

# Ontological Structure and Canonical Synthesis of NUVO Scalar Geometry

Rickey W. Austin

St Claire Scientific, Albuquerque, NM, USA

Email: rickeywaustin@stclairescientific.com

**How to cite this paper:** Austin, R.W. (2026) Ontological Structure and Canonical Synthesis of NUVO Scalar Geometry. *Journal of Applied Mathematics and Physics*, 14, 694-721. <https://doi.org/10.4236/jamp.2026.142037>

**Received:** January 12, 2026

**Accepted:** February 11, 2026

**Published:** February 14, 2026

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## Abstract

The NUVO framework has produced a sequence of peer-reviewed results spanning scalar-modulated spacetime geometry, loop-based matter structure, quantization from coherence and closure conditions, gauge correspondence, and finite saturation phenomena. These developments were largely results-driven, with ontological language evolving alongside formal derivations. This paper provides a consolidated synthesis of those results and presents a canonical clarification of NUVO ontology centered on the *Maintaining Attribute of Spacetime* (MAST), its globally conserved quantitative measure (*sinertia*), and the scalar modulation field  $\lambda(x)$  as the local availability of that maintaining capacity. The clarification replaces earlier heuristic “above/under substrate” terminology with a single-substrate spacetime ontology possessing dual functional structure: geometric response and finite maintaining capacity. No published equations, derivations, or correspondence limits are modified. Instead, the work stabilizes interpretation, re-expresses depletion and saturation phenomena as natural consequences of finite maintaining capacity, and establishes a minimal and durable ontological foundation for future peer-reviewed development within the NUVO program. The contribution of this work is foundational and structural rather than phenomenological. No new dynamical equations, coupling terms, or empirical predictions are introduced. Instead, the paper articulates admissibility, conservation, and scope constraints within the published NUVO framework, clarifying what the theory does and does not claim.

## Keywords

NUVO Scalar Geometry, Canonical Synthesis, Ontology, Sinertia, MAST, Scalar Modulation, Depletion, Coherence, Admissibility

## 1. Introduction

The NUVO program was developed through a sequence of mathematically ex-

PLICIT investigations into scalar-modulated spacetime geometry, transport structure, and finite coherence limits. These investigations yielded concrete results, including quantization from geometric arc closure, loop-based matter structure, gauge correspondence, and saturation phenomena<sup>1</sup> [1]-[5]. In many cases, these results were established prior to the stabilization of a fully unified ontological vocabulary.

Such a development path is not unusual in theoretical physics. Frameworks that generalize geometric structure or introduce new limiting capacities often progress through a results-first phase, with interpretive language serving initially as heuristic scaffolding rather than literal physical description. Historical precedents can be found in the development of general relativity, gauge theory, and thermodynamic treatments of spacetime, where conceptual consolidation followed the establishment of formal results [6]-[8].

As the body of peer-reviewed NUVO results matured, certain descriptive constructs—most notably the use of “above” and “under” substrate terminology—proved increasingly unnecessary for formal reasoning and, in some contexts, risked being interpreted more literally than intended. At the same time, a recurring structural theme became evident across otherwise independent results: physical structure in NUVO is limited not solely by energetic considerations, but by a finite capacity of spacetime itself to sustain coherent structure against perturbation<sup>2</sup>. Terms such as “admissible” are used throughout this paper only to summarize observable consequences of this finiteness, not to imply the existence of independent selection rules, governing principles, or normative constraints.

The purpose of the present work is twofold. First, it provides a unified synthesis of established, peer-reviewed NUVO results for reference and orientation. Second, it introduces a canonical clarification of NUVO ontology centered on three elements: the Maintaining Attribute of Spacetime (MAST), sinertia as its global quantitative measure, and the scalar modulation field  $\lambda(x)$  as the local availability of that global maintaining capacity. This clarification does not modify existing equations, derivations, or conclusions. Instead, it consolidates interpretation, eliminates unnecessary metaphors, and establishes a minimal ontological structure capable of supporting the full NUVO framework going forward.

**Scope and intent:** This manuscript is not a proposal of new field equations, interaction terms, or phenomenological predictions. All mathematical structures employed here—including the scalar-conformal geometry, conservation laws, and admissibility conditions—are taken as established results from previously published NUVO work. The role of the present paper is strictly foundational: to make explicit the ontological commitments, conservation constraints, and admissibility structure implicit in those results, and to delimit the scope within which

<sup>1</sup>**Empirically**, saturation phenomena in NUVO refer to the observable limits encountered when local maintaining capacity is drawn to the point that additional curvature, coherence, or structural complexity cannot be sustained without redistribution or transition.

<sup>2</sup>**In this context**, admissibility denotes the subset of configurations that support coherent internal structure and consistent unit scaling, rather than an externally imposed selection rule or prohibition.

NUVO claims apply.

Only peer-reviewed NUVO publications are used as foundational references in the main text. Where preprint material is mentioned, it appears exclusively in footnotes for contextual completeness and does not carry logical or evidentiary weight in the arguments presented here.

### **1.1. What This Paper Is (and Is Not)**

This paper is not a revision, correction, or replacement of previously published NUVO results. All equations, derivations, and correspondence limits established in prior peer-reviewed works remain intact and authoritative within their stated scope. The role of the present work is strictly interpretive and structural: to record the canonical ontology implicit in those results explicitly and to provide a stable reference for future work and peer review.

In particular, no new dynamical laws are proposed, no existing results are withdrawn, and no claims are made that exceed the scope of previously published analyses. Where earlier terminology is refined or replaced, the change reflects a consolidation toward minimal and non-misleading language rather than any alteration of physical content.

### **1.2. Organization of the Paper**

Section 2 summarizes the peer-reviewed NUVO results synthesized in this work. Section 3 discusses the role of ontological consolidation in mature theoretical frameworks. Section 4 introduces formal accounting and admissibility frameworks used solely for interpretive clarity and consistency. Section 5 reviews the historical role and limitations of earlier substrate-based terminology. Section 6 presents the single-substrate NUVO geometry with dual structural roles. Sections 7 through 10 introduce and formalize the canonical ontology of MAST, inertia, scalar modulation, availability flow, and intrinsic response timescales. Section 11 discusses implications for existing NUVO results, and Sections 12 and 13 conclude with discussion and outlook.

## **2. Overview of NUVO Results**

This section provides a concise synthesis of the peer-reviewed NUVO results relevant to the present ontological consolidation. Where later archival preprints are mentioned, they are cited only for context and continuity of development, and they carry no foundational or evidentiary weight in the arguments of this paper. The purpose is not to re-derive these results, but to situate them within a unified structural context and to clarify their mutual consistency. Detailed derivations and technical arguments remain in the cited works.

### **2.1. Scalar-Modulated NUVO Space and Unit-Constrained Frames**

The foundation of NUVO is a scalar-modulated spacetime geometry in which the physical metric is expressed as a conformal modulation of a flat background,

$$g_{\mu\nu} = \lambda^2(x)\eta_{\mu\nu},$$

subject to a unit constraint ensuring consistent scaling of space and time intervals [1] [2]. The scalar modulation  $\lambda(x)$  is not introduced as an independent dynamical field, but as a geometric response variable encoding how spacetime expresses structure under finite maintaining capacity.

A key result of this construction is the absence of metric modulation under constant-velocity motion alone. Scalar modulation arises only when acceleration acts against the sustaining inertia flow. Acceleration aligned with that structure produces no geometric response. In the absence of counter-flow acceleration, motion reduces to constant velocity, all frames are inertial, and spacetime reduces to its unmodulated form, corresponding directly to special relativity at this boundary.

## 2.2. Bundle Postulate and Loop Ontology

Building on scalar-modulated geometry, NUVO introduces a loop-based structural description in which physical entities are represented as closed or open transport configurations<sup>3</sup>. Closed loops correspond to mass-like structures with no net exchange, while open loops correspond to charge-like structures permitting controlled exchange.

This structural picture provides a basis for particle stability, interaction selectivity, and transport behavior without introducing additional fields or degrees of freedom beyond scalar geometry. Limitations on persistence arise from finite maintaining capacity rather than imposed selection rules.

## 2.3. Quantization from Arc Closure and Coherence Constraints

NUVO derives quantization conditions from finite coherence and closure limits rather than postulated operator algebra. In the first quantization development, discrete action and orbital structure emerge from arc-closure constraints on scalar transport [3]. Subsequent work extends this framework to phase coherence and invariant transport, yielding quantized action and phase relationships [4].

At the operator level, these results admit a correspondence with the Schrödinger framework, providing a geometric origin for quantum structure without modifying standard quantum mechanics [5]. Quantization reflects finite coherence and closure conditions intrinsic to scalar-modulated transport rather than the imposition of abstract admissibility rules.

## 2.4. Gauge Structure and Standard Model Correspondence

NUVO admits a structural correspondence with the Standard Model gauge groups  $U(1) \times SU(2) \times SU(3)$  through stable transport patterns supported by scalar ge-

<sup>3</sup>**Notationally**, the detailed formulation of the Bundle Postulate and its loop-theoretic interpretation of mass and charge is developed in NUVO preprints and is cited here solely for contextual completeness. The present paper relies only on peer-reviewed geometric and transport results.

ometry under finite maintaining capacity<sup>4</sup>. This correspondence is interpretive and kinematic: no replacement or modification of Standard Model dynamics is claimed.

Gauge structure is understood as arising from persistent transport patterns compatible with scalar-modulated geometry, preserving established phenomenology while offering a geometric interpretation of internal symmetries.

## 2.5. Dirac Equation and Spin Transport

Spin and fermionic transport are compatible with NUVO scalar geometry through a conformal treatment of the Dirac equation<sup>5</sup>. Standard relativistic spinor structure is preserved in the appropriate limits, demonstrating consistency between scalar-modulated geometry and relativistic quantum transport at the operator level.

## 2.6. Finite Coherence, Saturation, and Structural Limits

Across peer-reviewed NUVO results, finite limits on coherence, stability, and structural persistence consistently appear as consequences of scalar-modulated geometry and unit-constrained transport. These limits manifest as bounded families of stable configurations, finite coherence bandwidths, and transition regimes separating persistent from non-persistent structure.

Later NUVO work formalizes these observations in terms of depletion and saturation language; such formulations are referenced only for contextual continuity and do not introduce additional physical postulates in the present analysis.

## 2.7. Observational Compatibility and Gravitational Phenomena

NUVO admits gravitational phenomena consistent with leading-order predictions of general relativity, with scalar modulation introducing only small, controlled corrections at higher order. Wave propagation, polarization, and lensing remain compatible with observational constraints, reinforcing the phenomenological viability of scalar-modulated geometry<sup>6</sup>.

Together, these peer-reviewed results establish NUVO as a coherent scalar geometric framework whose core predictions remain stable under subsequent ontological consolidation.

For clarity, the present paper relies on the following previously established results: 1) the definition of NUVO space as a scalar-conformal geometry with metric  $g_{\mu\nu} = \lambda^2 \eta_{\mu\nu}$ ; 2) existence and regularity of the associated connection and conservation laws; and 3) admissibility constraints derived from scalar coherence and conservation. No new mathematical structures beyond these results are intro-

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<sup>4</sup>**Specifically**, extended discussions of dynamic loop ensembles and gauge correspondence appear in NUVO preprints and are cited here only for interpretive context.

<sup>5</sup>**Technically**, a detailed treatment of Dirac spinors and transport in NUVO geometry is provided in preprint form and is cited here solely for context.

<sup>6</sup>**Empirically**, gravitational wave analyses in NUVO scalar geometry are developed in preprint form and are cited here for completeness only.

duced here.

### 3. Ontology Consolidation in Mature Theoretical Frameworks

It is common in the development of foundational physical frameworks for formal results to precede fully stabilized ontological interpretation. Mathematical structures, variational principles, and correspondence limits are often explored and refined before a minimal and durable conceptual vocabulary is established. Only after a sufficient body of internally consistent results has accumulated does ontological consolidation become both possible and necessary.

This pattern is well documented across the history of modern physics. In general relativity, geometric formalism preceded clarity regarding the physical status of spacetime, energy localization, and coordinate invariance. In quantum mechanics and quantum field theory, operational rules and calculational success long outpaced consensus on interpretation. In each case, later consolidation did not invalidate earlier results, but instead clarified their scope, limits, and mutual consistency [6] [9] [10].

The NUVO framework has followed a similar trajectory. A sequence of peer-reviewed results concerning scalar-modulated geometry, transport structure, quantization from finite coherence limits, and correspondence with established physical theories was developed with an emphasis on formal consistency. Ontological language employed during this phase served primarily as descriptive scaffolding, facilitating reasoning across distinct functional roles rather than asserting literal physical separations.

#### 3.1. Results-First Development and Interpretive Scaffolding

Early-stage ontological metaphors play an important role in complex theoretical development. By allowing distinct functional roles to be named and discussed, they enable progress before a fully minimal formulation is available. However, such scaffolding is not intended to persist indefinitely. As formal structure stabilizes, descriptive language must be revisited to ensure that it does not introduce unintended commitments or obscure underlying unity.

In NUVO, terminology such as “above” and “under” substrate was introduced to distinguish between geometric response and limits arising from finite maintaining capacity. While this language proved useful during development, it was never intended to imply the existence of physically separate layers, additional dimensions, or literal interfaces. Its continued use beyond the development phase risks over-specifying ontology where none is required and complicating interpretation without corresponding explanatory gain.

#### 3.2. Criteria for Canonical Ontological Statements

A central goal of ontology consolidation is to arrive at statements that are both minimal and generative. In the present context, a canonical ontological statement

must satisfy several criteria:

- **Non-contradiction:** It must be compatible with all established NUVO results and correspondence limits.
- **Minimality:** It must avoid introducing entities, layers, or structures not required by the formalism.
- **Generativity:** It must support further derivation and extension without ad hoc modification.
- **Interpretive clarity:** It must reduce, rather than increase, ambiguity in physical interpretation.

The consolidation introduced in subsequent sections—centered on the Maintaining Attribute of Spacetime (MAST), sinertia as its global quantitative measure, and the scalar modulation field  $\lambda(x)$  as local availability—satisfies these criteria. It captures the functional distinctions previously described by scaffolded terminology while remaining firmly within a single-substrate spacetime ontology.

### 3.3. Purpose and Scope of the Present Consolidation

The consolidation undertaken here is interpretive rather than revisionary. No existing equations are altered, no derivations are withdrawn, and no previously established correspondence limits are weakened. Instead, the aim is to record explicitly the ontological structure that has emerged implicitly from the peer-reviewed NUVO program as a whole.

By clarifying this structure at the present stage, the work provides a stable reference for future development and peer review. It also reduces the risk of conceptual drift as NUVO results continue to expand into new physical domains.

To make these interpretive boundaries explicit, the next section introduces a formal accounting and admissibility framework used solely to clarify how observability, admissibility, and conservation are treated throughout the remainder of this work.

## 4. Closure Accounting Structure and Observability

The Closure Accounting Structure (CAS) introduced here is not a physical law, dynamical equation, or alternative formalism. It is an auxiliary accounting framework whose sole role is to track admissibility, conservation, and observability conditions across equivalent descriptions of the same underlying NUVO structure. CAS introduces no new dynamics and serves only to make explicit which configurations are permitted, forbidden, or undefined within the NUVO ontology.

Before introducing the canonical ontological elements specific to the NUVO framework, it is useful to clarify the abstract structural context in which terms such as *admissible*, *observable*, and *conserved* are employed throughout this work. The purpose of the present section is to introduce the *Closure Accounting Structure* (CAS), a formal accounting framework used solely to clarify the interpretation of observable structure. CAS introduces no physical postulates, dynamical assumptions, or admissibility rules, and it does not participate in the derivation

or justification of any NUVO results.

CAS is not a physical theory, nor does it prescribe dynamics, field equations, or selection principles. Instead, it functions as a structural accounting tool—analogue in role to algebra or bookkeeping—that constrains how any admissibility-based physical framework may consistently represent observation, ordering, and conservation once such a framework is given. In this sense, CAS serves as a formal language for organizing observable records rather than as a model of physical processes.

#### 4.1. Abstract Scope of CAS

The Closure Accounting Structure is defined independently of any specific physical realization. It assumes only the existence of:

- a space of possible configurations;
- a criterion distinguishing internally coherent configurations;
- an abstract observer understood strictly as an accounting reference rather than a physical entity.

CAS does not specify the nature of configuration space, the origin of coherence conditions, or the physical mechanisms governing transitions between configurations. These elements are supplied entirely by the physical framework under consideration. CAS constrains only how *observable records* may be formed and organized once such a framework is already defined.

In particular, CAS makes no commitment to continuity, discreteness, metric structure, dimensionality, or causal dynamics. Any apparent discreteness arises solely from limitations on observability rather than from imposed granularity, quantization rules, or stepwise evolution.

Nothing in the Closure Accounting Structure constrains the form or origin of admissibility conditions. In NUVO, admissibility arises solely from finite maintaining capacity intrinsic to spacetime, not from accounting rules or external selection principles.

**Why CAS is included here:** The purpose of CAS in the present work is methodological rather than physical: it makes explicit the minimal bookkeeping assumptions required to speak coherently about *observability*, *ordering*, and *closure* when a framework employs admissibility distinctions. This prevents tacit appeals to extra ontology (e.g. hidden layers, enforcement rules, or external selection) from entering implicitly through language. Nothing in CAS constrains the form or origin of admissibility conditions. In NUVO, admissibility arises solely from finite maintaining capacity intrinsic to spacetime, not from accounting rules or independent principles.

#### 4.2. Observability and Admissible Configurations

Within CAS, observability is identified with admissibility in a purely accounting sense. A configuration is said to be *observable* if and only if it satisfies the internal coherence conditions required to support a stable record. Configurations that fail

to meet these conditions may occur in the underlying physical evolution but do not appear as observable entries.

As a consequence, CAS records only admissible configurations in an observer's ledger. Transformations between admissible configurations—whether continuous or otherwise—are not themselves observable records. This distinction implies that coherence is observable, while transformation or decoherence is not. Apparent discreteness in observation therefore reflects the structure of recordability rather than the nature of underlying physical processes.

By analogy, admissible configurations may be compared to broadcast radio stations, which produce coherent signals that can be detected, while transformations between them resemble the static encountered when tuning between stations: such static may exist, but it does not constitute a recordable signal.

### 4.3. CAS Ledger and Ordering

For a given observer, CAS defines an ordered ledger consisting solely of observable configurations. The ordering of this ledger provides a local notion of sequence, while comparative separation between ledger entries gives rise to an emergent notion of duration. No global or external time parameter is assumed.

Importantly, adjacency in the ledger does not necessarily correspond to direct physical adjacency in the underlying evolution. Missing ledger entries may reflect intervals during which no admissible configurations were observable. CAS therefore distinguishes between memory order and admissible adjacency, a distinction that is essential for interpreting causal structure without introducing additional physical assumptions.

### 4.4. Coupling Constraint and Adjacency

Within CAS, the universal constant  $c$  appears only as an observational coupling constraint governing which observable configurations may appear as adjacent ledger entries. Each admissible configuration supports internally consistent scaling of spatial and temporal measures such that their ratio is fixed by  $c$ . This constraint applies solely at the level of recordability and does not constitute a dynamical speed limit or physical interaction.

If the inferred separation between two successive ledger entries would exceed this coupling bound, CAS admits only two accounting possibilities: either one or more admissible intermediate configurations were not recorded, or the apparent adjacency is not admissible and does not represent a true neighbor relation. This structure reproduces the operational content of light-cone limitations without presupposing spacetime geometry or dynamical propagation laws.

### 4.5. Conservation as Ledger Closure

Conservation within CAS applies exclusively at the level of observable records. CAS enforces closure across successive ledger entries but makes no claims regarding the behavior of quantities during unobservable transformation intervals. Ap-

parent violations of conservation therefore never arise: configurations that would violate closure conditions simply fail to appear as observable records.

In this sense, CAS formalizes the notion of *coherent conservation*: conservation as a property of observable structure rather than as a statement about all underlying processes.

While CAS provides a formal structure for interpreting observability and conservation, it does not specify which physical systems exist or which coherence conditions apply. These are supplied entirely by the physical theory under consideration.

#### 4.6. Relation to NUVO Ontology

The role of CAS within the present work is strictly auxiliary. It does not modify, constrain, generate, or justify any NUVO results. All NUVO equations, derivations, and correspondence limits remain valid independently of CAS.

Instead, CAS provides a neutral accounting framework within which the NUVO ontology—centered on the Maintaining Attribute of Spacetime (MAST), sinertia, and scalar availability—may be consistently interpreted. In NUVO, admissibility arises from finite maintaining capacity rather than from imposed selection rules. CAS supplies only the abstract structure needed to explain how such admissibility conditions give rise to observable discreteness, conservation across coherent configurations, and coupled temporal and spatial interpretation.

Accordingly, CAS should be understood as a mathematical and interpretive tool, not as a physical theory or governing principle. Its inclusion serves solely to clarify language and prevent interpretive ambiguity, and it may be omitted without affecting any physical conclusions of the NUVO framework.

### 5. Historical Substrate Language: Purpose and Limits

During the development of the NUVO framework, descriptive language invoking “above” and “under” substrates was introduced to distinguish functional roles within the theory. In particular, this terminology served to separate geometric response—expressed through scalar-modulated spacetime—from effects associated with finite maintaining capacity, including coherence limits, saturation, and structural exhaustion.

This language was employed as a conceptual aid rather than as a literal physical claim. It allowed discussion of finite capacity, saturation behavior, and transport persistence to proceed without prematurely fixing a minimal ontology, and it facilitated cross-domain reasoning during periods when the formal structure of the theory was still under active development.

#### 5.1. What the Substrate Terminology Captured

The substrate metaphor captured a genuine and important distinction present in peer-reviewed NUVO results. On one hand, scalar-modulated geometry provides the observable spacetime response through which motion, curvature, and

transport are described. On the other hand, finite maintaining capacity determines how much physical structure can be sustained before instability, depletion, or qualitative transition occurs.

Referring to these roles as distinct “substrates” made it possible to discuss capacity-driven effects without conflating them with geometric curvature itself. This distinction proved useful during development, particularly in analyses of quantization, coherence limits, and transport persistence, where finite limits arise independently of local geometric response.

## 5.2. Why the Terminology Is No Longer Minimal

As the NUVO framework matured, the continued use of substrate terminology became increasingly unnecessary. The accumulated results demonstrate that the functional distinction between geometric response and maintaining capacity does not require the introduction of physically separate layers, dimensions, or interfaces.

Moreover, substrate language risks unintended interpretation. In particular, it may suggest the presence of additional ontological structure beyond spacetime itself or invite analogies to branes, membranes, or hidden dimensions that are neither required nor supported by NUVO formalism. Such interpretations can obscure the fact that all NUVO structure is intrinsic to spacetime and governed by finite maintaining capacity rather than by independent selection rules or external enforcement principles.

For these reasons, the substrate metaphor has reached the limit of its utility. Retaining it beyond the development phase would over-specify ontology and complicate interpretation without providing corresponding explanatory benefit.

## 5.3. Compatibility with Existing Results

The retirement of substrate language does not alter any previously established NUVO results. All equations, derivations, and correspondence limits remain unchanged and retain their original scope and validity. The consolidation undertaken here simply re-expresses the same functional distinctions within a single-substrate spacetime ontology.

In particular, the roles previously described by substrate terminology are now captured explicitly through the Maintaining Attribute of Spacetime (MAST), its globally conserved quantitative measure (sinertia), and the scalar modulation field  $\lambda(x)$  as a local measure of maintaining capacity availability. This reformulation preserves the explanatory content of earlier work while removing unnecessary metaphorical structure.

The following section formalizes this single-substrate ontology and its dual structural roles.

## 6. Single-Substrate NUVO Geometry with Dual Structure

With the benefit of a consolidated body of peer-reviewed results, NUVO admits a

minimal single-substrate ontology in which all physical structure is intrinsic to spacetime itself. No additional layers, dimensions, interfaces, or external substrates are required. Instead, NUVO geometry exhibits a dual structural character: a geometric response sector and a maintaining-capacity sector, both defined on the same spacetime manifold.

This dual structure reflects distinct functional roles rather than ontological separation. Geometric response describes how spacetime intervals, curvature, and transport are expressed, while maintaining capacity characterizes the finite ability of spacetime to sustain physical structure against perturbation. Both aspects operate simultaneously within a unified spacetime framework and are inferred directly from established NUVO results.

### 6.1. Geometric Sector: Scalar-Modulated Spacetime

The geometric sector of NUVO is characterized by scalar-modulated spacetime, with the physical metric given by

$$g_{\mu\nu}(x) = \lambda^2(x)\eta_{\mu\nu},$$

where  $\eta_{\mu\nu}$  denotes a flat reference metric and  $\lambda(x)$  encodes local scalar modulation. This modulation is not introduced as an independent field, but as a geometric response variable reflecting how spacetime expresses structure under finite maintaining capacity.

A central structural result of NUVO is that scalar modulation arises only when acceleration acts against the sustaining inertia flow<sup>7</sup>. Gravitational potential corresponds to the cumulative geometric expression of such counter-flow mass coupling. In the absence of counter-flow acceleration, motion reduces to constant velocity, scalar modulation vanishes, and spacetime reduces to its unmodulated form, corresponding directly to special relativity as the inertial boundary of the framework.

### 6.2. Maintaining Capacity Sector

Complementing geometric response is a maintaining-capacity sector describing the finite ability of spacetime to sustain coherent physical structure against perturbation. This capacity does not introduce new geometric degrees of freedom; rather, it constrains how much curvature, coherence, acceleration, and structural complexity spacetime can support before exhaustion, redistribution, or qualitative transition occurs.

The maintaining-capacity sector manifests through coherence limits, saturation effects, depletion behavior, and structural closure phenomena. These effects are not governed by geometric curvature alone, but arise from intrinsic limits on

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<sup>7</sup>In NUVO, only acceleration that acts against the sustaining inertia flow (counter-flow acceleration) induces depletion of local availability and therefore necessitates scalar modulation. Acceleration aligned with the inertia flow (co-flow acceleration) demands no maintaining response and leaves the geometry unmodulated.

spacetime's finite maintaining ability, as evidenced across peer-reviewed NUVO results.

### 6.3. Role Separation without Ontological Separation

The distinction between geometric response and maintaining capacity is therefore functional rather than spatial or dimensional. Both structures are defined on the same spacetime manifold and act simultaneously. Geometric response determines how motion and curvature are expressed, while maintaining capacity determines how much physical structure can be sustained.

This separation of roles without ontological separation resolves ambiguities introduced by earlier descriptive metaphors. It preserves the explanatory power of prior NUVO developments while enforcing a strictly single-substrate spacetime ontology. The following sections formalize this structure through the Maintaining Attribute of Spacetime (MAST), its global quantitative measure (sinertia), and the local availability function  $\lambda(x)$ .

## 7. Maintaining Attribute of Spacetime (MAST)

The results summarized in the preceding sections collectively indicate the presence of a physical attribute distinct from energy, force, or geometric curvature. Across a wide range of peer-reviewed NUVO developments—spanning scalar-modulated geometry, coherent transport, quantization, loop structure, and saturation behavior—persistent limitations appear that cannot be attributed to energetic divergence or dynamical instability alone. Instead, these limitations consistently reflect a finite ability of spacetime itself to sustain physical structure.

This attribute is made explicit here as the *Maintaining Attribute of Spacetime* (MAST).

### 7.1. Canonical Definition of MAST

**Maintaining Attribute of Spacetime (MAST):** *An intrinsic and finite capacity of spacetime that supports the persistence of physical structure, including inertia, interaction continuity, bound states, and coherent transport. MAST is not energy, force, or matter, but a structural attribute inferred from the conditions under which physical configurations remain stable or undergo transition. It characterizes how much physical structure spacetime can sustain before redistribution, saturation, or qualitative change occurs.*

This definition reflects a unifying interpretation already implicit in NUVO results: spacetime is not a passive arena in which arbitrary structure may persist indefinitely, but a medium whose capacity to sustain structure is finite. Physical phenomena persist only insofar as they draw upon this capacity.

### 7.2. MAST as Physical Supply

MAST is most naturally interpreted as a supply-like attribute rather than as a constraint or rule. Inertia, charge stability, force persistence, coherent motion, and

field continuity all require ongoing maintenance. In standard formulations, this maintenance is typically assumed implicitly. NUVO renders this assumption explicit by recognizing that the capacity to maintain structure is finite.

When physical processes demand maintaining capacity beyond what is locally available, spacetime does not enforce a prohibition or impose an external selection rule. Instead, the excess demand cannot be met. The observable consequences include resistance to acceleration, saturation of coherence, depletion effects, structural instability, or transition to configurations that require less maintaining capacity. These outcomes are not failures of dynamics, but expressions of finite supply.

### 7.3. Distinction from Energy, Force, and Geometry

MAST is fundamentally distinct from familiar physical quantities. It is not a form of stored energy, nor does it mediate interaction as a force. It does not independently curve spacetime or alter the metric. Instead, it underlies the persistence of all such structures.

Energy and force describe how systems evolve *within* spacetime. Geometry describes how intervals and transport are expressed. MAST characterizes whether those structures can be sustained at all. In this sense, MAST operates at a structural level antecedent to specific dynamical descriptions, supplying the capacity upon which dynamical and geometric behavior depends.

### 7.4. Finiteness and Physical Consequences

The finiteness of MAST is not introduced ad hoc. It is inferred from the systematic appearance of saturation, bounded coherence, and structural limits across otherwise independent NUVO results. Finite families of stable configurations, coherence bandwidth limits, resistance to acceleration, and transition thresholds all point to the same conclusion: spacetime's maintaining capacity is finite.

This finiteness introduces no new pathology. When maintaining capacity is locally exhausted, the response is not divergence or breakdown, but redistribution, locking, or transition to configurations that require less maintenance. Such behavior is observed across physical scales and domains and is unified in NUVO through the concept of MAST.

### 7.5. Role of MAST in Ontological Consolidation

Making MAST explicit clarifies the ontology implicit in the NUVO framework. It eliminates the need for metaphors involving layered substrates or external constraints while preserving the explanatory content of earlier developments. Geometric response and maintaining capacity are now recognized as complementary structural aspects of a single spacetime substrate.

The following sections render MAST operational by introducing *sinertia* as its global quantitative measure and the scalar modulation field  $\lambda(x)$  as the local availability of that measure. Together, these constructs provide a complete and

internally consistent account of how finite maintaining capacity shapes observable structure in NUVO space.

## 8. Sinertia as the Global Quantitative Measure of MAST

The Maintaining Attribute of Spacetime (MAST), as defined in the previous section, characterizes spacetime's finite ability to sustain physical structure. To render this concept operational and compatible with mathematical and physical analysis, it is necessary to introduce a quantitative measure of this capacity. This measure is termed *sinertia*.

Sinertia is not a new field, interaction, or physical substance. It functions as a global quantitative accounting of spacetime's maintaining capacity. Whereas MAST characterizes *what* spacetime can sustain in principle, sinertia quantifies *how much* of that capacity is available and how it may be redistributed or locally accessed.

### 8.1. Definition of Sinertia

**Sinertia:** *The globally conserved quantitative measure associated with the Maintaining Attribute of Spacetime (MAST), representing the total maintaining capacity available to support persistent physical structure within spacetime.*

This definition establishes sinertia as a scalar quantity intrinsic to spacetime. It is not attached to particles, fields, or individual trajectories, nor does it appear as an independent driving term in NUVO's dynamical equations. Sinertia is globally conserved in the accounting sense, while its local availability may vary. When open-loop structures are present, this variation manifests as source–sink behavior in continuity relations, reflecting exchange of availability rather than creation or destruction.

### 8.2. Global Conservation and Local Utilization

A central feature of sinertia is its global conservation. While sinertia may be locally concentrated, depleted, or redistributed, the total sinertia budget of spacetime remains fixed. This conservation reflects the fact that MAST is an intrinsic attribute of spacetime rather than a consumable quantity.

Local physical phenomena interact only with the *availability* of sinertia, not with its global total. Acceleration, coherent transport, bound states, and field persistence require local maintaining capacity. When local availability is high, structure may be sustained with little resistance. When local availability is reduced, resistance, saturation, or structural transition occurs.

### 8.3. Sinertia, Resistance, and Inertia

The concept of sinertia provides a unified interpretation of inertial resistance. Acceleration acting against the sustaining sinertia flow draws upon local maintaining capacity. As this draw increases, resistance to further acceleration appears. Inertia, in this view, is not a primitive property of mass alone, but an expression of finite

local sinertia availability.

This interpretation unifies inertial behavior with other saturation phenomena identified in NUVO. The same finite capacity that limits coherent closure and bounded families of stable configurations also underlies resistance to acceleration. No separate or domain-specific mechanism is required.

#### 8.4. Relation to Scalar Modulation

Sinertia itself does not directly curve spacetime or modulate the metric. Instead, geometric response arises from the local availability of sinertia. Regions in which availability is reduced exhibit scalar-modulated geometry through the field  $\lambda(x)$ , which encodes how spacetime intervals are expressed under capacity draw.

In this sense,  $\lambda(x)$  is not a measure of sinertia itself, but a geometric representation of accessibility. High availability corresponds to weak scalar modulation, while reduced availability corresponds to stronger modulation. This distinction preserves the separation between capacity (accounted for by sinertia) and geometric response (expressed by  $\lambda(x)$ ).

#### 8.5. Sinertia and Finite Physical Structure

Introducing sinertia as a global quantitative measure unifies a wide range of physical limitations under a single accounting concept. Finite coherence bandwidths, bounded families of stable configurations, generation limits, saturation behavior, and inertial resistance all reflect different modes of interaction with a finite sinertia budget.

These phenomena do not require separate postulates or domain-specific constraints. They arise naturally from finite maintaining capacity quantified by sinertia. The following section formalizes this interaction through a continuity relation describing the flow and redistribution of sinertia availability in spacetime.

### 9. The Scalar Modulation Field $\lambda(x)$ as Local Availability

With sinertia defined as the global quantitative measure of spacetime's maintaining capacity, it remains to specify how physical processes interact with that capacity locally. This role is played by the scalar modulation field  $\lambda(x)$ , which encodes local availability rather than maintaining capacity itself.

The field  $\lambda(x)$  is not introduced as an independent dynamical entity. Instead, it provides a geometric representation of how spacetime intervals are expressed when maintaining capacity is locally drawn upon. Regions of high availability correspond to weak modulation, while regions of reduced availability correspond to stronger modulation.

#### 9.1. Local Availability versus Global Capacity

Sinertia represents the total maintaining capacity of spacetime and is globally conserved. Physical processes, however, do not access this capacity uniformly. They interact only with the amount of sinertia locally available. The scalar modulation

field  $\lambda(x)$  serves as the geometric measure of this local availability.

Importantly,  $\lambda(x)$  does not measure inertia itself. It does not store, transport, or deplete maintaining capacity. Instead, it reflects the local relationship between structural demand and available maintaining supply. In this sense,  $\lambda(x)$  functions as an availability factor rather than a resource density.

## 9.2. Relation to Geometric Response

Scalar modulation enters the physical metric as

$$g_{\mu\nu}(x) = \lambda^2(x)\eta_{\mu\nu},$$

providing the geometric response of spacetime to local capacity draw. When local availability is high,  $\lambda(x) \approx 1$  and spacetime remains weakly modulated. As availability decreases,  $\lambda(x)$  increases, altering interval structure and transport behavior.

This response does not imply that  $\lambda(x)$  is a source of curvature in its own right. Rather, it expresses how spacetime accommodates physical structure under finite maintaining capacity.

## 9.3. Counter-Flow Acceleration and Availability Reduction

A defining structural result of NUVO is that scalar modulation arises only when physical processes act against the sustaining inertia flow. Acceleration aligned with that flow draws no maintaining capacity and leaves  $\lambda(x)$  unchanged. Acceleration opposing the flow requires local capacity draw, reducing availability and inducing modulation.

Gravitational potential corresponds to the cumulative geometric manifestation of such counter-flow mass coupling. In all cases, scalar modulation reflects changes in local availability—whether by depletion or restoration—rather than the action of any external potential or force.

## 9.4. Role of $\lambda(x)$ in Ontological Consolidation

Interpreting  $\lambda(x)$  as local availability resolves several potential ambiguities. It eliminates the need to treat scalar modulation as an independent field, avoids reifying maintaining capacity as a physical substance, and preserves the single-substrate ontology of NUVO space.

With this interpretation, geometric response, maintaining capacity, and physical processes form a coherent hierarchy: MAST supplies capacity, inertia quantifies it globally,  $\lambda(x)$  expresses local availability, and geometry responds accordingly. The following section formalizes how local availability is redistributed through flow and exchange in spacetime.

## 10. Availability Flow, Depletion, and Continuity

With  $\lambda(x)$  identified as the geometric expression of local availability, it is now possible to formalize how maintaining capacity is redistributed across spacetime.

Physical processes do not act on sinertia as a global total, but on locally accessible maintaining capacity. Changes in availability therefore manifest as redistribution, depletion, or restoration, all of which occur without violating global conservation.

### 10.1. Global Conservation and Local Redistribution

Sinertia, as the global quantitative measure associated with the Maintaining Attribute of Spacetime (MAST), is conserved at the level of spacetime as a whole. No physical process creates or destroys sinertia globally. What changes is the distribution of its local availability.

Let  $\mathcal{S}$  denote the total sinertia budget and let  $\sigma(x, t)$  denote a local availability accounting density. Global conservation is expressed as

$$\frac{d\mathcal{S}}{dt} = 0,$$

while local behavior is governed by redistribution of  $\sigma(x, t)$  rather than variation of  $\mathcal{S}$  itself.

### 10.2. Continuity Relation for Availability

Redistribution of local availability may be represented through a continuity relation of the form

$$\frac{\partial \sigma}{\partial t} + \nabla \cdot \mathbf{J}_\sigma = \Gamma_{\text{ex}},$$

where  $\mathbf{J}_\sigma$  denotes the flux of availability and  $\Gamma_{\text{ex}}$  represents local exchange terms.

Closed-loop configurations satisfy  $\Gamma_{\text{ex}} = 0$ , reflecting the absence of net exchange of availability. Open-loop configurations permit  $\Gamma_{\text{ex}} \neq 0$ , corresponding to localized source or sink behavior. These terms represent redistribution through exchange rather than creation or destruction of sinertia. When integrated over spacetime, the net contribution of  $\Gamma_{\text{ex}}$  vanishes, preserving global conservation.

This continuity relation serves as an organizational description of availability redistribution rather than as an independent dynamical law.

### 10.3. Availability Redistribution and Counter-Flow Acceleration

Redistribution of availability is driven by gradients in local maintaining capacity. When physical processes act against the sustaining sinertia flow, local availability is drawn down, producing gradients that give rise to  $\mathbf{J}_\sigma$ . Resistance to further acceleration emerges naturally as availability decreases.

Conversely, when counter-flow demand is reduced or removed, availability may be restored through redistribution, allowing  $\lambda(x)$  to relax toward its unmodulated value. In all cases, scalar modulation reflects changes in availability rather than the action of an external potential or force.

### 10.4. Depletion, Saturation, and Structural Limits

Depletion of local availability produces gradients that favor motion aligned with

the sustaining sinertia flow. Motion toward a depleted region therefore proceeds without resistance, corresponding to gravitational free fall or inertial motion aligned with maintaining capacity redistribution. Resistance to acceleration arises only when physical processes attempt to act against this flow, requiring restoration or redistribution of availability.

Saturation phenomena represent natural limits on persistence imposed by finite maintaining capacity. They are reversible when redistribution restores availability and irreversible when structural transition occurs<sup>8</sup>.

### 10.5. Interpretive Summary

The continuity formulation unifies availability redistribution, depletion, and restoration within a single structural picture. MAST supplies finite maintaining capacity, sinertia quantifies it globally,  $\lambda(x)$  expresses local availability, and continuity relations organize redistribution and exchange.

No independent selection principle or admissibility rule is required. Structural limits arise because maintaining capacity is finite, not because configurations are forbidden. The next section introduces the Intrinsic Sinertia Frequency as a natural timescale associated with availability redistribution.

## 11. Intrinsic Sinertia Frequency (ISF)

The preceding sections establish that spacetime possesses a finite maintaining capacity (MAST), quantified globally by sinertia and accessed locally through availability encoded in the scalar modulation field  $\lambda(x)$ . Because this capacity is finite and redistributed rather than instantaneously replenished, physical processes that draw upon local availability necessarily involve characteristic response timescales. These timescales are not imposed by additional dynamics, but arise from the intrinsic response properties of spacetime itself.

The Intrinsic Sinertia Frequency is not introduced as an independent postulate, but as a derived scale associated with linearized scalar response about an admissible equilibrium configuration. Its role here is classificatory rather than predictive.

This motivates the introduction of the *Intrinsic Sinertia Frequency* (ISF).

### 11.1. Definition of ISF

**Intrinsic Sinertia Frequency (ISF):** *A characteristic response frequency associated with the rate at which local sinertia availability can be redistributed or restored following a draw on maintaining capacity.*

ISF does not represent oscillation of sinertia, nor does it correspond to a new physical field, interaction, or degree of freedom. Instead, it characterizes the intrinsic responsiveness of spacetime's maintaining capacity to perturbation. Where maintaining capacity is locally drawn upon, ISF sets the timescale over which

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<sup>8</sup>**Notably**, in NUVO irreversibility refers to loss of structural reachability rather than to entropy production or time asymmetry: a process is irreversible when restoration of availability cannot re-support the original transport or coherence structure without exceeding maintaining capacity.

availability gradients may relax or be re-established.

ISF is not assumed to be a universal constant. In general it may depend on local availability, coupling regime, and configuration class, and may therefore vary spatially and temporally. The term “intrinsic” refers to the fact that the scale is attributed to spacetime response properties rather than to external forcing or imposed parameters.

### 11.2. Origin of the Frequency Scale

The existence of ISF follows directly from the finiteness of maintaining capacity. Redistribution of availability requires reconfiguration of sustaining capacity across spacetime, which cannot occur instantaneously. Evidence for such a characteristic response scale is implicit wherever NUVO analyses exhibit finite recovery windows, saturation thresholds, or transition behavior tied to maintaining-capacity draw, even when no explicit timescale is introduced at the level of geometric closure. As a result, changes in availability introduce a natural temporal scale separating quasi-static response from saturation-driven transition.

This scale is intrinsic. It depends neither on external forcing nor on arbitrary parameter choice, but reflects the internal responsiveness of spacetime as a maintaining medium, as inferred from established NUVO results.

### 11.3. ISF, Acceleration, and Resistance

ISF plays a central role in distinguishing assisted from resisted motion. Acceleration aligned with availability gradients proceeds without resistance, limited only by geometric structure. In contrast, acceleration requiring restoration or counter-flow redistribution of availability is constrained by the response rate set by ISF.

When the rate of demanded reconfiguration exceeds the intrinsic redistribution rate, resistance to acceleration emerges. Inertia in NUVO is therefore not an instantaneous opposition, but a rate-limited response governed by finite maintaining capacity and its intrinsic response frequency.

### 11.4. ISF and Reversibility

The distinction between reversible and irreversible processes in NUVO is naturally expressed in terms of ISF. Processes are reversible when availability can be redistributed on timescales comparable to or shorter than those set by ISF, such that original structural configurations remain reachable.

When perturbations drive demand beyond the response rate characterized by ISF, structural transition occurs and irreversibility results. ISF therefore does not impose irreversibility, but delineates the boundary between recoverable and non-recoverable structural evolution.

### 11.5. Relation to Quantization and Coherence

In NUVO, quantization does not arise from intrinsic timescales or dynamical response limits. Quantized structure emerges from geometric closure and coherence

conditions requiring consistency between local transport and global scalar geometry. These conditions are structural and persist independently of temporal response properties.

The role of the Intrinsic Sinertia Frequency is therefore regulatory rather than generative. ISF governs how rapidly spacetime can redistribute availability when quantized or coherent structures are perturbed. It influences dynamical stability, transition behavior, and recoverability of quantized states without determining their existence or discrete character.

In this sense, ISF constrains the dynamical accessibility of quantized configurations rather than their geometric admissibility. Quantization remains a consequence of metric synchronization and transport closure, while ISF sets the response timescale over which such structures can adjust or undergo irreversible transition.

### **11.6. Interpretive Summary**

The Intrinsic Sinertia Frequency completes the operational description of maintaining capacity in NUVO. MAST supplies finite capacity, sinertia quantifies it globally,  $\lambda(x)$  encodes local availability, continuity relations organize redistribution, and ISF sets the intrinsic timescale of response.

Together, these elements form a closed and internally consistent ontological framework capable of supporting the full range of NUVO results without reliance on external selection principles, imposed dynamical rules, or additional ontological layers.

## **12. Implications for Existing NUVO Results (Interpretive Clarification Only)**

The ontological consolidation introduced in this work does not modify, revise, or supersede any previously published NUVO results. All equations, derivations, correspondence limits, and phenomenological conclusions established in earlier peer-reviewed NUVO publications remain intact within their stated scope. The role of the present section is strictly interpretive: to clarify how those results are situated within the consolidated ontology centered on the Maintaining Attribute of Spacetime (MAST), sinertia, scalar availability, and intrinsic response timescales.

In particular, this consolidation eliminates the need for layered or substrate language while preserving the functional distinctions that earlier terminology was designed to capture. Where earlier works employed terms such as admissibility, depletion, or constraint, these are now understood as descriptive outcomes of finite maintaining capacity rather than as governing principles or independent selection rules.

At the level of established correspondence, the consolidated ontology is empirically compatible with standard general-relativistic and quantum descriptions within their validated regimes. Any empirical distinctiveness, if present, is ex-

pected to arise in regimes where maintaining-capacity saturation, recovery, or transition behavior becomes observable rather than in ordinary weak-response limits.

### 12.1. Scalar Geometry and Gravitational Phenomena

Results concerning scalar-modulated geometry, gravitational fields, and post-Newtonian behavior are unaffected by the present consolidation. The scalar modulation field  $\lambda(x)$  retains its mathematical role in expressing the physical metric, and all geometric derivations remain valid.

What changes is the interpretive framing. Scalar modulation is now explicitly understood as the geometric response to local availability of maintaining capacity rather than as a field encoding admissibility conditions. Gravitational acceleration corresponds to motion aligned with availability gradients produced by depletion around mass-coupled loop structures, while resistance arises only for counter-flow processes requiring restoration of availability. This clarification resolves potential ambiguity regarding inertial versus gravitational motion without altering any gravitational results.

### 12.2. Quantization and Coherence Results

All NUVO quantization results remain exactly as derived. Discrete action, orbital structure, and operator correspondence emerge from geometric closure, metric synchronization, and coherence constraints between local transport and global scalar geometry. These results do not depend on intrinsic response rates or temporal cutoff mechanisms.

The consolidated ontology clarifies that maintaining capacity and inertia do not generate quantization. Instead, they regulate the stability, accessibility, and transition behavior of quantized structures under perturbation. This distinction preserves the geometric origin of quantization while providing a unified interpretation of saturation, coherence bandwidth, and irreversible transition phenomena discussed across NUVO developments.

### 12.3. Loop Ontology, Charge, and Gauge Correspondence

The loop-based interpretation of mass and charge is fully preserved. Closed-loop configurations continue to correspond to mass-like structures with no net exchange, while open-loop configurations permit exchange and underlie charge-like behavior.

Within the consolidated ontology, exchange associated with open loops is interpreted as redistribution of inertia availability rather than as sourcing or depletion of global capacity. Gauge correspondence results and Standard Model interfaces remain purely kinematic and structural, with no modification of established phenomenology. The clarification offered here removes any residual suggestion that exchange processes require additional ontological layers or hidden substrates.

### 12.4. Depletion, Saturation, and Irreversibility

The interpretation of depletion and saturation phenomena is sharpened by distinguishing clearly between depletion-driven availability gradients and restoration-driven resistance. Depletion facilitates motion aligned with availability gradients and accounts for gravitational free fall and inertial co-flow behavior. Resistance arises only when processes require counter-flow redistribution or restoration of availability.

Irreversibility is now understood as loss of structural reachability rather than as violation of conservation or introduction of time asymmetry. Structural transition occurs when restoration cannot re-support prior configurations within available maintaining capacity. This interpretation aligns with all previously identified saturation, decay, and transition phenomena.

### 12.5. Intrinsic Sinertia Frequency and Dynamical Response

The Intrinsic Sinertia Frequency provides a unified temporal framework for understanding dynamical response without altering any structural results. ISF governs the rate at which availability can be redistributed or restored following perturbation, influencing transition rates and stability windows.

Importantly, ISF does not generate quantization or coherence. It constrains the dynamical accessibility of structures already defined by geometric closure. This clarification prevents misinterpretation of ISF as a hidden clock, substrate time-scale, or dynamical selection principle.

### 12.6. Summary

Taken together, the consolidated ontology reinforces the internal consistency of the NUVO framework. It removes unnecessary metaphors, resolves interpretive ambiguities, and provides a minimal physical language capable of supporting all existing results. No prior work is invalidated or weakened. On the contrary, the consolidation strengthens the conceptual foundations upon which future NUVO developments may reliably build.

## 13. Conceptual Consequences, Scope, and Conclusions

This work has presented a consolidated ontological framework for the NUVO scalar-conformal program that emerges directly from its existing, peer-reviewed results. Without modifying any equations, derivations, or correspondence limits, the paper clarifies the physical interpretation implicit across scalar-modulated geometry, loop-based structure, quantization, depletion phenomena, and dynamical response.

By identifying a finite maintaining capacity intrinsic to spacetime and separating global capacity from local availability and geometric response, the NUVO framework acquires a clearer and more economical interpretive structure. The Maintaining Attribute of Spacetime (MAST) characterizes what spacetime can sustain in principle; sinertia provides a globally conserved quantitative accounting

of that capacity; the scalar modulation field  $\lambda(x)$  encodes local availability through geometric response; and continuity relations organize redistribution without violating conservation. Together, these elements provide a minimal and internally consistent ontology aligned directly with the mathematical structure of NUVO space.

A central consequence of this consolidation is a sharper separation of structural, geometric, and dynamical roles. Each ontological element occupies a distinct function, reducing interpretive ambiguity and preventing overlap. In particular, inertial resistance, gravitational response, coherence limits, and saturation phenomena are understood as different expressions of how finite maintaining capacity is accessed, redistributed, and restored. Motion aligned with availability gradients proceeds without resistance, while resistance arises only for counter-flow processes that require restoration of availability. In this way, the equivalence principle is preserved at the level of observable motion while acquiring a deeper structural interpretation.

Importantly, this unification does not introduce new forces, particles, interaction mechanisms, or modifications of established field equations within their validated regimes. General relativity, quantum mechanics, and the Standard Model remain fully intact within their domains of applicability. The present work is strictly interpretive and foundational: it advances no new phenomenological predictions and makes no claims beyond structural consistency, admissibility, and conservation within the published NUVO framework. Any predictive or experimental consequences arise only in subsequent, explicitly dynamical analyses and are not asserted here.

The intent of this paper is not to conclude the NUVO program, but to stabilize its foundations. By removing developmental metaphors, clarifying ontological commitments, and explicitly stating scope and non-claims, the work provides a disciplined and durable baseline for future peer-reviewed development. With this consolidated ontology in place, subsequent investigations may proceed with greater conceptual economy, improved communicability, and a clearer path toward systematic verification and critique.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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## Appendices

### A. Notation and Conventions

This appendix summarizes the principal symbols and conventions used throughout the paper. All notation is consistent with prior NUVO publications unless explicitly stated otherwise.

- $\eta_{\mu\nu}$  denotes a flat reference metric with Minkowski signature. It serves as a baseline for expressing scalar-modulated geometry and does not represent a physically preferred frame.
- $g_{\mu\nu}$  denotes the physical spacetime metric, expressed in NUVO as a scalar modulation of the reference metric,

$$g_{\mu\nu}(x) = \lambda^2(x)\eta_{\mu\nu}.$$

- $\lambda(x)$  is the scalar modulation field. In the consolidated ontology,  $\lambda(x)$  encodes the *local availability* of spacetime's maintaining capacity rather than a stored resource or independent dynamical field.
- **MAST** (Maintaining Attribute of Spacetime) denotes the intrinsic, finite capacity of spacetime to sustain physical structure against perturbation. It is a qualitative ontological attribute rather than a dynamical variable.
- **Sinertia** denotes the globally conserved quantitative measure of MAST. It represents the total maintaining capacity of spacetime and is not localized on particles, fields, or trajectories.
- $\sigma(x, t)$  denotes a local sinertia availability density, used for accounting and continuity relations. It represents accessibility, not capacity itself.
- $J_\sigma$  denotes the flow of sinertia availability in spacetime. It is an accounting construct describing redistribution rather than transport of a substance.
- $\Gamma_{\text{ex}}$  denotes local exchange of availability permitted by open-loop configurations. It vanishes for closed-loop structures and integrates to zero globally.
- Indices  $\mu, \nu, \dots$  run over spacetime coordinates. Natural units are not assumed unless explicitly stated.

Unless otherwise noted, all quantities are defined on a single spacetime manifold with no additional dimensions or layered substrates.

### B. Canonical Definitions (MAST, Sinertia, $\lambda$ )

This appendix records the finalized canonical definitions introduced in this work. These definitions are intended to be copy-paste stable and suitable for reference in future NUVO publications.

#### B.1. Maintaining Attribute of Spacetime (MAST)

*The Maintaining Attribute of Spacetime (MAST) is a finite, intrinsic capacity of spacetime that supplies the persistence of physical structure, including inertia, bound states, interaction continuity, and coherent transport. MAST is not energy, force, or matter, but a pre-dynamical property determining how much physical structure spacetime can sustain before redistribution, transition, or loss of structural reachability occurs.*

## B.2. Sinertia

*Sinertia is the globally conserved quantitative measure of the Maintaining Attribute of Spacetime (MAST). It represents the total maintaining capacity available within spacetime. Sinertia is not localized on particles, fields, or trajectories and does not act as a primitive source term in dynamical field equations. Local source and sink behavior arises only through redistribution and exchange of availability.*

## B.3. Scalar Modulation Field $\lambda(x)$

*The scalar modulation field  $\lambda(x)$  encodes the local availability of sinertia and provides the geometric response of spacetime to capacity draw. It does not measure sinertia itself and does not store maintaining capacity. Changes in  $\lambda(x)$  reflect changes in local availability, whether through depletion or restoration, and determine how spacetime intervals are expressed under finite maintaining capacity.*

Together, these definitions establish a single-substrate ontology in which capacity, availability, and geometric response are clearly distinguished.

## C. Continuity and Compartment Structure Details

This appendix provides additional detail on the continuity formulation used to describe redistribution of sinertia availability. The presentation is intended to clarify accounting structure rather than to introduce new dynamics.

### C.1. Global Conservation

Let  $\mathcal{S}$  denote the total sinertia of spacetime. By definition,  $\mathcal{S}$  is globally conserved,

$$\frac{d\mathcal{S}}{dt} = 0.$$

This conservation reflects the intrinsic nature of MAST and does not depend on the presence or absence of physical structures.

### C.2. Local Availability and Redistribution

Local physical processes interact only with availability, represented by a density  $\sigma(x, t)$ . Redistribution of availability is governed by a continuity relation,

$$\frac{\partial \sigma}{\partial t} + \nabla \cdot \mathbf{J}_\sigma = \Gamma_{\text{ex}},$$

where  $\mathbf{J}_\sigma$  accounts for flow driven by availability gradients and  $\Gamma_{\text{ex}}$  represents exchange permitted by open-loop structures.

Closed-loop configurations satisfy  $\Gamma_{\text{ex}} = 0$ , while open-loop configurations permit nonzero local exchange. When integrated over spacetime,  $\Gamma_{\text{ex}}$  contributes no net change, ensuring consistency with global conservation.

### C.3. Compartment Interpretation

The continuity formulation admits a natural compartment interpretation. Regions of spacetime may be treated as exchanging availability with neighboring re-

gions or with open-loop structures, while the total capacity remains fixed. This interpretation supports discussion of depletion, saturation, restoration, and irreversibility without introducing additional fields or enforcement principles.

The compartment structure is therefore an accounting device rather than an ontological partition and is fully compatible with the single-substrate NUVO framework.