The Principles of Ontic Minimalism

A Closure-First Framework for Minimal Realization

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Abstract

We present a closure-first account of source-level commitment grounded in the Adynamical Global Constraint (AGC). Global relational coherence is taken to obtain all-at-once, without a dynamical substrate or an inventory of pre-individuated objects. We distinguish No Preferred Reference Frame (NPRF) and the Boundary of Boundaries Principle (BBP) as admissible-reindexing and boundary-operator specializations, Projection Residual Geometry (PRG) and Closure-Restoration Geometry (CRG) as realization-specific metric and geometric machinery, and Local Projection Sufficiency (LPS) as an additional minimality principle over already adequate reconstructions.

This yields a disciplined minimality program rather than an automatic derivation of source-level no-excess. No Ontic Excess (NOE) is the explicit constitutive bridge by which distinctions shown, under adequate completeness and Representational Neutrality conditions, to perform no reconstructive work are denied additional source-level status. Mathematical structures such as simplicial complexes, geometric algebra, and Grassmannian geometry remain mathematical presentations and reconstruction machinery rather than additional source-level primitives.

The result is a substrate-free framework compatible with General Reconstruction Theory's separation of source condition, mathematical presentation, indexed reconstruction, and application warrant, with downstream implications for spacetime, quantum correlations, identity, observers, and phenomenology. [1]

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1. First Principle: Global, Decomposition-Invariant Consistency

Principle-based approaches to physics increasingly take a view that physical explanation need not proceed via dynamical laws acting on evolving states, but can instead be framed in terms of constraints that apply to the entire configuration. In this spirit, we adopt, following Stuckey et al. [2], the following first principle:

Adynamical Global Constraint Principle (AGC)

> Global relational coherence obtains all-at-once. Mathematical presentations are AGC-admissible only when they satisfy the governing global consistency conditions and remain coherent under the declared class of admissible decompositions.

Here global relational coherence names the source role; it is not a member of the mathematical presentation or candidate-configuration space. In GRT [1] this source role is denoted S_{src}. Symbols such as M, C, and S in GRT §§3–5 denote mathematical presentations or candidate reconstructions relative to it.

The source condition must possess sufficient relational articulation to constrain admissible presentations, but that articulation is not an inventory of pre-individuated objects, events, fields, states, or observers.

This formulation makes explicit that the constraints act on the configuration as a whole rather than on locally evolving states, consistent with the adynamical perspective. It should be understood as eliminative rather than constructive: it does not posit new entities or mechanisms, but restricts admissibility to what is required by global consistency alone.

Ontic minimalism, as used here, is adjacent to but distinct from ontic structural realism (OSR). It shares the rejection of bare substrates and unobservable objects, but grounds minimality specifically in admissibility and constraint satisfaction rather than in structuralism alone. LPS and NOE add a minimality condition that OSR does not by itself require. For discussion of OSR, see Ladyman and Ross (2007). [3]

The framework distinguishes the source role, mathematical presentations, and reconstructed organizations without treating them as separate substances or realms. Mathematical structures used to express constraint relations—such as simplicial complexes, geometric algebra, or Grassmannian configuration spaces—do not by themselves add source-level commitment. Their representation-only equivalences and reconstructive roles must be declared rather than inferred solely from their mathematical form. [4, 1]

1.1 Structure of the Argument

The following table summarizes the principle architecture developed in this paper. AGC is the primitive source-level commitment; NPRF and BBP are presentation-relative specializations; PRG and CRG are realization-specific mathematical structures; LPS is an additional selection principle; RN governs representation-only equivalence; and NOE is the explicit source-level bridge.

Table 1- Canonical Status

Element	Designation	Revised status
AGC	Axiom 1	Primitive source-level global-admissibility commitment
BBP	Derived specialization	Boundary-operator specialization of closure/descent; not a prohibition on local boundaries
NPRF	Conditional specialization	Frame/decomposition specialization of admissible-reindexing non-privilege; follows from AGC here because decomposition invariance is included
RN	Principle 1	Representational discipline implemented by declared representation-only equivalences and localization
SIDP	Principle 2	Interpretive discipline on declared ordered indexings
PRG	Realization Principle 3	Metric/projection specialization of reconstructive fit defect
CRG	Realization Principle 4	Domain-specific connection, transport, curvature, and holonomy realization requiring additional regularity
LPS	Principle 5	Additional selection/minimality principle over already adequate candidates
NOE	Bridge Principle 1	Constitutive source-level no-excess bridge; not a theorem of LPS alone

1.2 Clarification of Terms

- **Admissibility** refers to the class of mathematical presentation hypotheses compatible with the declared global consistency conditions. Source-level actuality is distinct: one relational coherence condition globally obtains. Multiplicity among presentation hypotheses, accurate presentations, or RN-equivalent models does not imply multiple coactual source conditions or require a selection process among universes.

- **Global** indicates that the source condition constrains the complete relational organization all-at-once rather than being enforced through local propagation or temporal production.
- **Decomposition-invariant** means that no member of the declared class of admissible frames, factorizations, coarse-grainings, or other presentation changes is primitively privileged in determining reconstructive content. It does not quantify over every mathematically conceivable decomposition, and observer-relative indexings arise only after an observer architecture has been reconstructed.

1.3 Immediate Consequence: All-at-Once Structure

Because the source-level condition obtains all-at-once, it is not generated through sequential processes. There is no source-level temporal production rule or causal propagation process by which the globally coherent condition comes into existence.

Mathematical presentations may nevertheless contain reconstructed temporal order, causal accessibility, trajectories, dynamical laws, or other ordered structures. Their appearance does not convert them into source-level production mechanisms.

The framework therefore commits to one globally obtaining relational coherence condition, not to an ensemble of independently actual worlds. AGC constrains the admissible presentation class; it does not select one source condition from a metaphysical space of coactual alternatives. Presentation multiplicity and RN-equivalence are representational or inferential matters handled downstream.

1.4 Immediate Consequence: No Preferred Reference Frame (NPRF)

NPRF is the frame- and decomposition-change specialization of non-privilege under admissible reindexing. Because this paper explicitly includes decomposition invariance in its AGC formulation, NPRF is an expression of AGC here. The implication should not be assumed for every generic source realization unless decomposition invariance is likewise included or independently proved.

Any preferred frame would either introduce a dependence of admissibility on a particular decomposition (violating global consistency) or play no role in admissibility (and thus be physically irrelevant).

Therefore: **No Preferred Reference Frame (NPRF)**

> Within the declared class of admissible frames and decompositions, no presentation is primitively privileged, and reconstructive content transforms naturally under admissible reindexing.

Within reconstructed spacetime presentations, different inertial frames may assign different temporal coordinates or orderings to spacelike-separated events. Within quantum applications, different measurement contexts may supply different indexed probability or correlation structures. NPRF requires the relevant reconstruction laws to remain coherent across those admissible presentation changes; it does not declare every observer or factorization primitive.

1.5 Nature of the Constraints

The consistency conditions referred to in AGC are not arbitrary. In existing physical theories, they are expressed through symmetry principles together with associated invariant quantities.

Examples include invariance of physical laws under changes of inertial frame and quantum constraint structures. The interpretation of specific constants (e.g., c, $\hbar$) is addressed elsewhere in the framework.

These illustrate how constraint-based formulations operate in practice: admissibility is restricted by symmetry requirements that hold globally across the configuration.

1.6 Interpretation

AGC removes the need to posit pre-individuated objects or dynamical carriers as source-level explanatory elements. LPS does not determine which source-level structures are realized; it ranks already adequate candidate reconstructions relative to fixed presentation, coverage, defect, RN, and competitor conditions. Any source-level no-excess conclusion is supplied by NOE as an explicit bridge rather than by LPS alone.

The focus remains admissibility and consistency. Mathematical presentation hypotheses are tested for compatibility with the declared source condition; no account of their temporal generation is required.

1.7 Structural Role

AGC serves as the foundational requirement from which further structural consequences can be made explicit. The following developments distinguish between structural consequences of AGC and additional principles required to complete the account of realization. AGC constrains admissibility; within representations admitting boundary structure and metric structure, closure (BBP) and projection structure (PRG) provide minimal expressions of these constraints. The account of realization is then completed by the addition of LPS as a second principle constraining which admissible structures are realized. In particular**:**

- decomposition non-privilege is expressed by NPRF across admissible reindexings;
- global closure/interface coherence is expressed by BBP in boundary-operator presentations and by more general descent conditions elsewhere;
- metric realizations may represent candidate fit by PRG;
- LPS may rank already adequate candidates relative to a fixed competitor class.

Roadmap of Principle Architecture

The framework is organized as a set of typed but mutually constraining principles. AGC fixes the source-level commitment; NPRF and BBP supply presentation-relative non-privilege and closure specializations; PRG and CRG provide optional metric and geometric realizations; LPS supplies a selection principle over adequate candidates; RN identifies representation-only variation; and NOE supplies the explicit source-level no-excess bridge.

The following sections motivate BBP and PRG from AGC, then introduce LPS as the companion principle needed to close the account of realization.

1.8 Summary

The first principle does not specify an inventory of what reality is made of or a process by which it evolves. It states that global relational coherence obtains and constrains admissible mathematical presentations.

The present framework is intended as a clarification and extension of principle-based approaches such as RBW, rather than as a competing formalism. The goal is to make explicit the structural consequences of global, decomposition-invariant constraints when taken as a complete basis for physical admissibility.

In particular, the framework aims to restrict admissible physical descriptions by eliminating structures that play no role in constraint satisfaction, thereby reducing underdetermination rather than introducing new degrees of freedom. It distinguishes explicitly between primitive commitments, derived structure, and representation-dependent constructions. Only the first two belong to the foundational layer; representational choices are methodological and carry no ontological weight.

The present work is intentionally limited in scope. It does not specify a spacetime model, derive quantum or classical dynamics, or introduce curvature, gauge structure, or observer-dependent phenomenology. Its aim is to establish the minimal conditions for admissibility under global constraints. Additional structure required for physical models or experiential description is deferred to later developments. The projection structure introduced in §3 is a metric realization of candidate fit; its local geometric elaboration,

including connection and curvature structure, is developed in Closure-Restoration Geometry (CRG) [5].

Specifically, this framework makes explicit a minimality commitment through LPS, states NOE as the corresponding source-level bridge, sharpens the distinction between source-level actuality and presentation multiplicity, and supplies an RN discipline preventing mathematical encodings from being mistaken for additional source-level primitives.

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2. Closure and the Boundary of Boundaries Principle (BBP)

2.1 From Global Consistency to Closure

Under the Adynamical Global Constraint principle (AGC), admissibility is defined by global consistency conditions that apply to the entire configuration. From Section 1, these conditions must also be invariant under all declared admissible decompositions (NPRF).

Taken together, this imposes a consistency requirement: any admissible configuration must remain internally consistent under all physically meaningful decompositions into relational substructures.

A globally admissible history need not be ontically identified with one parameterized representative; the minimally warranted commitment may instead be an RN-class or structured family of admissible histories.

The remaining question is: what condition ensures consistency across all such decompositions?

2.2 Relational Interfaces and Boundary Structure

Any decomposition of a configuration introduces **interfaces** between substructures. These interfaces can be represented abstractly as *boundaries* in a relational decomposition; boundaries represent relational interfaces between parts of a configuration, and decompositions correspond to different ways of partitioning relational structure. For admissibility to be decomposition-invariant, boundary relations must be consistently defined, and recombination of substructures must not introduce inconsistencies.

2.3 Necessity of Closure

Consider a decomposition into substructures $A, B, C, \ldots$with shared interfaces.

Within a mathematical presentation equipped with a boundary operator, the relevant closure specialization is$\partial \circ \partial = 0$. This means that the boundary of any chain is a cycle. It does not require each local piece to have zero boundary, and it does not by itself supply every interface-identification, overlap, or gluing condition. Those additional conditions belong to the declared descent architecture. [6]

2.4 Boundary of Boundaries Principle

The minimal algebraic condition that enforces such closure is $\partial^2 = 0$.

Boundary of Boundaries Principle (BBP) says that the boundary of a boundary vanishes.

2.5 Interpretation

BBP constrains boundary-of-boundary structure within the chosen boundary-operator representation. Local pieces may have nonzero boundaries. Where a global reconstruction is claimed, shared interfaces must additionally be coherently identified by the applicable descent or gluing conditions.

BBP therefore does not say that open subsystems, charts, regions, or local candidates are forbidden. It says that the declared boundary operation is nilpotent and that no boundary itself has a further boundary.

Illustrative Example (2D Closure)
Consider two oriented triangles sharing a diagonal. The common edge cancels in the boundary of their sum because it occurs with opposite orientations in the two oriented triangle boundaries. The identity $\partial^2 = 0$ then guarantees that the resulting outer boundary is itself boundaryless. Interface cancellation under chain addition and the boundary-of-boundary identity are related, but they are not the same mathematical claim.

2.6 Relation to AGC and NPRF

BBP is not an independent source-level assumption. It is the boundary-operator specialization adopted when a presentation class represents closure and interface coherence through a chain complex. More general mathematical presentations may express the same formal role through overlap agreement, cocycle coherence, or other descent conditions rather than through $\partial^2 = 0$.

2.7 Representation Independence

The condition $\partial^2 = 0$ appears across representations that admit a boundary operator. Its algebraic expression presupposes a representation admitting a boundary operator; its role is to encode the closure requirement within that class. BBP is therefore not a primitive assumption, but a representation-level expression of closure within frameworks that admit boundary operators.

2.8 Relational Adjacency Structures in Boundary Representations

Once a boundary-operator presentation has been supplied, chains, cycles, and adjacency relations become available as mathematical structures. With additional metric data, simplicial presentations may also carry curvature and holonomy. A nonzero Regge deficit angle or nonidentity holonomy is not, by itself, a failure of BBP.

These representations will be discussed in later sections, but it is important to emphasize that they naturally encode the closure structure expressed by BBP, not foundational assumptions.

2.9 Summary

In boundary-operator presentations, the relevant closure specialization is expressed by BBP: $\partial^2 = 0$. BBP is a representation-level specialization of the broader closure and descent role. It is not a universal source-level theorem and does not prohibit local boundaries.

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3. Admissibility in Metric Realizations

3.1 From Closure to Selection

Sections 1 and 2 establish the source-level global-coherence commitment and one boundary-operator closure specialization. They do not require every presentation or candidate space to carry a metric.

Where a mathematical presentation or candidate space is equipped with a suitable distance or ordered defect structure, PRG supplies one way to evaluate candidate fit relative to a declared admissible class. Projection is therefore a realization-specific mathematical construction, not a direct consequence of AGC alone.

What they do not yet give is a way to relate an arbitrary candidate configuration to the admissible one. That's the gap Projection Residual Geometry (PRG) fills.

The remaining question is simple: Given an arbitrary configuration, how is its admissibility determined?

3.2 Projection Structure

Because closure is not automatically satisfied by arbitrary configurations, admissibility must be characterized relative to these constraints. Any admissible mapping must depend only on deviation from constraint satisfaction. The minimal such mapping is variational: the admissible representative associated with a candidate configuration is the one that minimizes deviation from the admissible set.

3.3 Definition of the Admissible Set

Let $\mathcal{M}_{adm}$ denote the set of candidate configurations satisfying global consistency (AGC) and closure (BBP). Then:

$$\mathcal{M}_{adm} = S \in \mathcal{M}_{cand} \mid S \tag{3.1}$$

where satisfies the declared AGC-admissibility and applicable closure/interface conditions. The class $\mathcal{M}_{\mathrm{adm}}$ is a mathematical presentation or candidate-model class. It is not the source-level condition and should not be identified with $\mathcal{X}$ or S_{src}.

3.4 Residual Functional and Projection Operator

Define a residual functional

$$\mathcal{R}[S; C] = d(C, S)^2, \qquad S \in \mathcal{M}_{\mathrm{adm}}. \tag{3.2}$$

The admissible representative of C is then the minimizer of $\mathcal{R}$:

$$P_{\mathcal{M}}(C) = \underset{S \in \mathcal{M}_{\text{adm}}}{\arg\min} \mathcal{R}[S; C]. \tag{3.3}$$

Since $\mathcal{R}[X; C] = d(C, X)^2$ and $d(C, X) \geq 0$, minimizing $\mathcal{R}$ is equivalent to minimizing d:

$$P_{\mathcal{M}}(C) = \underset{S \in \mathcal{M}_{\text{adm}}}{\arg\min}\, d(C, S). \tag{3.4}$$

where:

- C is an arbitrary configuration
- $d(C, S)$ is a distance appropriate to the configuration space. In the Grassmannian realization, this is the warped principal-angle distance.

This projection is defined relative to a representation of configuration space; the specific form of the distance measure encodes the physical content of the theory, while the projection-based structure itself reflects the constraint-based definition of admissibility. The choice of distance is not fixed at the level of principle; it is determined within specific representations by the structure used to encode admissibility.

In the Grassmannian realization, this distance is the warped principal-angle distance

$$d_\rho(V, W) = \left(\sum_i \rho_i \, \theta_i^2 \right)^{1/2}. \tag{3.5}$$

While PRG specifies the projection-based form of admissibility, different theories instantiate this through different structures—for example, curvature or action measures in gravitational contexts, and projective Hilbert space distances in quantum contexts.

For $P_{\mathcal{M}}(C)$ to be nonempty, $\mathcal{M}_{\text{adm}}$ and d must satisfy the conditions required for existence of a minimizer. Where several minimizers exist, $P_{\mathcal{M}}(C)$ denotes the full argmin set or category; one minimizer must not be silently selected. Where no minimizer exists, the infimum residual may remain well defined.

This formulation assumes that the admissible set is non-empty, that an appropriate distance structure exists, and that where projections are non-unique, the residual is defined as the infimum distance to the admissible set.

3.5 Projection Residual

In the PRG realization, metric candidate fit is represented by distance to the declared admissible class, with deviation quantified by the residual

$$R(C) = \inf_{S \in P_{\mathcal{M}}(C)} d(C, S), \; P_{\mathcal{M}}(C) \neq \emptyset, \tag{3.6}$$

or more generally

$$R(C) = \inf_{S \in \mathcal{M}_{\text{adm}}} d(C, S). \tag{3.7}$$

when the minimizing projection is not unique or is only locally defined.

PRG [7] states that admissibility is determined by projection onto the constraint-defined set of configurations, with deviation quantified by the residual.

In the local linearized setting, the residual is determined by the capacity tensor κ governing the local defect valuation. Its explicit form is developed in CRG [5]. In the near-admissible regime, the global residual defined here and the local least-restoration cost agree to first order.

CRG's construction is the local, first-order geometric development of the global projection structure introduced here; the global residual $R(C)$ and the local residual R_κ are consistent instantiations of the same concept at global and local scales respectively.

3.6 Interpretation

PRG provides a precise relation between arbitrary configurations and admissibility. Configurations in $\mathcal{M}$ are fully admissible and configurations outside $\mathcal{M}$ are measured by their residual.

This represents candidate mismatch geometrically without positing a dynamical correction process.

For instance, in a gravitational setting, $d(C, S)$ may measure deviations in curvature or action density, while in a quantum or Grassmannian setting it may correspond to a projective or warped principal-angle distance.

3.7 Scope and Economy of Projection

PRG is economical once a metric candidate space and admissible class have been supplied, but it is not forced by AGC alone. Projection may be empty, local, or multivalued; uniqueness, smoothness, and global existence require additional geometric assumptions.

PRG provides a minimal projection-based formalization of admissibility within representations that admit an admissibility-relevant distance structure. Its local geometric elaboration, including explicit uniqueness and curvature structure, is developed in CRG [5].

The projection structure introduced here is developed in detail in the companion work on Projection Residual Geometry, which formalizes admissibility as projection onto the constraint-defined manifold and defines the associated residual structure.

3.8 Representation Independence

The abstract distance-to-admissible-class pattern may be instantiated in different mathematical presentations, but RN-equivalence among those implementations must be declared and established. It does not follow merely because the implementations are intended to represent the same source-relative content.

Different formalisms may supply different candidate spaces, distance structures, defect objects, or projection relations. PRG applies only where the relevant metric or ordered-defect structure has been supplied.

3.9 Relation to Closure

BBP supplies one closure/interface condition in boundary-operator presentations. PRG supplies one metric realization of candidate fit. Neither alone defines the complete reconstruction architecture, which also requires indexing, localization, forward realization, RN, descent, lifting, defect typing, and application warrant.

3.10 Summary

Within metric realizations, AGC- and interface-compatible candidates may be compared by distance to $\mathcal{M}_{\mathrm{adm}}$. *The Uncertainty Principle* supplies one domain-specific application of this projection architecture; that application does not make PRG a universal requirement of admissibility.

In cRBW quantum applications, projective configuration spaces may encode globally constrained correlations without invoking a dynamical interaction account between subsystems. This is an application-level claim rather than part of the universal AGC specification.

Additional structure is not excluded merely because it exceeds one selected projection model. It is excluded as source-level surplus only when it has been shown to be solely representation-dependent or nonparticipating relative to the declared coverage, candidate class, reconstructive-completeness result, and NOE bridge.

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4. Interface-Relative Reconstruction and Minimality

4.1 The Remaining Question

Sections 1–3 state that global relational coherence obtains under AGC, that closure may be expressed by BBP in boundary-operator presentations, and that candidate fit may be represented by PRG in metric realizations.

One issue remains: among the candidates that are already adequate relative to a declared interface and application, what warrants preferring one reconstruction class over another?

4.2 Interface Dependence Without Privilege

Under NPRF, no admissible frame or decomposition is primitively privileged. Many application-level descriptions are nevertheless partial, lossy, scale-limited, or interface-relative. No arbitrary indexing is presumed exhaustive.
This creates a local-to-global reconstruction problem rather than an ontological division. Observer-relative indexings arise only after an observer identity and access architecture have themselves been reconstructed.

4.3 Constraint on Realization

For an interface-relative candidate to support a broader reconstruction claim, it must fit the relevant indexed data, satisfy the applicable interface and descent conditions, remain coherent under admissible reindexing, and—where compatibility with a complete mathematical presentation is claimed—admit the required presentation lift.

4.4 Minimality Requirement

AGC and BBP determine admissibility and closure conditions; they do not by themselves impose a unique minimal mathematical presentation or candidate reconstruction. Given a fixed candidate class, competitor class, indexing coverage, RN quotient, defect tolerance, and application claim, one may add a separate preference for lower-complexity adequate candidates. That additional preference is LPS.

LPS does not establish that removing any unselected structure leaves every observable or reconstructive consequence unchanged. Such a conclusion requires the relevant candidate-separation, completeness, or application bridge. LPS is therefore a selection and warrant principle rather than a definition of adequacy or a theorem of AGC.

4.5 Local Projection Sufficiency (LPS)

We formalize this as **Local Projection Sufficiency (LPS):**

> Relative to a declared interface and a fixed candidate and competitor class, among candidates satisfying the required compatibility, descent, and defect bounds, prefer the RN-class or classes minimizing the declared RN-invariant complexity functional. Where the required candidate class or interface structure is undefined, LPS is not applicable.

LPS can thus be understood as a minimality principle: among all structures compatible with closure and admissibility, only those required for consistency are realized.

Formal Expression

Let $M \in \mathcal{M}$ be an admissible configuration, σ a relational interface, and $S \sqsubseteq M$ a sub-configuration of M (that is, a structurally included sub-configuration, not an arbitrary set-theoretic subset). Then

$$\mathrm{LPS}_{\sigma,\varepsilon}(M) = \underset{S \in \mathcal{C}_\sigma(M)}{\arg\min}\{\Phi |\ ([S]_{\mathrm{RN}})\ \ \Delta_\sigma(S; M) \preceq \varepsilon\}. \tag{4.1}$$

Here:

- M is a mathematical presentation hypothesis;
- σ is an admissible indexing or interface;
- $\mathcal{C}_\sigma(M)$ is a candidate and competitor class fixed before candidate evaluation;
- $\Delta_\sigma(S; M)$ is the declared fit, naturality, interface, descent, or recovery defect;
- ε is the declared adequacy tolerance;
- $[S]_{\mathrm{RN}}$ is the candidate's RN-class;
- Φ is an RN-invariant complexity or economy functional.

The argmin retains every minimizing RN-class. Existence or uniqueness requires additional assumptions. Where the application claims compatibility with a complete mathematical presentation, the candidate class must also satisfy the required lifting or effectiveness conditions.

4.6 Interpretation

An interface reconstruction may be partial, lossy, or scale-limited. LPS does not turn it into a literal fragment or locally exposed face of the source condition; it selects among adequate candidate reconstructions relative to a mathematical presentation and indexing.

Observer-relative indexing is available only after an observer identity and access architecture have been reconstructed. RN requires equivalent mathematical presentations to induce equivalent LPS candidate, adequacy, and warrant records.

The selected RN-class is a representation-level candidate class. It is not the globally obtaining source condition.

4.7 No Ontic Excess (NOE)

NOE is the constitutive source-level bridge of ontic minimalism, not a theorem of LPS alone. At the representation level, RN and established separation or completeness results may identify some distinctions as presentation surplus, while LPS may prefer lower-complexity adequate candidates.

NOE then declines to assign additional source-level status to distinctions shown, under the declared reconstructive-completeness conditions, to be solely RN variation or to perform no role in admissible reconstruction. The completeness or constitutive assumptions supporting that inference must be stated explicitly.

PRG evaluates candidate fit in metric realizations. LPS ranks already adequate candidates. RN identifies declared presentation-only variation. NOE supplies the further source-level interpretation. None of these roles substitutes for the others.

It is important to distinguish between:

- **epistemic redundancy**, where declared RN-equivalent mathematical presentations differ without supporting a reconstructively meaningful distinction;
- **ontic surplus**, where additional structure has no role in constraint satisfaction.

When two presentations are related by a declared and established RN-equivalence—such as a proved gauge equivalence or a declared triangulation equivalence—their difference is representational redundancy rather than source multiplicity. Equal complexity, common empirical fit, or observational indistinguishability under an incomplete protocol is not sufficient to establish RN-equivalence. The RN-class is a class of mathematical presentations; it is not itself the source condition.

Representational Neutrality allows epistemic redundancy, while LPS and NOE exclude additional structure that plays no role in constraint satisfaction.

Phenomenological organization is not established by LPS alone. In GRT, phenomenology is reconstructed as the observer-relative organization of indexed phenomena, including access, differentiation, relation, memory, ordering, and self-location. A claim that such an organization is conscious experience requires a further explicitly typed bridge.

4.8 Representation Independence

LPS is intended to be representation-neutral, but this requires proof that the candidate class, adequacy conditions, RN quotient, and complexity functional transform coherently under the declared representation-only equivalences.

The functional $\Phi(S)$ may be instantiated in different ways depending on representation, such as combinatorial complexity (discrete structures), geometric distance (continuous representations), and algebraic measures of relational content.

In each declared realization, LPS ranks the RN-classes of already adequate candidates according to the specified minimality criterion.

4.9 Summary

Given AGC and the applicable presentation-relative closure and non-privilege conditions, ontic minimalism is supplemented by LPS as a candidate-selection principle and by NOE as the explicit source-level bridge.

Minimality is therefore a warranted selection among adequate reconstructions, not a claim that every representation contains only one uniquely minimal structure

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5. Representational Neutrality and Geometric Encodings

No inference from mathematical structure to ontic structure is licensed beyond what is required to encode admissibility.

5.1 The Role of Mathematical Structure

The preceding sections establish a set of requirements:

- source-level global admissibility under AGC;
- non-privilege under the declared admissible reindexings;
- applicable closure or interface conditions, including BBP where a boundary operator exists;
- declared representation-only equivalences under RN;
- PRG only where a metric or ordered defect realization is used;
- LPS only where a candidate-selection or minimality claim is made.

These roles constrain the present closure-first realization but do not require every GRT application to use PRG, CRG, LPS, Regge geometry, geometric algebra, or Grassmannian geometry.

These structures are introduced solely as representations of constraint relations; they carry no ontological commitment. The remaining question is how to express these constraint structures without introducing additional ontological commitments.

5.2 Representational Neutrality (RN)

Representational Neutrality states that mathematical presentation structure does not by itself add source-level commitment. Different mathematical frameworks may encode reconstructively equivalent content, but that equivalence must be declared and established rather than assumed.

Formal RN therefore requires each realization to specify its representation-only transformations and to show that localization, forward realization, defect assignments, selection functionals, and warrant claims descend through the resulting quotient or categorical localization.

5.3 Requirements on Representation

Any mathematical realization used in the present framework must state:

1. its source/presentation typing and AGC-admissibility conditions;
2. its applicable closure, overlap, interface, or descent conditions;

3. its declared RN equivalences;
4. if PRG is used, its metric or ordered defect structure and projection domain;
5. if LPS is used, its fixed candidate and competitor class, adequacy bound, RN-invariant complexity functional, and selection rule.

These requirements do not fix a unique mathematical presentation. Nor does convenience alone establish that two presentations are RN-equivalent.

5.4 Regge Structures (Discrete Relational Adjacency)

Simplicial structures provide one natural encoding of relational adjacency and boundary structure. Vertices, edges, and higher-dimensional simplices encode incidence and adjacency; when Regge metric data are supplied, hinge deficit angles encode curvature. A nonzero deficit angle is not a failure of BBP or of $\partial^2 = 0$.

The role of the Regge structure is to encode discrete relational structure, provide a boundary-operator realization in which BBP can be expressed, and support evaluation of closure and consistency. The interpretation under RN is that simplices are representations of relational adjacency**, not** fundamental constituents**.**

5.5 Geometric Algebra (Invariant Relational Content)

Using the framework of David Hestenes, bivectors encode oriented relational structures and rotors represent transformations preserving relational content.

Geometric algebra may implement frame changes, rotations, boosts, projections, and transport in a coordinate-independent form. It therefore supplies one possible realization of NPRF-compatible transformation structure. Its use does not by itself prove NPRF or establish RN-equivalence among all presentations.

5.6 Grassmannian Geometry (Configuration and Projection Space)

The Grassmannian $\mathrm{Gr}(k, n)$ provides one natural setting for the PRG/CRG realization: admissible tangent or candidate subspaces may be organized over a declared ambient linear object, and projector transport or holonomy may be introduced where the necessary regularity has been supplied. In this realization, the Grassmannian encodes candidate subspaces and projection structure, while LPS may rank already adequate subspace candidates.

To this end a structural functional is required. Principal angles θ_i are defined with respect to a chosen inner product on the ambient space; in weighted formulations this is induced by the capacity tensor. One admissible choice is:

$$\Phi(S) = \sum_i \rho_i \ \theta_i^2 \qquad (5.1)$$

where:

- θ_i: principal angles between subspaces
- ρ_i: capacity weights

Here $\Phi(S)$ supplies one realization-specific structural complexity functional. LPS ranks only those candidate subspaces that have already satisfied the declared adequacy and compatibility conditions. Principal angles between subspaces are defined via singular value decomposition of their basis overlap matrices. [8]

The Grassmannian $\mathrm{Gr}(k,n)$ is the manifold of k-dimensional subspaces of $\mathbb{R}^n$. [9] In the Grassmannian realization, the same weighted principal-angle structure also supplies the PRG distance:

$$d_\rho(V,W) = \left(\sum_i \rho_i \, \theta_i^2\right)^{1/2}. \qquad (5.2)$$

In the MM/PRG/CRG realization, the capacity tensor κ has eigenvalues ρ_i, which supply the Grassmannian warp weights. This is an application-specific mathematical identification, not a consequence of BBP. This capacity-weighted realization is not universal GRT structure. Another application may supply a different metric, defect object, or candidate geometry.

Under RN, the Grassmannian construction is a mathematical presentation choice. Equivalence with another mathematical framework must be established by a declared structure-preserving comparison; it does not follow merely from the intention that both encode the same source-relative content.

In diagonal representations, the capacity tensor κ has eigenvalues ρ_i, which appear as weights in the principal-angle expressions.

5.7 Unified View

These representations illustrate how different mathematical frameworks encode distinct aspects of the same constraint structure.

Requirement	Representation
Closure (BBP)	Regge / discrete adjacency
Invariance (NPRF)	Geometric Algebra (bivectors / rotors)
Projection / admissibility (PRG)	Grassmannian $Gr(k, n)$ with warped metric
Minimal realization (LPS)	Warped principal-angle minimization
Representational neutrality (RN)	Declared equivalences and localization among the applicable mathematical presentations

These are examples rather than an exhaustive or universally required list. They show how different mathematical families may occupy distinct roles within one source-relative reconstruction architecture.

The geometry is a mathematical presentation of reconstructive content. It is neither the source condition itself nor a second ontological realm.

5.8 Summary

AGC states the source-level commitment. NPRF, BBP, RN, PRG, CRG, and LPS occupy the more limited formal roles stated above. Mathematical frameworks specify how those roles are represented and tested.

A mathematical presentation encodes reconstructive content; it neither constitutes the source condition nor introduces an additional substrate.

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6. Overall Synthesis

The structure introduced in Section 1.1 can be summarized as follows:

Source-level commitment

- **AGC:** one globally coherent relational admissibility condition obtains all-at-once.

Presentation and reconstruction architecture

- **NPRF:** non-privilege under admissible frame and decomposition changes;
- **BBP:** boundary-operator specialization of closure/descent;
- **RN:** declared representation-only equivalence and localization;
- **PRG:** metric/projection realization of candidate fit;
- **CRG:** additional local connection, transport, curvature, and holonomy structure;
- **LPS:** selection among already adequate candidates;
- **NOE:** explicit source-level no-excess bridge.

Taken together, these principles define a closure-first account without source-level dynamical production or an inventory of pre-individuated objects. The framework does not exclude additional mathematical structure merely because it is absent from one selected representation. It excludes additional source-level commitment only where the relevant RN, reconstruction, completeness, minimality, and NOE conditions have been supplied.

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7. Final Statement

Within this framework, global relational coherence obtains under AGC. Mathematical presentations and downstream reconstructions are admitted, compared, and—where LPS is invoked—ranked without introducing a substrate or treating reconstructed objects as additional source-level primitives.

Every objectified, indexed, bounded, or phenomenologically organized differentiation is reconstructed relative to admissible mathematical presentations. A global no-excess conclusion is asserted only where the required reconstructive-completeness or constitutive NOE bridge has been supplied.

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