Ontological Closure, Recursive Survivability, and Closure–Latency Dynamics:
Persistence Under Undecidability in an Implication-Closed Universe

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Abstract

This paper formalizes a unified account of persistence in an implication-closed universe. The framework has two core layers, an internal realization rule, and one phenomenological instantiation.

(1) *Ontological Closure.* Reality is a single ontological object U with fixed internal admissibility structure $\mathcal{A}$. There is no external container, no ontologically primitive time-flow, and no ontic category of "potential" distinct from admissibility. Strong novelty—new being entering ontology—is rejected: whatever is real is already implied by $\mathcal{A}$.

(2) *Recursive Survivability.* In closure, persistence is not a brute fact but a structural phenomenon. Persistent systems sustain non-terminating traversal between two failure bounds: WI (collapse of viability into inert rigidity or incoherence) and WU (collapse into terminal closure/halting). A conditional *self-reference schema* captures a consequence of implemented expressive self-reference: complete provability-closure is unattainable without loss of consistency or expressivity. The resulting operational pressure is *Gödel tension* Θ_G.

(3) *Constraint-Selected Realization Dynamics (CSRD).* To connect closure to measurement-like narrowing without introducing objectives, CSRD formalizes admissible branching, convex effective superposition over admissible successors, and boundary-driven enforcement as pure admissibility effects.

(4) *Closure–Latency Dynamics (CLD).* As a physics-facing supporting instantiation, CLD reinterprets metric-like observables as latency effects produced by an internal scalar potential Λ coupled to an organization statistic χ within the admissibility substrate. Weak-field consistency is recovered under an operational calibration $\Lambda \sim \Phi/c^2$, while predicting falsifiable structure-dependent residuals at fixed baryonic mass.

A constructive computational instantiation is provided via RNSE: a minimal operator architecture that preserves admissibility, expands differentiation, regulates collapse, and enforces anti-closure without optimizing toward targets. The paper concludes with comparative positioning and objections.

Keywords: ontological closure; admissibility; survivability; self-reference; Gödel tension; constructive dynamics; RNSE; CLD.

Contents

1 Introduction

1.1 The problem: persistence without extra ontology

Two pressures dominate contemporary metaphysics and foundations.

First, there is a closure-like intuition: the total structure of reality does not require an external generator (a metaphysical time-flow, a selector, or a novelty operator) to "produce" what is real. Second, there is the persistence problem: the world contains stable identities, robust adaptive organization, and regularities that support complex structures capable of tracking and maintaining themselves.

A standard move is to introduce extra primitives (primitive time, primitive probability, ontic selection, strong emergence). This paper pursues the opposite move:

> Keep ontological closure, and explain persistence as an internal structural phenomenon: a consequence of admissibility geometry and non-terminating self-reference under constraint.

The intent is not to deny change or complexity, but to deny that such phenomena require new ontic categories.

1.2 Overview

Section 3 defines ontological closure with a clean separation between admissibility and instantiation. Section 4 introduces CSRD: an internal realization rule that produces optimal-looking evolution and measurement-like narrowing without objectives. Section 5 defines persistence as traversal between two failure regions (WI and WU) expressed via descriptive functionals. Section 6 formalizes a self-reference schema and Gödel tension Θ_G as a conditional engine of anti-closure. Section 7 introduces CLD as a supporting instantiation that reproduces weak-field scalings while predicting structure-dependent residuals. Section 8 presents RNSE as a constructive computational realization. Section 9 treats tracking without memory as deformation of continuation geometry. Section 10 positions the framework and addresses objections.

2 Notation and Conventions

We fix a configuration space $\mathcal{C}$ whose elements $c \in \mathcal{C}$ represent *states of articulation* (descriptions, worlds, models, or realizations, depending on context). An *admissibility structure* $\mathcal{A}$ assigns to each configuration c (and optionally a boundary condition B) a nonempty set of admissible continuations $\mathcal{A}(c)$ or $\mathcal{A}_B(c)$.

We use the following recurring symbols.

$\mathcal{C}$ configuration space.

c, c', c_n
: configurations (with n used for discrete iterates).

B boundary condition / external constraint interface.

$\mathcal{A}, \mathcal{A}_B$
: admissibility structure, optionally boundary-conditioned.

$\prec$ a *continuation-derived* preorder between configurations (introduced in Section 4).

$\rightsquigarrow_{\mathcal{A}}$ admissibility-respecting transition relation (the *realization step*).

$\mathrm{Cont}(c)$
: continuation set of c (used to quantify "room to continue").

$\Psi(c)$
: an efficacy / survivability functional derived from admissible continuation (not an external objective).

$\mathrm{Cl}, \mathrm{Inst}$
: closure and instantaneity predicates introduced in Parts I–II.

Θ_G Gödel tension (Part III), a pressure induced by self-reference under closure.

Λ, χ
: CLD latency and structure parameters (Part IV), treated phenomenologically.

Convention. "Closure" is ontological (what is real is internally implied), not a claim about finite knowledge. When we write "optimal" or "selected," it always means *selected by admissibility* (i.e., by the internal survival geometry determined by $\mathcal{A}$), not by an external cost function.

3 Part I: Ontological Closure

3.1 Primitive commitments

Axiom 3.1 (Ontological Closure)**.** *There exists exactly one ontological object U (the universe). There are no entities outside U. U is not embedded in any external space, time, container, or meta-domain.*

Axiom 3.2 (Admissibility Structure)**.** *U possesses a fixed internal admissibility structure $\mathcal{A}$ consisting of constraints, relations, and invariants that determine which internal arrangements are admissible and which are inadmissible. Nothing outside $\mathcal{A}$ occurs.*

Remark 3.3. This does not claim $\mathcal{A}$ is simple, finite, or known. It claims only that admissibility is fixed by internal structure rather than by external selection or ontological growth.

3.2 Configuration space, consequence, and admissible succession

Definition 3.4 (Configuration space)**.** Let $\mathcal{C} = \mathcal{C}(U, \mathcal{A})$ be the set of all configurations of U consistent with $\mathcal{A}$.

Definition 3.5 (Configuration)**.** A configuration is an element $c \in \mathcal{C}$, interpreted as a complete internal specification of relations in U consistent with $\mathcal{A}$.

Definition 3.6 (Consequence relation)**.** Let $\vdash_{\mathcal{A}}$ be the consequence relation induced by $\mathcal{A}$. For $c, c' \in \mathcal{C}$,

$$c \vdash_{\mathcal{A}} c' \quad \text{iff} \quad c' \text{ is implied by } c \text{ under } \mathcal{A}.$$

Proposition 3.7 (Minimal properties of $\vdash_{\mathcal{A}}$)**.** *For all $c, c', c'' \in \mathcal{C}$:*

*(i) (**Reflexive**) $c \vdash_{\mathcal{A}} c$.*

*(ii) (**Transitive**) If $c \vdash_{\mathcal{A}} c'$ and $c' \vdash_{\mathcal{A}} c''$, then $c \vdash_{\mathcal{A}} c''$.*

Proof. By Definition 3.6, $\vdash_{\mathcal{A}}$ is the consequence/entailment relation induced by $\mathcal{A}$. Reflexivity holds because any configuration implies itself under the same admissibility constraints. Transitivity holds because consequence relations are closed under chaining: if c entails c' and c' entails c'' (under the same $\mathcal{A}$), then c entails c''. □

Definition 3.8 (Admissible transition relation)**.** Let $\rightsquigarrow_{\mathcal{A}} \subseteq \mathcal{C} \times \mathcal{C}$ be an admissible successor relation such that:

(i) If $c \rightsquigarrow_{\mathcal{A}} c'$, then $c, c' \in \mathcal{C}$ (admissibility is respected).

(ii) If $c \rightsquigarrow_{\mathcal{A}} c'$, then $c \vdash_{\mathcal{A}} c'$ (succession is consequence-consistent).

Write $c \rightsquigarrow^*_{\mathcal{A}} c'$ if c' is reachable from c by finitely many $\rightsquigarrow_{\mathcal{A}}$-steps (reflexive-transitive closure).

Remark 3.9. This separation is deliberate: entailment ($\vdash_{\mathcal{A}}$) is not, by itself, a dynamics. Closure constrains both, but does not require identifying them.

Definition 3.10 (Logical closure set)**.** For any $c \in \mathcal{C}$, define

$$\mathrm{Cl}(c) := \{\, c' \in \mathcal{C} \mid c \vdash_{\mathcal{A}} c' \,\}.$$

Definition 3.11 (Continuation set)**.** For any $c \in \mathcal{C}$, define

$$\mathrm{Cont}(c) := \{\, c' \in \mathcal{C} \mid c \rightsquigarrow^*_{\mathcal{A}} c' \,\}.$$

Proposition 3.12 (Monotonicity of continuation)**.** *If $c \rightsquigarrow^*_{\mathcal{A}} c'$, then $\mathrm{Cont}(c') \subseteq \mathrm{Cont}(c)$.*

Proof. If $d \in \mathrm{Cont}(c')$, then $c' \rightsquigarrow^*_{\mathcal{A}} d$. With $c \rightsquigarrow^*_{\mathcal{A}} c'$ and transitivity of $\rightsquigarrow^*_{\mathcal{A}}$, we have $c \rightsquigarrow^*_{\mathcal{A}} d$, hence $d \in \mathrm{Cont}(c)$. □

3.3 Consequence equivalence and quotient order

Definition 3.13 (Consequence equivalence)**.** For $c, c' \in \mathcal{C}$, write $c \sim_{\mathcal{A}} c'$ iff $c \vdash_{\mathcal{A}} c'$ and $c' \vdash_{\mathcal{A}} c$.

Proposition 3.14 (Quotient partial order)**.** *The relation $\vdash_{\mathcal{A}}$ induces a partial order on $\mathcal{C}/\!\sim_{\mathcal{A}}$.*

Proof. Define $[c] \preceq [c']$ iff $c \vdash_{\mathcal{A}} c'$. Reflexivity and transitivity descend from $\vdash_{\mathcal{A}}$. If $[c] \preceq [c']$ and $[c'] \preceq [c]$, then $c \sim_{\mathcal{A}} c'$ and thus $[c] = [c']$. □

3.4 Instantiation (type separation with empirical bite)

Definition 3.15 (Instantiation set)**.** Let $\mathrm{Inst} \subseteq \mathcal{C}$ denote the set of instantiated configurations.

Axiom 3.16 (Instantiation respects admissibility)**.** $\mathrm{Inst} \subseteq \mathcal{C}$.

Axiom 3.17 (Instantiation is internally specifiable)**.** *There exists a predicate $I_{\mathcal{A}} : \mathcal{C} \to \{0, 1\}$ induced by internal structure (and thus compatible with $\mathcal{A}$) such that*

$$\mathrm{Inst} = \{\, c \in \mathcal{C} \mid I_{\mathcal{A}}(c) = 1 \,\}.$$

In particular, no external selector is posited.

Remark 3.18. This is compatible with $\mathrm{Inst} = \mathcal{C}$ (an eternalist reading), or with Inst as a proper subset determined internally by $\mathcal{A}$ without a meta-process that "adds" reality over time.

Proposition 3.19 (Why Inst is not decorative)**.** *Empirical claims require restriction to* Inst*. In particular, any observation report is a functional on instantiated configurations, i.e. a map* $O : \mathrm{Inst} \to \mathcal{Y}$*. Therefore:*

(i) Two models can share the same $\mathcal{C}$ *and* $\mathcal{A}$ *but differ in* Inst*, yielding different observable datasets* $\{O(c) : c \in \mathrm{Inst}\}$*.*

(ii) Purely ontological statements quantify over $\mathcal{C}$*, while empirical/measurement statements quantify over* Inst*.*

Thus Inst *is the minimal type-separation needed to state observational constraints without introducing an external "becoming" operator.*

Proof sketch. An empirical report requires a well-defined observation map O whose domain is restricted to realizable/instantiated configurations. If one quantifies over all of $\mathcal{C}$ (including non-instantiated configurations), then two incompatible observational datasets can be equally compatible with the same $(\mathcal{C}, \mathcal{A})$ by choosing different realizability predicates, making any empirical claim underdetermined. Therefore, separating Inst is the minimal move that (i) states what is actually measured, and (ii) preserves closure by avoiding an external "becoming" operator. □

Axiom 3.20 (Implication closure (structural form))**.** *For all* $c \in \mathcal{C}$*, both* $\mathrm{Cl}(c)$ *and the admissible transition constraints on* $\rightsquigarrow_{\mathcal{A}}$ *are determined by* $\mathcal{A}$*. No ontological primitive (e.g. time-flow, external selection, ontology-extending operator) enlarges* $\mathcal{C}$ *or modifies* $\mathcal{A}$*.*

4 Admissibility-Based Realization: Constraint-Selected Realization Dynamics (CSRD)

This section supplies a minimal internal realization rule compatible with ontological closure. It formalizes how admissibility alone can yield (i) objective-free "optimal" evolution in an intrinsic sense, (ii) branching continuation, and (iii) measurement-like narrowing as boundary effects—without introducing an external objective functional or a metaphysically primitive collapse postulate.

4.1 Primitive configuration and absence of objectives

Axiom 4.1 (No external objective)**.** *No external evaluative functional is assumed:*

$$\nexists\, \Phi : \mathcal{C} \to \mathbb{R},$$

where Φ *would represent an objective, cost, or preference measure.*

4.2 Admissible continuation set

Definition 4.2 (Admissible successor set)**.** For each $c \in \mathcal{C}$, define the admissible successor set

$$\mathcal{A}(c) \;:=\; \{\, c' \in \mathcal{C} \mid c \rightsquigarrow_{\mathcal{A}} c' \,\} \;\subseteq\; \mathrm{Cont}(c).$$

Remark 4.3. CSRD makes the minimal claim: admissibility fixes the *set* of allowed successors. It does not add a ranking, a utility, or a target.

On the semantics of $\prec$ (no hidden objective)

Definition 4.4 (Continuation-induced suboptimality preorder)**.** CSRD does not assume an objective-induced ranking. When a strict suboptimality relation $\prec$ is used, it is understood as *emergent from continuation deformation under coupling and records*, not as a primitive preference.

Fix an interaction/coupling context (including record-formation constraints) producing a post-coupling deformation of continuation sets. For $c_1, c_2 \in \mathcal{C}$, define

$$c_1 \prec c_2 \quad \text{iff} \quad |\mathrm{Cont}_{\mathrm{post}}(c_1)| < |\mathrm{Cont}_{\mathrm{post}}(c_2)|,$$

where $\mathrm{Cont}_{\mathrm{post}}(\cdot)$ denotes the continuation set after applying the relevant coupling/record constraints.

Remark 4.5. This $\prec$ is not a utility ranking. It measures *survivable continuation capacity* under a specified interaction context. It is therefore non-global, context-indexed, and derived from admissibility geometry. In particular, it does not reintroduce any external evaluative functional Φ; it is computed from (deformed) continuation structure already permitted by closure. This aligns with RNSE differentiation/anti-closure: larger $\mathrm{Cont}_{\mathrm{post}}$ means more instantiable branches under null-seed recursion.

4.3 Intrinsic optimality (non-ranking)

Definition 4.6 (Intrinsic optimality)**.** A configuration c is intrinsically optimal (relative to admissibility) if no admissible successor is ranked as inferior to another:

$$\forall c_1, c_2 \in \mathcal{A}(c), \quad \neg(c_1 \prec c_2),$$

where $\prec$ denotes strict suboptimality. In CSRD, $\prec$ is not primitive and is not assumed to be induced by any Φ.

Remark 4.7. Intrinsic optimality here is a structural statement: if the theory has no objective, then "optimality" reduces to "no inadmissible realization is produced". This is not a semantic trick; it is the literal removal of ranking from the dynamics.

4.4 Continuation within instantiation

Proposition 4.8 (Non-stagnation within instantiation)**.** *If $c \in \mathrm{Inst}$ and $\mathcal{A}(c) \neq \varnothing$, then there exists $c' \in \mathrm{Inst}$ such that $c \rightsquigarrow_{\mathcal{A}} c'$.*

Proof sketch. By definition, $\mathcal{A}(c) = \{c' \in \mathcal{C} : c \rightsquigarrow_{\mathcal{A}} c'\}$. The assumption $\mathcal{A}(c) \neq \varnothing$ gives at least one admissible successor $c^\star \in \mathcal{C}$ with $c \rightsquigarrow_{\mathcal{A}} c^\star$. The CSRD non-stagnation clause asserts that instantiation is closed under realized admissible succession: whenever $c \in \mathrm{Inst}$ admits successors, at least one successor is instantiated. Hence there exists $c' \in \mathrm{Inst}$ with $c \rightsquigarrow_{\mathcal{A}} c'$. This is the minimal anti-stasis condition: instantiation propagates through admissibility without external forcing. $\square$

Remark 4.9. This is not a metaphysical "must" over $\mathcal{C}$. It is a minimal operational clause tying empirical persistence to instantiated successor availability.

4.5 Constraint determinism and realization multiplicity

Proposition 4.10 (Constraint determinism)**.** *For each $c \in \mathcal{C}$, the set $\mathcal{A}(c)$ is uniquely determined by $(c, \mathcal{A})$, while realized choice need not be unique:*

$$\mathcal{A}(c) \text{ is fixed by } (c, \mathcal{A}), \qquad |\mathcal{A}(c)| \geq 1.$$

Proof. By Definition 4.2, $\mathcal{A}(c) = \{c' \in \mathcal{C} \mid c \rightsquigarrow_{\mathcal{A}} c'\}$ is defined purely from the transition relation $\rightsquigarrow_{\mathcal{A}}$. By Axiom 3.20, the admissible transition constraints on $\rightsquigarrow_{\mathcal{A}}$ are determined by $\mathcal{A}$ (and the current configuration c), hence $\mathcal{A}(c)$ is fixed by $(c, \mathcal{A})$. Non-uniqueness of realized choice is compatible with determinism of $\mathcal{A}(c)$ whenever $|\mathcal{A}(c)| > 1$. □

4.6 Effective superposition (predictive state)

Definition 4.11 (Effective predictive state)**.** Define an effective predictive state as a convex mixture over admissible successors:

$$\Psi(c) \;:=\; \sum_{c' \in \mathcal{A}(c)} w_{c \to c'}\, c', \qquad \sum_{c'} w_{c \to c'} = 1, \quad w_{c \to c'} \geq 0.$$

Remark 4.12. $\Psi(c)$ is not an added ontic object; it is an internal effective descriptor of admissible branching under coarse-graining. In weak-boundary regimes (large $\mathcal{A}(c)$ with mild restriction), propagation admits a linear superposed approximation. When constraints tighten, the mixture concentrates, yielding measurement-like narrowing as an admissibility effect.

4.7 Boundary enforcement and realized uniqueness

Definition 4.13 (Boundary restriction)**.** A boundary condition B restricts admissibility by intersection:

$$\mathcal{A}_B(c) \;:=\; \mathcal{A}(c) \cap B.$$

If $|\mathcal{A}_B(c)| = 1$, a unique successor is enforced by constraint.

Remark 4.14 (Sources of boundary tightening)*.* Boundaries may arise internally from (i) self-reference constraints (Section 6), (ii) coupling to other subsystems (Section 9), and (iii) record formation via many-to-one coarse-grain maps that stabilize deformation of continuation sets.

Theorem 4.15 (Optimality without optimization)**.** *A system governed solely by admissibility evolves* optimally *in the intrinsic sense: it produces no inadmissible realized successors, without minimizing or maximizing any objective functional.*

$$\textit{Optimality (CSRD)} \iff \neg\exists \textit{ inadmissible realized successor.}$$

Proof sketch. ($\Rightarrow$) By definition, realization in CSRD occurs only through admissible succession: realized successors are selected from $\mathcal{A}_B(c) \subseteq \mathcal{A}(c) \subseteq \mathcal{C}$. Therefore no realized successor is inadmissible.

($\Leftarrow$) If no realized successor is inadmissible, then every realized update respects $\mathcal{A}$. Since CSRD assumes no external objective functional Φ (Axiom 4.1), there is no optimization criterion available beyond admissibility itself. Hence "optimality" reduces to the structural fact that the realized evolution never violates admissibility. □

Remark. Selection is not a choice. It is the geometry of admissibility under boundary tightening.

5 Part II: Recursive Survivability

Closure forbids explaining persistence by adding ontic machinery. Therefore persistence must be explained as a structural phenomenon internal to admissibility, realized operationally as non-terminating traversal that avoids both viability collapse and terminal halting.

5.1 Failure topology and survivability bands

Definition 5.1 (Dual viability). A subsystem-pattern is persistent only if it satisfies:

(a) **Local viability**: coherence and responsiveness under nearby constraints.

(b) **Global sustainability**: robustness under unbounded interaction, perturbation, and recursive self-reference.

Definition 5.2 (Viability functional and closure-distance). Let $V : \mathcal{C} \to \mathbb{R}$ measure persistence-capacity, and let $D : \mathcal{C} \to \mathbb{R}_{\geq 0}$ measure distance-from-closure, where $D(c) = 0$ denotes terminal closure.

Remark 5.3. V and D are descriptive functionals used to express failure topology. They need not be fundamental quantities of $\mathcal{A}$; they may be induced by coarse-graining, domain modeling, or internal evaluation procedures of subsystems.

Definition 5.4 (Failure regions). Define

$$\mathcal{F}_{\mathrm{WI}} := \{c \in \mathcal{C} : V(c) \leq v_{\min}\}, \qquad \mathcal{F}_{\mathrm{WU}} := \{c \in \mathcal{C} : D(c) \leq d_{\min}\}.$$

Definition 5.5 (Traversal band). Define

$$\mathcal{B} := \mathcal{C} \setminus (\mathcal{F}_{\mathrm{WI}} \cup \mathcal{F}_{\mathrm{WU}}).$$

Definition 5.6 (WI bound). WI is the failure boundary characterized by $V(c) \leq v_{\min}$ (viability collapse: inert rigidity or incoherent fragmentation).

Definition 5.7 (WU bound). WU is the failure boundary characterized by $D(c) \leq d_{\min}$ (terminal closure/halting).

Observation 5.8 (Viability-band interpretation of "fine-tuned" regularities). Apparent "fine-tuned" ranges correspond to regions of configuration space in which dual viability holds. They appear special because non-viable regions do not support persistent observation-capable tracking structures.

5.2 A toy computational example (non-physical V and D)

Definition 5.9 (Toy system: recursive prover with resource budget). Consider a subsystem that implements a recursive inference process on an evolving theory-state. Let:

(i) $H(c) \geq 0$ denote a halting/closure proxy (e.g. unresolved obligation count, remaining open goals, or undecided commitments).

(ii) $R(c) \geq 0$ denote a rigidity proxy (e.g. constraint saturation, loss of degrees of freedom, or inability to adapt outputs under perturbation).

(iii) $E(c) \geq 0$ denote an expressivity proxy (e.g. representational capacity or language/feature span).

Define

$$D(c) := \frac{H(c)}{1 + H(c)} \quad \text{and} \quad V(c) := \frac{E(c)}{1 + R(c)}.$$

Remark 5.10. Here D decreases as obligations vanish ($H \to 0$), i.e. the system approaches terminal closure; V decreases as rigidity grows ($R \to \infty$) or expressivity collapses ($E \to 0$). This provides a concrete witness that WI and WU can be defined without physical assumptions.

5.3 Traversal and persistence

Definition 5.11 (Admissible trajectory)**.** A sequence $\{c_n\}_{n \in \mathbb{N}}$ is an admissible trajectory if for all n, $c_n \rightsquigarrow_{\mathcal{A}} c_{n+1}$.

Definition 5.12 (Traversal)**.** Traversal $\mathcal{T}$ is sustained reconfiguration along an infinite admissible trajectory $\{c_n\}_{n \in \mathbb{N}}$ such that $c_n \in \mathcal{B}$ for all n.

Axiom 5.13 (Non-termination requirement for persistence)**.** *A subsystem-pattern persists as a system iff it sustains non-terminating differentiation under admissibility constraints, i.e. it does not enter $\mathcal{F}_{\mathrm{WI}}$ (viability collapse) nor $\mathcal{F}_{\mathrm{WU}}$ (terminal closure).*

Corollary 5.14 (Life-like persistence as process)**.** *Life, cognition, and intelligence can be treated as stable patterns of traversal: ongoing differentiation without terminal closure.*

Derivation sketch. By the survivability definitions in Section 5, persistence is identified with non-terminating traversal that remains within the survivability band $\mathcal{B}$. A "life-like" subsystem is one that maintains this traversal while continuing to register/track constraints (i.e. while remaining in Inst) rather than collapsing into terminal closure. Therefore life-like persistence is not an added substance but the operational fact of continued admissible continuation under boundary tightening without terminal closure. □

Remark 5.15. CSRD (Section 4) supplies the minimal realization rule behind traversal: admissibility produces branching; boundary tightening produces enforcement; survivability selects the band in which enforcement does not annihilate the capacity to keep going.

6 Part III: Self-Reference Schema and Gödel Tension

6.1 Gödel incompleteness (classical statement)

Theorem 6.1 (Gödel incompleteness theorem (Gödel, 1931))**.** *For any consistent, effectively axiomatized theory T capable of representing basic arithmetic, there exists a sentence G_T such that (under standard soundness assumptions) G_T is true but not provable in T. [1].*

Imported result. See [1] (and standard expositions). We use this theorem as a referenced constraint on provability-closure, not as an in-text derivation. □

6.2 The self-reference schema

Axiom 6.2 (Self-reference schema)**.** *If a subsystem implements a consistent, effectively generable inferential closure capable of arithmetic-like self-reference, including a diagonalization-capable encoding of its own rule-application, then it cannot achieve complete internal provability-closure without loss of consistency or expressivity.*

Remark 6.3. "Implements" is functional: the subsystem reliably realizes inference-like transformations with self-reference capacity, not necessarily explicit symbol manipulation.

Definition 6.4 (Gödel tension)**.** Gödel tension Θ_G is the operational pressure induced by Axiom 6.2: an irreducible drive toward continued computation/reconfiguration generated by incomplete closure in expressive self-reference.

Remark 6.5 (When Θ_G is nonzero). Θ_G is not universal. It requires at least: (i) implemented self-reference with diagonalization capacity, (ii) an operationally enforced non-contradiction constraint, and (iii) effective generability (finite procedure) for the subsystem's inference/transition rules. Absent these, non-termination may still occur, but it is not licensed as Gödel tension in this framework.

Proposition 6.6 (Anti-closure from self-reference)**.** *For any subsystem satisfying the self-reference schema, stable approach to $D(c) = 0$ (terminal closure) is blocked: attempts at complete closure either (i) reduce expressivity, (ii) sacrifice consistency, or (iii) induce non-termination.*

Proof sketch. By Axiom 6.2, any subsystem that implements effective, consistent, diagonalization-capable self-reference cannot achieve complete internal provability-closure without sacrificing either consistency or expressivity. Attempting to force closure therefore creates an operational pressure toward (i) expressive restriction, (ii) inconsistency, or (iii) non-termination, i.e. an anti-closure tendency. □

Corollary 6.7 (Incompleteness as persistence engine (conditional))**.** *Whenever traversal-compatible persistence depends on implemented expressive self-reference, Θ_G supplies a necessary source of anti-closure pressure.*

Dependency sketch. Assume traversal-compatible persistence requires the availability of non-terminal admissible continuation (remaining within $\mathcal{B}$) while retaining enough internal expressivity to track constraints. Under Proposition 6.6, self-reference induces Θ_G as an anti-closure pressure: any attempt to fully close internal provability either restricts expressivity, breaks consistency, or forces non-termination. Thus, conditional on persistence depending on self-referential tracking, Θ_G is a necessary source of the non-closure pressure that keeps traversal from collapsing into terminal closure. □

Remark 6.8. In CSRD terms: self-reference can keep $\mathcal{A}(c)$ globally non-trivial (preventing universal enforcement into halting), while still allowing local boundary tightening events that look like "measurements".

6.3 Constraint → movement → structure

Definition 6.9 (Generative cycle)**.** A traversal-compatible system exhibits a recurring cycle:

(1) **Constraint**: current structure restricts admissible continuations (risk of WI if over-rigid).
(2) **Movement**: the system explores admissible responses (computation, adaptation, signaling), driven by Θ_G when applicable.
(3) **Structure**: successful responses stabilize, becoming new constraint (risk of WU if over-closed).

Theorem 6.10 (Universality of the cycle for persistent systems)**.** *Any persistent system (non-terminating traversal in $\mathcal{B}$) exhibits the constraint → movement → structure cycle at some descriptive level. Systems that cannot sustain the cycle exit $\mathcal{B}$.*

Proof sketch. By definition, a persistent system is a non-terminating traversal that remains in the survivability band $\mathcal{B}$ (Section 5). Remaining in $\mathcal{B}$ requires (i) continuation not collapsing ($\mathcal{A}(c) \neq \emptyset$) and (ii) boundary constraints not dissolving into unconstrained drift. The cycle enumerated here is the minimal pattern that simultaneously preserves admissible continuation while producing tightening/recording events that keep the system within $\mathcal{B}$. If a system fails to instantiate one of the cycle stages, it either terminates (loss of continuation) or exits $\mathcal{B}$ (loss of survivability constraints). □

7 Part IV: Closure–Latency Dynamics (CLD) as Supporting Instantiation

7.1 Scope and limits

CLD is used here as an instantiation that shares the CSRD commitments (closure, no primitive time-flow, no objective function). This paper does not claim a full replacement of General Relativity nor a complete parameter fit across all regimes. The hard claim is narrower: if an operational latency field Λ and a structure proxy χ enter admissible continuation dynamics, then structure-dependent residuals at fixed baryonic mass are predicted and are falsifiable. Where CLD is under-specified (e.g., exact S decomposition, noise model, hysteresis form), those are treated as modeling choices that must be pinned down by explicit reporting standards and tests.

This section integrates the framework with a concrete theory-class: Closure–Latency Dynamics (CLD) [6]. CLD is treated as a supporting instantiation demonstrating how metric-like observables can be derived from internal admissibility-governed latency mechanisms without introducing primitive time-flow, external geometry, or ontic emergence.

7.2 CLD primitives as internal admissibility-coupled observables

Definition 7.1 (Latency potential (CLD))**.** A latency potential is a dimensionless scalar field $\Lambda(x,t)$ such that, in the weak-latency regime,

$$d\tau = dt\,(1 - \Lambda(x,t)) + O(\Lambda^2),$$

where t is a chosen coordinate label and τ is operational proper time measured by an idealized local clock.

Remark 7.2. In the closure framework, t is not an ontic primitive; it is a coordinate parameter used to index ordered configuration differences. The CLD statement is interpreted as an operational relation between two internal process-measures: a coordinate labeling convention and a local clock-process.

Definition 7.3 (Structure parameter (CLD))**.** A structure parameter is a dimensionless functional $\chi(x,t) \geq 0$ intended to quantify temporal clustering and multi-scale organization of update events in an underlying constrained dynamical substrate.

Axiom 7.4 (Admissibility axioms for χ (CLD))**.** *An operational statistic χ is admissible if it satisfies:*

(1) Nonnegativity: $\chi \geq 0$.

(2) Flux invariance: χ may vary at fixed total event count (or fixed mean flux).

(3) Hierarchy sensitivity: χ increases under temporal clustering and coarse-grained multi-scale organization.

(4) Uniform limit: $\chi \to 0$ for perfectly uniform event spacing.

Remark 7.5. χ is not a new ontic category; it is an admissible internal statistic of organization within U. It is exactly the kind of object closure allows: stable organization measures compatible with fixed admissibility.

7.3 CLD kinematics: metric-like observables as latency observables

Definition 7.6 (Refractive representation (CLD))**.** For small Λ, define an effective refractive index analogue

$$n(x,t) = 1 + \alpha_n \Lambda(x,t) + O(\Lambda^2).$$

Propagation paths are modeled by extremizing optical path length,

$$\delta \int n \, ds = 0,$$

and travel time by

$$T = \frac{1}{c} \int n \, ds.$$

Remark 7.7. Within closure, these are derived operational laws for signal propagation under an internal latency description. No external spacetime substance is assumed; the construction remains internal to U and its admissible measurement conventions.

7.4 Representative latency relaxation

Definition 7.8 (Representative latency relaxation law (CLD))**.** A minimal phenomenological relaxation model for Λ is

$$\partial_t \Lambda = D \nabla^2 \Lambda + \kappa \, S[\chi, \text{matter}] - \mu \Lambda + \xi(x,t),$$

with diffusion-like coefficient D, coupling κ, decay μ, and optional noise ξ.

Definition 7.9 (Closure load source (CLD))**.** The closure load S is any source term entering the latency evolution law. A representative decomposition is

$$S = a\rho + bp + s_\chi \chi + \cdots,$$

where ρ is an effective density, p an effective stress proxy, and s_χ a structure coupling.

Remark 7.10. If χ can vary at fixed flux and source Λ, then metric-like observables become structure-sensitive rather than mass-only. This links persistence-friendly organization to operational timing and propagation effects in a falsifiable way.

7.5 Weak-field consistency

Proposition 7.11 (Redshift consistency (CLD))**.** *Under $d\tau = dt(1-\Lambda) + O(\Lambda^2)$, the frequency ratio of identical clocks at two stationary locations satisfies*

$$\frac{\nu_2}{\nu_1} = 1 + (\Lambda_1 - \Lambda_2) + O(\Lambda^2).$$

Under the operational calibration $\Lambda \approx \Phi/c^2$ (not an ontological identity), this reproduces the Newtonian weak-field gravitational redshift scaling (cf. [7, 9]).

Proof. If proper time satisfies $d\tau = dt(1-\Lambda) + O(\Lambda^2)$, then a clock at location i accumulates τ_i with rate $d\tau_i/dt = 1 - \Lambda_i + O(\Lambda^2)$. Frequency is inverse period, so comparing identical clocks gives

$$\frac{\nu_2}{\nu_1} = \frac{d\tau_1/dt}{d\tau_2/dt} = \frac{1-\Lambda_1 + O(\Lambda^2)}{1-\Lambda_2 + O(\Lambda^2)} = 1 + (\Lambda_1 - \Lambda_2) + O(\Lambda^2).$$

The calibration $\Lambda \approx \Phi/c^2$ then reproduces the standard Newtonian weak-field scaling. □

Proposition 7.12 (Time-delay scaling (CLD))**.** *Under $T = (1/c)\int n ds$ with $n = 1 + \alpha_n\Lambda + O(\Lambda^2)$, excess travel time satisfies (cf. [8, 9])*

$$\Delta T \approx \frac{\alpha_n}{c}\int \Lambda\, ds + O(\Lambda^2).$$

Under the operational calibration $\Lambda \approx \Phi/c^2$, this matches the standard weak-field scaling of radar echo delay.

Proof. With $T = (1/c)\int n\, ds$ and $n = 1 + \alpha_n\Lambda + O(\Lambda^2)$,

$$T = \frac{1}{c}\int (1 + \alpha_n\Lambda + O(\Lambda^2))\, ds = \frac{1}{c}\int ds \;+\; \frac{\alpha_n}{c}\int \Lambda\, ds \;+\; O(\Lambda^2).$$

Subtracting the flat baseline $(1/c)\int ds$ yields the stated excess delay to first order. □

7.6 Structure-sensitive deviations and falsifiability

Prediction 7.13 (Structure-dependent residuals (CLD))*.* If the closure load S contains a non-negligible $s_\chi\chi$ contribution, then at fixed baryonic mass distribution (fixed ρ, p profiles) the theory permits:

(1) lensing residuals correlated with χ via induced modifications to Λ,

(2) time-delay anomalies correlated with χ at fixed mass,

(3) environment- or history-dependent effects if χ has hysteresis.

These constitute falsifiable departures from mass-only sourcing. (see also [6]).

Justification sketch. By Definition 7.9 and the latency evolution law, a non-negligible s_χ term allows Λ to depend on structure proxies χ even when baryonic profiles (ρ, p) are held fixed. Since operational observables (redshift, propagation delay, lensing proxies) are expressed via Λ and n, this induces residuals that correlate with χ at fixed mass. If no such correlation is observed beyond noise after controlling for mass/environment, the s_χ channel is falsified (or bounded). □

7.7 CSRD–CLD coupling: where Λ, χ touch realization

Remark 7.14 (A closure-compatible coupling hypothesis)*.* CLD can be coupled to CSRD (Section 4) without introducing objectives by letting organization modulate (i) the *boundary tightening rate* or (ii) the *dispersion* of admissible branching. For example, high χ regions may impose stronger mutual constraints (faster formation of effective boundaries B), concentrating $\Psi(c)$ more rapidly and producing earlier enforcement events. Equivalently, χ may reduce the spread of $w_{c\to c'}$ at fixed flux, yielding organized regions with faster actualization but not necessarily mass-only sourcing.

7.8 Toy proxy for χ and reporting standard

To enable reproducible testing, define a toy proxy for χ from a timestamp sequence $\{t_i\}_{i=1}^N$ with inter-event intervals $\Delta_i = t_{i+1} - t_i$. For a coarse-graining scale m, define block-summed intervals

$$\Delta_j^{(m)} := \sum_{k=0}^{m-1} \Delta_{jm+k},$$

and coefficient of variation

$$\mathrm{CV}_m := \frac{\sigma(\Delta^{(m)})}{\mu(\Delta^{(m)})}.$$

Choose scales $M = \{m_1, \dots, m_L\}$ (e.g. dyadic) with weights $w_m \geq 0$ and define

$$\chi := \sum_{m \in M} w_m \, \mathrm{CV}_m.$$

Remark 7.15. Reporting standard: report M, the weights w_m, the vector $(\mathrm{CV}_m)_{m \in M}$, the observation window definition, and censoring rules. This supports the paper's theme: admissible structure parameters are not unique, but must be reported reproducibly to make falsifiable claims.

8 Part V: RNSE as Constructive Computational Instantiation

CLD provides physics-facing support. RNSE provides computational support: a minimal operator family that realizes admissibility-preserving, anti-closure traversal without target optimization.

8.1 RNSE operator core

Definition 8.1 (RNSE operator)**.** Let $F : \mathcal{C} \rightharpoonup \mathcal{C}$ be a partial operator such that:

(i) **Admissibility**: if $c \in \mathcal{C}$ and $F(c)$ is defined, then $F(c) \in \mathcal{C}$.

(ii) **Expansion**: F increases differentiation by unfolding unresolved implications (increasing structured variety).

(iii) **Constraint**: F applies stabilizing filters that prevent incoherent divergence.

(iv) **Anti-closure**: F preserves unresolved structure so terminal closure is avoided (prevents $D \to 0$ collapse).

Remark 8.2. RNSE is not defined by optimizing an objective. It is defined by admissibility preservation and anti-closure: it regulates collapse rather than maximizing utility.

RNSE dynamics are given by recursion $c_{n+1} = F(c_n)$, which induces a successor relation $\rightsquigarrow_F$ and hence a CSRD admissible set $\mathcal{A}_F(c)$.

Remark 8.3 (CSRD as realization kernel for RNSE)*.* RNSE can be read as a concrete computation of CSRD admissible branching and boundary tightening. Operationally, RNSE computes an admissible successor family

$$\mathcal{A}_F(c) = \{\, c' \in \mathcal{C} \mid c \rightsquigarrow_F c' \,\},$$

and implements (explicitly or implicitly) boundary restriction events B that yield $\mathcal{A}_{F,B}(c) = \mathcal{A}_F(c) \cap B$. In this reading, RNSE is not an optimizer: it is a null-seed recursion that (i) expands differentiation, (ii) filters incoherence (constraint), and (iii) maintains anti-closure, while CSRD describes how realized successors are enforced under boundary tightening when $|\mathcal{A}_{F,B}(c)|$ concentrates.

In short: **RNSE supplies the operator physics; CSRD supplies the realization semantics.**

This duality resolves apparent tension between closure (Part I) and dynamics (Part II): closure fixes *what can occur* ($\mathcal{A}$); RNSE/CSRD compute *what does occur* (Inst) via boundary tightening.

Proposition 8.4 (Constructive realization of CSRD traversal)**.** *If there exists F satisfying admissibility, expansion, constraint, and anti-closure, then there exist trajectories that remain in the survivability band $\mathcal{B}$ and thus realize traversal-compatible persistence.*

Construction sketch. A constructive RNSE realization can be given by an update operator F_B on a finite state grid with fixed boundary condition B:

(i) Define a local admissibility filter A_B that marks cell-updates as admissible iff they preserve boundary constraints and local consistency rules.

(ii) Define the step relation $c \rightsquigarrow_F c'$ iff $c' = F_B(c)$ and $A_B(c \to c')$ holds; then $\mathcal{A}(c) = \{c' \mid c \rightsquigarrow_F c'\}$ is non-empty by construction (e.g. include an identity/fallback admissible update).

(iii) Define Inst as the set of configurations reachable from an initial seed under iterated $\rightsquigarrow_F$; define observables O on Inst (e.g. boundary and center activity traces, phase-lag maps).

This construction implements admissible continuation, boundary tightening via B, and observable tracking on Inst. □

8.2 Testable signatures and falsification checklist

The RNSE claim in this paper is *not* "it optimizes a target"; it is that the operator F realizes structure by iterating admissibility under boundary pressure while preserving unresolved implication (anti-closure). That claim is only worth making publicly if it comes with concrete signatures that can fail.

A minimal falsification checklist (computationally testable on RNSE runs) is:

(1) **Boundary-leading pulse.** Under fixed B, activity measures computed at the boundary should *lead* interior measures in time (positive phase lead), with the lead surviving permutation/shuffle controls.

(2) **Directional phase-lag map.** Phase-lag fields should be structured (non-random) and stable across repeated runs with the same reporting standard.

(3) **Non-objective compression.** "Compression" effects (e.g., stabilization/regularization of structure) should correlate with admissibility-derived quantities (such as changes in $|\mathrm{Cont}(c)|$ or proxy efficacy), and *not* require an externally injected loss.

(4) **Boundary sensitivity.** Small changes to boundary conditions B should produce measurable changes in pulse period / coherence length, reproducibly (same $B \Rightarrow$ same signatures, within stated stochasticity).

To make these signatures publishable, the reporting standard should include: a run identifier M; operator/version hash; boundary specification; weights and metrics used; observation window; censoring rules; and a negative control (at minimum, a timing shuffle) so that "structure" cannot be explained as post-hoc pattern selection.

8.3 RNSE failure modes and mapping to WI/WU

Definition 8.5 (Two dominant RNSE failure modes)**.** Consider the balance among expansion, constraint, and anti-closure. Two generic failures are:

(a) **Over-constraint / under-expansion**: exploration collapses; differentiation stalls (rigidity).

(b) **Under-constraint / unregulated expansion**: exploration becomes incoherent; identity fragments (viability collapse).

Principle 8.6 (Failure mode mapping). In the survivability topology:

(i) Over-constraint / under-expansion tends toward WI via $V \downarrow$ (rigidity-like collapse).

(ii) Under-constraint / unregulated expansion also tends toward WI via $V \downarrow$ (loss of coherent tracking/identity).

(iii) Insufficient anti-closure permits drift toward WU (terminal halting/closure) via $D \downarrow$.

Thus RNSE requires a regulated balance: enough anti-closure to avoid terminal halting, enough constraint to preserve coherence, enough expansion to avoid rigidity.

Justification. Each failure mode corresponds to violating one of the survivability-band requirements (non-empty continuation, bounded boundary constraints, and stable observational tracking on Inst). The mapping is therefore a direct operational restatement of the definitions in Section 5 applied to RNSE-style realizations. □

Remark 8.7. This makes RNSE's role explicit: it is not "non-termination at any cost"; it is non-terminating coherent traversal inside $\mathcal{B}$.

9 Part VI: Systems and Tracking Without Memory

9.1 Interaction and tracking via consequence/continuation geometry

Definition 9.1 (Interaction)**.** An interaction is any admissible constraint-coupling relation $I \subseteq \mathcal{C} \times \mathcal{C}$ such that if $(c, d) \in I$, then admissible successors for c are conditioned by d (i.e. $\mathcal{A}(c)$ changes under coupling).

Definition 9.2 (Tracking)**.** A system tracks interaction-history iff interaction induces a change in continuation geometry:

$$\mathrm{Cont}(c) \neq \mathrm{Cont}(c_0),$$

where c_0 is a representative of a maximally symmetric pre-interaction reference class.

Axiom 9.3 (Consequence separability (up to $\sim_{\mathcal{A}}$))**.** *For any $c_1, c_2 \in \mathcal{C}$, if $c_1 \not\sim_{\mathcal{A}} c_2$, then* $\mathrm{Cl}(c_1) \neq \mathrm{Cl}(c_2)$.

Definition 9.4 (Robust tracking)**.** A system robustly tracks iff the interaction-induced change in $\mathrm{Cont}(\cdot)$ is (i) stable up to $\sim_{\mathcal{A}}$ and (ii) persists across a neighborhood of admissible perturbations.

Remark 9.5. CSRD makes this operational: interactions shrink (or reshape) $\mathcal{A}(c)$ and can induce boundary conditions B (Definition 4.13). Record formation corresponds to stable deformation of continuation geometry, producing irreversible-looking narrowing without positing primitive irreversibility.

Remark 9.6. CLD supplies a concrete tracking-observable class: if χ changes at matched flux and induces measurable Λ changes, then deformation of continuation geometry is experimentally anchored by propagation-delay observables.

10 Part VII: Comparative Positioning and Objections

10.1 Eternalism and closure

Eternalism aligns with closure in treating the total structure as fixed. The present framework strengthens this by separating (i) ontological closure over $\mathcal{C}$ and $\mathcal{A}$ from (ii) empirical restriction via Inst, with CSRD providing internal realization without an external "becoming" operator.

10.2 Strong emergentism

Strong emergentism posits ontically novel properties. Under implication closure (Axiom 3.20), such novelty requires ontology extension and is therefore incompatible with closure. CLD instead provides a structure-sensitive mechanism: phenomena that look like "new gravity"-like behavior can be reinterpreted as latency effects sourced by organization statistics at fixed mass, without new ontic categories.

10.3 Fine-tuning and survivability

The survivability view reinterprets apparent fine-tuning as viability bands in admissible configuration space. CSRD gives this bite: boundary tightening produces selection without objectives, and survivability constrains which selections sustain observation-capable organization. CLD adds empirical teeth by proposing falsifiable correlations between organization (χ) and metric observables (Λ, delay, lensing).

10.4 Objection: "You smuggle time back in via t and c_n"

Reply: t and n are representational indices. In CLD, t is a coordinate label; τ is an operational clock process; their relation is an internal latency law. In traversal, $\{c_n\}$ is an admissible ordering device for configuration differences via $\rightsquigarrow_{\mathcal{A}}$. No external temporal container is assumed.

10.5 Objection: "CSRD is just renamed optimization"

Reply: CSRD explicitly removes ranking (Axiom 4.1, Definition 4.6). "Optimality" is not a minimization principle; it is the absence of inadmissible realized successors (Theorem 4.15). Selection arises from boundary restriction, not from preference.

10.6 Objection: "CLD is kinematic and incomplete"

Reply: CLD is used here as a supporting instantiation, not a finished replacement theory. Its incompleteness requirements are explicit (covariant completion, radiative sector, etc.). The role of CLD in this paper is to show compatibility between closure and weak-field observables while generating falsifiable structure-dependent residuals.

11 Conclusion

This paper formalized ontological closure and recursive survivability as a unified framework: admissibility is fixed by $\mathcal{A}$; strong emergence is incompatible with closure; and persistence is a structural phenomenon realized as non-terminating traversal between viability collapse and terminal closure failure regions.

CSRD supplied the missing internal realization rule: admissibility fixes the set of successors; convex effective superposition captures branching under coarse-graining; boundary tightening produces enforced realization without objectives.

The framework was supported by Closure–Latency Dynamics (CLD) as a physics-facing instantiation: effective metric observables can be reinterpreted as latency effects produced by internal scalar structure coupled to an organization statistic χ, reproducing weak-field consistency while predicting falsifiable structure-dependent residuals at fixed mass [6].

Finally, RNSE was provided as a constructive computational realization: an admissibility-preserving anti-closure operator family implementing traversal without target optimization, with explicit failure modes mapping back to WI/WU.

Data and Code Availability

All definitions and claims in this manuscript are stated so they can be audited from the reported run specification. When computational artifacts are referenced (runs, traces, operators), the intended publication standard is to provide: (i) a repository or archive identifier, (ii) a version/hash for the operator, (iii) boundary condition specification, and (iv) the minimal scripts needed to reproduce the reported metrics and controls.

Acknowledgments

This work integrates and reinterprets insights associated with Gödel, Turing, Poincaré, and later work in complexity, self-reference, and systems theory; any errors or overextensions are my own.

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