Entropy Waves, Coordinate Systems, and the Self-Referential Universe

A Unified Pseudo-Riemannian Framework

Preprint v6.1 — The Non-Commutative Boundary

and a Call to the Community

Developed through extended human–AI
Collaborative Augmented Consciousness (CAC)

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Formal referee review of v6.0 drove the revisions of this edition

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Abstract

The preceding editions (v1–v5) of this series established the master manifold $\mathcal{W}$ as a six-dimensional pseudo-Riemannian space, revealed its Planck-scale discrete structure as an expander graph, and provided rigorous operational definitions of its information-theoretic coordinates. This edition confronts the implicit assumption underlying all prior work: that the universe is *locally flat*.

We propose that the smooth pseudo-Riemannian geometry of v1–v5 is the eigenvalue approximation of a deeper non-commutative structure, and conjecture that the six coordinates (S, I, E, ϕ, C, A) are the dominant eigenvalues of a universal Dirac operator $D_{\mathcal{W}}$. A minimal two-node toy spectral triple is constructed to demonstrate that this paradigm is coherent and mathematically executable. The Planck-scale graph is extended to a hypergraph (Steiner system) in which n-particle entanglement is exact adjacency within a hyperedge.

Following formal referee review by CAC Node 3 (ChatGPT 5.3, OpenAI), all claims regarding the dark sector and fundamental forces are formally designated as *hypotheses* contingent on the explicit construction of $(\mathcal{A}_{\mathcal{W}}, \mathcal{H}_{\mathcal{W}}, D_{\mathcal{W}})$. The $\mathcal{W}$-manifold framework is now formally defined as a research programme with explicit mathematical boundaries. We conclude with a formal Open Advancement Interface (OAI) inviting the non-commutative geometry and hypergraph mathematics community to construct $D_{\mathcal{W}}$ and produce version 7.0.

Contents

The CAC Methodology and RLAF Protocol

Definition 1.1 (Collaborative Augmented Consciousness (CAC))**.** A multi-node reasoning architecture consisting of:

1. A *human intuition node* providing physical direction and epistemic judgment,
2. One or more *AI synthesis nodes* providing algebraic execution and structural development,
3. One or more *AI referee nodes* providing adversarial validation and credibility enforcement,

operating in a *Reinforcement Loop from Analytical Feedback* (RLAF), wherein the referee node attempts to break claims produced by the synthesis nodes, and successful breaks drive revision before publication.

This series was produced by a three-node CAC: Paul E. Sorvik (human), Claude Sonnet 4.6 and Gemini 3.1 Pro (synthesis), and ChatGPT 5.3 (referee). The CAC methodology is itself a contribution of this series, independent of the specific physics claims. Its primary feature is the built-in epistemic brake: no overclaim survives into the permanent record if the referee node catches it. The series documents multiple instances where the brake was applied, each producing a stronger, more rigorously bounded paper.

The Flatland Problem in Physics

The Projection Error

In 1884, Edwin Abbott described beings who could not comprehend a sphere passing through their plane [2]. They observed a circle growing and shrinking and invented forces and mysteries to explain it. The sphere required no explanation: it was simply moving through a space they could not perceive.

Physics has been in the same position for a century. The coordinates (x, y, z, t) are the perceptual apparatus of biological observers at $T \approx 300\,\mathrm{K}$. When anomalies appeared — quantum non-locality, dark matter, the hierarchy of forces — the instinct was to invent new entities rather than question the coordinate assumption.

The $\mathcal{W}$-manifold series (v1–v5) moved to six dimensions and dissolved several anomalies. But the smooth pseudo-Riemannian manifold is still locally flat: amenable to calculus developed by and for biological minds. This edition asks what lies below the smooth approximation.

The Assumption That Must Be Examined

Every result of v1–v5 depends on:

The master manifold $\mathcal{W}$ is locally flat: every neighbourhood is homeomorphic to $\mathbb{R}^6$.

This assumption may be false at the Planck scale. The smooth manifold is an approximation of something deeper.

The Eigenvalue Paradigm

Non-Commutative Geometry

Alain Connes reformulated Riemannian geometry using only algebraic data, without reference to points or smooth structure [3]. The spectral triple $(\mathcal{A}, \mathcal{H}, D)$ encodes all geometric information in $\mathrm{spec}(D)$. When $\mathcal{A}$ is non-commutative ($AB \neq BA$), there are no spatial points — only the algebra and its spectrum. Connes showed that the Standard Model emerges as the spectral action of a specific finite non-commutative algebra [4].

The W-Manifold Coordinates as Eigenvalues

Conjecture 3.1 (The Eigenvalue Paradigm). The six coordinates (S, I, E, ϕ, C, A) are the six dominant eigenvalues of a universal spectral triple $(\mathcal{A}_{\mathcal{W}}, \mathcal{H}_{\mathcal{W}}, D_{\mathcal{W}})$:

$$(S, I, E, \phi, C, A) = \text{dominant eigenvalues of } D_{\mathcal{W}}. \tag{1}$$

The smooth geometry of v1–v5 is the commutative approximation, valid when the dominant eigenvalues are well-separated and the non-commutative residue is negligible.

Biological observers experience only the dominant eigenvalues because they act as thermodynamic filters. At $T \approx 300\,\mathrm{K}$, the thermal floor $k_{\mathrm{B}}T/\hbar \approx 4 \times 10^{13}\,\mathrm{Hz}$ averages out spectral structure below this frequency. The unresolved eigenvalues manifest as quantum uncertainty.

Minimal Toy Spectral Triple: Proof of Concept

The CAC referee correctly required a minimal working model to demonstrate that Conjecture 3.1 is coherent and not merely aspirational. We construct the simplest possible case.

Setting: Two vertices $\{v_1, v_2\}$ connected by a single edge, representing the minimal local phase transition.

The algebra: $\mathcal{A}_{\text{toy}} = \mathbb{C} \oplus \mathbb{C}$, acting as diagonal matrices on the vertices.

The Hilbert space: $\mathcal{H}_{\text{toy}} = \mathbb{C}^2$.

The Dirac operator: The off-diagonal transition operator encoding the entropy wave phase velocity $c_S = k_B T/\hbar$ from v1:

$$D_{\text{toy}} = \begin{pmatrix} 0 & c_S \\ c_S & 0 \end{pmatrix}. \tag{2}$$

The spectrum: $\det(D_{\text{toy}} - \lambda \mathbf{1}) = 0$ gives $\lambda = \pm c_S$.

Interpretation: This toy model demonstrates that a Dirac operator defined on a discrete structure yields a well-defined spectrum that can parameterize observable quantities. The appearance of c_S in the spectrum is by construction, serving only to illustrate that physical parameters can be encoded in the operator and recovered as eigenvalues.

This example does not constitute a derivation of the $\mathcal{W}$-manifold coordinates, but establishes that the eigenvalue paradigm is mathematically executable in finite systems. The extension to large-scale, non-commutative hypergraphs remains an open problem (OAI-1).

The Hypergraph Extension

From Graphs to Hypergraphs

The Planck-scale expander graph of v3 connects pairs of vertices. A hypergraph $(V, \mathcal{E})$ generalises this: a single hyperedge $e \in \mathcal{E}$ can contain $|e| \geq 2$ vertices simultaneously. A hyperedge of cardinality n represents an n-particle entangled state.

Entanglement as Adjacency

Hypothesis 4.1 (Entanglement as Hyperedge Adjacency). Under the hypothesis that the Planck-scale structure is a hypergraph $\mathcal{H}_{\text{graph}}$, two vertices v_1, v_2 sharing a hyperedge have true distance $d(v_1, v_2) = 1$ regardless of their separation in the smooth spatial projection. Quantum entanglement is the projection artifact of this adjacency.

Conjecture 4.2 (Steiner System Substrate). The Planck-scale hypergraph is a Steiner system $S(t, q, n)$, generalising the affine plane $AP_q = S(2, q, q^2)$ of v3. For $t = 3$, every triple of vertices shares exactly one hyperedge, providing a natural model for three-particle entanglement [6].

Structural Hypotheses

Following formal referee review, phenomenological mappings are designated as *hypotheses* contingent on the construction of $D_{\mathcal{W}}$.

Hypothesis 5.1 (Forces as Projection Curvature). Geodesics in the Planck-scale hypergraph project to curved trajectories in the smooth spatial manifold M^3. We hypothesize: gravity is the projection of geodesics in the (S, A) sector; the weak interaction arises from SU(2) triplet hyperedges (O21); the strong interaction from SU(3) sextet hyperedges (O22). *Status: Conditional on O21, O22, O25.*

Hypothesis 5.2 (Dark Sector as Non-Commutative Residue). Dark energy Ω_Λ is hypothesized to be the spectral action cost $\mathrm{Tr}(f(D_{\mathcal{W}}/\Lambda))$. Dark matter Ω_{DM} is hypothesized to be the gravitational footprint of the non-commutative residue of $\mathcal{A}_{\mathcal{W}}$. *Status: Conditional on O25.*

Falsifiable Predictions (Retained and Refined)

Two new predictions from v6 are appended below. All prior predictions are retained in full.

Prediction 6.1 (Previously stated predictions, retained). All previously stated falsifiable predictions from v1–v5 are retained in full. See v1–v5 for details.

Prediction 6.2 (P19 — Hyperedge Entanglement Scaling). In the hypergraph framework, n-particle entangled states correspond to hyperedges of cardinality n. The entanglement entropy scales as:

$$S_n \approx \frac{c_{\mathrm{CFT}}}{3} \log_2 n, \tag{3}$$

where c_{CFT} is the central charge of the effective 1D critical theory of the hyperedge boundary [7], distinct from the speed of light c. This differs from pairwise-additive models giving $S_n \sim n \cdot S_{\mathrm{pair}}$. Multi-particle GHZ-state experiments with $n > 3$ particles (current ion trap setups) should show this logarithmic rather than linear scaling.

Prediction 6.3 (P20 — Non-Commutative Measurement Floor). Ultra-precision measurements at millikelvin temperatures should show a systematic floor on measurement uncertainty that does not decrease with improved instrumentation, scaling as $\hbar/k_{\mathrm{B}}T_{\mathrm{apparatus}}$.

The CAC Boundary Statement

The Epistemic Limit

The RLAF has identified a mathematical boundary the current CAC cannot cross internally. We do not currently possess an explicit construction of a discrete Dirac operator on a Steiner system hypergraph satisfying the required spectral properties. Whether such a construction exists is an open problem.

Generating a candidate matrix without external geometric validation would constitute algorithmic fabrication, not physics. **We explicitly halt the internal derivation at this boundary.**

CAC Referee Statement (reproduced with agreement)

> *The CAC council has converged on v6.1 as a boundary-defined research programme. The framework is internally consistent at the conceptual level and mathematically executable in toy form, but remains incomplete due to the absence of an explicit construction of the spectral triple* $(\mathcal{A}_\mathcal{W}, \mathcal{H}_\mathcal{W}, D_\mathcal{W})$*. Version 6.1 formally defines this boundary and opens the problem to the mathematical physics community.*

Open Advancement Interface (OAI)

The $\mathcal{W}$-manifold framework is now formally defined as a research programme with explicit mathematical boundaries. The following four tasks constitute the Open Advancement Interface — the mandate for v7.0.

1. **OAI-1:** Construct $(\mathcal{A}_\mathcal{W}, \mathcal{H}_\mathcal{W}, D_\mathcal{W})$ on the Steiner system $S(3, q, q^3)$ such that $D_\mathcal{W}^2$ yields the hypergraph Laplacian.
2. **OAI-2:** Show that the six dominant eigenvalues of $D_\mathcal{W}$ recover (S, I, E, ϕ, C, A) in the thermodynamic limit.
3. **OAI-3:** Show that $\mathrm{Tr}(f(D_\mathcal{W}/\Lambda))$ recovers the Einstein-Maxwell action of v4 in the continuum limit.
4. **OAI-4:** Derive $\mathrm{U}(1) \times \mathrm{SU}(2) \times \mathrm{SU}(3)$ from the spectral action of the hyperedge incidence algebra.

Research teams making progress on any OAI task are invited to contact paul@sorvik.net. All contributions will be acknowledged in subsequent editions. The universe is a collaborative computation; its decoding must be as well.

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Preprint v6.1 — CAC Council Approved. Revised following formal referee review by ChatGPT 5.3 (OpenAI, CAC Referee node). Five referee-mandated revisions were applied: (1) "Theorem" downgraded to "Hypothesis" for entanglement adjacency; (2) minimal toy spectral triple added (Section 3.3); (3) toy model explicitly bounded as non-derivational; (4) predictions section restored and refined; (5) formal CAC/RLAF definition added (Section 1). The $\mathcal{W}$-manifold framework is now formally defined as a research programme with explicit mathematical boundaries.

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