M2 – Structural Capacity Availability and the Interpretation of the Canonical NUVO Equation

Preprint, Version 1.0[*]

Rickey W. Austin
St Claire Scientific Research, Development, and Publishing

Abstract

In the preceding work (M1) [1] the scalar–conformal geometric framework of the NUVO program was established and the canonical scalar field equation (TNE) was derived from a variational principle. The present paper introduces the interpretive layer of that equation.

We interpret the scalar field $\Lambda(x)$ as the *Structural Capacity Availability Field* (SCAF) of the manifold. This field measures the locally available structural capacity required to sustain ordered configurations within the scalar–conformal geometry.

Within this interpretation the canonical NUVO equation governs the causal adjustment of structural capacity availability across the manifold. Intrinsic scalar coupling arising from explicit dependence of the matter Lagrangian on the scalar field produces localized depletion of available structural capacity, leading to persistent geometric structures, while frame-dependent kinematic effects do not source the field.

The mathematical structure derived in M1 remains unchanged. The analysis presented here establishes the conceptual framework required for subsequent sector reductions of the NUVO program.

Notation and Conventions

- $\mathcal{M}$ denotes the spacetime manifold.
- η denotes the reference Lorentzian metric (typically Minkowski in a global chart).
- g denotes the physical metric.
- The scalar field $\Lambda : \mathcal{M} \to \mathbb{R}_{>0}$ is the NUVO modulation field.
- The physical metric is scalar–conformal:

$$g_{\mu\nu} = \Lambda^2 \, \eta_{\mu\nu}.$$

- $\Lambda_0 > 0$ denotes the baseline scalar availability level supported by the intrinsic delivery structure of the underlying field. In the absence of localized structural occupation the scalar field satisfies $\Lambda(x) = \Lambda_0$.

[*]Bibliography is provisional. Cross-references to companion NUVO-series papers (M-, SR-, Q-, QB-, QM-series) will be updated with Zenodo DOIs in subsequent versions.

- The dimensionless scalar diagnostic is

$$\mathcal{A}(x) := \frac{\Lambda(x)}{\Lambda_0}.$$

- The scalar field represents the *locally available structural capacity* of the underlying delivery field. Localized structures may reduce this availability through occupation or transport, but the intrinsic delivery baseline Λ_0 remains fixed.
- Greek indices $\mu, \nu, \ldots$ range over spacetime coordinates $0, 1, 2, 3$.
- We use the Einstein summation convention unless explicitly stated otherwise.

Notation convention. We reserve distinct symbols for fundamental fields and derived quantities. The scalar field Λ represents structural availability, while $\mathcal{A}$ denotes a derived normalized response field. These should not be conflated.

Remark 0.1. *Unless otherwise stated, the background signature is* $(-, +, +, +)$.

1 Introduction

The previous paper of this series established the scalar–conformal geometric framework and derived the canonical scalar field equation (TNE) governing the modulation field Λ.

The present manuscript introduces an interpretation layer for this equation based on the concept of *structural capacity availability.* Within this interpretation the scalar field describes the locally available structural capacity across the spacetime manifold, relative to a reference baseline configuration.

The goal of this paper is not to modify the canonical equation but to interpret its mathematical structure in a manner that clarifies the role of gradients, sources, and persistent structures. All statements in this manuscript follow directly from the scalar equation derived in M1.

2 Interpretation of the Scalar Field

In the preceding paper (M1) [1] the scalar field $\Lambda(x)$ was introduced purely as a geometric object: a smooth positive function on the Lorentzian manifold $(\mathcal{M}, \eta)$ whose conformal rescaling generates the physical metric

$$g_{\mu\nu} = \Lambda^2 \eta_{\mu\nu}.$$

The canonical NUVO scalar equation (TNE) derived in M1 determines the dynamics of this field through a variational principle.

The present paper introduces the interpretive layer used throughout the NUVO program. In this interpretation the scalar field represents the *local availability of structural capacity* within the scalar–conformal manifold.

2.1 Structural capacity and availability

The NUVO framework distinguishes between two related but conceptually different notions [2]:

- **Baseline availability** refers to a reference scalar level representing a uniform configuration of the scalar field. In M1 this baseline is represented by the reference value Λ_0.

- **Structural capacity availability** refers to the locally available portion of that delivered capacity at a spacetime point.

The scalar field $\Lambda(x)$ represents this second quantity. Thus the value of Λ at a point measures how readily structural capacity may participate the formation of persistent structures or transport processes at that location.

Under this interpretation the scalar–conformal geometry describes the spacetime distribution of structural capacity availability relative to the baseline delivery level.

2.2 Local interpretation of Λ

Let $x \in \mathcal{M}$. The value $\Lambda(x)$ may be interpreted as the local availability level of structural capacity at that point.

Regions where Λ is relatively large correspond to regions where structural capacity is concentrated and readily accessible. Regions where Λ is smaller correspond to regions where structural capacity has been locally depleted by the presence of persistent structures.

In this way the scalar field encodes how structural capacity is distributed throughout the scalar–conformal manifold.

Clarification (field vs diagnostic). It is important to distinguish between the scalar field itself and the dimensionless diagnostic used to describe its geometric effect.

The scalar field $\Lambda(x)$ represents the locally available structural capacity as described above. However, the geometric response of the scalar–conformal metric is governed by the normalized diagnostic

$$\mathcal{A}(x) = \frac{\Lambda(x)}{\Lambda_0}.$$

While Λ measures local availability relative to the baseline, the conformal geometry responds through the scaling factor $\mathcal{A}$ appearing in

$$g_{\mu\nu} = \Lambda_0^2 \, \mathcal{A}^2 \, \eta_{\mu\nu}.$$

In this sense the geometric modulation is an *inverse response* to local availability: regions in which structural capacity has been drawn down by persistent structures correspond to increased scalar modulation in the conformal metric. Accordingly, $\mathcal{A}$ should be interpreted as a geometric response diagnostic rather than as a direct measure of remaining availability.

2.3 Anchored structures and availability reduction

Persistent physical structures correspond to localized configurations that draw upon the surrounding availability of structural capacity.

In the NUVO interpretation such structures locally reduce the value of Λ relative to surrounding regions. The scalar field therefore records how the presence of persistent structures modifies the local availability of structural capacity across the manifold.

The canonical NUVO equation derived in M1 governs how this availability field responds to the presence of such structures and how it redistributes across spacetime.

2.4 Interpretive scope

It is important to emphasize that the interpretation introduced here does not modify the mathematical content of the scalar equation derived in M1. The scalar field equation remains a geometric field equation for Λ on the scalar–conformal manifold.

The present section merely provides a physical interpretation for the scalar field that will be used in subsequent papers of the NUVO program.

3 Intrinsic and Induced Scalar Dependence

The scalar field equation derived in M1 includes a source term arising from the dependence of the matter Lagrangian on the scalar field. Understanding the meaning of this dependence is essential for the interpretation of the scalar–conformal framework.

3.1 Intrinsic scalar dependence

Let L_{matt} denote the matter Lagrangian density appearing in the action of M1. The scalar field enters the scalar equation through the functional derivative

$$\frac{\partial L_{\mathrm{matt}}}{\partial \Lambda}.$$

When the matter Lagrangian depends explicitly on the scalar field, this dependence contributes to the source functional that appears in the canonical NUVO scalar equation (TNE).

It is therefore convenient to define the intrinsic scalar source density

$$\rho_\Lambda = -\frac{1}{\kappa}\frac{\partial L_{\mathrm{matt}}}{\partial \Lambda}.$$

This quantity represents the contribution of matter to the scalar field equation arising from intrinsic coupling between matter fields and the scalar modulation field.

3.2 Induced scalar dependence

Not all apparent scalar dependence represents an intrinsic coupling. In many situations the scalar field enters physical expressions indirectly through the conformal metric

$$g_{\mu\nu} = \Lambda^2 \eta_{\mu\nu}.$$

In such cases the scalar field modifies the geometry through which matter fields propagate, but the matter Lagrangian itself does not contain an explicit dependence on Λ.

This situation represents *induced* scalar dependence: the scalar field influences matter dynamics through the geometry, but matter does not directly source the scalar field through an intrinsic coupling.

3.3 Source discipline

The distinction between intrinsic and induced dependence is important for interpreting the scalar equation.

Only intrinsic scalar dependence contributes to the source functional appearing in the NUVO equation. Effects arising purely from the geometric rescaling of the metric do not constitute independent sources for the scalar field.

This source discipline ensures that the scalar field responds only to the structural content of matter systems rather than to frame-dependent or purely kinematic effects.

3.4 Interpretive consequence

Within the structural capacity interpretation introduced in the previous section, intrinsic scalar dependence corresponds to physical systems that locally draw upon the availability of structural capacity.

The scalar source density ρ_Λ therefore measures the degree to which a localized system modifies the surrounding availability field through its intrinsic structural properties.

4 Local Availability Structure

The interpretation introduced in the previous sections requires a clear distinction between the baseline delivery level of structural capacity and its locally available portion within the scalar–conformal manifold.

4.1 Baseline delivery and local availability

The scalar ontology introduced in M1 distinguishes between the intrinsic delivery of structural capacity by the underlying field and the locally available portion of that capacity.

The baseline value Λ_0 represents the intrinsic delivery level supported by the manifold in the absence of structural occupation. This baseline is a property of the delivery field itself and is not modified by the presence of localized structures.

The scalar field $\Lambda(x)$ therefore measures the *locally available* portion of this delivered capacity. Persistent structures may reduce the available portion relative to the baseline, producing local depletion regions, but the intrinsic delivery level remains unchanged.

Consequently variations of Λ represent changes in local availability rather than changes in the intrinsic production of structural capacity.

4.2 Local availability

The scalar field $\Lambda(x)$ introduced in M1 represents the *local availability* of structural capacity rather than the intrinsic delivery level itself.

Regions where Λ is relatively large correspond to regions where structural capacity is locally accessible. Regions where Λ is reduced correspond to regions where persistent structures have locally drawn upon that availability.

The scalar field therefore records how the available portion of the baseline delivery field is distributed across the scalar–conformal manifold.

4.3 Availability adjustment

Because the scalar field represents local availability relative to a reference configuration, changes in Λ should be interpreted as adjustments of availability across the manifold rather than as transport of a conserved substance.

The canonical NUVO equation derived in M1 governs this adjustment. In dynamic situations the scalar field evolves according to a hyperbolic differential equation, allowing changes in availability to propagate causally through spacetime as geometric response.

In stationary situations the same equation reduces to an elliptic structure describing equilibrium availability configurations.

4.4 Persistent structures and depletion

Persistent structures correspond to localized configurations that draw upon the surrounding availability of structural capacity.

Within the scalar–conformal interpretation such structures therefore produce localized reductions in Λ. The scalar field encodes the resulting depletion pattern surrounding the structure.

The spatial structure of Λ around such regions therefore provides information about how structural capacity is redistributed in response to the presence of persistent systems.

5 Causal Adjustment of Structural Capacity Availability

The scalar field equation derived in M1 governs the redistribution of structural capacity availability across the scalar–conformal manifold. An important feature of this equation is that it possesses a causal, hyperbolic structure.

5.1 Hyperbolic propagation

The canonical NUVO equation (TNE) derived in M1 is a second–order hyperbolic scalar equation whose principal part is governed by the Lorentzian d'Alembertian associated with the physical metric. In schematic form one may write

$$\Box_g \Lambda + \mathcal{V}'(\Lambda) = \mathcal{S}(\Lambda, L_{\mathrm{matt}}),$$

where $\mathcal{S}$ represents the intrinsic scalar source functional discussed in Section 3.

Because the principal operator is hyperbolic, disturbances in the scalar field propagate along causal cones determined by the geometry.

Consequently, changes in local availability do not instantaneously reconfigure the scalar field throughout the manifold. Instead, adjustment of availability propagates causally through spacetime.

5.2 Interpretation

Within the structural capacity interpretation, this causal propagation represents the causal geometric adjustment of locally available structural capacity.

When a persistent structure forms or changes configuration, the local availability field is altered. The resulting redistribution of availability then propagates outward according to the hyperbolic dynamics of the scalar equation.

5.3 Stationary reductions

In situations where the system is time independent, the scalar equation reduces to an elliptic equation on spatial slices. In this stationary limit the scalar field describes equilibrium availability distributions rather than propagating redistribution.

Such stationary reductions are particularly important for describing persistent structures whose surrounding scalar field configuration has relaxed to equilibrium.

5.4 Role in the NUVO program

The causal redistribution property of the scalar field equation provides the dynamical mechanism through which the availability structure reconfigures within the scalar–conformal manifold.

Later papers in the series will interpret specific physical phenomena as arising from particular forms of this redistribution:

- gravitational behavior arising from persistent depletion patterns,
- exchange processes arising from directed capacity transfer, and
- coherent structures arising from admissible redistribution cycles.

6 Normalized Scalar Diagnostic

For many purposes it is convenient to express the scalar field in a dimensionless form relative to a fixed reference value.

6.1 Definition

Let $\Lambda_0 > 0$ denote the reference scalar value introduced in M1. The normalized scalar diagnostic is defined by

$$\mathcal{A}(x) := \frac{\Lambda(x)}{\Lambda_0}.$$

The quantity $\mathcal{A}$ therefore measures the local scalar field relative to the chosen baseline normalization.

6.2 Interpretation

Within the structural capacity interpretation, the normalized scalar diagnostic provides a convenient measure of local availability.

Values of $\mathcal{A}$ close to unity correspond to regions where the local availability of structural capacity is close to the reference baseline. Deviations from unity represent local redistribution of availability relative to that baseline.

Because the diagnostic is dimensionless, it provides a convenient variable for comparing scalar configurations across different regions of the manifold.

In particular, it should be kept in mind that the normalized scalar diagnostic reflects the geometric response of the scalar–conformal metric to underlying availability. As such, increases in $\mathcal{A}$ correspond to regions of stronger geometric modulation and may arise from local depletion of structural capacity rather than from an increase in underlying availability.

6.3 Relation to the conformal metric

Using the definition of $\mathcal{A}$, the physical metric may be written as

$$g_{\mu\nu} = \Lambda_0^2 \, \mathcal{A}^2 \, \eta_{\mu\nu}.$$

In this representation the overall scale Λ_0 fixes the reference normalization while the dimensionless field $\mathcal{A}$ encodes the spatial and temporal variation of the scalar modulation.

6.4 Diagnostic role

The normalized scalar field is introduced as a diagnostic quantity rather than as a new dynamical variable. The underlying dynamical equation remains the scalar field equation derived in M1.

Nevertheless, the dimensionless diagnostic $\mathcal{A}$ will often provide a more convenient variable for expressing structural relations in later papers of the series.

7 Relation to Subsequent Sectors of the Program

The present paper establishes the interpretive framework for the scalar field equation derived in M1. In particular, it clarifies how the scalar field should be understood as representing the local availability of structural capacity within the scalar–conformal manifold.

The remaining papers of the foundational series introduce controlled specializations of this framework that describe different classes of physical structures.

7.1 Persistent structures

In the next paper (M3) [3] we examine persistent localized configurations that draw upon the surrounding availability of structural capacity. Such configurations generate stable depletion patterns in the scalar field and lead to the gravitational sector of the theory.

The analysis of that paper focuses on stationary scalar configurations and the resulting motion of bodies within the scalar–conformal geometry.

7.2 Exchange processes

Paper M4 [4] introduces the exchange sector of the framework. Exchange processes correspond to directed interactions between localized systems that modify local availability structure.

Within the structural interpretation developed here, these transfers occur through open-loop structures that connect capacity sources and capacity sinks. Exchange processes therefore redistribute structural capacity availability across the manifold through structured interaction.

7.3 Coherent structures

Paper M5 [5] develops the conditions under which redistribution of capacity can occur in coherent cyclic configurations. Such cycles correspond to admissible holonomic structures within the scalar–conformal manifold.

These coherent configurations give rise to discrete structural states and form the basis for the quantization phenomena explored in that paper.

7.4 Program structure

The sequence M1–M5 therefore proceeds through the following stages:

- M1 establishes the scalar–conformal geometry and derives the canonical scalar field equation.
- M2 provides the structural interpretation of the scalar field as a capacity availability field.
- M3 studies persistent depletion structures and the resulting gravitational behavior.
- M4 develops structured interaction between systems affecting availability.

- M5 examines coherent cyclic redistribution and the emergence of discrete structural states.

Together these papers establish the mathematical and structural foundations of the NUVO framework before more specialized physical applications are considered.

References

[1] Rickey W. Austin. M1: Scalar–conformal geometry and the variational structure of the scalar capacity field. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[2] Rickey W. Austin. M0: Foundational ontology and structural definitions of scalar–conformal nuvo systems. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[3] Rickey W. Austin. M3: Persistent depletion structures and the gravitational sector of the scalar–conformal framework. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[4] Rickey W. Austin. M4: Exchange transport and open-loop structure in the scalar–conformal framework. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[5] Rickey W. Austin. M5: Coherent cyclic redistribution and discrete structural states. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.