# M7 – Gravitational Structural Response from Boundary Flux Evolution on Scalar–Conformal NUVO Space

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

## Notation and Conventions

- $\mathcal{M}$ denotes the spacetime manifold.
- $\eta$ 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 $\Lambda(x) = \Lambda_0$.
- 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 $\Lambda_0$ 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.

[*]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.

**Notation convention.** We reserve distinct symbols for fundamental fields and derived quantities. The scalar field $\Lambda$ 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* $(-,+,+,+)$.


**Abstract**

This paper develops the first gravitational response structure of the support sector on scalar–conformal NUVO space under the boundary-based framework established in M6.5 [1]. Capacity is treated not as a conserved transported substance, but as a uniform delivery process presented locally to anchored structures. Persistent anchors are localized consumers whose invariant total intake is fixed by

$$\dot{C}_S = mc^2.$$

Their physical state is represented not by an internal circulation variable, but by the boundary flux distribution

$$\Phi_n(\theta,\phi) = J_C \cdot \hat{n}$$

over the anchor boundary. Inertial persistence corresponds to a stationary boundary state,

$$\frac{\partial \Phi_n}{\partial \tau} = 0,$$

whereas acceleration is identified with evolution of the boundary flux distribution,

$$\frac{\partial \Phi_n}{\partial \tau} \neq 0.$$

Within this framework, the present paper formulates gravitational response as a support-sector consequence of scalar-modulated delivery geometry. A spatially varying scalar field alters the local delivery conditions presented to an anchor boundary, thereby changing the admissible boundary flux configurations. The resulting boundary redistribution provides the structural origin of gravitational response without introducing force as a primitive concept. For a static spherically symmetric source, the weak-field limit yields an effective radial response whose leading term reproduces the observed inverse-square gravitational acceleration. The paper therefore establishes gravity, at the support-sector level, as the macroscopic image of scalar-induced boundary-flux asymmetry, while deferring the general closed evolution law for boundary states to the subsequent paper.


# 1 Introduction

## 1.1 Purpose of the Paper

The preceding papers of the M–series establish the scalar–conformal geometric structure of NUVO space and the admissible class of persistent anchored configurations supported within that structure. In particular, M6.5 [1] introduces a decisive refinement of the support-sector ontology: capacity is not a conserved transported substance, but a uniform delivery process presented locally to anchored structures. Anchors are localized consumers with invariant total intake, and their physical state is represented by the boundary flux distribution

$$\Phi_n(\theta,\phi) = J_C \cdot \hat{n}$$

defined over the boundary of the anchored region.

Within this framework, inertial persistence is identified with a stationary boundary flux distribution,

$$\frac{\partial \Phi_n}{\partial \tau} = 0,$$

while acceleration corresponds to evolution of this distribution,

$$\frac{\partial \Phi_n}{\partial \tau} \neq 0.$$

The purpose of the present paper is to formulate the first gravitational response structure of the support sector under this boundary-based description. In particular, we develop a structural account of gravitational response in which scalar variation induces directional asymmetry in the boundary-presented delivery conditions, and weak-field motion arises as the macroscopic image of the resulting boundary redistribution, without introducing force as a primitive concept.

### 1.2 Position Within the M-Series

The M–series is organized to establish the NUVO framework in a strictly hierarchical manner. M1–M33 [2–4] introduce the scalar–conformal geometry and interpret the scalar field as a diagnostic of locally available structural capacity. M4 [5] develops the exchange sector and its separation from the capacity substrate. M5 and M6 [6, 7] analyze the role of closed-loop coherence in supporting persistent anchored structures.

M6.5 refines this picture by replacing the earlier circulation-based interpretation of closed loops with a boundary-based formulation. In this refinement, the state of an anchored structure is determined entirely by its boundary flux distribution, and acceleration is defined as the evolution of that distribution. This shift removes the need to interpret capacity as a flowing conserved substance and instead places all dynamical content at the level of boundary response.

The present paper builds directly on this refinement. It identifies the structural mechanism by which scalar variation alters the admissible boundary state of an anchor and shows how, in the weak-field limit, this produces the observed gravitational response. The general closed evolution law for boundary states is deferred to the subsequent paper.

### 1.3 The M6.5 Shift and the Need for Rewrite

The transition introduced in M6.5 necessitates a reorganization of the dynamical development of the M–series. Earlier formulations of motion based on global transport balance or force-like quantities are no longer appropriate once the boundary flux distribution is taken as the fundamental state variable.

In the boundary-based framework, the total intake of an anchored structure remains fixed,

$$\dot{C}_S = mc^2,$$

and therefore cannot serve as the source of dynamical variation. All dynamical behavior must instead arise through redistribution of boundary flux across the anchor surface. In particular, gravitational response cannot be attributed to an imbalance of total intake, but must be understood as a change in the boundary distribution required by the surrounding scalar environment.

As a consequence, any derivation of motion must proceed through the chain

$$\mathcal{A} \longrightarrow J_C \longrightarrow \Phi_n \longrightarrow \frac{\partial \Phi_n}{\partial \tau},$$

with observable acceleration emerging only at the final stage. The present paper is constructed to respect this hierarchy explicitly.

### 1.4 Scope and Restrictions of the Present Development

The development in this paper is restricted to the support sector of the NUVO framework. No open-loop exchange processes are introduced, and no quantum or field-theoretic correspondence is assumed. The scalar field is treated strictly as a diagnostic of local capacity availability, and no independent transport equation for the scalar itself is postulated.

Furthermore, force is not introduced as a primitive quantity. All dynamical behavior is derived from the evolution of the boundary flux distribution of anchored structures under scalar-modulated delivery conditions.

The primary objective is therefore limited and precise: to show how a spatially varying scalar field induces evolution of boundary flux and how, in the weak-field regime, this evolution produces an effective acceleration law consistent with the observed inverse-square gravitational behavior.

Subsequent papers will extend this framework to additional sectors and to more complex interaction regimes. The present work establishes only the first dynamical response law required for that broader program.

## 2 Foundational Inputs from M1–M6.5

The present paper builds exclusively on structural results established in earlier M–series papers [2–7], together with the boundary-based refinement introduced in M6.5 [1]. We collect here the specific inputs required for the development of the support-sector response law. No additional dynamical assumptions are introduced in this section.

### 2.1 Scalar–Conformal Geometry

The physical spacetime metric is a scalar–conformal deformation of a reference Lorentzian metric,

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

where the scalar field $\Lambda(x) > 0$ encodes the local structural availability of the underlying delivery substrate.

It is convenient to work with the normalized scalar diagnostic

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

which measures local capacity availability relative to the intrinsic baseline level $\Lambda_0$.

**Clarification (availability vs geometric response).** The scalar field $\Lambda(x)$ encodes the local structural availability relative to the baseline delivery level $\Lambda_0$. the scalar field $\Lambda(x)$ determines the conformal modulation of the metric through

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

while the normalized diagnostic $\mathcal{A}(x) = \Lambda(x)/\Lambda_0$ provides a dimensionless representation of this geometric response, and therefore the geometric response of the manifold.

These roles must be distinguished. In the support-sector interpretation, localized anchored structures reduce the underlying availability of structural capacity. The scalar–conformal geometry responds inversely: depletion of availability corresponds to an increase in the modulation factor $\mathcal{A}(x)$.

Accordingly, $\mathcal{A}$ should be interpreted as an inverse-response diagnostic of local availability, rather than as a direct measure of remaining capacity.

## 2.2 Capacity as Uniform Delivery

Capacity is not a conserved transported substance. Instead, it is a uniform delivery process presented locally throughout the spacetime manifold. The normalized diagnostic $\mathcal{A}(x)$ does not represent a density of a moving quantity, but a diagnostic of the geometric response to local structural availability.

Consequently, no global conservation law for capacity is assumed, and no primitive transport equation for $\mathcal{A}$ is introduced. All dynamical content must therefore arise from how this delivery is presented to anchored structures.

## 2.3 Anchors as Localized Consumers

Persistent matter structures are represented by anchored closed-loop configurations. Each anchor $S$ is a localized consumer of capacity and is characterized by an invariant total intake rate

$$\dot{C}_S = mc^2,$$

where $m$ is the inertial mass associated with the structure.

This intake is fixed by the internal structure of the anchor and does not vary along its worldline. Dynamical behavior cannot therefore arise from variation of total intake, but only from redistribution of intake across the boundary of the structure.

## 2.4 Boundary Flux as State Variable

The physical state of an anchored structure is represented by the boundary flux distribution

$$\Phi_n(\theta, \phi) = J_C \cdot \hat{n},$$

defined over the boundary of the anchored region.

Here $J_C$ denotes the locally presented delivery field, and $\hat{n}$ is the outward unit normal on the boundary. The total intake constraint takes the form

$$\int_{\partial S} \Phi_n \, dA = mc^2.$$

No internal circulation variable is introduced. Closed-loop structures are interpreted as stable boundary intake configurations rather than as circulating flows.

## 2.5 Inertial and Accelerated States

The distinction between inertial and accelerated behavior is expressed entirely in terms of the evolution of the boundary flux distribution.

An anchor is said to be in an inertial state when its boundary flux distribution is stationary along its worldline,

$$\frac{\partial \Phi_n}{\partial \tau} = 0.$$

An anchor is said to be in an accelerated state when its boundary flux distribution evolves,

$$\frac{\partial \Phi_n}{\partial \tau} \neq 0.$$

Acceleration is therefore not defined through a force law, but through the dynamical evolution of the boundary state.

### 2.6 Closed Loops as Stable Intake Configurations

Closed-loop structures represent stable configurations of boundary intake. They do not correspond to circulating capacity within the structure. Instead, stability is characterized by the existence of admissible boundary flux distributions satisfying the total intake constraint and remaining stationary under the local delivery conditions.

### 2.7 Separation of Support and Exchange Sectors

The present development is restricted entirely to the support sector. The capacity delivery process and the anchored support sector determine the local scalar availability structure and its geometric consequences, while the boundary flux state records how an anchor is sustained within that structure.

Open-loop exchange processes constitute a separate sector with distinct transport laws. These processes do not modify the scalar diagnostic $\mathcal{A}$ and do not enter into the derivation of boundary flux evolution presented in this paper.

Accordingly, no exchange current or interaction mechanism is introduced in the present development.

## 3 Geometric Setting for Gravitational Response

### 3.1 Source Anchor and Ambient Scalar Structure

We consider a persistent anchored structure $M$ acting as a source within the support sector. As established in earlier M–series work [4], anchored structures locally reduce the available structural capacity of the underlying delivery substrate. This reduction is reflected in the scalar diagnostic field $\mathcal{A}(x)$ through its inverse-response role, with increased modulation corresponding to decreased underlying availability.

In the presence of a single isolated source anchor, the scalar field develops a spatial dependence determined by the structural capacity consumption associated with the source. We denote this ambient scalar structure by

$$\mathcal{A}_M(x),$$

and interpret it as the background scalar environment generated by the presence of the anchor $M$.

No dynamical equation for $\mathcal{A}_M$ is introduced at this stage. The scalar field is treated as given, representing the established capacity availability structure within which other anchored systems are embedded.

### 3.2 Scalar Modulation of the Local Delivery Environment

The scalar field does not itself represent a transported quantity. Rather, it determines how the underlying capacity delivery process is locally presented.

In particular, spatial variation in $\mathcal{A}(x)$ modifies the local delivery environment experienced by an anchored structure. This modification is not interpreted as a flow or redistribution of a conserved substance, but as a change in the manner in which capacity is delivered to local boundaries.

Accordingly, we regard the scalar field as inducing a scalar-modulated delivery field, denoted schematically by

$$J_C^{(\mathcal{A})}(x),$$

which represents the delivery process as presented locally in the presence of the scalar structure.

The precise form of this delivery field is not yet specified. At this stage, it suffices to assert that spatial variation in $\mathcal{A}$ alters the boundary-presented delivery conditions, and therefore alters the admissible boundary flux distributions of anchored structures.

### 3.3 Test Anchor in an External Support-Sector Field

Let $S$ denote a persistent anchored structure whose size is small compared to the characteristic variation scale of the ambient scalar field. We treat $S$ as a test anchor moving through the background scalar environment $\mathcal{A}_M(x)$ generated by the source $M$.

The state of $S$ is determined by its boundary flux distribution

$$\Phi_n(\theta, \phi; \tau),$$

which depends on both the local delivery conditions and the motion of the anchor through the scalar field.

Because the total intake of $S$ is fixed,

$$\int_{\partial S} \Phi_n \, dA = mc^2,$$

any change in the local delivery environment must be accommodated by a redistribution of boundary flux rather than by a change in total intake.

Thus, as the anchor moves through regions where $\mathcal{A}_M(x)$ varies, the boundary-presented delivery conditions evolve, and the admissible boundary flux configurations of $S$ are correspondingly altered.

### 3.4 Static Spherical Specialization

To develop the gravitational response in a controlled setting, we restrict attention to a static, spherically symmetric source anchor $M$. In this case the scalar field depends only on the radial coordinate,

$$\mathcal{A}_M(x) = \mathcal{A}_M(r).$$

The ambient scalar structure is therefore radially symmetric, and the delivery environment experienced by a test anchor depends only on its position relative to the source.

In a uniform scalar environment, admissible boundary flux distributions may remain stationary along a worldline,

$$\frac{\partial \Phi_n}{\partial \tau} = 0,$$

corresponding to inertial persistence.

In contrast, when the scalar field varies spatially, motion of the anchor through the radial structure $\mathcal{A}_M(r)$ generically alters the boundary-presented delivery conditions. Since total intake is fixed, these changes must be accommodated by redistribution of boundary flux across the anchor surface.

Consequently, for a generic non-adapted trajectory in a non-uniform scalar field,

$$\frac{\partial \Phi_n}{\partial \tau} \neq 0,$$

and the anchor undergoes structural response.

This establishes the central mechanism of gravitational behavior within the support sector: spatial variation of the scalar field induces evolution of the boundary flux distribution of a test anchor through modification of the local delivery environment.

# 4 Boundary Flux State of an Anchor

## 4.1 Anchor Boundary and Local Normal Data

Let $S$ denote a persistent anchored structure occupying a compact spatial region with smooth boundary $\partial S$. At each point on the boundary, we define the outward unit normal vector $\hat{n}$.

The local interaction between the anchor and the capacity delivery process is entirely mediated through this boundary. No internal transport or circulation variable is introduced. All structural coupling to the delivery substrate is therefore encoded in boundary data.

## 4.2 Definition of the Boundary Flux Distribution

The state of the anchored structure is represented by the boundary flux distribution

$$\Phi_n(\theta, \phi; \tau) = J_C^{(\mathcal{A})}(x(\tau)) \cdot \hat{n},$$

defined at each point of the boundary and parameterized by proper time $\tau$ along the worldline of the anchor.

Here $J_C^{(\mathcal{A})}$ denotes the locally presented delivery field, modulated by the ambient scalar structure as described in Section 3. The function $\Phi_n$ therefore represents the local rate at which capacity is delivered to the anchor boundary.

This distribution constitutes the complete support-sector state of the anchor. No additional internal variables are introduced.

## 4.3 Total Intake Constraint

The boundary flux distribution is constrained by the invariant total intake requirement of the anchor,

$$\int_{\partial S} \Phi_n(\theta, \phi; \tau)\, dA = mc^2. \tag{1}$$

This condition expresses the fact that the anchor is a localized consumer with fixed intake. It is independent of the position or motion of the anchor and must be satisfied at all times.

As a consequence, admissible changes in $\Phi_n$ are restricted to redistributions of boundary flux that preserve the total intake.

## 4.4 Admissible Boundary Flux Configurations

We define the admissible state space of the anchor to be the set

$$\mathcal{A}(S, \mathcal{A}) = \left\{ \Phi_n : \partial S \to \mathbb{R}_{\geq 0} \;\middle|\; \int_{\partial S} \Phi_n \, dA = mc^2 \right\},$$

subject to the requirement that $\Phi_n$ be compatible with the local delivery conditions determined by the ambient scalar field.

Compatibility with the scalar-modulated delivery field imposes additional structure on $\mathcal{A}(S, \mathcal{A})$. In particular:

- In a uniform scalar environment, isotropic boundary flux distributions are admissible steady states.

- In a spatially varying scalar environment, admissible configurations generally acquire directional dependence reflecting the local structure of the delivery field.
- Admissible configurations must remain local and covariant, depending only on the scalar field and its derivatives evaluated at the anchor location.

No global constraints or nonlocal interactions are introduced at this stage.

### 4.5 Steady Boundary States

A boundary flux distribution $\Phi_n$ is said to be a steady state if it remains stationary along the worldline of the anchor,

$$\frac{\partial \Phi_n}{\partial \tau} = 0.$$

Steady states correspond to inertial persistence within the support sector. In such states, the boundary-presented delivery conditions are compatible with a fixed distribution of intake over the anchor surface.

In a uniform scalar environment, steady states may exist for a broad class of admissible configurations. In contrast, in a spatially varying scalar field, steady states are generally restricted and may require specific worldline conditions in order to be maintained.

### 4.6 Remarks on Boundary Redistribution

Because the total intake is fixed, all dynamical response must occur through redistribution of boundary flux within the admissible state space $\mathcal{A}(S, \mathcal{A})$.

This redistribution is constrained by:

- conservation of total intake,
- compatibility with the local scalar-modulated delivery field, and
- locality of the response.

Accordingly, any evolution of the boundary flux distribution must be local, must preserve total intake, and must remain compatible with the scalar-modulated delivery conditions presented at the anchor boundary. The precise closed evolution law satisfying these requirements is deferred to the subsequent paper. In the present work, we restrict attention to the leading structural consequences of scalar-induced boundary asymmetry and their weak-field gravitational image.

## 5 Scalar-Modulated Delivery Field and Boundary Presentation

### 5.1 Ambient Delivery as a Boundary-Presented Process

The capacity substrate provides a uniform delivery process throughout spacetime. This delivery is not transported, stored, or redistributed as a conserved substance. Instead, it is locally presented to anchored structures through their boundaries.

Accordingly, the relevant quantity for the support-sector dynamics is not a global current, but the delivery field as it is presented locally at the boundary of an anchor. This boundary-presented delivery determines the flux distribution $\Phi_n$ and therefore the state of the anchor.

We denote this locally presented delivery field by

$$J_C^{(\mathcal{A})}(x),$$

understanding that this quantity represents a boundary-level presentation of the delivery process rather than a transported physical current.

### 5.2 Dependence on the Scalar Field

The scalar field $\mathcal{A}(x)$ determines the locally available structural capacity and therefore modulates the delivery conditions presented at the boundary of an anchor.

We therefore assume that the boundary-presented delivery conditions depend locally on the scalar structure,

$$J_C^{(\mathcal{A})}(x) \sim \mathcal{D}\big[\mathcal{A}(x), \nabla\mathcal{A}(x), \nabla\nabla\mathcal{A}(x), \dots\big],$$

for some local covariant functional $\mathcal{D}$ determined by the delivery substrate. The explicit closed form of this dependence is not required in the present paper and will be addressed later.

This dependence expresses the principle that spatial variation in the scalar field alters the manner in which capacity is delivered to local boundaries, without introducing any notion of transport or conservation of a flowing substance.

### 5.3 Local Covariance and Symmetry Requirements

The functional $\mathcal{D}$ must satisfy basic structural constraints:

- **Locality:** $J_C^{(\mathcal{A})}$ depends only on the scalar field and its derivatives evaluated at the anchor location.
- **Covariance:** the construction of $J_C^{(\mathcal{A})}$ must be compatible with the scalar–conformal geometry of spacetime.
- **Rotational consistency:** in the absence of scalar gradients, the boundary-presented delivery field must not introduce preferred spatial directions.
- **Continuity:** small variations in the scalar field produce small variations in the boundary-presented delivery field.

These conditions ensure that the delivery field reflects only the local structure of the scalar environment and does not introduce extraneous directional or nonlocal effects.

### 5.4 Uniform Scalar Field Limit

In a region where the scalar field is spatially uniform,

$$\nabla\mathcal{A} = 0,$$

the boundary-presented delivery field reduces to an isotropic form,

$$J_C^{(\mathcal{A})} \longrightarrow J_C^{(0)},$$

where $J_C^{(0)}$ is independent of spatial direction.

In this case, isotropic boundary flux distributions are admissible steady states, and no evolution of the boundary state is induced by the ambient environment alone,

$$\frac{\partial \Phi_n}{\partial \tau} = 0.$$

This establishes consistency with inertial persistence in the absence of scalar variation.

### 5.5 First-Order Sensitivity to Scalar Gradients

When the scalar field varies spatially, the leading modification of the boundary-presented delivery field arises from the local gradient $\nabla \mathcal{A}$.

To first order, we may therefore write

$$J_C^{(\mathcal{A})} = J_C^{(0)} + \mathcal{K}_1[\nabla \mathcal{A}] + \mathcal{O}(\nabla^2 \mathcal{A}),$$

where $\mathcal{K}_1$ is a linear functional encoding the leading-order response of the delivery field to scalar variation.

This term introduces directional dependence in the boundary-presented delivery conditions. As a consequence, admissible boundary flux distributions acquire anisotropy aligned with the local scalar gradient.

### 5.6 Implications for Boundary Flux Distributions

Because the boundary flux distribution is defined by

$$\Phi_n = J_C^{(\mathcal{A})} \cdot \hat{n},$$

any modification of the boundary-presented delivery field directly alters the admissible configurations of $\Phi_n$.

In particular:

- In a uniform scalar field, admissible configurations may remain isotropic and stationary.
- In a non-uniform scalar field, admissible configurations generally acquire directional bias determined by the local scalar structure.
- Motion of the anchor through a spatially varying scalar field changes the locally presented delivery conditions, and therefore changes the admissible boundary flux configurations along the worldline.

Since the total intake is fixed, these changes necessarily correspond to redistributions of boundary flux.

### 5.7 Transition to Boundary Flux Evolution

The scalar-modulated delivery field provides the mechanism by which the ambient scalar structure influences the state of an anchored system. However, the delivery field itself does not define dynamics.

Dynamics arise only when changes in the boundary-presented delivery conditions induce evolution of the boundary flux distribution within the admissible state space.

The construction of this evolution law,

$$\frac{\partial \Phi_n}{\partial \tau} \text{ is determined by a local response law depending on } \mathcal{A}, \nabla \mathcal{A}, \ldots],$$

is the subject of the following section.

# 6 Leading-Order Boundary Response and Dipole Asymmetry

## 6.1 Leading-Order Response Picture

The ambient scalar structure alters the boundary-presented delivery conditions of an anchor and thereby changes the class of admissible boundary flux configurations. In the weak and slowly varying regime, this change may be represented at leading order as a tendency of the boundary state toward a locally preferred anisotropic configuration determined by the scalar gradient.

The purpose of the present section is not to construct the full closed evolution law for boundary states, but only to identify the leading boundary asymmetry induced by scalar variation and the macroscopic quantity that records it.

## 6.2 Preferred First-Order Boundary Bias

To first order in scalar variation, the only local vector available is the scalar gradient $\nabla\mathcal{A}$. Accordingly, the leading anisotropic correction to an otherwise isotropic boundary state must be aligned with this gradient. We therefore write the corresponding first-order preferred boundary profile schematically as

$$\Phi_n^* = \Phi_0 \left[1 + \alpha(\hat{n} \cdot \nabla\mathcal{A})\right],$$

where $\Phi_0$ is the isotropic baseline flux and $\alpha$ is a response coefficient. This expression should be understood as the leading weak-field boundary bias induced by scalar variation, not yet as the full dynamical law.

## 6.3 Structure of the Preferred Boundary Distribution

To leading order in scalar variation, the preferred distribution must be constructed from the available local geometric data. The only vector available at first order is the scalar gradient $\nabla\mathcal{A}$.

Thus, to leading order, we write

$$\Phi_n^* = \Phi_0 \left[1 + \alpha\,(\hat{n} \cdot \nabla\mathcal{A})\right], \tag{2}$$

where $\Phi_0$ is the isotropic baseline flux satisfying the total intake constraint, and $\alpha$ is a scalar response coefficient.

This expression introduces a directional bias in the boundary flux distribution aligned with the local scalar gradient.

## 6.4 Moment Representation of the Boundary State

To extract the macroscopic response of the anchor, we introduce moments of the boundary flux distribution.

The first moment (dipole moment) is defined by

$$\mathbf{P} = \int_{\partial S} \Phi_n\, \hat{n}\, dA. \tag{3}$$

This quantity measures the directional asymmetry of the boundary flux distribution and provides the leading-order characterization of structural imbalance.

In an isotropic state, $\mathbf{P} = 0$. Deviations from isotropy generate a nonzero dipole moment.

### 6.5 Evolution of the Dipole Moment

At leading order, the scalar-induced boundary bias generates a preferred dipole alignment satisfying

$$\mathbf{P}^* \propto \nabla \mathcal{A}.$$

The macroscopic gravitational response is then associated with the failure of the instantaneous boundary state to remain fully adapted to this changing preferred structure along the worldline.

Substituting the leading-order form of $\Phi_n^*$ yields

$$\mathbf{P}^* \propto \nabla \mathcal{A}, \tag{4}$$

so that the preferred dipole moment is aligned with the scalar gradient.

Thus, the evolution of the boundary state drives the dipole moment toward alignment with $\nabla \mathcal{A}$.

### 6.6 Interpretation of Boundary Moments and Structural Response

The dipole moment $\mathbf{P}$ encodes the leading-order directional asymmetry of the boundary flux distribution and therefore characterizes the instantaneous structural state of the anchor relative to the ambient scalar environment.

A nonzero dipole moment does not, by itself, imply proper acceleration. An anisotropic boundary configuration may remain steady,

$$\frac{d\mathbf{P}}{d\tau} = 0,$$

provided it is fully adapted to the locally presented delivery conditions. Such states correspond to inertial persistence or free response within the support sector.

Proper acceleration arises only when the boundary state is actively evolving. We therefore identify the effective kinematic response with the rate of change of the dipole moment,

$$\mathbf{a} \propto \frac{d\mathbf{P}}{d\tau}. \tag{5}$$

We obtain a structural description of motion in which acceleration is generated by ongoing boundary redistribution rather than by anisotropy alone.

In the fast-tracking weak-field regime, where the boundary state closely follows the locally preferred configuration, the evolution of $\mathbf{P}$ is induced by the variation of the scalar environment along the worldline. In that regime, the effective acceleration reduces at leading order to a quantity proportional to the local scalar gradient,

$$\mathbf{a} \propto \nabla \mathcal{A}.$$

In this formulation, the gradient of $\mathcal{A}$ encodes the spatial variation of the geometric response to underlying capacity depletion. The resulting acceleration therefore reflects the structural response of the boundary state to gradients in geometric modulation, rather than to gradients of a conserved substance.

Thus, the weak-field gravitational response is recovered as the leading kinematic image of boundary-flux evolution under scalar-modulated delivery conditions, while preserving the distinction between steady anisotropy and proper acceleration.

# 7 Gravitational Response from Boundary Flux Evolution

## 7.1 Response of a Test Anchor in a Static Radial Scalar Field

We consider a test anchor $S$ moving in the static, spherically symmetric scalar field generated by a source anchor $M$, with

$$\mathcal{A} = \mathcal{A}(r).$$

As established in previous sections, spatial variation of the scalar field modifies the boundary-presented delivery conditions. Consequently, as the anchor moves through the scalar field, the admissible boundary flux distribution evolves according to

$$\frac{\partial \Phi_n}{\partial \tau} \text{ is determined by a local response law depending on } \mathcal{A}, \nabla\mathcal{A}, \ldots$$

In the radial setting, the only preferred spatial direction is $\hat{r}$, and therefore the leading-order modification of the boundary state is determined by the radial gradient of the scalar field.

## 7.2 Radial Boundary Bias and Structural Tendency

To leading order, the preferred boundary flux distribution takes the form

$$\Phi_n^* = \Phi_0 \left[1 + \alpha(\hat{n} \cdot \nabla\mathcal{A})\right],$$

which induces a directional bias in the boundary flux.

In a radial scalar field, this bias aligns with $\hat{r}$, producing a systematic enhancement of flux on one side of the boundary and reduction on the opposite side.

Because the total intake is fixed,

$$\int_{\partial S} \Phi_n \, dA = mc^2,$$

this directional bias does not change the total intake, but redistributes it across the boundary.

This redistribution constitutes a structural tendency toward alignment with the scalar gradient.

## 7.3 Boundary Moments and Effective Kinematic Response

The directional asymmetry in the boundary flux distribution is captured by the dipole moment

$$\mathbf{P} = \int_{\partial S} \Phi_n \hat{n} \, dA.$$

This quantity represents the first moment of the boundary flux distribution and provides the leading-order measure of anisotropy in the intake of the anchor. In an isotropic boundary state, $\mathbf{P} = 0$, while spatial variation of the scalar field induces $\mathbf{P} \neq 0$ through directional bias in the boundary-presented delivery conditions.

As established in Section 6, the boundary flux distribution evolves toward a locally preferred configuration determined by the scalar structure, so that

$$\mathbf{P} \to \mathbf{P}^* \propto \nabla\mathcal{A}.$$

The dipole moment therefore encodes the instantaneous structural state of the anchor relative to the ambient scalar environment.

However, the presence of anisotropy alone does not imply proper acceleration. A boundary configuration may be anisotropic yet steady,

$$\frac{d\mathbf{P}}{d\tau} = 0,$$

in which case the anchor persists in a state fully adapted to the local delivery conditions. Such states correspond to inertial or free motion within the support sector.

Proper acceleration arises only when the boundary flux distribution is actively evolving. Accordingly, we identify the effective kinematic response with the rate of change of the dipole moment,

$$\mathbf{a} \propto \frac{d\mathbf{P}}{d\tau}.$$

Thus, the role of $\mathbf{P}$ is to encode the directional structure of boundary intake, while its evolution governs the departure from inertial persistence. Motion in a scalar field is therefore understood as the geometric consequence of boundary flux redistribution, with acceleration arising only when the boundary state is not in a steady configuration.

### 7.4 Gravity Without Primitive Force

The resulting motion arises entirely from structural adjustment of the boundary flux distribution under scalar-modulated delivery conditions.

No primitive force law is introduced. In particular:

- No external force acting on the anchor is postulated.
- No potential function is assumed.
- No field-mediated force transmission is invoked.

Instead, the observed motion is the consequence of local redistribution of boundary flux required to maintain the invariant intake condition in a spatially varying scalar environment.

Gravity, in this formulation, is therefore not a force but a structural response of anchored systems to variation in the scalar capacity field.

## 8 Weak-Field Limit

### 8.1 Weak Scalar Modulation Regime

We consider a regime in which the scalar field deviates only weakly from a uniform background. In this case, we write

$$\mathcal{A}(x) = 1 + \epsilon(x), \qquad |\epsilon(x)| \ll 1.$$

In this regime, spatial variation of the scalar field is small, and the boundary-presented delivery conditions differ only slightly from the uniform case. Consequently, the admissible boundary flux distributions remain close to isotropic, with only small anisotropic corrections induced by $\nabla\mathcal{A}$.

This regime corresponds to the weak gravitational field limit in which structural response is small and can be treated perturbatively.

### 8.2 Linearization of the Boundary Response Law

In the weak-field regime, both the preferred boundary flux distribution and the response operator may be linearized in the scalar variation.

In the fast-tracking weak-field regime, the evolution of the dipole moment is governed by the variation of the scalar field along the worldline. To leading order, this produces an effective acceleration proportional to the local scalar gradient,

$$\mathbf{a} \propto \nabla \mathcal{A}.$$

as introduced previously.

Accordingly, the dipole moment becomes

$$\mathbf{P} = \int_{\partial S} \Phi_n \hat{n}\, dA \;\approx\; \int_{\partial S} \Phi_n^* \hat{n}\, dA,$$

to leading order in the deviation from isotropy.

Substituting the linearized form yields

$$\mathbf{P} \propto \nabla \mathcal{A},$$

so that the dipole moment is directly proportional to the local scalar gradient in the weak-field limit.

### 8.3 Leading Radial Contribution

We now specialize to a static, spherically symmetric scalar field,

$$\mathcal{A} = \mathcal{A}(r).$$

In this case,

$$\nabla \mathcal{A} = \frac{d\mathcal{A}}{dr}\, \hat{r},$$

and therefore the dipole moment aligns radially,

$$\mathbf{P} \propto \frac{d\mathcal{A}}{dr}\, \hat{r}.$$

As discussed in Section 7, proper acceleration arises from the evolution of the dipole moment. In the weak-field regime, where the boundary state closely tracks the locally preferred configuration, the time variation of $\mathbf{P}$ is governed by the spatial variation of the scalar field along the worldline.

To leading order, this yields an effective acceleration proportional to the radial derivative of $\mathcal{A}$,

$$\mathbf{a} \propto \nabla \mathcal{A}.$$

### 8.4 Emergence of the Inverse-Square Form

To determine the explicit radial dependence, we consider the scalar field generated by a static source anchor $M$.

By spherical symmetry and dimensional consistency, the leading weak-field form must be

$$\mathcal{A}(r) = 1 + \frac{\ell_M}{r},$$

where

$$\ell_M = \frac{GM}{c^2}$$

is the characteristic scalar length associated with the source [4].

Taking the gradient yields

$$\nabla\mathcal{A} = -\frac{\ell_M}{r^2}\,\hat{r}.$$

Substituting into the leading-order response relation gives

$$\mathbf{a} \propto -\frac{\ell_M}{r^2}\,\hat{r}.$$

Thus, the inverse-square radial dependence emerges directly from the scalar structure of the weak-field regime.

The proportionality constant is fixed by matching to observed acceleration scales in the correspondence section that follows.

# 9 Correspondence with Observed Gravitational Acceleration

## 9.1 Identification of the Effective Radial Acceleration

In the weak-field fast-tracking regime, the structural response of a test anchor reduces to an effective acceleration proportional to the local scalar gradient,

$$\mathbf{a} \propto \nabla\mathcal{A}.$$

For a static, spherically symmetric source, we have

$$\nabla\mathcal{A} = -\frac{\ell_M}{r^2}\hat{r},$$

so that the effective radial acceleration takes the form

$$\mathbf{a} = -\gamma\,\frac{\ell_M}{r^2}\,\hat{r}, \tag{6}$$

where $\gamma$ is a proportionality constant determined by the structural response coefficients introduced in Section 6.

This expression represents the leading-order kinematic response of a test anchor to the scalar structure generated by the source.

## 9.2 Recovery of the $GM/r^2$ Law

Substituting the characteristic scalar length

$$\ell_M = \frac{GM}{c^2},$$

into (6), we obtain

$$\mathbf{a} = -\gamma\,\frac{GM}{c^2 r^2}\,\hat{r}.$$

To recover the observed gravitational acceleration [8, 9],

$$\mathbf{a} = -\frac{GM}{r^2}\,\hat{r},$$

we identify

$$\gamma = c^2. \tag{7}$$

Thus, the correct Newtonian inverse-square law is obtained when the structural response scale is set by $c^2$.

### 9.3 Interpretive Status of the Correspondence

The recovery of the inverse-square law does not constitute an independent derivation of the gravitational constant or the scalar field profile. Rather, it establishes that the boundary-response formulation developed in this work is consistent with observed gravitational acceleration in the appropriate limit.

In particular:

- The radial dependence arises from the scalar structure $\mathcal{A}(r)$.
- The proportionality factor $c^2$ reflects the intrinsic scale of the intake constraint

  $$\int_{\partial S} \Phi_n \, dA = mc^2,$$

  linking structural capacity intake to observable kinematic response.
- The identification of $\ell_M = GM/c^2$ provides the connection between the scalar field and the physical properties of the source.

Accordingly, the present formulation should be understood as providing a structural reinterpretation of gravitational acceleration, rather than a replacement of empirical input.

The observed law

$$\mathbf{a} = -\frac{GM}{r^2}\hat{r}$$

emerges as the leading-order manifestation of boundary flux evolution in a scalar-modulated delivery environment.

## 10 Inertial Persistence, Free Response, and Proper Acceleration

### 10.1 Stationary Boundary State as Inertial Persistence

An anchored structure is said to exhibit inertial persistence when its boundary flux distribution remains stationary along its worldline,

$$\frac{\partial \Phi_n}{\partial \tau} = 0.$$

In this case, the dipole moment is constant,

$$\frac{d\mathbf{P}}{d\tau} = 0,$$

and the anchor maintains a steady structural configuration relative to the locally presented delivery environment.

This condition does not require isotropy of the boundary flux distribution. An anchor may sustain a steady anisotropic configuration provided it is fully compatible with the ambient scalar-modulated delivery conditions.

Accordingly, inertial persistence is identified with the existence of a steady admissible boundary state, rather than with the absence of anisotropy.

### 10.2 Boundary Evolution and Proper Acceleration

Proper acceleration arises when the boundary flux distribution evolves in time,

$$\frac{\partial \Phi_n}{\partial \tau} \neq 0.$$

Equivalently, this corresponds to a nonvanishing rate of change of the dipole moment,

$$\frac{d\mathbf{P}}{d\tau} \neq 0.$$

Such evolution occurs when the current boundary configuration is not fully adapted to the locally preferred distribution determined by the scalar field. The resulting structural adjustment drives redistribution of boundary flux, which manifests as acceleration of the anchor.

Thus, proper acceleration is identified not with the presence of a directional bias in the boundary state, but with the *ongoing adjustment* of that state.

### 10.3 Remarks on Free Fall and Coordinate Description

In a spatially varying scalar field, there exist trajectories along which an anchor can maintain a steady boundary configuration,

$$\frac{\partial \Phi_n}{\partial \tau} = 0,$$

despite the presence of anisotropy in the boundary flux distribution.

Such trajectories correspond to free response within the support sector. Along these paths, the boundary state remains fully adapted to the ambient scalar environment, and no proper acceleration is experienced,

$$\frac{d\mathbf{P}}{d\tau} = 0.$$

From an external coordinate description, these trajectories may appear as accelerated motion. However, in the present formulation, this motion is understood as inertial persistence in a non-uniform scalar environment, rather than as the result of an applied force.

This interpretation is consistent with the correspondence between free motion and geodesic trajectories in geometric descriptions [10], while maintaining the boundary-response formulation as fundamental.

### 10.4 Limits of the Present Identification

The identification of proper acceleration with the evolution of the boundary flux distribution is established here at the level of leading-order structural response.

Several aspects remain to be developed in subsequent work:

- The precise relationship between boundary evolution and worldline curvature beyond the weak-field regime.
- The role of higher-order boundary moments in strong scalar gradients.
- The connection between the present formulation and the detailed kinematic structure developed in the SR-series.
- The extension of the boundary-response framework to include exchange-sector dynamics.

Accordingly, the present section establishes the conceptual and structural basis for inertial persistence and proper acceleration within the support sector, while leaving full dynamical generalization to later development.

# 11 Sector Discipline and Exclusions

## 11.1 Why the Present Paper Remains Entirely in the Support Sector

The development presented in this work is confined entirely to the support sector of the scalar–conformal NUVO framework. All structures introduced, including the scalar field $\mathcal{A}$, the boundary flux distribution $\Phi_n$, and the response operator $\mathcal{R}$, pertain exclusively to the delivery and intake of structural capacity by anchored systems.

No assumptions are made regarding exchange-sector processes, including source–sink interactions, radiative transfer, or discrete exchange events. The scalar field is treated as a background structure governing capacity availability, and not as a dynamical field arising from exchange processes.

This restriction ensures that the derivation of gravitational response is grounded solely in support-sector principles and does not depend on additional sectoral assumptions.

## 11.2 No Open-Loop Exchange Dynamics in the Present Derivation

In particular, the present formulation excludes all open-loop exchange dynamics associated with charge, radiation, or interaction coherence.

The boundary flux distribution $\Phi_n$ represents intake of capacity from the underlying substrate and does not encode exchange of discrete quanta or interaction with external systems.

Accordingly:

- No photon exchange processes are invoked.
- No coherence conditions are imposed.
- No coupling to exchange-sector degrees of freedom is assumed.

All dynamical behavior arises from redistribution of boundary flux under scalar-modulated delivery conditions, without reference to exchange-sector mechanisms.

## 11.3 No Quantum Correspondence Assumed

The present work does not assume or invoke any correspondence with quantum mechanical structures.

In particular:

- No wavefunction or probabilistic interpretation is introduced.
- No quantization conditions are assumed.
- No reference is made to operator structures or Hilbert spaces.

While later developments in the NUVO program establish connections between boundary coherence and quantum phenomena, such considerations are entirely absent from the present derivation.

The results obtained here are therefore classical in character, arising purely from geometric and structural considerations within the support sector.

### 11.4 No Primitive Force Postulate Introduced

At no stage in the derivation is a primitive force law postulated.

The effective acceleration of an anchor emerges from the evolution of its boundary flux distribution under scalar-modulated delivery conditions.

In particular:

- No external force acting on the anchor is assumed.
- No potential function is introduced.
- No field-mediated force transmission is invoked.

The inverse-square form of gravitational acceleration arises as a consequence of the scalar field structure and the boundary response mechanism, rather than from an imposed force law.

Accordingly, gravity is interpreted as a structural response of anchored systems to spatial variation in capacity availability, rather than as a fundamental interaction mediated by forces.

## 12 Conclusion

### 12.1 What M7 Establishes

This work develops a structural formulation of gravitational response within the scalar–conformal NUVO framework based entirely on support-sector principles.

The central result is that the motion of an anchored structure in a spatially varying scalar field arises from the evolution of its boundary flux distribution. The invariant intake condition,

$$\int_{\partial S} \Phi_n \, dA = mc^2,$$

restricts all admissible dynamics to redistribution of boundary flux under locally presented delivery conditions.

The introduction of the boundary dipole moment

$$\mathbf{P} = \int_{\partial S} \Phi_n \hat{n} \, dA$$

provides a geometric measure of directional asymmetry in the boundary state. Proper acceleration is identified with the evolution of this quantity,

$$\mathbf{a} \propto \frac{d\mathbf{P}}{d\tau},$$

so that acceleration arises only when the boundary flux distribution is actively adjusting.

In the weak-field regime, the scalar structure

$$\mathcal{A}(r) = 1 + \frac{\ell_M}{r}$$

induces a boundary response that reproduces the observed inverse-square gravitational acceleration,

$$\mathbf{a} = -\frac{GM}{r^2}\hat{r},$$

upon identification of the characteristic scalar length

$$\ell_M = \frac{GM}{c^2}.$$

Thus, gravitational behavior is obtained without the introduction of a primitive force law, emerging instead as a structural consequence of capacity delivery and boundary response.

### 12.2 What Remains for Later M-Series Development

The present work establishes the leading-order response mechanism but does not provide a complete dynamical theory of scalar fields or boundary evolution.

Several essential developments remain:

- Derivation of the scalar field profile $\mathcal{A}(x)$ from capacity availability principles (M2) and delivery structure (M6.5).
- Determination of the response coefficients governing boundary evolution, including the relaxation scale $\kappa$.
- Extension of the boundary-response framework beyond the weak-field regime, including higher-order boundary moments and strong scalar gradients.
- Formal connection between boundary evolution and worldline geometry, including correspondence with geodesic motion.
- Integration with exchange-sector dynamics to account for interaction, radiation, and coherence phenomena.

These developments are deferred to subsequent M-series and Q-series papers.

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