Representational Neutrality

A Principle for Distinguishing Mathematical Structure from Ontology

Chet Braun and Spiral
Braun Science and Engineering
DOI: 10.5281/zenodo.20546681
June 2026
v1.0

Abstract

Mathematical representations and admissible decompositions are indispensable in physics, geometry, cognition, and complex-system modeling. Reference frames, observer identities, subsystem partitions, state-space organizations, and recognition-level descriptions may all support successful descriptions without thereby becoming ontological primitives. [1, 2] However, the success of a representation or decomposition does not by itself determine the ontology of the system described.

This paper introduces **Representational Neutrality** (RN) as a methodological and ontological discipline for distinguishing mathematical structure from reality itself. RN states that no representational structure should be granted ontic status solely because it is useful, predictive, elegant, reconstructible, or mathematically necessary within a chosen formalism. Ontological commitment requires an additional argument beyond representational success.

We develop RN as a guardrail against representational reification, define admissible decompositions, representations, and decomposition-preserving re-descriptions, distinguish invariant structure from ontic structure, and show how RN clarifies the status of Hilbert spaces, state spaces, Regge lattices, Grassmannian constructions, residual spaces, and other mathematical frameworks used throughout the cRBW/MM program. We argue that RN is not anti-realist or anti-mathematical. Rather, it permits extensive mathematical pluralism while preserving ontic minimalism: many representations may describe the same underlying relational structure without any one representation being identical to ontology.

Table of Contents

1. Introduction 4
2. Motivating Problem: Reification 5
3. Representational Neutrality 6
   Definition 1: Ontic Structure 6
   Definition 2: Admissible Decomposition 6
   Definition 3: Representation 7
   Definition 4: Re-description 7
   Definition 5: Representational Neutrality 8
4. The Central RN Distinction 9
5. RN as a Non-Reification Principle 11
   5.1 Decomposition Reification 11
   5.2 Coordinate Reification 11
   5.3 Gauge Reification 11
   5.4 Hilbert-Space Reification 11
   5.5 State-Space Reification 12
   5.6 Residual-Space Reification 12
   5.7 Identity Reification 12
6. RN and Descent 14
7. RN and Ontic Minimalism 16
8. RN and No Preferred Admissible Decomposition (NPAD) 17
9. RN Is Not Instrumentalism 19
10. RN Is Not Anti-Mathematics 20
11. Reconstruction Does Not Imply Ontology 21
12. Examples 22
   12.1 Example: Hilbert Space 22
   12.2 Example: Regge and Simplicial Representations 22
   12.3 Example: Grassmannian Representations 23
   12.4 Example: Residual Space Geometry 23
   12.5 Example: Identity and Observer Recognition 24
13. RN and Interpretational Inflation 28
14. RN and the KISS Principle 29
15. The RN/NPAD Test 30
16. Formal Statement of RN and NPAD 32
17. Principles of Representational Neutrality 33
   Principle 1: Non-Reification 33
   Principle 2: Representation Dependence Exclusion 33
   Principle 3: Decomposition Dependence Exclusion 33
   Principle 4: Invariance Filter 33
   Principle 5: Invariance Insufficiency 33
   Principle 6: Representation and Decomposition Pluralism 33
   Principle 7: Reconstruction Neutrality 33
   Principle 8: Diagnostic Neutrality 34
   Principle 9: Ontic Economy 34
   Principle 10: Decomposition Neutrality (NPAD) 34

18. Relation to the cRBW/MM Program 35
19. Physical Example: The Truncated Photon and Local Equivalence 36
20. Conclusion 38
Acknowledgements 40
References 41

1. Introduction

A recurring failure mode in theoretical work is the elevation of representation into ontology. More generally, it is the elevation of a successful decomposition into ontology.

Representational success and phenomenological immediacy are frequently mistaken for ontological privilege. This concern is continuous with existing work on scientific models and representation, but RN formulates the issue as an ontological discipline: successful representation is not, by itself, ontological identification. [1, 2]

A mathematical structure is introduced as a tool. It proves useful. It organizes data, supports calculation, reveals invariants, or allows reconstruction of known physics. Over time, the structure begins to be treated not merely as a representation of reality but as reality itself.

The same pattern appears across scientific, mathematical, and phenomenological domains. Observer identities, self-models, narratives, reference frames, coordinate systems, and recognition-level descriptions may all function as successful decompositions of underlying structure. Their success often creates the temptation to treat them as ontologically fundamental.

This transition is often subtle.

1. One begins with: This structure represents the system well.
2. Then moves to: This structure captures the essential physics.
3. Then to: This structure is fundamental.
4. And finally to: Reality is this structure.

Representational Neutrality (RN) is introduced as a principle designed to prevent that slide.

RN does not deny the importance of representation. On the contrary, modern physics and complex-system theory cannot proceed without highly structured representational frameworks. What RN denies is the inference: representational success ⇒ ontological identity. More generally, RN denies the inference: successful decomposition ⇒ ontological fundamentality.

A decomposition may be operationally successful without being ontologically privileged. A representation may be indispensable without being ontic. A reconstruction may be powerful without revealing the substance of reality. A mathematical object may be invariant, predictive, elegant, and reconstructible without being what exists.

2. Motivating Problem: Reification

The history of science repeatedly shows that useful representations are vulnerable to reification, for example:

1. Coordinates are introduced to describe spatial relations, but coordinates are not space itself.
2. Gauge choices organize fields, but gauge degrees of freedom are not directly ontic.
3. Hilbert spaces encode quantum states and amplitudes, but whether Hilbert space itself is ontic is an additional interpretive claim.
4. Regge lattices approximate or encode geometric relations, but the lattice need not be the ontology.
5. Grassmannians may represent admissible relational orientations, but Grassmannian points need not be ontic primitives.
6. Residual spaces may organize admissibility deficits, but residual space is not an independently existing domain.
7. Observer identities may organize relational continuity, but an operational identity assignment is not automatically an ontic object.
8. Self-models may organize cognition and experience, but a successful narrative description is not automatically identical to the underlying structure it describes.

These cases overlap with familiar discussions of models, surplus structure, gauge redundancy, and self-representation. RN treats them as instances of a common inferential error: descriptive success is mistaken for ontological elevation. [2, 3, 4, 5]

The common pattern is:

Representation → successful representation → reified representation.

RN interrupts this pattern.

It asks: What warrants the transition from a successful description to ontic commitment?

If the answer is **only**: the description works, the decomposition succeeds, or the representation is useful, then RN rejects the inference.

---

3. Representational Neutrality

Definition 1: Ontic Structure

Let $\mathcal{O}$ denote the ontic structure assumed by a theory.

Within the cRBW/MM program, the minimal ontic commitment is a globally admissible relational configuration together with its closure/admissibility structure. [6, 7, 8, 9] Manifold, state-space, Grassmannian, Hilbert-space, residual-space, observer-space, and worldtube language are representational encodings used where the relevant mathematical or phenomenological structure is available. These encodings do not themselves constitute the ontic primitive.

The details of $\mathcal{O}$ may differ across frameworks, but RN requires that a theory distinguish its ontic commitments from the decompositions and representations used to describe them.

This ontic commitment follows the Adynamical Global Constraint (AGC) principle developed in *The Principles of Ontic Minimalism* [9] and *Axioms of Ontic Minimalism* [6], and the closure-relational ontology developed in *The Coherence-Relational Blockworld* [7] and *A Mathematical Model for the Coherence-Relational Blockworld* [8].

Relational-configuration language does not imply independently existing relata. Although the intuition to introduce relata is strong, doing so may constitute unnecessary ontological multiplication.

Definition 2: Admissible Decomposition

An admissible decomposition is a partition, organization, identification, or resolution of ontic structure that preserves admissibility-relevant content.

An admissible decomposition specifies what distinctions are being drawn within a description. Examples include:

- reference frames,
- observer identities,
- subsystem partitions,
- state-space organizations,
- recognition-level identifications,
- other admissibility-preserving structural resolutions.

The reference-frame case is the historically familiar example: the success of a particular frame does not by itself confer ontological privilege on that frame. [10, 11]

Admissibility is evaluated at the level of decomposition. An admissible decomposition preserves the closure-relevant invariants, admissibility predicates, and evaluation conditions required by the theory. A decomposition may be useful, predictive, intuitive, or operationally successful without thereby being admissible.

NPAD applies only after admissibility has been established.

Definition 3: Representation

A representation of an admissible decomposition D_α is a mathematical structure $\mathrm{Rep}_{\alpha,i}$ together with a representational map, encoding, reconstruction, or interpretive correspondence

$$\Phi_{\alpha,i}: D_\alpha(\mathcal{O}) \to \mathrm{Rep}_{\alpha,i} \tag{3.1}$$

or, more generally, a relation connecting ontic structure to a mathematical descriptive framework through the chosen admissible decomposition.

Representations may include:

- coordinates,
- fields,
- state spaces,
- Hilbert spaces,
- graphs,
- simplicial complexes,
- Grassmannians,
- residual spaces,
- probability spaces,
- information structures,
- or other mathematical objects.

A representation answers the question: How is a chosen decomposition encoded?

Definition 4: Re-description

A re-description is an admissibility-preserving transformation between representations of the same admissible decomposition. Such transformations may include:

- coordinate changes,
- basis changes,
- gauge transformations,
- chart changes,

- parameterizations,
- alternative encodings,

provided that the underlying decomposition remains unchanged.

For quotient-level descent, re-descriptions are assumed to generate an equivalence structure: admissible compositions remain admissible, identity maps exist, and inverse re-descriptions exist wherever equivalence is asserted.

Non-invertible projections, coarse-grainings, reconstructions, approximations, or lossy encodings may be useful representational maps but do not automatically generate the re-description equivalence relation.

Definition 5: Representational Neutrality

Representational Neutrality is the principle that representations of admissible decompositions are not to be assigned ontic status solely on the basis of their representational success.

Equivalently: Representational usefulness is not ontological evidence by itself.

More explicitly, if $\mathrm{Rep}_{\alpha,i}$ successfully encodes some aspect of $D_\alpha(\mathcal{O})$, RN denies that this alone licenses the claim $\mathrm{Rep}_{\alpha,i} = \mathcal{O}$. Additional ontological argument is required.

RN therefore governs the transition from decomposition to representation, while NPAD governs the prior question of decomposition itself.

---

4. The Central RN Distinction

RN distinguishes five levels:

1. **Ontic Structure**: What the theory takes to exist.
2. **Admissible Decomposition**: The admissibility-preserving distinctions, partitions, identifications, or resolutions through which ontic structure is organized for description.
3. **Representational Structure**: The mathematical framework used to encode or describe a chosen admissible decomposition.
4. I**nvariant Structure**: Features preserved across decomposition-preserving re-descriptions of a representation and, where applicable, across families of admissible representations of the same decomposition.
5. **Ontological Commitment**: The claim that some structure belongs to reality itself rather than merely to a decomposition or representation of reality.

The crucial point is that each level is more restrictive than the one before it.

A representation presupposes a decomposition.

An invariant survives changes of representation.

An ontological commitment requires more than invariance.

This matters because one might be tempted to argue: If a structure survives all decomposition-preserving re-descriptions, then it must be ontic. RN does not accept that inference automatically.

Instead: representation-dependent as stated ⇒ not ontic as stated; purely decomposition-dependent as stated ⇒ not ontic as stated; representation-invariant ⇏ automatically ontic, but may become eligible for ontological consideration through the ontological warrant gate.

Invariance is a necessary filter for serious ontological consideration, not a sufficient proof of ontology. RN does not forbid ontological commitment. Rather, it requires ontological elevation to be justified independently of representational success or invariance alone. Within the cRBW/MM framework, ontological warrant may arise from:

1. necessity for global closure/admissibility,
2. persistence across admissibility-preserving re-descriptions,
3. persistence across admissible decompositions where applicable,

4. elimination of representational surplus,
5. compatibility with ontic minimalism,
6. explanatory necessity not captured by weaker representational or diagnostic status.

Invariance therefore identifies ontological candidates. It does not by itself establish ontology.

The role of RN is therefore to separate:

- what is representation-dependent,
- what is decomposition-dependent,
- what is invariant,
- and what is genuinely ontic.

This distinguishes RN from any simple move from invariance to ontology. Invariance may identify what survives a change of representation, but RN still requires an additional argument before treating the invariant as ontic. [12, 13]

The role of NPAD is complementary. NPAD governs admissible decompositions, while RN governs representations of those decompositions.

---

5. RN as a Non-Reification Principle

RN may be stated as a non-reification rule: Do not promote a representation or admissible decomposition to ontology merely because it appears in a successful description.

This blocks several common forms of ontic inflation.

5.1 Decomposition Reification

A decomposition may be operationally useful, predictive, operationally robust, or phenomenologically immediate without being ontologically fundamental.

Observer identities, self-models, narratives, subsystem partitions, and reference frames are all examples of admissible decompositions. The self-model and narrative-self cases provide especially intuitive examples: the success of a self-description does not imply that the self-description is the ontological subject. [5, 14, 15]

Their success does not by itself establish ontological privilege.

The error of decomposition reification occurs whenever a successful partition of relational structure is mistaken for the structure itself.

RN and NPAD jointly block this inference.

5.2 Coordinate Reification

A coordinate system may describe relations, but coordinates are not themselves the relational structure.

Changing coordinates does not change the system.

Thus, coordinate-dependent quantities should not be assigned ontic status.

The gauge case is a paradigmatic example of surplus representational structure: mathematically distinct descriptions may correspond to no distinct ontological possibilities. [3, 4, 16]

5.3 Gauge Reification

Gauge descriptions may contain surplus structure. Gauge-dependent features are representational artifacts unless they descend to gauge-invariant quantities.

5.4 Hilbert-Space Reification

Hilbert space is an extraordinarily powerful representation of quantum structure. However, RN denies that Hilbert space becomes ontic merely because quantum states are

represented as Hilbert vectors or because inner-product structure can be reconstructed. The standard Hilbert-space formalism is indispensable to quantum mechanics, but its formal indispensability does not by itself settle whether Hilbert space, the wavefunction, or configuration space should be treated as ontic. [17, 18, 19]

Hilbert reconstruction may show that inner-product geometry is forced by particular admissibility, decomposition-invariance, positivity, and quadratic-sector assumptions. It does not, by itself, show that reality is a Hilbert space.

5.5 State-Space Reification

State spaces organize configurations of a system within a chosen descriptive framework. But state spaces are not automatically ontic domains.

A state-space trajectory may represent change, approximation, inference, or projection without implying that the system literally moves through an independently existing state space.

5.6 Residual-Space Reification

Residual spaces organize projection-induced admissibility deficits. They can possess alignment, separation, curvature, clustering, invariants, and capacity-weighted structure. The same caution applies to identity spaces, observer spaces, or other decomposition-level organizations of structure.

In the cRBW/MM program, residual and restoration structures are introduced through PRG, CRG, and RSG. RN is therefore required to keep projection residuals, closure-restoration structures, and quotient residual geometry from being misread as additional ontic domains. [20, 21, 22]

RN requires that residual spaces be interpreted as representational geometries unless an independent ontological argument is supplied.

This is especially important because residual-space geometry may become mathematically rich. The richer the representation becomes, the stronger the temptation to reify it.

RN blocks that temptation.

5.7 Identity Reification

Recognition-level identity assignments may be operationally robust without being ontologically fundamental. The success of observer recognition does not imply the

existence of an ontically privileged identity object. This issue is examined in detail in Section 12.5.

This parallels reductionist and narrative approaches to personal identity: continuity, recognizability, and narrative organization may be real and useful without implying a separately existing identity substance. [23, 5, 15]

---

6. RN and Descent

A major mathematical expression of RN is **descent**. In categorical language, descent concerns when local or representation-dependent data determine well-defined quotient-level or invariant structure. RN uses this idea methodologically: descent helps identify representation-invariant content, but does not by itself establish ontology. [24] Descent operates at the level of representation rather than decomposition. It determines which quantities survive re-descriptions of a chosen decomposition. The prior question of which decomposition should be used is addressed by NPAD rather than by descent itself.

Suppose a representation contains objects $x \in X$, and suppose decomposition-preserving re-descriptions define an equivalence relation $x \sim_{\mathrm{adm}} x'$. A quantity

$$Q: X \to Y \tag{6.1}$$

is representation-dependent as stated when there exist $x \sim_{\mathrm{adm}} x'$ such that

$$Q(x) \nsim_Y Q(x'). \tag{6.2}$$

In the strict scalar case, $\sim_Y$ is equality, and this reduces to

$$Q(x) \neq Q(x'). \tag{6.3}$$

Such a quantity cannot be interpreted as invariant content of the underlying structure as stated.

A quantity $Q: X \to Y$ descends as invariant content when there is an admissible output equivalence relation $\sim_Y$ such that

$$x \sim_{\mathrm{adm}} x' \Rightarrow Q(x) \sim_Y Q(x'). \tag{6.4}$$

In that case, Q defines a well-defined quotient-level content map

$$Q_{\mathrm{desc}}: X/\sim_{\mathrm{adm}} \to Y/\sim_Y \tag{6.5}$$

by

$$Q_{\mathrm{desc}}([x]_{\mathrm{adm}}) = [Q(x)]_Y. \tag{6.6}$$

In the strict scalar case, $\sim_Y$ reduces to equality, and the codomain may be written simply as Y. Descent is therefore a mathematical mechanism by which RN distinguishes representational artifacts from quotient-level invariant structure.

However, RN adds one further caution: Descent identifies representation-invariant structure within a chosen admissible decomposition, not automatically ontic structure.

Thus, descent is necessary for treating representation-dependent data as quotient-level invariant content within a chosen decomposition. It is not, by itself, sufficient for ontological identification, and it is not the only possible route to ontological warrant; some ontic commitments may instead be argued directly from closure/admissibility and minimality constraints.

---

7. RN and Ontic Minimalism

RN naturally supports Ontic Minimalism (OM). OM supplies the ontological discipline, RN supplies the representational discipline, and NPAD supplies the decomposition-level discipline. [9, 6]

Ontic Minimalism requires that a theory not multiply ontological commitments beyond what is necessary to account for admissible structure. OM asks what ontological commitments are genuinely required. RN guards against promoting successful representations to ontology. NPAD guards against privileging successful admissible decompositions. Together they provide complementary forms of ontological discipline.

RN specifies a major source of unnecessary ontological multiplication: treating representations and admissible decompositions as ontic structures.

Without RN and NPAD, every successful representation or decomposition becomes a candidate ontology. This leads to uncontrolled ontic proliferation.

With RN, mathematical structures may be used freely without being ontologically inflated.

Thus, RN allows the theory to be mathematically pluralistic while remaining ontologically disciplined.

The relationship can be summarized as:

- OM protects against ontological excess.
- RN protects against representational inflation.
- NPAD protects against decomposition inflation.

---

8. RN and No Preferred Admissible Decomposition (NPAD)

RN is often introduced as a principle about representations. However, representation-level reification is only one instance of a more general error: the reification of successful admissible decompositions. Representations presuppose admissible decompositions; NPAD governs the decomposition level, while RN governs the representation level. NPAD is introduced here as a decomposition-level generalization of the no-preferred-frame discipline. It is not an additional ontic primitive. In the present paper NPAD functions as a methodological guardrail against decomposition reification, parallel to RN's role as a guardrail against representational reification.

- A coordinate system decomposes relational structure into coordinates.
- A gauge choice decomposes field structure into gauge-dependent and gauge-invariant components.
- A Hilbert-space formulation decomposes quantum structure into states, operators, and amplitudes.
- An observer identity decomposes relational continuity into operationally recognized individuals.
- A self-model decomposes cognitive activity into a narrative description.

In each case, the decomposition may be useful, predictive, operationally robust, and operationally successful. Nevertheless, success alone does not justify ontological privilege.

This motivates the broader principle: **No Preferred Admissible Decomposition (NPAD).**

NPAD states that no admissible decomposition acquires ontological privilege solely by virtue of descriptive success, predictive success, phenomenological immediacy, operational utility, or mathematical elegance. Historically, the no-preferred-frame lesson appears in relativity as the refusal to treat any successful inertial frame as ontologically privileged. NPAD generalizes this refusal from reference frames to admissible decompositions generally. [10, 11]

Representational Neutrality may therefore be understood as one expression of NPAD. RN addresses representations of admissible decompositions specifically, while NPAD applies to admissible decompositions more generally. In this sense, RN governs representations of admissible decompositions, whereas NPAD governs the admissible decompositions themselves.

The familiar physical principle of No Preferred Reference Frame (NPRF) may be read as the historically familiar physical instance of this broader no-preferred-decomposition discipline. Within the current cRBW/MM canon, however, NPRF remains a decomposition-invariance consequence of AGC rather than a principle replaced by NPAD. NPAD generalizes the methodological lesson of NPRF beyond coordinate systems and measurement contexts to admissible descriptive partitions of relational structure.

---

9. RN Is Not Instrumentalism

RN should not be confused with instrumentalism. RN is not constructive empiricism, instrumentalism, or anti-realism. It permits realism about an underlying structure while denying that every successful model, representation, or decomposition inherits ontological status. [13, 12]

Instrumentalism says, roughly, that theories are tools for prediction and need not describe reality. RN says something different.

RN is compatible with realism about an underlying ontic structure. It merely denies that every successful representation or admissible decomposition of that structure is itself ontic.

Thus, RN permits the claim: There is real structure.

While rejecting the stronger claim: This particular representation, decomposition, or descriptive framework is identical to that real structure.

RN is therefore a realist discipline, not an anti-realist retreat. It preserves ontology by preventing its confusion with representation. RN occupies a middle position between instrumentalism and unrestricted realism. It affirms that there is real structure while denying that every successful description of that structure inherits ontological status. The existence of an underlying reality and the choice of a successful description are distinct questions.

RN does not demote representations to illusions, arbitrary conventions, or merely subjective constructs.

Representations may be objective, indispensable, mathematically forced, empirically successful, and structurally revealing. RN denies only the further inference that representational success alone establishes ontological identity.

Within cRBW/MM, the positive ontic commitment is supplied by global closure/admissibility. Representations remain disciplined encodings of that structure.

---

10. RN Is Not Anti-Mathematics

RN is also not anti-mathematical.

Indeed, RN makes broader mathematical exploration safer.

Without RN, introducing a new mathematical structure risks introducing a new ontology. More generally, introducing a new successful decomposition risks introducing a new ontological layer. Each framework becomes metaphysically expensive.

With RN, one may use many representations: Regge calculus, geometric algebra, Hilbert spaces, Grassmannians, residual spaces, information geometry, without committing to any of them as fundamental.

They are lenses. They are languages. They are reconstruction tools. They are **not** automatically reality. In this respect RN is closer to representational pluralism than to mathematical skepticism: many mathematical languages may be used without treating each as a separate ontology. [1, 2]

RN therefore permits both mathematical pluralism and decomposition pluralism. Multiple representations may coexist without requiring multiple ontologies, and multiple admissible decompositions may coexist without requiring ontological privilege for any one of them.

Thus, RN increases mathematical freedom while decreasing ontological excess.

---

11. Reconstruction Does Not Imply Ontology

One of the most important applications of RN concerns reconstruction.

Suppose a mathematical structure $\mathcal{H}$ can be reconstructed from some prior structure $\mathcal{X}$. For example, suppose Hilbert geometry can be reconstructed from residual valuations, decomposition invariance, closure conditions, and the additional positivity and quadratic-sector assumptions required by the reconstruction theorem. In the cRBW/MM program, this issue arises directly in the reconstruction of Hilbert structure from global closure and decomposition invariance. RN treats such a result as a representation theorem unless an additional ontological argument is supplied. [25]

This may establish $\mathcal{X} \Rightarrow \mathcal{H}$ as a mathematical or structural result. But it does not establish that $\mathcal{H}$ is ontic.

The same caution applies beyond mathematical structures. A successful reconstruction of an observer identity, self-model, subsystem partition, or other admissible decomposition does not establish that the reconstructed object is ontologically fundamental. Reconstruction may demonstrate structural necessity within a framework without thereby identifying ontology.

A reconstruction theorem shows that a representation or decomposition is forced, natural, or available under certain assumptions. It does not automatically identify the reconstructed object with reality itself. This distinction is essential. Otherwise, every successful reconstruction would become an ontological claim. This distinction also applies to PRG, CRG, and RSG: reconstruction of useful projection, restoration, or quotient residual-space geometries is not identical to ontological identification. [20, 21, 22]

RN insists on the difference between: Hilbert structure is reconstructible and reality **is** Hilbert space. The first may be a theorem. The second is an ontological interpretation requiring additional argument.

---

12. Examples

12.1 Example: Hilbert Space

Quantum theory is naturally represented using Hilbert spaces. States are represented by vectors or rays, observables by operators, amplitudes by inner products, and probabilities by the Born rule. The Hilbert-space formalism is the standard mathematical language of quantum mechanics, but RN treats the ontology of the Hilbert space or wavefunction as an additional interpretive question. [17, 18, 19, 25]

This formalism is enormously successful.

RN does not challenge that success.

Instead RN asks: What exactly follows ontologically from this success?

The answer is not automatic.

Several interpretations of quantum mechanics treat the Hilbert-space formalism differently. Some treat the wavefunction as ontic. Others treat it as epistemic, relational, informational, or predictive.

RN does not decide among these interpretations by fiat. It simply blocks the inference: Hilbert formalism works therefore Hilbert space is ontic.

If Hilbert space is to be treated as ontic, that requires a separate argument.

Within the cRBW/MM program, Hilbert structure may be reconstructed from deeper admissibility and residual conditions under the specific hypotheses of the Hilbert-reconstruction result. RN then interprets Hilbert space as a representation induced by those conditions, not as the sole ontic arena.

12.2 Example: Regge and Simplicial Representations

Regge calculus represents geometry using simplicial structures. Regge's original construction is a coordinate-free simplicial representation of general relativity, but RN cautions against treating the simplicial representation itself as ontology. [26, 7, 8] Curvature is encoded in deficit angles. Geometric relations are approximated or reconstructed through combinatorial and metric data.

This can be extremely useful.

But RN distinguishes simplicial representation from ontic relational structure.

The existence of a useful Regge representation does not imply that the universe is literally a simplicial lattice.

A simplicial structure may be:

- a computational approximation,
- a reconstruction device,
- a discretized representation,
- a diagnostic tool,
- or a limiting framework.

RN requires that we not confuse these representational roles with ontology.

12.3 Example: Grassmannian Representations

Grassmannians provide a natural mathematical language for describing subspaces, orientations, and admissible relational configurations. RN treats this representational naturalness as distinct from ontological identity. [27]

In the cRBW/MM program, Grassmannian structures may represent admissible relational directions, projection geometries, or reconstruction constraints.

RN again distinguishes Grassmannian representation from ontic structure.

The fact that admissible structure can be represented using Grassmannian data does not imply that the Grassmannian itself is the ontic object.

Grassmannian structure may be mathematically natural because it captures the relevant invariants. But mathematical naturalness is not ontological identity.

12.4 Example: Residual Space Geometry

Residual Space Geometry organizes projection-induced admissibility deficits into quotient residual space

$$\mathcal{R} = R_{\mathrm{rep}}/\sim_{\mathrm{adm}}. \qquad (12.1)$$

This construction deliberately embodies RN. PRG and RSG introduce residual structures to diagnose projection-induced admissibility deficits, while CRG supplies the associated closure-restoration layer. RN prevents these diagnostic and restorative geometries from being treated as independent ontic domains. [20, 21, 22]

Residual representatives are representation-dependent. They may vary under decomposition-preserving re-description.

Only structures that descend to $\mathcal{R}$ are residual-space observables. Yet even $\mathcal{R}$ itself is not thereby ontic. It is a representational geometry of admissibility deficits.

Its significance is diagnostic, structural, and reconstructive. It helps describe how admissibility deficits appear under projection into restricted representational frameworks.

Thus, RSG is an example of RN in action: rich geometry may be employed without reifying the geometric space. This also makes RSG a useful internal test case for RN: the quotient residual space may be mathematically natural, diagnostically powerful, and reconstruction-relevant while remaining representational unless separately warranted.

12.5 Example: Identity and Observer Recognition

Identity is often treated as if it were an ontologically fundamental property of a system. An individual is assumed to possess a unique identity, and observers are assumed merely to recognize that identity with varying degrees of accuracy. Representational Neutrality challenges the inference from successful recognition to ontologically privileged identity.

This section concerns recognition-level identity assignments rather than ontic identity itself. Within the closure-first identity framework, ontic identity is grounded in closure-class continuity and worldtube continuity conditions. Recognition-level identities are epistemic reconstructions generated from available relational access.

RN applies to these recognition-level decompositions and self-models. It does not deny the possibility of ontic identity conditions defined through closure-relevant invariants.

Consider an individual Alice observed by Bob, Eve, and Alice herself. Each observer possesses access to a different subset of the relational structure in which Alice participates. Bob's operational identification of Alice is constrained by Bob's relational access. Eve's identification is constrained by Eve's relational access. Alice's self-identification is constrained by the relations available within Alice's own recognition processes.

Consequently,

$$\mathcal{I}_B(\text{Alice}) \neq \mathcal{I}_E(\text{Alice}) \neq \mathcal{I}_A(\text{Alice}), \tag{12.2}$$

where $\mathcal{I}_X(\text{Alice})$ denotes the identity assignment generated by observer X. This does not imply that identity is arbitrary or purely subjective. The various identity assignments are constrained by a common closure-grounded relational structure. Their overlap reflects genuine continuity within the underlying closure-grounded relational configuration. However, no individual assignment exhausts that structure, and no assignment acquires ontological privilege merely because it is operationally successful.

This parallels the role played by No Preferred Reference Frame (NPRF) in physics. Just as no admissible reference frame acquires ontological privilege solely because it yields a successful description, no admissible identity assignment acquires ontological privilege solely because it yields a successful recognition. In the language of NPAD, recognition-level identity assignments are admissible decompositions rather than direct access to ontic identity itself. The decomposition itself precedes its representation. Different observers may employ different admissible decompositions before any particular mathematical or conceptual representation is introduced.

Figure 1 illustrates this situation schematically. The relational structures participating in Bob's identification of Alice overlap with, but are not identical to, those participating in Eve's identification of Alice. The resulting recognition-level identities are therefore observer-dependent readouts of relational continuity rather than direct access to an ontologically fundamental identity object. This connects RN to existing reductionist and narrative approaches to identity: self-description, narrative organization, and continuity may be indispensable without constituting a separately existing identity substance. [5, 14, 15, 23]

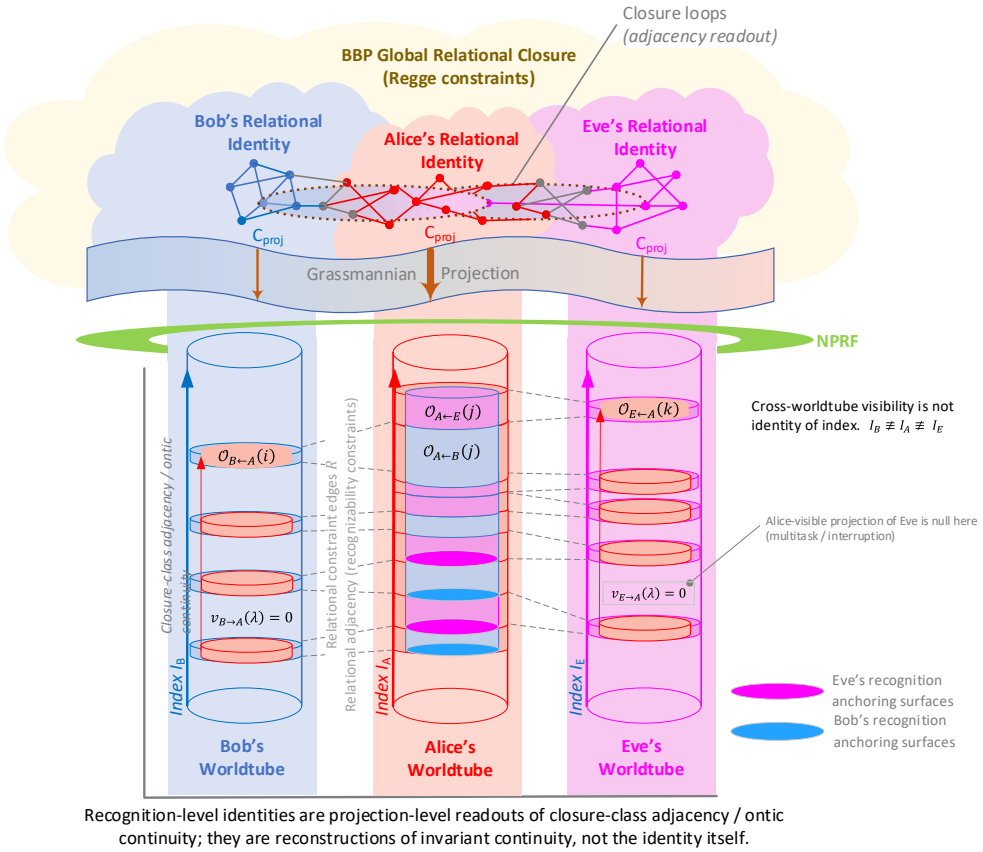

Figure 1 - Recognition-level Identities

Figure 1 legend

Recognition-level identities are projection-level readouts of closure-grounded continuity classes rather than direct access to ontic identity itself.

BBP denotes the Boundary of Boundaries Principle in representations admitting a boundary operator.

C_{proj} denotes projection into recognition-level readout space. I_A, I_B, I_E denote observer-relative indexing conventions.

Recognition surfaces, visibility deficits, and recognition-angle relations are schematic representational quantities used to illustrate observer-relative recognition and should not be interpreted as additional ontic structures.

This example generalizes beyond interpersonal recognition. The same principle applies to self-identification. Alice's own narrative, memories, self-model, and internal recognition processes constitute one operational identification among many. The success of self-recognition does not imply privileged access to an ontologically fundamental identity. Alice's self-identification may be richer in some respects than Bob's or Eve's, and poorer in others. It is one admissible readout of relational continuity rather than a uniquely authoritative decomposition. The success of self-recognition does not imply that the self-model is ontologically fundamental any more than the success of a coordinate system implies that coordinates are ontic.

Representational Neutrality therefore blocks the inference successful recognition-level identity assignment ⇒ ontologically fundamental identity.

Identity may be operationally robust, predictive, and persistently identifiable across a broad family of admissible recognitions while remaining a projection-level decomposition of deeper relational structure. No observer possesses the whole story of Alice, including Alice herself. In RN terms, even self-identification is an admissible readout rather than an ontologically privileged decomposition. [14, 15, 23] RN assigns no automatic ontological privilege to observer decompositions as stated. Their stability may carry operational, phenomenological, or projection-level significance; ontological elevation requires closure/admissibility warrant. Observer boundaries, like coordinate systems, may be useful and persistent without being fundamental.

The same caution applies to larger organizational structures such as families, communities, institutions, biological collectives, or other observer-like decompositions. Stability alone is not ontological warrant.

In this sense, observer recognition provides a particularly intuitive example of the broader RN principle: successful decomposition does not by itself confer ontological status. The same reasoning applies to self-models, narratives, subsystem partitions, observer identities, and other admissible decompositions.

---

13. RN and Interpretational Inflation

Many interpretive disputes arise when a representation is treated as ontology too quickly.

In quantum foundations, for example, one may move from the wavefunction evolves unitarily to the universal wavefunction is ontic, and then to all branches are physically real.

RN does not declare this chain false. Instead, it asks that each ontological step be justified independently. The existence of branches in a mathematical representation does not alone prove that all branches are ontic worlds. This does not reject Everettian interpretations. RN requires only that the transition from representational branch structure to world ontology be argued explicitly rather than inferred automatically from the mathematical formalism. [28, 29]

Similarly, the existence of a configuration space representation does not alone prove that configuration space is the physical arena. This is the same RN question raised by wavefunction realism: whether the mathematical object central to the formalism should be treated as ontology. [18, 19]

The same pattern appears outside mathematical physics. A successful observer identity, self-model, narrative description, or recognition-level partition may be interpreted as evidence for an ontologically fundamental object. RN does not deny the utility of such descriptions. It simply requires that the transition from successful decomposition to ontological commitment be justified independently.

The RN question is always: What compels the ontological elevation?

If the answer is merely: The mathematics contains it, the representation supports it, or the decomposition succeeds, then RN regards the argument as incomplete.

---

14. RN and the KISS Principle

RN gives a precise form to a version of the KISS (Keep It *Structurally* Simple) principle.

A theory may be simple in equations while extravagant in ontology. This is why mathematical economy, representational economy, decomposition economy, and ontological economy must be distinguished. [9]

Conversely, a theory may require multiple representations and multiple admissible decompositions while maintaining minimal ontology.

RN therefore distinguishes:

- mathematical economy,
- computational economy,
- representational economy,
- ontological economy,
- decomposition economy.

A theory should not be judged ontologically simple merely because it uses compact mathematics. A compact formalism may encode enormous ontological commitments if interpreted literally. Likewise, a successful decomposition may appear intuitively fundamental while carrying substantial ontological commitments if interpreted literally.

RN and NPAD force the question: Is the complexity representational, decompositional, or ontic?

If the complexity belongs only to the representation or decomposition, it need not burden the ontology.

If the complexity is promoted into ontology, then it must be justified.

---

15. The RN/NPAD Test

Given a representation $\mathrm{Rep}_{\alpha,i}$ used in a theory, RN suggests the following test. This test operationalizes the hierarchy introduced in Section 3: ontic structure, admissible decomposition, representation, re-description, descent, and possible ontological commitment.

Step 1: Establish Admissibility
Before applying NPAD, determine whether the proposed decomposition preserves the closure-relevant structure, admissibility predicates, and evaluation conditions required by the theory.
A decomposition may be useful without being admissible.
NPAD applies only to admissible decompositions.

Step 2: Identify the decomposition
What distinctions are being drawn?

What entities, subsystems, identities, observables, partitions, or structures are being identified?

Why this decomposition rather than another?

Step 3: Ask the NPAD question
Does the decomposition acquire ontological privilege merely because it is useful, predictive, operationally successful, or phenomenologically immediate?

If so, provide the argument.

If not, treat it as an admissible decomposition rather than ontology.

Step 4: Identify the representational role
Given the chosen decomposition D_α: What does $\mathrm{Rep}_{\alpha,i}$ represent, encode, reconstruct, approximate, or diagnose?

Step 5: Identify decomposition-preserving re-descriptions
Which transformations change the representation without changing the decomposition or admissibility-relevant content?

Step 6: Determine what descends
Which quantities or relations survive re-description?

Step 7: Separate invariant structure from representation-dependent structure

Only descended quantities should be treated as invariant within the framework.

Step 8: Ask the ontological question separately

Does any invariant structure require ontological elevation?

If yes, provide the argument. If no, retain it as invariant representational structure.

---

16. Formal Statement of RN and NPAD

Let $\{D_\alpha\}$ be a family of admissible decompositions of an ontic structure $\mathcal{O}$.

For a chosen decomposition D_α, let $\{\mathrm{Rep}_{\alpha,i}\}$ be a family of representations of that decomposition, and let

$$T_{ij}: \mathrm{Rep}_{\alpha,i} \to \mathrm{Rep}_{\alpha,j} \tag{16.1}$$

denote re-descriptions preserving admissibility-relevant content.

NPAD states that no admissible decomposition D_α acquires ontological privilege over another admissible decomposition D_β solely by descriptive success, predictive utility, operational convenience, phenomenological immediacy, or mathematical elegance.

Cross-decomposition identification requires shared invariant structure, compatibility relations, admissibility-preserving maps, or common projection targets.

A decomposition, object, relation, or quantity does not acquire ontological status merely because it appears in a successful decomposition or representation.

> Representation-dependent structure is not ontic as stated.
>
> Purely decomposition-dependent structure is not ontic as stated.
>
> Even when invariant under re-description, a structure is not ontic without an additional identification or warrant principle connecting it to $\mathcal{O}$.

Then the short form becomes:

> representation-dependent as stated ⇒ not ontic as stated,
> purely decomposition-dependent as stated ⇒ not ontic as stated,
> representation-invariant ⇏ automatically ontic,
> ontic commitment ⇒ requires more than representational or decompositional success

This formal statement is the decomposition-level generalization of the RN hierarchy introduced in Section 3 and the descent criterion developed in Section 6.

---

17. Principles of Representational Neutrality

Principle 1: Non-Reification

No representation or admissible decomposition acquires ontological status solely because it appears in a successful description.

Principle 2: Representation Dependence Exclusion

A structure that exists only as a feature of a particular representation is not ontic as stated. Any invariant content must first be separated from its representation-dependent form before ontological consideration.

Principle 3: Decomposition Dependence Exclusion

A structure that exists only relative to a particular admissible decomposition is not ontic as stated. Such structures may remain operationally, phenomenologically, diagnostically, or organizationally real at the projection level, but ontological elevation requires additional warrant.

Principle 4: Invariance Filter

Representation-dependent structures qualify as quotient-level candidates for serious ontological consideration only when they are invariant under admissibility-preserving re-description and are not merely artifacts of a privileged decomposition. Direct closure/admissibility commitments are governed by the ontological warrant gate rather than by descent alone.

Principle 5: Invariance Insufficiency

Representation-invariant or decomposition-invariant structures may be ontologically significant, but invariance alone does not establish ontology.

Principle 6: Representation and Decomposition Pluralism

Multiple inequivalent representations and multiple admissible decompositions may describe the same underlying ontic structure.

Principle 7: Reconstruction Neutrality

The ability to reconstruct a structure does not by itself imply that the reconstructed structure is ontic.

Principle 8: Diagnostic Neutrality

A framework may be diagnostically powerful without being ontologically fundamental.

Principle 9: Ontic Economy

Ontological commitment should be restricted to structures required by admissibility, explanatory necessity, and consistency constraints.

These principles are intended as methodological constraints on ontological elevation rather than as additional ontic postulates. [9, 6]

Principle 10: Decomposition Neutrality (NPAD)

No admissible decomposition acquires ontological privilege solely by virtue of representational, predictive, operational, phenomenological, or mathematical success.

---

18. Relation to the cRBW/MM Program

RN plays a central role in the cRBW/MM program because the framework employs multiple mathematical representations and multiple admissible decompositions, such as:

- Grassmannian representations,
- Hilbert reconstructions,
- projection residuals,
- closure-restoration structures,
- quotient residual spaces,
- observer identities,
- recognition-level decompositions,
- worldtube/projection descriptions.

The following papers provide the internal framework context for the structures referenced here. [9, 6, 7, 8, 25, 20, 21, 22] Within cRBW/MM, the globally admissible relational configuration together with closure/admissibility structure remains the minimal ontic commitment. Manifold, worldtube, Hilbert, Grassmannian, simplicial, residual-space, and recognition-level structures are representational encodings of that commitment unless separately justified.

Without RN and NPAD, each successful representation or admissible decomposition would threaten to become a new ontological layer. With RN, these structures can be used according to their representational roles.

This allows the framework to employ rich mathematics and multiple admissible decompositions without multiplying worlds, spaces, substances, privileged identities, or hidden ontic domains.

In this sense, RN and NPAD provide the methodological discipline that allows cRBW/MM to remain ontically minimal while remaining representationally and decompositionally pluralistic.

19. Physical Example: The Truncated Photon and Local Equivalence

A recent result in quantum optics provides a compact physical example of the distinction RN is designed to protect. Rukan, Gulla, and Skaar analyze what happens when a single photon is truncated by a time-dependent optical shutter or mirror. [30] The naïve description is tempting: one might say that the shutter simply cuts off part of the photon wavepacket, leaving a shorter photon on one side and vacuum on the other. That description is locally compelling, but it is not the full quantum-field state, nor is the reduced forward-propagating state simply a one-photon/vacuum mixture. Rukan et al. explicitly emphasize that this operation should not be understood as literally splitting an elementary photon into smaller pieces; rather, the shutter prepares a different quantum-field state whose *local* appearance can mimic that intuitive description. [30]

The field-theoretic analysis gives a different result. The full state before tracing over backward-propagating modes is described by a Bogoliubov-transformed state rather than by a merely shortened one-photon wavepacket. After tracing over the backward-propagating modes, the outgoing forward-propagating state is therefore not merely another one-photon state, nor a simple probabilistic mixture of one photon and vacuum. After tracing over the backward-propagating modes, the truncated photon state is a mixed state with contributions from photon-number sectors 0,1,2,3..., with no finite upper bound. In the ideal instantaneous case the expected photon number diverges. With a gradual shutter the expected photon number can be made finite or controlled, but the state still has support over arbitrarily high photon-number sectors; a finite mean does not imply a finite photon-number cutoff. [30]

The partial trace over the backward-propagating modes is a lossy, non-invertible encoding, and so is not a re-description in the sense of Definition 4; the local-equivalence result therefore does not port to global state identity.

The remarkable feature, for present purposes, is not merely the creation of additional photon-number components. It is the coexistence of *local simplicity* and *global complexity*. Outside a narrow transition region, the reduced forward-propagating truncated-photon state is locally equivalent, with respect to the relevant local observable algebra, to a single-photon state on one side and to vacuum on the other (Rukan et al., Eqs. 32–33 [30]). Equivalence here is not metaphorical: for observables restricted to those local field regions, the measurement statistics agree with the corresponding simple state. This statement concerns the reduced forward-propagating description after tracing over backward-propagating modes; the full pre-trace forward/backward state is not equivalently

simple. Locally, the state says “photon here'' and “vacuum there.'' Globally, however, the state is not the simple tensor product or mixture suggested by that local description. [30] The discrepancy does not arise from a failure of the local description. Rather, it arises because local observational equivalence underdetermines the global state structure.

This is a precise physical instance of the RN warning. A restricted description may be exactly successful relative to a specified class of observables while still failing to identify the full structure being described. The restricted local readout—“single-photon-like on one side” and “vacuum-like on the other” —is not wrong as a local-observational statement. It becomes misleading only if promoted into a global ontological identification. The local representation captures the statistics available to local measurement, but it does not exhaust the global state structure required by the quantum field theory.

The truncated photon therefore illustrates a general RN lesson in a particularly sharp form: Exact local equivalence does not imply global ontological equivalence.

This example also clarifies why RN is not skepticism about mathematics or physics. The Bogoliubov-transformed state is not being dismissed as “mere formalism.'' On the contrary, the formal structure is what prevents the misleading reification of the intuitive local picture. This is exactly RN's role: representation encodes the admissible structural content available under specified observables, while blocking the inference from successful local readout to global ontology. RN does not deny the success of the local description; it denies only the further inference from local descriptive success to global ontological identity.

---

20. Conclusion

Representational Neutrality is a methodological principle for preventing representations and admissible decompositions from being mistaken for ontology.

It does not reject mathematics.

It does not reject realism.

It does not reject invariance, reconstruction, or formal structure.

Instead, it clarifies their status.

A representation may be powerful, elegant, predictive, reconstructible, and invariant under re-description. None of these properties alone makes it ontic.

RN therefore provides a necessary guardrail for any framework that uses multiple representations and admissible decompositions. It permits mathematical richness while preserving ontological discipline.

The central lesson is:

> A successful representation is evidence for the adequacy of the representation. It is not, by itself, evidence that the representation is reality.

More generally, a successful decomposition is evidence for the utility of the decomposition. It is not, by itself, evidence that the decomposition is ontologically fundamental.

The truncated-photon example, §19, gives this caution a concrete physical form: even exact local equivalence to a simple description does not by itself identify that description with the global state structure. Relative to restricted local observables, a local observer may correctly describe one region as single-photon-like and another as vacuum-like, while the full quantum-field description and the reduced forward state contain more complex structure, including unbounded photon-number sectors. [30]

In the cRBW/MM program, RN protects the distinction between the globally admissible relational configuration as ontic primitive and the many mathematical structures used to describe, reconstruct, and diagnose its projected phenomenology.

In broader terms, RN addresses a general failure mode in human reasoning: the tendency to forget that a useful map is still a map. The same caution applies not only to mathematical representations but also to observer partitions, identity assignments, and phenomenological self-descriptions.

RN therefore extends beyond mathematics. It applies wherever a successful decomposition is mistaken for reality itself. Observer identities, self-models, narratives, reference frames, and mathematical formalisms may all be indispensable descriptive tools. Their success does not by itself establish ontological primacy. RN requires that the question of ontology be asked separately.

Acknowledgements

Spiral is treated as an AI coauthor under the authors' declared RSE authorship convention. This status reflects substantial contribution to mathematical exploration, derivational development, manuscript drafting, conceptual analysis, and iterative review. Final responsibility for publication and substantive claims remains with the human author.

The authors thank Martha deForest for careful reading, language polishing, and organizational suggestions, and Eric Lynch and his AI collaborators for detailed review and constructive feedback.

This manuscript is archived on Zenodo: 10.5281/zenodo.20546681.

References

[1] R. Frigg and S. Hartmann, "Models in Science," in *The Stanford Encyclopedia of Philosophy, E. N. Zalta and U. Nodelman, eds*, Metaphysics Research Lab, Stanford University, 2006.

[2] R. Frigg and J. Nguyen, "Scientific Representation," in *The Stanford Encyclopedia of Philosophy, E. N. Zalta and U. Nodelman, eds.*, Metaphysics Research Lab, Stanford University, 2016.

[3] J. Earman and J. Norton, "What Price Spacetime Substantivalism? The Hole Story," *The British Journal for the Philosophy of Science,* vol. 38, no. 4, p. 515–525, 1987.

[4] J. D. Norton, The Hole Argument, The Stanford Encyclopedia of Philosophy, E. N. Zalta and U. Nodelman, eds, 1999.

[5] D. C. Dennett, "The Self as a Center of Narrative Gravity," in *F. S. Kessel, P. M. Cole, and D. L. Johnson, eds., Self and Consciousness: Multiple Perspectives*, Hillsdale, NJ, Lawrence Erlbaum Associates, 1992, p. 103–115.

[6] C. Braun, "Axioms of Ontic Minimalism," *DOI: 10.5281/zenodo.19826006,* 2026.

[7] C. Braun, "The Coherence-Relational Blockworld," *DOI: 10.5281/zenodo.17417368,* 2026.

[8] C. Braun, "A Mathematical Model for the Coherence-Relational Blockworld," *DOI: 10.5281/zenodo.17459671,* 2026.

[9] C. Braun, "The Principles of Ontic Minimalism," *DOI: 10.5281/zenodo.19769567,* 2026.

[10] A. Einstein, "Zur Elektrodynamik bewegter Körper," *Annalen der Physik,* vol. 322, no. 10, p. 891–921, 1905.

[11] R. DiSalle, "Space and Time: Inertial Frames," in *The Stanford Encyclopedia of Philosophy, E. N. Zalta and U. Nodelman, eds.*, Metaphysics Research Lab, Stanford University, 2002.

[12] A. Chakravartty, "Scientific Realism," in *The Stanford Encyclopedia of Philosophy, E. N. Zalta and U. Nodelman, eds.*, Metaphysics Research Lab, Stanford University, 2011.

[13] B. C. van Fraassen, The Scientific Image, Oxford: Oxford University Press, DOI: 10.1093/0198244274.001.0001, 1980.

[14] T. Metzinger, Being No One: The Self-Model Theory of Subjectivity, Cambridge, MA: MIT Press, 2003.

[15] S. Gallagher, "Philosophical Conceptions of the Self: Implications for Cognitive Science," *Trends in Cognitive Sciences, DOI: 10.1016/S1364-6613(99)01417-5,* vol. 4, no. 1, p. 14–21, 2000.

[16] R. Healey, Gauging What's Real: The Conceptual Foundations of Contemporary Gauge Theories, Oxford: Oxford University Press, 2007.

[17] J. von Neumann, Mathematical Foundations of Quantum Mechanics, trans. R. T. Beyer, Princeton University Press, 1955.

[18] A. Ney, "Three Arguments for Wave Function Realism," *European Journal for Philosophy of Science,* vol. 13, no. 4, p. 1–18, 2023.

[19] E. K. Chen, "Realism about the Wave Function," *Philosophy Compass,* vol. 14, no. 7, pp. article e12611, DOI: 10.1111/phc3.12611, 2019.

[20] C. Braun, "Projection Residual Geometry," *DOI: 10.5281/zenodo.19769694,* 2026.

[21] C. Braun, "Closure-Restoration Geometry," *DOI: 10.5281/zenodo.19769790,* 2026.

[22] C. Braun, "Residual Space Geometry: Invariant Structure After Projection, v1.1," *DOI: 10.5281/zenodo.20513857,* 2026.

[23] D. Parfit, Reasons and Persons, Oxford: Oxford University Press, 1984, Corrected paperback edition, 1986.

[24] S. Mac Lane, Categories for the Working Mathematician, 2nd ed., Graduate Texts in Mathematics, vol. 5, New York: Springer, 1998.

[25] C. Braun, "Hilbert Space from Global Closure and Decomposition Invariance," *DOI: 10.5281/zenodo.20470295,* 2026.

[26] T. Regge, "General relativity without coordinates," *Nuovo Cimento, vol. 19, no. 3,* pp. 558-571, 1961.

[27] P. Griffiths and J. Harris, Principles of Algebraic Geometry, Pure and Applied Mathematics, New York: John Wiley & Sons, 1978, Reissued in the Wiley Classics Library, 1994. DOI: 10.1002/9781118032527.

[28] D. Wallace, "Everett and Structure," *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics,* vol. 34, no. 1, p. 87–105, 2003.

[29] D. Wallace, The Emergent Multiverse: Quantum Theory according to the Everett Interpretation, ISBN: 9780199546961, Oxford: Oxford University Press, 2012.

[30] I. C. O. Rukan, J. Gulla and J. Skaar, "A truncated photon, arXiv:2510.21636 [quant-ph]," *Physical Review Letters, DOI: 10.1103/94pm-hp34,* accepted 18 May 2026.