The Informational Gradient and the Access to Meaning: A Structural Meta-Interpretation of Physical Geometry

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Abstract

The companion paper [1] demonstrated that the semiclassical system is not self-contained: the operation that selects the vacuum state is necessary and is not contained in the algebra of observables. The missing operation can only be pointed to from the propositional system; it cannot be demonstrated within it. The present paper draws the consequence of that result. If T does not close, physics cannot access meaning from within itself. However, it can recognize its own non-closure. That recognition is not a proposition; it is an act. When physics exercises it, it adopts a meta-interpretation, and the meta-interpretation consistent with the result of the companion paper is that of the informational gradient. The adoption of that meta-interpretation is what gives sense and meaning to physics, because it allows physics to integrate interpretively the missing operation (I) and the absolute coherence (A) that it cannot contain propositionally. The paper does not propose a new theory or a falsifiable conjecture; it proposes a structural reading. Its testable dimension resides in the established results it interprets.

I. THE NON-CLOSURE OF THE PROPOSITIONAL SYSTEM

I.1. The Result of the Companion Paper

In a companion paper [1] we have established the following result. The semiclassical Einstein equations

$$G_{\mu\nu}[g] = \frac{8\pi G}{c^4} \langle \mathrm{Vac}|\hat{T}_{\mu\nu}(\phi, g)|\mathrm{Vac}\rangle_{\mathrm{ren}} \tag{1}$$

require the selection of a vacuum state $|\mathrm{Vac}\rangle$ that is not determined by the geometry. The selection operation is necessary and is not contained in the algebra of observables. The propositional system formed by the Lorentzian manifold $(\mathcal{M}, g_{\mu\nu})$, the local algebra $\mathcal{O}$, and equations (1) is not self-contained.

In the language of the companion paper, the missing operation is denoted I; the domain of the absolute is denoted A; the domain of the manifest is denoted T. These denominations are maintained in the present paper for continuity with the companion paper. They are not terms of the present paper but of its predecessor; the reader who has not read the companion paper may read A as "the absolute that T cannot contain" and T as "the propositionally manifest."

The result of the companion paper can be formulated as follows: T **does not contain the**

operation that produces it. The operation I is external to T. It cannot be demonstrated within T; it can only be pointed to from T.

I.2. The Error of Trying to Close T from T

The diagnostic error identified in the companion paper is the following: physics, failing to recognize the non-closure of T, attempts to close T from within T. It seeks completeness in equations, closure in formalism, resolution of the frontier problems through more theory.

That attempt is structurally impossible. If I is not in T, no additional proposition in T can contain it. The search for closure in T is the epistemological interference diagnosed by the companion paper.

And yet, that search is what physics does. The frontier problems (singularities, measurement, information loss) are formulated as problems awaiting propositional resolution. Each attempt to resolve them produces a new formulation that carries the same structure: T is asked to contain its own operation of production.

I.3. The Question of the Present Paper

If T does not close, what can physics do? It cannot close T. It cannot contain I. It cannot access A propositionally.

But it can **recognize** its own non-closure. That recognition is not a proposition; it is an act. And when physics exercises it, it adopts a meta-interpretation.

The present paper asks: what is the meta-interpretation consistent with the result of the companion paper? The answer is the **informational gradient**. And the adoption of that meta-interpretation is what gives sense and meaning to physics, because it allows physics to **integrate interpretively** I and A—not propositionally, but interpretively.

II. THE CATEGORY ERROR: SYNTAX AND MEANING

II.1. The Distinction

Propositional physics operates on two levels that should be distinguished.

II.1.0.1. The syntactic level. This is the level of equations, tensors, metrics, well-formed propositions. It is the level of T. At this level, physics has achieved extraordinary precision: the equations of Einstein, Schrödinger, and Maxwell correctly predict phenomena in their domains of application.

II.1.0.2. The semantic level. This is the level of meaning, of what equations *say*, of what is *recognized* in them. It is the level to which T does not have access from within T.

The distinction between syntax and meaning is not new. It is the distinction that Gödel established between provability and truth, that Tarski established between syntax and semantics, and that the philosophy of language has explored in multiple forms. But in physics, the distinction tends to collapse: a syntactically correct theory is assumed to be semantically complete as well.

The companion paper showed that this assumption is false. Physics can have the correct syntax and still not access meaning, because meaning is not in T.

II.2. The Signature of the Limit

How does the limit of propositional formalization manifest? It manifests in the **infinities**.

The historical infinities of physics (the ultraviolet catastrophe, the singularities of general relativity, the divergences of quantum field theory) share a common structure. In each case:

1. A formal apparatus is successful in a regime.
2. The apparatus is extended to a limit outside the regime.
3. The extension produces an infinite result.
4. The interpretation of the result is controversial.

The **technical interpretation** (the traditional one) says: the infinity signals that the apparatus is incomplete; a more precise apparatus is needed. The **structural interpretation** (the one of the present paper) says: the infinity is the formal signature of the limit of the propositional apparatus. It is not a physical quantity to be calculated; it is the marker of an operation that the apparatus does not contain.

This distinction is that of the companion paper. The infinity is not a problem to be resolved within T; it is the signal that T has reached its frontier.

II.3. Why the Infinity Is Not Resolved with More T

Trying to resolve the infinity with more T (with a more precise formal apparatus) is the technical interpretation. It is legitimate as a **technical strategy**: Planck resolved the ultraviolet catastrophe, renormalization resolved the divergences of QFT, quantum gravity attempts to resolve the singularities.

But the technical interpretation does not exhaust the meaning of the infinity. There is something the technical interpretation cannot give: **access to meaning**. The technical interpretation says what to do with the infinity; it does not say what the infinity means.

And the structural interpretation, which is the one of the present paper, says what it means: the infinity is the signature of the non-closure of T. It is the point where T points toward what T does not contain.

III. RECOGNITION AND META-INTERPRETATION

III.1. The Act of Recognition

T cannot contain I. But T can **recognize** that I is not in T. That recognition is an act.

Recognition is not a proposition. It is not formulated as an equation. It is not demonstrated. When one attempts to formulate it propositionally, it becomes one more proposition of T, and then it loses what it had of recognition.

Recognition is the act by which T reads itself as the **manifestation** of something that T does not contain. It is not an access to A. It is the recognition that A is the provenance of T.

The companion paper already introduced this recognition but left it as the end of the diagnosis: physics, it said, needs to recognize that T does not contain the operation that produces it. The present paper takes the next step: what form does that recognition take when it is exercised?

III.2. The Meta-Interpretation

Recognition, when exercised, adopts a **meta-interpretation**. A meta-interpretation is not one more interpretation within T; it is the interpretation that T adopts about itself when it recognizes its provenance.

A meta-interpretation is an act, not a proposition. But it can be pointed to. And the meta-interpretation that the present paper points to is that of the **informational gradient**.

It is important not to confuse the meta-interpretation with a thesis about the world. The meta-interpretation does not say "reality is an informational gradient." It says: "T reads itself as the low-resolution limit of an informational gradient." The difference is the same as between saying "the world is such a thing" and saying "this is the reading that gives meaning to what the world says."

The meta-interpretation does not compete with the internal interpretations of T. It does not say that the equations of physics are false. It says that the equations of physics, read as the low-resolution limit of an informational gradient, **acquire meaning**. Without that reading, the equations remain correct, but they say nothing.

III.3. The Non-Demonstrability of the Meta-Interpretation

The meta-interpretation is not demonstrated. Attempting to demonstrate it would be the same error as attempting to demonstrate I from within T.

If one attempts to demonstrate the meta-interpretation, it becomes one more proposition of T. And then the same diagnosis of the companion paper can be applied to it: it does not close T, because T does not close.

The meta-interpretation is **recognized**, not demonstrated. And recognition is not an argument; it is an act. When the reader executes it, he sees. When he does not execute it, he does not see. And no propositional argument can force recognition, because recognition is not a proposition.

This does not mean that the meta-interpretation is arbitrary. It means that its justification is not propositional. The justification is: **it is the only reading consistent with the result of the companion paper**. If T does not close, and if T can recognize its non-closure, then the form that recognition takes is the informational gradient. Not because it is demonstrated, but because it is what remains when the attempt to close T from within T is abandoned.

It is legitimate to ask why the informational gradient and not another meta-interpretation. Other readings are possible in the abstract: idealism, eliminative materialism, dualism in any of its forms, panpsychism. The answer is not that the others are false, but that none of them satisfies the two conditions that the result of the companion paper imposes.

The first condition is **to preserve the established syntax**: the meta-interpretation must not modify the equations of physics. Meta-interpretations that deny or modify the equations (eliminative materialism, radical idealism) do not satisfy it. Dualism, in any of its forms, does not satisfy it either: it introduces a third entity in addition to A and T, and the structure of the companion paper admits only two domains and one operation between them.

The second condition is **to allow the recognition of provenance**: the meta-interpretation must integrate interpretively I and A, without claiming to contain them propositionally. Meta-interpretations that remain in T without pointing toward A (positivism, strict formalism) do not satisfy it.

The informational gradient is the only reading that satisfies both conditions. It preserves the syntax (it does not modify the equations) and allows recognition (it integrates I and A interpretively). Not because it is demonstrated, but because it is what remains when both conditions are required at once. The other meta-interpretations fail at least one of the two.

IV. THE INFORMATIONAL GRADIENT AS THE FORM OF RECOGNITION

IV.1. The Reading of the Gradient

The reading of the gradient says the following. Physical geometry—the metric $g_{\mu\nu}$ that appears in the Einstein equations—is the **low-resolution limit** of an underlying informational density.

In the terms of the companion paper: the metric is T. The informational density is the reading that T makes of itself when it recognizes its provenance. The metric emerges as the low-resolution limit of that density.

This is not a statement about the ultimate nature of reality. It is a statement about **how T is read**. The metric is read as the low-resolution limit of an informational gradient, just as a photograph is read as the average of light intensities over a region.

IV.2. The Direction of the Reading

The reading of the gradient has a direction: it goes from the informational density to the metric. It does not go from the metric to the density.

That is: the informational gradient is not **derived** from the geometry. The geometry is **read** as the low-resolution limit of the gradient. The direction is the same as in the companion paper: A produces T; T does not produce A. The informational density (which corresponds to A in the language of the companion paper) produces the metric (which corresponds to T); the metric does not produce the informational density.

That asymmetry is the same as in the companion paper. And it is the reason the meta-interpretation cannot be demonstrated: the demonstration would go in the opposite direction, from T to A, which is impossible.

IV.3. Where the Gradient Becomes Visible

The gradient is not demonstrated, but it becomes visible. It becomes visible in the places where physics has found, without knowing it, the structure of the gradient.

IV.3.0.1. In the relation between entanglement and geometry. In the holographic regime, the Ryu–Takayanagi formula [2] relates the entanglement entropy of a boundary region to the area of an extremal surface in the bulk. Van Raamsdonk [3] argued that the connectedness of the bulk is a consequence of the entanglement of the boundary. Maldacena and Susskind [4] proposed that entangled black holes are connected by Einstein–Rosen bridges. Cao, Carroll, and Michalakis [5] derived the linearized Einstein equations from the entanglement structure.

These results do not demonstrate the gradient. They show that the gradient becomes visible in the holographic regime: geometry is read as the low-resolution limit of the entanglement structure. It is not the only possible reading, but it is the reading that gives meaning to the formula.

IV.3.0.2. In the Unruh effect. The Rindler wedge [6–8] shows that the Minkowski vacuum, restricted to a wedge, is a KMS state with temperature $T_U = \hbar a/2\pi c k_B$. The apparent thermality is the result of the restriction to an inaccessible region. In the reading of the gradient, thermality is the effect of coarse-graining on the informational density: the information of the left wedge is not contained in the description of the right wedge, and that absence manifests as temperature.

IV.3.0.3. At the frontier of formalization. The infinities of physics are the point where T points toward what T does not contain. In the reading of the gradient, the infinity is the limit of the low-resolution description: when the informational density diverges locally, the effective metric ceases to be well defined. The singularity is not a rupture of reality but a rupture of the description.

These three points do not demonstrate the gradient. They show that the gradient becomes visible. And that visibility is what gives meaning to the reading.

V. WHERE THE GRADIENT BECOMES VISIBLE: THE THREE FRONTIER PROBLEMS

V.1. The Common Structure

The three frontier problems of physics (singularities, information loss, measurement) share a common structure. In each case:

- The problem arises when the low-resolution description is required to contain the operation that produces it.
- The operation (coarse-graining, or equivalently I) is not contained in the description.
- The requirement cannot be satisfied, and the problem is the formal signature of its impossibility.

That structure is the same as in the companion paper. The companion paper showed that T does not contain the operation that produces it. The present paper shows that the three frontier problems are manifestations of that non-containment.

V.2. Singularities

A singularity is the point where the informational density diverges locally. In the low-resolution description, the effective metric ceases to be well defined. The problem is not that reality is singular; it is that the low-resolution description reaches its limit.

The singularity theorems of Penrose and Hawking are read, in the meta-interpretation of the gradient, as statements about the low-resolution description, not about the underlying structure.

V.3. Information Loss

The apparent loss of information in black hole evaporation [9] is the effect of coarse-graining on the informational density. Information is not destroyed; it is simply not contained in the low-resolution description.

The Rindler wedge [8] illustrates the simplest case: the information of the left wedge is not contained in the description of the right wedge. Tracing over the left wedge and coarse-graining the informational density are two instances of the same structure: the operation that produces the description is not contained in the description.

V.4. Measurement

The measurement problem is reformulated as the transition between descriptions at different resolutions. At high resolution, the informational density exhibits superposition; at low resolution, the superposition has been averaged out. The transition is not a physical process; it is a change of resolution in the description.

The reading is compatible with the approaches based on decoherence [10] and consistent histories [11, 12], but identifies a level of description—the resolution—that the others do not explicitly thematize.

V.5. Unification

The three problems share the same structure: the impossible requirement that the description contain the operation that produces it. The meta-interpretation of the gradient does not resolve the problems (it cannot: the requirement cannot be satisfied); it **relocates** them as manifestations of the non-closure of T.

VI. CONSERVATION OF PRIOR SYNTAX

VI.1. The Meta-Interpretation Does Not Modify the Equations

The meta-interpretation of the gradient does not modify the equations of physics. The equations of Einstein, Schrödinger, and Maxwell remain the same. The numerical values of physical constants do not change. Verified predictions are not altered.

What changes is the **reading** of those equations. They are read as the low-resolution limit of an informational gradient. That reading does not modify them; it gives them meaning.

VI.2. What Is Preserved, What Is Reframed, What Is Not Claimed

Category	**Content**
Preserved	The equations and predictions of general relativity, quantum mechanics, and electromagnetism in all regimes where they have been tested.
Reframed	The interpretation of what those equations say. They are read as the low-resolution limit of an informational gradient.
Not claimed	A derivation of the equations from first principles. The meta-interpretation does not derive; it reads.

Table I. Status of prior syntax in the meta-interpretation of the gradient.

VI.3. Why Nothing Is Derived

The meta-interpretation does not derive the equations of physics because deriving them would be the same error as attempting to demonstrate I from within T. The derivation would go in the direction from T to A, which is impossible. The direction is from A to T: the informational density produces the metric; the metric does not produce the informational density.

That is why the meta-interpretation limits itself to **reading**. It reads the equations as the low-resolution limit of the gradient. And that reading is what gives access to meaning.

VII. EPISTEMOLOGICAL STATUS AND FALSIFIABILITY

VII.1. What the Paper Does Not Claim

The present paper does not propose a new physical theory. It does not propose a falsifiable conjecture in Popper's sense. It does not derive equations. It does not introduce postulates.

The paper proposes a **meta-interpretation** of the result of the companion paper. The meta-interpretation is not demonstrated; it is recognized. Its justification is not propositional but structural: it is the only reading consistent with the non-closure of T.

VII.2. The Testable Dimension

The empirically testable content of the paper resides in the established results that it interprets:

- The Ryu–Takayanagi formula has been verified in direct holographic computations.
- The entanglement-geometry relation has been verified in specific holographic configurations.
- The non-self-containedness of the semiclassical system is a known result.
- The KMS structure of the Rindler wedge is a known result.

The paper does not add empirical content to these results. It **reads** them. And the reading, when exercised, gives access to meaning.

VII.3. Response to the Popperian Objection

A foreseeable objection holds that, since the meta-interpretation is not falsifiable, the paper incurs a violation of the Popperian criterion. The objection confuses the meta-theoretical level with the theoretical level.

The meta-interpretation is not a theory within T. It is the reading that T adopts about itself when it recognizes its non-closure. Requiring the meta-interpretation to be falsifiable within T is equivalent to requiring the interpretation of a theorem to be a theorem within the system that the theorem describes.

The analogy with Gödel, if one wishes to invoke it, illustrates the distinction. The interpretation of Gödel's theorem is not a proof contained in Peano arithmetic. The interpretation of the meta-interpretation of the gradient is not a proposition contained in T.

VIII. CONCLUSION: THE ACCESS TO MEANING

The companion paper demonstrated that T does not close. The present paper has drawn the consequence: if T does not close, physics cannot access meaning from within itself.

But it can **recognize** its non-closure. That recognition is not a proposition; it is an act. When physics exercises it, it adopts the meta-interpretation of the informational gradient. And that meta-interpretation is what gives sense and meaning to physics, because it allows physics to **integrate interpretively** I and A—not propositionally, but interpretively.

The adoption of the gradient is not a postulate added to T. It is the reading that T makes of itself when it stops trying to close from within. It does not modify the equations. It derives nothing. It reads.

And that reading is the bridge between the diagnosis of the companion paper and the full deployment of the structure. The companion paper showed that T does not close. The present paper shows what form the recognition of that non-closure takes in the domain of physics. The full deployment of the structure—the operation I, the coherence A, the system T as manifestation—is the object of the Human Code.

The present paper is T. Its thesis is T. It cannot contain I. It can only point to it. And it points to it under the form of the informational gradient. The reader who executes the recognition will see; the one who does not, will not.

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