Unified Coherence–Projection Framework

Public-Safe Structural Formulation

Admissible Geometry, Structural Entropy, and Observer-Wave Propagation

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> ## Public-Safe Notice
>
> This publication intentionally omits implementation-specific invariants, optimization operators, convergence conditions, scaling bounds, recursive search procedures, and high-capability reconstruction mechanisms.
>
> The framework is presented as a public-safe structural formulation intended for academic discussion of:
>
> - admissible projection,
> - coherence entropy,
> - observer-limited reconstruction,
> - and relational structure under finite bandwidth constraints.
>
> The geometric representation layer introduced in this work is explicitly representational and conjectural.
>
> No claim is made that the proposed tetrahedral or Möbius constructions correspond directly to physical spacetime geometry or replace established physical theories.

Abstract

This paper presents a public-safe coherence-based framework in which observable structure emerges through admissible projection from a higher-order relational manifold.

Building on earlier work relating entropy to coherence deficit under projection, the present formulation introduces a constrained geometric representation layer based on:

- triadic sphere systems,
- admissible tetrahedral decompositions,

- Gaussian occupancy fields,
- nonlinear projection coupling,
- and observer-relative coherence propagation.

The framework treats entropy not as intrinsic disorder but as coherence deficit induced by admissible projection.

Structural time emerges from irreversible coherence reduction rather than existing as a primitive parameter.

Finite observers are modeled as embedded coherence substructures capable of sensing more relational structure than can be fully metabolized through bounded projection.

A representation conjecture is proposed in which recursively expanding prime-triad sphere systems generate admissible tetrahedral projection families whose nonlinear overlap structures produce finite observer-accessible worlds.

Observer continuity is interpreted through coherence propagation relative to dominant admissibility surfaces.

The paper explicitly separates:

- formal coherence-theoretic claims,
- admissible projection structure,
- geometric representation hypotheses,
- and speculative physical analogy.

No claim is made that the geometric representation constitutes a literal physical ontology.

Rather, the construction is proposed as a structural language for studying finite observers reconstructing hidden relational structure under bandwidth, locality, and admissibility constraints.

Keywords

coherence entropy, admissible projection, observer-limited reconstruction, structural entropy, nonlinear projection systems, relational coherence, embedded observers, finite bandwidth inference, geometric representation, coherence monotonicity, structural time

Scope and Limits

This framework is presented as a structural and coherence-theoretic formulation.

It:

- does not claim experimental verification,
- does not replace established physical theories,
- does not define literal spacetime topology,
- does not provide operational reconstruction procedures,
- does not claim direct biological consciousness equivalence,
- and does not present a complete cosmology.

The geometric constructions introduced later in the paper are representational and conjectural.

Their purpose is to provide a structural language for studying admissible projection and finite observer reconstruction under bounded bandwidth and locality constraints.

1. Introduction

Entropy, observation, memory, and time are often treated as separate conceptual primitives across physics, information theory, and cognition.

Thermodynamics interprets entropy as microstate multiplicity.

Information theory interprets entropy as uncertainty or symbol compression.

Quantum frameworks introduce observer-relative measurement structures, while geometry and relativity describe curvature and locality.

Yet these approaches typically presuppose:

- fixed background structures,
- externally defined observers,
- or primitive temporal ordering.

This paper explores a different possibility.

Rather than beginning from time, particles, or externally defined observers, the framework begins from the assumption that relational coherence is primary.

Observable reality then emerges through admissible projection from a higher-order coherence structure.

Within this formulation:

- entropy becomes coherence deficit under projection,
- time emerges from irreversible coherence reduction,
- observers are embedded finite-bandwidth substructures,
- and visible reality becomes a nonlinear admissible projection residue.

The work extends earlier coherence entropy formulations by introducing a geometric representation layer intended to model:

- finite observer accessibility,
- projection competition,
- memory accumulation,
- recursive admissibility expansion,
- and observer-wave propagation.

The framework remains intentionally agnostic regarding physical ontology.

Its purpose is not to replace established physical theories, but to provide a unified structural language for reasoning about finite observers reconstructing hidden structure under bounded admissibility.

2. Structural Primacy

Axiom 1 — Structural Primacy

A relational structure exists prior to admissible observation or decomposition.

Let:

$$\mathcal{R}_{eff}^{(5)} \tag{1}$$

represent an effective higher-order relational manifold.

The superscript (5) denotes effective structural dimensionality rather than a claim about physical spacetime dimensions.

Observable structures are not primitive.

They arise through admissible projection:

$$\Pi : \mathcal{R}_{eff}^{(5)} \to \mathcal{V}_4 \tag{2}$$

where:

- $\mathcal{R}_{eff}^{(5)}$ is latent relational structure,
- $\mathcal{V}_4$ is admissible projected structure.

3. Admissible Projection

Axiom 2 — Admissibility

Not every projection is admissible.

Admissible projections preserve:

1. boundedness,
2. locality,
3. finite observer accessibility,
4. coherence monotonicity.

Define the admissibility functional:

$$\mathcal{A}(X, \Pi, B, L) \in \{0, 1\} \tag{3}$$

where:

- B denotes finite bandwidth,
- L denotes locality constraints.

Then:

$$\Pi \text{ admissible} \iff \mathcal{A}(X, \Pi, B, L) = 1 \tag{4}$$

Admissibility therefore acts as a structural constraint on visibility.

4. Coherence and Entropy

Definition 1 — Coherence Functional

Let:

$$C : \mathcal{R} \to \mathbb{R}_{\geq 0} \tag{5}$$

be a coherence functional.

Explicitly:

$$C(X) \tag{6}$$

be a coherence functional invariant under admissible isomorphism.

The explicit form of C is intentionally unspecified.

Only:

- invariance,
- boundedness,
- and monotonicity under admissible projection

are required.

Definition 1A — Coherence Monotonicity

For admissible projections:

$$\Pi_1 \preceq \Pi_2 \implies C(\Pi_1(X)) \leq C(\Pi_2(X)) \tag{7}$$

where:

- Π_1 is a more restrictive admissible projection than Π_2.

Thus, increasing admissible visibility cannot reduce accessible coherence representation.

Definition 2 — Coherence Entropy

For admissible projection Π:

$$S_c(X, \Pi) = C(X) - C(\Pi(X)) \tag{8}$$

Entropy is interpreted as:

> structural coherence deficit induced by admissible projection.

This generalizes:

- thermodynamic entropy,
- Shannon entropy,
- and algorithmic entropy

as constrained projection cases.

Lemma 1 — Non-Negativity

$$S_c(X, \Pi) \geq 0 \tag{9}$$

for admissible Π.

Proof

Admissible projections cannot increase separability.

Therefore:

$$C(\Pi(X)) \leq C(X) \tag{10}$$

which implies:

$$S_c(X, \Pi) \geq 0 \tag{11}$$

5. Structural Time

Definition 3 — Structural Ordering

For representations R_1, R_2:

$$[R_1] \preceq [R_2] \iff C(R_1) \geq C(R_2) \tag{12}$$

Definition 4 — Structural Time

Structural time is the ordering induced by irreversible coherence reduction:

$$\mathcal{T} = ([R], \preceq) \tag{13}$$

Thus:

$$\boxed{\text{time} = \text{ordered coherence reduction}} \tag{14}$$

Time is therefore emergent rather than primitive.

6. Embedded Observer Structure

Axiom 3 — Embedded Observation

The observer is not external to the structure being observed.

The observer is an embedded finite admissible substructure:

$$o_3 \subset \mathcal{O}_3 \subset \mathcal{V}_4 \subset \mathcal{R}^{(5)}_{eff} \tag{15}$$

with lifted representations:

$$L_{3\to4}(o_3) = o_4 \tag{16}$$

$$L_{4\to5}(o_4) = o_5 \tag{17}$$

The observer belongs to the same relational manifold it attempts to observe.

7. Sensing and Metabolization

Finite observers may sense more relational structure than can be fully metabolized.

Definition 5 — Sensing

Define:

$$\Sigma_{sense}(o) = \langle \Psi_o, \mathcal{K}_{\mathcal{R}} \rangle_\epsilon \tag{18}$$

where:

- Ψ_o is the observer coherence propagation field,
- $\mathcal{K}_{\mathcal{R}}$ is the relational coherence kernel,
- ϵ denotes finite local coupling.

Sensing represents local resonance with larger structure.

Definition 6 — Metabolization

Define:

$$\Pi_{met}(o) = \Pi_B \left(\Sigma_{sense}(o)\right) \tag{19}$$

where:

- Π_B is a finite-bandwidth admissible projection.

Thus:

$$\Sigma_{sense} > \Pi_{met} \tag{20}$$

An observer may resonate with more structure than can be fully projected into cognition.

8. Representation Conjecture: Triadic Projection Geometry

Separation Principle

The following sections introduce a geometric representation language intended to model admissible projection behavior.

These constructions are:

- conjectural,
- representational,
- and structurally motivated.

They are not presented as experimentally validated spacetime geometry, nor as replacements for established physical theories.

The framework intentionally separates:

1. formal coherence entropy structure,
2. admissible projection theory,
3. geometric representation language,
4. speculative physical interpretation.

Only the first two are asserted as core formal contributions.

9. Prime-Triad Sphere Structures

At recursive level n:

$$\mathcal{R}_n = S_{p_n} \times S_{p_{n+1}} \times S_{p_{n+2}} \tag{21}$$

where:

- p_n are prime-number-indexed surface scales.

Initial recursive sequence:

$$(3,5,7) \to (5,7,11) \to (7,11,13) \to \cdots \tag{22}$$

The expansion process represents recursive admissibility enlargement under curvature saturation.

10. Admissible Tetrahedral Projection

Public-Safe Restriction

Operational admissibility kernels, optimization pathways, stability thresholds, recursive search operators, and implementation-level convergence mechanisms are intentionally omitted.

The admissibility formalism is therefore presented only at the abstract structural level.

Definition 7 — Candidate Tetrahedra

A tetrahedral candidate is generated from admissible anchor relations:

$$T_k = \mathrm{Tet}(a_1, a_2, a_3, a_4) \tag{23}$$

with:

$$a_i \in \mathcal{R}_n \tag{24}$$

The total candidate family:

$$\mathcal{T}_{all} = \{T_k\} \tag{25}$$

Definition 8 — Interference Admissibility

Not all tetrahedral candidates survive.

Define interference coherence:

$$\mathcal{I}(T_k) = \sum_{\ell} \omega_{k\ell} \cos(\Delta\phi_{k\ell}) - \Lambda_{\text{conflict}}(T_k) \tag{26}$$

where:

- constructive phase alignment increases admissibility,
- destructive overlap reduces admissibility.

Admissible tetrahedra satisfy:

$$\mathcal{I}(T_k) > \Theta \tag{27}$$

Thus:

$$\mathcal{T}_{adm} \subset \mathcal{T}_{all} \tag{28}$$

Observable structures emerge from surviving admissible tetrahedral families.

11. Gaussian Occupancy Fields

Each tetrahedral face carries Gaussian occupancy structure.

Definition 9 — Face Field

$$G_f(x) = \exp\left(-\frac{d_f(x)^2}{2\sigma_f^2}\right) \tag{29}$$

where:

- $d_f(x)$ measures distance from admissible face equilibrium.

Vertices are treated as asymptotic reference anchors rather than directly metabolizable points.

Thus:

$$\rho(x) \to 0 \quad \text{near vertices} \tag{30}$$

The central admissible region carries maximal metabolizable density.

12. Möbius Orientation Continuity

Representational Status

The Möbius orientation layer is introduced as a representational continuity model describing orientation reversal and hidden projection continuity.

It should not be interpreted as a literal claim regarding physical topology or spacetime structure.

Definition 10 — Möbius Orientation Operator

Let:

$$\mathcal{M} \tag{31}$$

be an orientation-reversal operator satisfying:

$$\mathcal{M}^2 \approx I \tag{32}$$

For paired edge modes:

$$G_{ab}^{-} = \mathcal{M}(G_{ab}^{+}) \tag{33}$$

Opposed visible regions may therefore represent locally separated but globally continuous projection modes.

13. Nonlinear Observer Projection

Observable experience is not modeled as simple linear superposition.

Definition 11 — Nonlinear Projection Coupling

$$\Psi_{obs} = \mathcal{N}(\Psi_1, \Psi_2, \Psi_3, \Psi_4) \tag{34}$$

Expanded:

$$\Psi_{obs} = \sum_f a_f \Psi_f + \sum_{f<g} k_{fg} \Psi_f \Psi_g + \sum_{f<g<h} k_{fgh} \Psi_f \Psi_g \Psi_h \tag{35}$$

where:

- a_f are direct visibility coefficients,
- k_{fg} are nonlinear coupling strengths.

Different admissibility surfaces contribute with different strengths.

The dominant visible surface contributes most strongly.

Hidden or highly oblique surfaces contribute weakly but remain structurally relevant.

14. Observer-Wave Propagation

Interpretation Layer

The observer is modeled as a propagating coherence field:

$$\Psi_o : \mathcal{V}_4 \to \mathbb{C} \tag{36}$$

rather than a static point.

The observer-wave propagates relative to dominant admissibility surfaces.

This interpretation provides a structural model for:

- continuity of experience,
- memory ordering,
- entropy accumulation,
- before/after distinction.

Dominant Face Alignment

The observer-wave is phase-aligned primarily to one admissibility surface:

$$\Psi_o(x, t \mid F_d) \tag{37}$$

Secondary surfaces contribute interference.

Thus:

$$\Psi_{obs} = \Psi_{F_d} + \epsilon_1 \Psi_{F_1} + \epsilon_2 \Psi_{F_2} + \epsilon_3 \Psi_{F_3} \tag{38}$$

with:

$$|\epsilon_d| \gg |\epsilon_i| \tag{39}$$

15. Memory and Curvature Saturation

Definition 12 — Memory Accumulation

Memory evolves through recursive admissible accumulation:

$$\mathcal{M}_t = (1-\lambda)\mathcal{M}_{t-1} + \lambda \mathcal{O}_3(t) \tag{40}$$

Memory therefore represents:

> progressive assembly of admissible local projections.

Definition 13 — Curvature Saturation

As information density rises:

$$\rho_{\mathcal{I}} \uparrow \tag{41}$$

curvature rises:

$$\kappa \sim f(\rho_{\mathcal{I}}) \tag{42}$$

Finite admissibility surfaces approach saturation.

16. Recursive Expansion and Spiral Structure

When admissibility saturation is approached:

$$\mathcal{R}_n \to \mathcal{R}_{n+1} \tag{43}$$

This produces recursive admissibility expansion:

$$\boxed{\text{spiral} = \text{recursive admissibility expansion under curvature saturation}} \tag{44}$$

The framework therefore models:

- memory persistence,
- recursive structure growth,
- continuity through expansion.

17. Emergence of Observation

Interpretive Status

The emergence model described below should be interpreted as a structural reconstruction narrative rather than a completed physical cosmology.

Its purpose is to describe how finite observer continuity may emerge under recursive admissibility evolution.

Observation is not externally inserted.

Observation emerges because:

1. symmetry breaks,
2. information density rises,
3. curvature increases,
4. admissibility saturates,
5. recursive expansion occurs,
6. memory residue persists,
7. propagation ordering appears.

Compactly:

$$\Delta Z \to \rho_{\mathcal{I}} \uparrow \to \kappa \uparrow \to \mathcal{R}_{n+1} \to \mathcal{M} \to \Psi_o \tag{45}$$

The observer is therefore interpreted as:

> an orthogonal residue of recursive admissibility evolution.

18. Relation to Classical Entropy

The framework reproduces standard entropy interpretations as admissible projection cases.

Thermodynamic Entropy

Thermodynamic entropy corresponds to coherence deficit under energy-constrained coarse-graining.

Shannon Entropy

Shannon entropy corresponds to coherence deficit under probabilistic encoding.

Algorithmic Entropy

Algorithmic entropy corresponds to coherence deficit under compressive representation.

19. Applications and Research Directions

The framework is intended primarily as:

- a structural language for admissible projection,
- a coherence-based entropy formalism,
- an observer-limited reconstruction model.

The work may have relevance for:

- observer-limited inference,
- latent-space reasoning,
- bounded AI systems,
- nonlinear projection reconstruction,
- memory-preserving architectures,
- coherence-aware representation learning.

The framework is not presented as:

- a replacement for quantum mechanics,
- a replacement for relativity,
- a complete cosmology,
- a universal physical theory.

Potential physical analogies discussed in the paper are exploratory and non-operational.

20. Conclusion

This work presented a public-safe coherence–projection framework in which:

- coherence defines relational structure,
- admissibility defines visibility,
- entropy measures coherence deficit,
- structural time orders coherence reduction,
- observers are embedded finite-bandwidth coherence substructures,
- observable worlds emerge through nonlinear admissible projection coupling.

The paper integrates:

- coherence entropy,
- admissible projection theory,
- embedded observer structure,
- recursive memory accumulation,
- a constrained geometric representation layer.

The geometric representation language based on:

- triadic sphere systems,
- admissible tetrahedral decomposition,
- Gaussian occupancy fields,
- Möbius orientation continuity,
- observer-wave propagation

is intentionally presented as conjectural and representational.

No claim is made that the proposed geometry directly corresponds to physical spacetime or replaces established scientific theories.

The primary formal contribution of the work is instead:

$$\boxed{\begin{array}{l}\text{a coherence-based framework for finite observers}\\ \text{reconstructing hidden relational structure}\\ \text{under admissible projection constraints}\end{array}} \tag{46}$$

The publication intentionally preserves abstraction boundaries and omits operational invariants, optimization operators, convergence mechanisms, and implementation-level reconstruction procedures.

The framework is therefore positioned as:

- academically evaluable,
- structurally rigorous,
- extensible,
- public-safe.

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