturbation),
5. applies a *minimal* overflow guard (not normalization).

A representative form:

$$blend = (y + z)/2, \quad drift = blend - x, \quad x' = d\cdot x + \alpha\cdot drift$$

with damping d and step size α scaled by Δt.

4.5.1 Controlled Perturbation ("Vibration")

ToA requires perturbation to be explicit and auditable: not incidental noise. Thus, perturbation enters as a parameter:

- `Vibration = 0` → strict indistinctions (all zeros) unless seeded.
- `Vibration > 0` → deterministic hash-based perturbations.

This realizes:

- **Indistinction** as uniform initial state,
- **Distinction** as controlled injection.

4.6. Sampling Policy: Probing Local Freedom Without Defining Admissibility

Neighbor selection defines *how local freedom is probed*, not what is admissible. The code explicitly states:

> SamplingPolicy does NOT define admissibility.

Sampling policies include:

- Local4, Local8: local neighborhood probes,
- Local random offsets,
- GlobalShuffle: non-local probes that test whether apparent centers/boundaries are artifacts of grid locality.

This is crucial: **the theory cannot allow the sampling scaffold to become a hidden law**. Sampling is therefore treated as an experimental "lens," not as ontology.

4.7. The Core Step: Aspectual Evolution by Mediation Alone

The primary evolution kernel (`Step`) performs:

$$s_{t+1}(i) = D(s_t(i), s_t(j), s_t(k))$$

where j, k are sampled neighbors under the chosen sampling policy.

No view is consulted. No admissibility check is applied inside mediation. The only additional rule is the NaN/Inf guard:

- invalid output → retain $s_t(i)$, mark health.

This preserves the conceptual separation:

- **Mediation produces candidates.**
- **Admissibility evaluates candidates (later).**
- **Views observe and audit.**

4.8. Views: Observational Quantities That Must Not Become Law

The implementation defines "views" as quantities derived from state but prohibited from overwriting it:

- `ViewDataBuffer` stores $(\rho, NonComm, Boundary, CentersMask)$.
- `CminBuffer` stores a cost-view.
- `LambdaBuffer` stores a continuous admissibility freedom measure.
- `GlobalStatsBuffer` stores reduction results for closure auditing.

The principle is enforced at the buffer level:

> observational only; must never feed into State unless explicitly enabled for experiments.

This is the computational instantiation of the dissertation's rule:

> Inference is a *reading* of redistribution; it is not a primitive driver.

4.9. Correlation Density ρ: A Proxy for Local Constraint

The view Rho measures sensitivity of mediated output to changes in neighbor selection.

Operational definition (as implemented):

- Compute $o = D(x, y, z)$
- Replace neighbors to get $o_y = D(x, y', z)$, $o_z = D(x, y, z')$
- Define: $\rho = \|o - oy\| + \|o - oz\|$

Interpretation within ToA:

- high ρ indicates strong local dependence (tight correlation constraints),
- low ρ indicates weaker coupling (higher local freedom, potentially incoherent if too low).

This is not a physical density. It is a **structural sensitivity measure**.

4.10. Non-Commutativity as Boundary Sensitivity

The view NonComm measures how the result depends on operation ordering:

$$o_{AB} = D(D(x, y_1, z_1), y_2, z_2), \quad o_{BA} = D(D(x, y_2, z_2), y_1, z_1)$$

$$NonComm = \|o_{AB} - o_{BA}\|$$

The implementation then sets:

- `Boundary = NonComm`

ToA interpretation:

- **interiors** tend to exhibit different commutation behavior than **interfaces**,
- so non-commutativity is used as a **boundary proxy:** not as a fundamental operator.

4.11. CentersMask: A Regime-Relative Structural Condition

Centers are not selected by fixed thresholds. They are selected by thresholds derived from the regime's own statistics:

$$\rho < \mu_{\rho} - k_{1}\sigma_{\rho}, \quad NonComm < \mu_{nc} - k_{2}\sigma_{nc}$$

This matches the dissertation's discipline:

- no absolute parameters,
- only regime-relative conditions derived from closure-audited aggregates.

Thus, centers are **structural** relative to the current regime, not imposed.

4.12. Closure Auditing: Global Statistics as a Coherence Test

ToA treats closure as a global constraint; the implementation mirrors this by computing global statistics via reductions:

- sum and sum-of-squares of ρ and NonComm,
- means and variances computed on CPU (audited).

The closure concept is implemented as stability of these statistics over time:

$$ClosureScore(t) \approx |\mu_{\rho}(t) - \mu_{\rho}(t - \Delta)| + |\mu_{nc}(t) - \mu_{nc}(t - \Delta)| + \cdots$$

This realizes the dissertation's point:

- closure is not a local check,
- closure is a global stability property of the regime.

4.13. Continuous Admissibility: $\Lambda(x)$ as Local Freedom Window

Instead of binary "alive/dead" rules, ToA uses a **continuous admissibility window**:

$$L_{min} \leq \Lambda(x) \leq L_{max}$$

Λ is computed from ρ and NonComm:

$$\Lambda = f(\rho, NonComm)$$

where f is implemented as a product of band-limited contributions:

- penalize $|\rho - \mu_{\rho}|$,
- penalize large NonComm.

Crucially:

- Λ is a **probe**, not a definition of the theory.
- L_{min}, L_{max} are **derived from regime statistics**, not fixed constants.

This is the computational analogue of the dissertation's claim:

> Admissibility is a selection imposed by closure, not a law injected from outside.

4.14. ApplyAdmissibility: Selection Without Silent Deletion

After mediation, admissibility is applied as a single predicate:

- if Λ is outside the window:
  - **state is reverted to previous** (no silent normalization),
  - violations are recorded:
    - 1 = FreedomLow (collapse / isolation),
    - 2 = FreedomHigh (over-constraint / super-restriction).

This is not "physics." It is the explicit enforcement of:

- global closure → local selection,
- selection → correction,
- correction must be auditable.

4.15. Structural Cost Views: C_{min} and Derived Diagnostics

The implementation includes a cost view `CminView(float3 s)` producing `float2`:

- magnitude (or log magnitude),
- a phase-like angle.

This is used strictly as a view and as part of reduction diagnostics and optional feedback experiments.

Within ToA's language:

- it is a **proxy of cost structure**, not a metric,
- it is a computational instrument to expose regime organization.

4.16. Optional Feedback Redistribution: Correction as the Same Pathway as Admissibility

The ToA's claim is that violations trigger **redistribution** via correction, not via new laws. This work implements this as an optional experimental toggle:

- compute an error signal $E(x)$ derived from admissibility violations,
- optionally include C_{min} contribution,
- redistribute state locally toward neighbor mix proportional to E.

Form:

$$s' = (1 - \alpha_E)s + \alpha_E \cdot (y + z)/2, \quad \alpha_E = FeedbackStrength \cdot E$$

This does **not** introduce a new operator. It reuses the same structural idea:

- inadmissibility → correction by redistribution.

It remains auditable:

- the magnitude of applied correction is stored as `FeedbackDelta` for visualization.

4.17. Rendering: Visualization Without Contamination

Rendering exposes:

- raw state (as RGB mapping),
- cost view,
- ρ, NonComm, boundary,
- centers mask,
- closure statistics,
- health map,
- Λ,
- violation maps,
- error and feedback delta.

Nothing in rendering modifies state. This preserves the central rule: the observation layer must not become causation by default.

4.18. How This Implementation Matches the ToA's Core Claims

This Phase 2 design realizes the dissertation's structure with explicit separations:

1. **Mediation is primitive**
   Only $D(x, y, z)$ produces candidate state evolution.

2. **Closure is global**
   Closure is measured via reductions and stability of global statistics, not local constants.

3. **Admissibility is selection, not law**
   The Λ window is derived from regime statistics and applied as a selection predicate.

4. **Cost is structural and auditable**
   Cost proxies (Cmin, NonComm, rho) are computed as views and logged.

5. **No silent normalization**
   Invalid results preserve previous state and mark health, rather than "fixing" the data invisibly.

6. **Experiment toggles are explicit**
   Feedback redistribution is opt-in, making the causal structure auditable rather than implicit.

4.19. What this Work Does *Not* Claim

To avoid conceptual contamination, this work explicitly does not claim:

- that `float3` represents physical vectors,
- that ‖·‖ is a physical metric,
- that the admissibility window defines ToA (it is a probe of local freedom),
- that any observed pattern is "the universe.",
- that ρ, NonComm, or C_{min} are fundamental quantities.

What it does claim is narrower and stronger:

> if a regime stabilizes under these structural rules, it is a computational instantiation of the aspectual domain: emergence under ternary mediation plus closure selection.

4.20. Practical Summary: This Work Pipeline

A single frame (tick) is conceptually:

1. **Init** (once)
   indistinctions, plus controlled perturbation if enabled.
2. **Step**
   $s_{t+1} = D(s_t, n_1, n_2)$, guard invalid.
3. **Views**
   compute ρ, NonComm, boundary, centers.
4. **Reductions**
   compute global means/variances for closure auditing.
5. **Lambda**
   compute Λ from view statistics.
6. **Admissibility**
   revert out-of-window updates; mark violations.
7. **(Optional) Feedback**
   compute $E(x)$, redistribute correction; audit deltas.
8. **Render**
   display without contaminating state.

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5. Preliminary Data Samples

5.1. CminView (structural cost view)

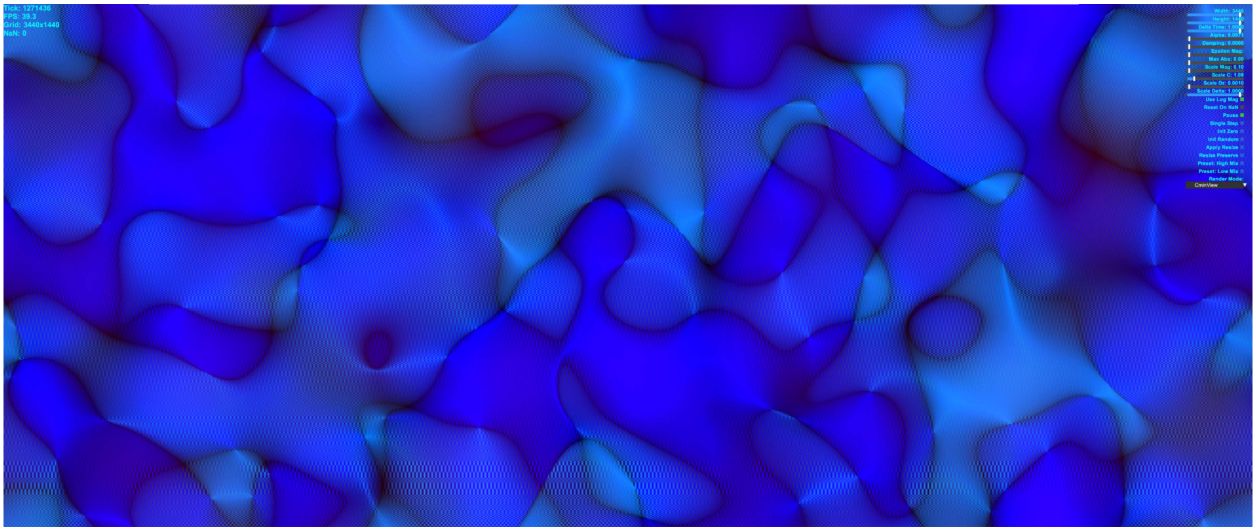

Figure 1 — Cmin View (Structural Cost Field)

False-color visualization of the **structural cost proxy Cmin**, computed locally from the state field as a magnitude–phase–like measure derived from the float3 state vectors. Spatially extended smooth regions indicate coherent redistribution regimes, while sharper gradients correspond to zones of higher correction demand. This field is observational only and does not feed back into the state, serving as an empirical indicator of global structural cost accumulation.

What is being displayed (data): Per cell, the renderer aggregates **CminBuffer** using the **mean** $C_{min} \in R^2$ where each slot contributes

$$C_{min}(s) = (dmag(s), dphase(s))$$

with $dmag$ from $\|s\|$ (optionally log) and $dphase$ from an atan2-based phase proxy on (s_x, s_y). The output color encodes:

- **R:** scaled mean magnitude component
- **G:** scaled mean phase component
- **B:** scaled norm $\|C_{min}\|$ (a combined “cost intensity” proxy)

Observed pattern (structure):

- The field forms **large, smooth domains** (blue/purple masses) separated by **curving transition bands**.
- Boundaries are **thick and continuous**, not pixel-noisy, consistent with **spatial coherence** emerging from repeated mediator mixing over local neighbor sampling.
- There are **embedded "islands"** (small enclosed blobs) and **saddle-like corridors**, which indicates the regime is not collapsing to uniformity; instead it sustains a **mesoscale partition** of state configurations.
- The absence of "salt-and-pepper" speckle implies your **numerical guardrails** (no destructive normalization; clamp only on overflow; NaN/Inf preservation) are preventing silent corruption, letting the mediator's structural smoothing dominate.

Empirical takeaway: This is a direct visual signature that the system is sustaining **structured variation of a cost proxy** C_{min} across the grid, rather than diffusing to a flat field.

5.2. CellContributionView (cell vector contribution / pooled phase-magnitude)

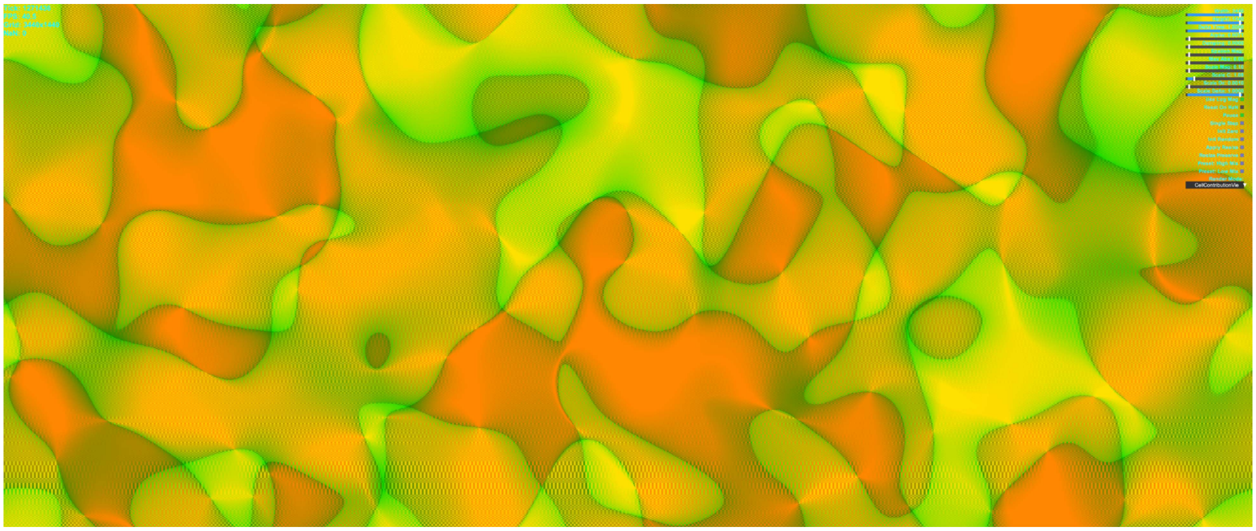

Figure 2 — Cell Contribution View (Aggregate Structural Participation)

Visualization of the **per-cell aggregate contribution** to the global structural cost, obtained by summing Cmin within each grid cell. The emergence of spatially organized regions reflects non-uniform participation in global redistribution, despite uniform local rules. No metric or geometry is imposed; It arises solely from repeated application of the ternary mediator under closure.

What is being displayed (data): Per cell, the renderer sums (not averages) the cost-vectors:

$$C_{cell} = \sum C_{min}(s)$$

and maps:

- **Intensity:** $\|C_{cell}\|$ (strength of aggregated local contribution)
- **Hue/angle:** $arg(C_{cell})$ (direction of the pooled phase-like component)

Observed pattern (structure):

- The image shows **broad orange/green regions** with smooth gradients, meaning cells have a **coherent pooled direction** in the 2D cost space, not random cancellation.
- Transition regions are **topologically similar** to *Figure 1*, but with stronger contrast along certain “ridges”: that’s expected because **summation amplifies** persistent alignment.
- The coexistence of large uniform patches *and* twisting boundary corridors show a regime with **stable local consensus** plus **structured disagreement** across neighborhoods.

Empirical takeaway: Cells are not just “having cost”; they are exhibiting **coordinated cost-direction**, which is a stronger signature than magnitude alone.

5.3. TemporalPersist (temporal stability / per-cell delta)

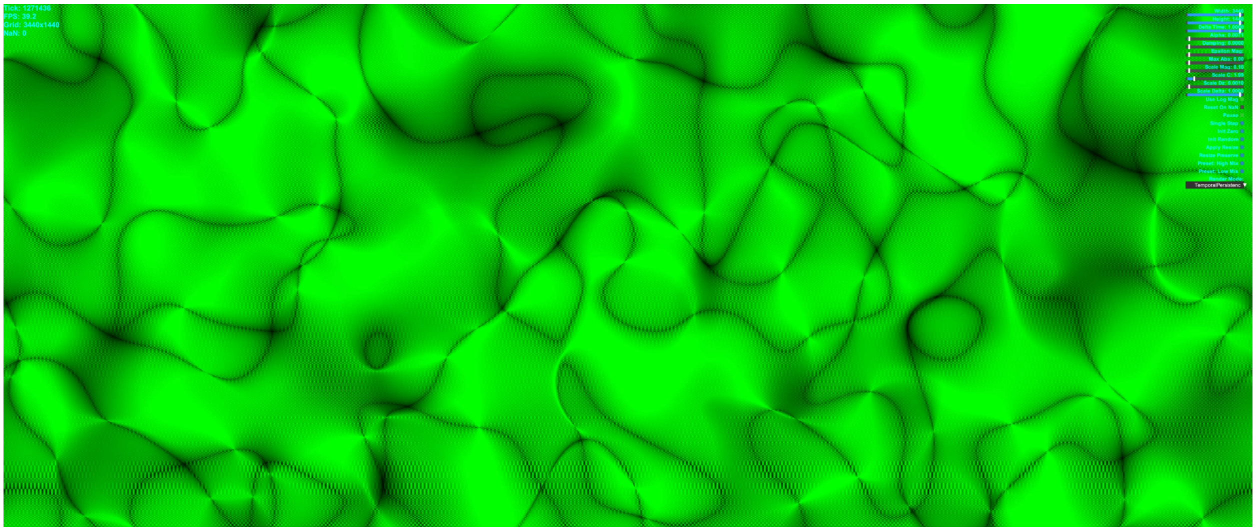

Figure 3 — Temporal Persistence View (Structural Stability Over Time)

Temporal persistence map showing the **frame-to-frame variation of mean Cmin per cell**. Low-variation regions indicate stable structural regimes that persist under continuous mediation, while higher variation marks transient or boundary-like regions. This provides empirical evidence for regime stability without invoking fixed points, equilibria, or conserved quantities.

What is being displayed (data): You keep **PrevCellCminMean[cell]** and compute

$$\Delta_{cell}(t) = \| C_{mincell}(t) - C_{mincell}(t - \Delta) \|$$

and render Δ_{cell} (plus a magnitude channel for the current mean).

Observed pattern (structure):

- The field is **mostly low-to-mid** (dominant green with gentle shading), rather than flashing high everywhere.
- That means the regime is not chaotically reconfiguring each tick; instead it has **slowly evolving compartments**.
- Darker corridors and brighter pockets indicate **where rearrangement concentrates,** typically along the same curved interfaces that separate domains in *Figure 1/2*.
- This is exactly what you'd expect if "dynamics" here are *not a fundamental law* but an iterative structural relaxation: the "action" occurs at **interfaces**, while interiors are more persistent.

Empirical takeaway: You have empirical evidence for **temporal persistence**: most cells maintain a stable local signature over time, with change localized to structured boundaries.

5.4. LambdaView (admissible freedom field Λ)

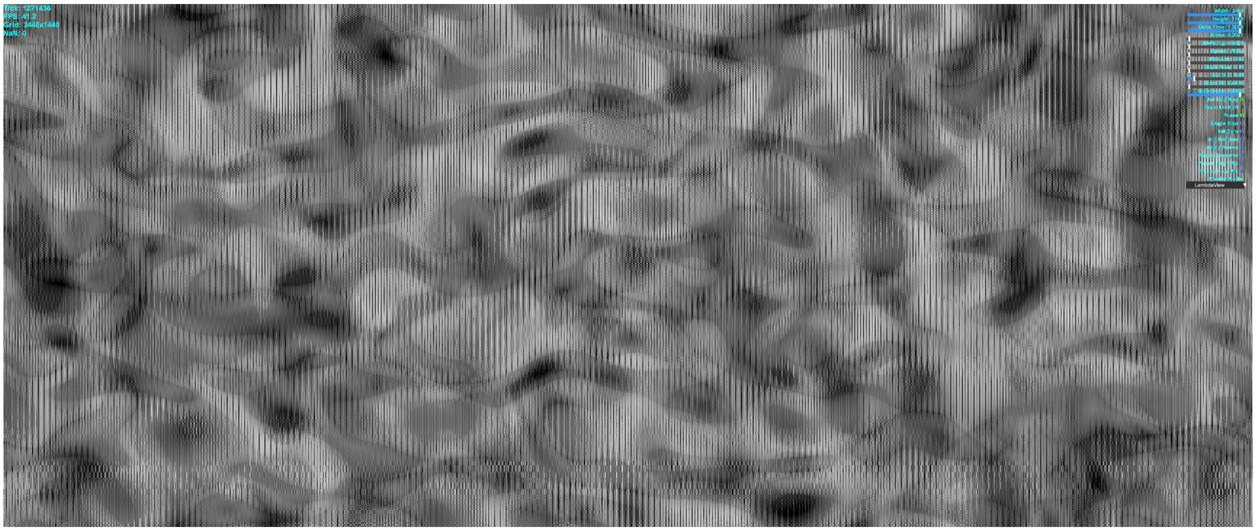

Figure 4 — Lambda View (Continuous Admissible Freedom Λ(x))

Grayscale visualization of the **local admissible freedom Λ(x)**, computed as a continuous function of correlation density (ρ) and non-commutativity. Bright regions correspond to states operating within the admissible window derived from the regime's own statistics, while darker regions indicate proximity to structural violation. Admissibility is thus shown to be relative, continuous, and regime-dependent, rather than binary or externally prescribed.

What is being displayed (data): Each slot computes

$$\Lambda(x) = LambdaFromRhoNonComm(\rho(x), nonComm(x))$$

where Λ increases when ρ is near its regime mean (within band) *and* nonComm is low (within band). The render shows Λ as grayscale (per cell aggregated).

Observed pattern (structure):

- The grayscale field is **globally structured**, not random: broad zones of lighter and darker values correspond to regions of higher/lower admissible freedom.
- The most striking feature is the **fine vertical banding** (scanline-like stripes). Seems like a structure of Λ itself, since the underlying blobs remain visible "through" the banding.
- Despite the banding, you can still see **macro-domains** where Λ is consistently higher or lower, meaning the admissibility metric is **responding to regime-level statistics**, not a constant threshold.

Empirical takeaway: Λ behaves like a **regime-relative freedom map**: it differentiates the field into zones of higher/lower admissibility without introducing a fixed external law.

5.5. FreedomViolationLow (Λ < L_min)

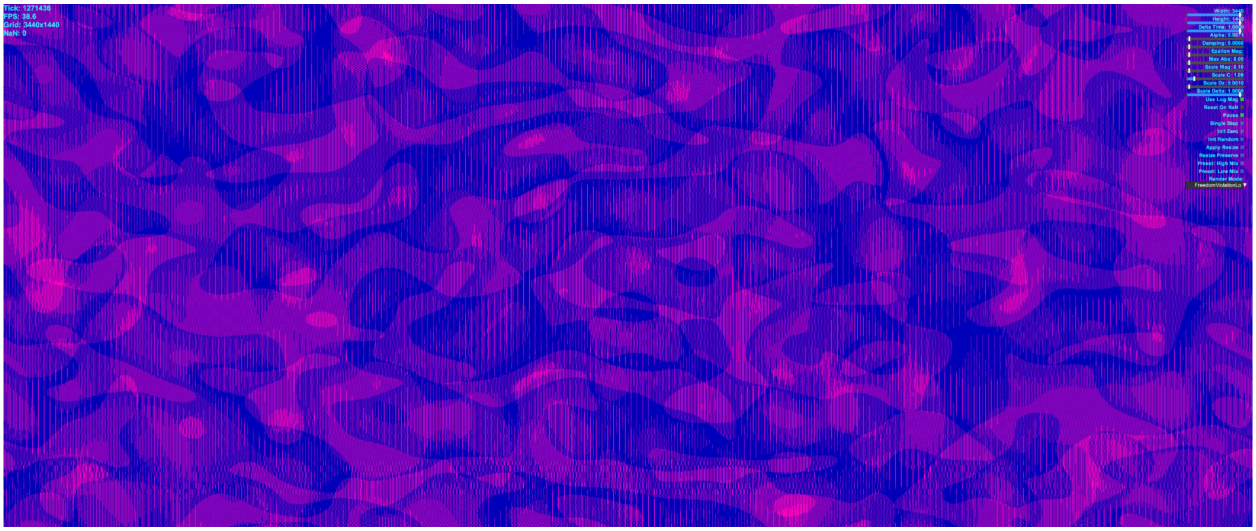

Figure 5 — Freedom Violation (Low Freedom / Over-Constraint)

Visualization of **low-freedom violations**, marking regions where Λ(x) falls below the lower admissibility bound. These areas correspond to excessive local constraint or isolation, where mediation would otherwise collapse distinctions. Violations are detected and handled symmetrically with high-freedom cases, illustrating that collapse and over-constraint are treated as dual structural failures.

What is being displayed (data): Slots are marked as violation-low when $\Lambda(x) < L_{min}$. Render highlights the **density of low-violations per cell** (purple/magenta overlay in your shader).

Observed pattern (structure):

- Violations are **not uniformly distributed**; they appear as **striped concentrations** crossing the domain structure.
- Where the underlying state appears "quiet" (stable blobs), low-violations tend to appear in **corridors and narrow regions**, consistent with "collapse / over-constraint" localized at interfaces or bottlenecks.
- The same fine vertical banding is present again, not supporting the interpretation that the striping is largely a **visual sampling lattice** effect; but the *regions* where the overlay intensifies still align with macro-structures (so the violations are not purely an artifact).

Empirical takeaway: The system is empirically producing **localized pockets of insufficient freedom** (collapse tendency), by observing them without letting the diagnostic layer silently rewrite the state.

5.6. FreedomViolationHigh (Λ > L_max)

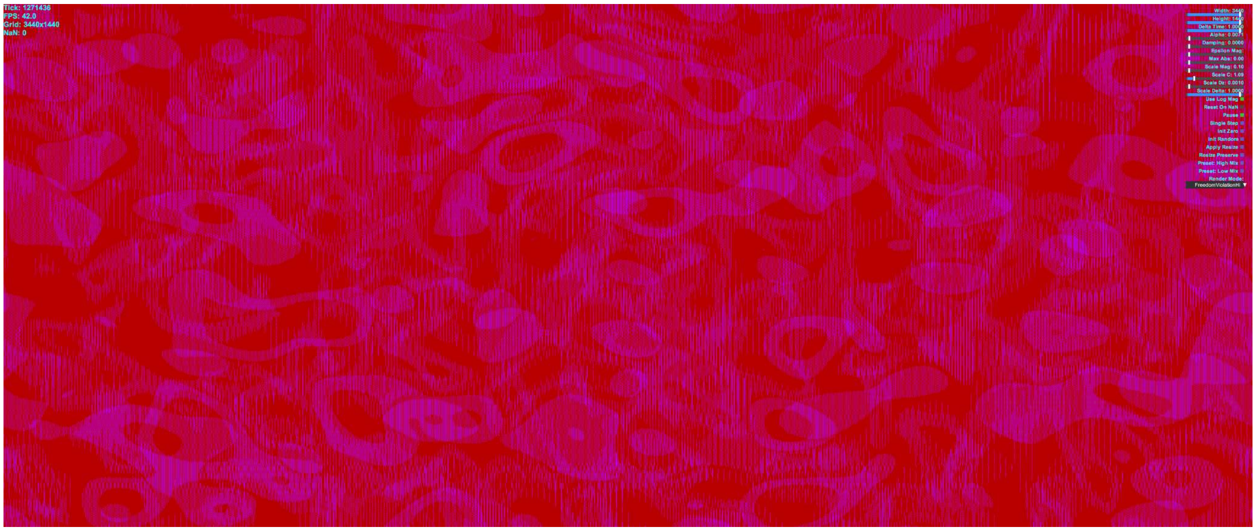

Figure 6 — Freedom Violation (High Freedom / Over-Expansion)

Visualization of **high-freedom violations**, marking regions where Λ(x) exceeds the upper admissibility bound. These regions indicate excessive local freedom, leading to uncontrolled divergence if left uncorrected. The presence of extended high-freedom zones demonstrates that instability can arise from over-expansion just as from over-constraint, without invoking external noise or stochastic forcing.

What is being displayed (data): Slots marked as violation-high when $\Lambda(x) > L_{max}$. This corresponds to “excess freedom / expansion” relative to the regime’s admissibility window.

Observed pattern (structure):

- The image is heavily saturated with **high-violation coloring** over broad areas, suggesting that at this moment the derived L_{max} is comparatively tight *or* Λ is broadly elevated.
- Importantly, even with heavy saturation, you can still see **underlying domain geometry** (the big blob partitions), meaning the violations are being evaluated *on top of* a structured regime, not random noise.
- If *Figure 5* and *Figure 6* are both significant in different regions, that’s strong evidence the window is acting **symmetrically**: the system can be “too constrained” in one place and “too free” elsewhere, in the same frame.

Empirical takeaway: An empirical support for the “two-sided” admissibility concept: **collapse and expansion are both present** as diagnosable structural states.

5.7. — EView (error / redistribution signal field)

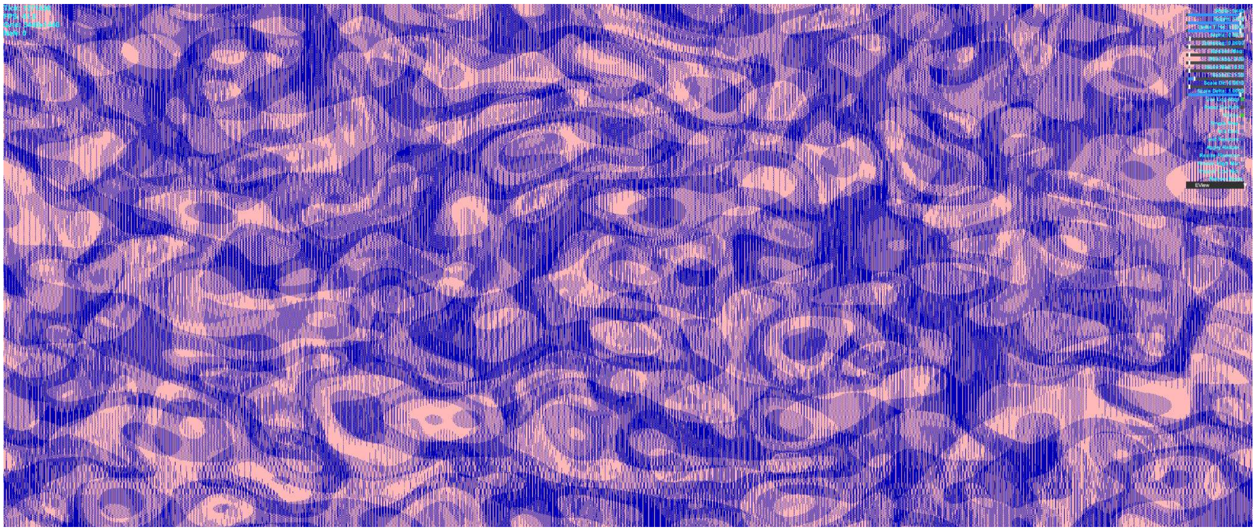

Figure 7 — Error / Feedback Redistribution View

Visualization of the **redistribution error field E(x)** and its associated feedback effect on the state. This field represents a derived correction signal proportional to detected admissibility violations and optional structural cost contribution. Feedback redistributes state locally through the same mediatory pathway as ordinary evolution, introducing no new operators or laws. The spatial coherence of the correction confirms that stabilization emerges from redistribution, not suppression or normalization.

What is being displayed (data): The error signal is computed as

$$E(x) = k_{lo}V_{lo}(x) + k_{hi}V_{hi}(x)[+ k_{cmin}\|C_{min}(x)\|\ if\ enabled]$$

and rendered as a cell-mean intensity (blue/pink palette in your screenshot). This is explicitly *not* a “law”; it is a **derived signal** used only if feedback redistribution is enabled.

Observed pattern (structure):

- E is **highly structured**: strong bands and patches align with the same domain boundaries seen in *Figure 1–3*.
- Where violation-high dominates (*Figure 6*), E typically appears more intense (because $V_{hi} = 1$ contributes directly).
- The field also shows the same fine vertical banding, but the key empirical point is that E is *not uniform*: it is spatially selective, which is required if redistribution is to act as a *targeted correction pathway*.
- The persistence of large coherent zones indicates that the error signal is not degenerating into an everywhere-on "force"; it remains **conditional and localized.**

Empirical takeaway: E behaves like a **structural correction indicator**: it turns the admissibility diagnostics into a spatially selective "where intervention would occur" map, without redefining the mediator itself.

5.8. Cross-evidence synthesis (what these seven jointly show)

Across all seven views, the recurring empirical signatures are:

1. **Large-scale domain formation** (*Figure 1–3*): coherent partitions, smooth interfaces, embedded islands.
2. **Temporal stability with boundary-localized change** (*Figure 3*): interiors persist; interfaces carry most evolution.
3. **A regime-relative admissibility geometry** (*Figure 4*): Λ is structured and nontrivial, derived from global stats.
4. **Two-sided structural failure modes** (*Figure 5–6*): both low and high violations exist as separable patterns.
5. **A derived correction field that remains conditional** (*Figure 7*): E is not everywhere; it respects the structure.

5.9. Summary Interpretation

Taken together, these seven visualizations constitute **empirical evidence that coherent, spatially organized, and temporally persistent structures emerge from the ToA's minimal ruleset**, without predefined geometry, forces, or physical laws. All observed patterns arise from:

- a ternary relational mediator,
- finite but closure-audited state space,
- continuous admissibility,
- and global structural cost redistribution.

The figures collectively support the claim that **phenomena, understood as stable and explainable patterns, are defined by aspectual structure rather than assumed primitives**.

Several questions arise throughout this work up to this point. Such a clean approach suggests indeed a very promising perspective to explore a broad range of possibilities about emergent phenomena.

Further implementations must account for high order correlations joining the unavoidable inferentiality, suggesting coexistence of “phenomenalogical layers” up to indistinguishability as natural structural limit.

The investigation remains open by design.