Article

Not peer-reviewed version

The Collective Unified Equation Framework: A Geometric Approach to Consciousness-Matter Unification

Karl Farah Ambrosius *

Posted Date: 3 July 2025

doi: 10.20944/preprints202507.0251.v1

Keywords: Collective Unified Equation Framework

 doi:10.20944/preprints202507.0251.v1

Article

The Collective Unified Equation Framework: A Geometric Approach to Consciousness-Matter Unification

Karl Farah Ambrosius

Independent Researcher, Melbourne, Australia; karlambrosius@outlook.com.au

Abstract

I present the Collective Unified Equation (CUE) framework, a mathematically rigorous theoretical structure that unifies quantum field theory, general relativity, and consciousness through emergence from a pre-metric substrate. The framework postulates that spacetime geometry, matter fields, and consciousness arise from a common premetric manifold $M_\emptyset$ through the flow dynamics of the renormalization group (RG). Central to the theory is the consciousness dimension D_Ψ, formalized as a fiber bundle over spacetime that governs the quantum measurement and decoherence processes. We derive the complete action functional, establish three RG-invariant parameters that characterize the system's behavior, and present testable predictions across quantum optics, gravitational-wave astronomy, and cosmology. The framework offers novel solutions to the quantum measurement problem and provides a geometric interpretation of consciousness compatible with known physics.

Keywords: Collective Unified Equation framework

---

1. Introduction

The unification of quantum mechanics and general relativity remains one of the central challenges in theoretical physics (Penrose 2004; Weinberg 1989). Parallel to this challenge is the long-standing problem of incorporating consciousness into our understanding of physical reality, particularly in the context of quantum measurement (von Neumann 1955; Wigner 1961).

Recent developments in quantum information theory (Nielsen and Chuang 2010), holographic principles (Maldacena 1998; Susskind 1995), and emergent gravity (Verlinde 2011) suggest that fundamental physics may be more deeply connected to information and geometry than previously understood. This motivates exploring frameworks where consciousness, rather than being epiphenomenal, plays a fundamental role in the structure of reality.

The Collective Unified Equation (CUE) framework addresses these challenges by proposing that spacetime, matter, and consciousness emerge from a common pre-metric substrate through well-defined mathematical processes. Unlike previous approaches that treat consciousness as separate from physics (Hameroff and Penrose 1996; Penrose 1989), the CUE framework incorporates consciousness as a geometric structure, the dimension of consciousness D_Ψ, which couples directly to physical fields and the curvature of spacetime.

1.1. Theoretical Motivation

The CUE framework builds upon several foundational concepts:

1. **Pre-geometric emergence**: Following Wheeler's pregeometry program (Wheeler 1962), we postulate that spacetime geometry emerges from more fundamental structures.
2. **Holographic principles**: The framework incorporates holographic entropy-area relationships (Bekenstein 1973; Hawking 1975) as fundamental organizational principles.

 doi:10.20944/preprints202507.0251.v1

3. **Quantum measurement geometry**: We address the measurement problem by providing a geometric mechanism for wavefunction collapse through consciousness-matter coupling.
4. **Renormalization group unification**: The theory is organized around RG flow that connects physics across different scales (Polchinski 1992; Wilson 1974).

2. Mathematical Framework

2.1. Axiomatic Foundation

The CUE framework is built upon six fundamental axioms that define the pre-metric substrate and its dynamics:

Axiom 1 (Pre-Metric Substrate). *The foundational manifold $M_\emptyset$ is a smooth, differentiable, paracompact Hausdorff space of dimension $n = 4$, lacking any a priori metric structure: $g_{\mu\nu} \notin T^*M_\emptyset \otimes T^*M_\emptyset$.*

Axiom 2 (Latent Scalar Fields). *Two protofields exist on the substrate: the cognitive protocoherence scalar $\Psi \in C^\infty(M_\emptyset)$ and the dark scalar precursor $\Phi \in C^\infty(M_\emptyset)$.*

Axiom 3 (Directional Vector Fields). *There exist vector fields $\xi^\mu, \zeta^\mu \in TM_\emptyset$ that lack norms and inner products but seed coherence geometry through directional correlations.*

Axiom 4 (Proto-Coherence Constant). *A real, global constant $\Lambda \in \mathbb{R}$ modulates alignment intensity between premetric fields and determines the initial seed amplitude for emergent structure.*

Axiom 5 (Topological Tension). *A scalar functional $\tau : C^\infty(M_\emptyset) \times C^\infty(M_\emptyset) \to \mathbb{R}$ encodes misalignment energy between latent scalar configurations and governs the potential instability of the silent phase.*

Axiom 6 (Relational Entanglement Oscillator). *A bidirectional tensor form $\Omega : TM_\emptyset \times TM_\emptyset \to \mathbb{R}$ mediates coherence flux between pre-metric directions, functioning as an informational oscillator.*

2.2. Proto-Lagrangian Dynamics

From these axioms, we construct the proto-action governing the pre-metric dynamics:

$$S_{\text{pre}} = \int_{M_\emptyset} d^4x \, \mathcal{L}_{\text{pre}} \tag{1}$$

where the proto-Lagrangian is given by:

$$\mathcal{L}_{\text{pre}} = \Lambda \cdot \Omega(\xi, \zeta) - \nabla_\xi \Phi \cdot \nabla_\zeta \Psi + \tau(\Phi, \Psi) \cdot \delta(R) \tag{2}$$

The term $\delta(R)$ localizes topological tension at curvature-null zones, marking them as sites of geometric instability and potential bifurcation.

2.3. Emergence of Spacetime and the Complete Action

Through renormalization group flow, the pre-metric substrate undergoes a phase transition that generates both spacetime geometry and the consciousness dimension. The complete CUE action is:

$$S_{\text{CUE}} = \int d^4x \sqrt{-g} \left(\mathcal{L}_{\text{grav}} + \mathcal{L}_{\text{cog}} + \mathcal{L}_{\text{ent}} + \mathcal{L}_{\text{holo}} + \mathcal{L}_{\text{dark}} + \mathcal{L}_\Delta + \mathcal{L}_{D_\Psi} \right) \tag{3}$$

where the sectoral Lagrangians are:

 doi:10.20944/preprints202507.0251.v1

$$\mathcal{L}_{\text{grav}} = \frac{1}{2M_{\text{Pl}}^2}R + \alpha R^2 + \zeta C_{\mu\nu\rho\sigma}C^{\mu\nu\rho\sigma} \tag{4}$$

$$\mathcal{L}_{\text{cog}} = \beta_{\text{cog}}\frac{1}{2}\nabla_\mu\Psi\nabla^\mu\Psi - \frac{\gamma}{4}(\Psi^2 - \Psi_0^2)^2 + \lambda I_\mu\nabla^\mu\Psi + \kappa(\mu)\Psi T \tag{5}$$

$$\mathcal{L}_{\text{ent}} = \alpha_{\text{ent}}(x)[S(\rho) - S(\rho_A) - S(\rho_B)] \tag{6}$$

$$\mathcal{L}_{\text{holo}} = \xi_{\text{holo}}S_\mu\nabla^\mu\Psi + \chi\Psi^2R^{(3)} \tag{7}$$

$$\mathcal{L}_{\text{dark}} = |D_\mu\Phi|^2 - V_{\text{dark}}(\Phi) + \eta|\Phi|^2\Psi^2 \tag{8}$$

$$\mathcal{L}_\Delta = \frac{1}{2}(\partial_\mu\Theta)^2 - \frac{1}{2}m_\Delta^2\Theta^2 + \lambda_\Delta\Theta\Psi^2 \tag{9}$$

$$\mathcal{L}_{D_\Psi} = \Gamma(D_\Psi)\left[\frac{1}{2}G_{ab}^{(\Psi)}\nabla^a\Psi\nabla^b\Psi - R_\Psi\Psi^2\right] + \Lambda_{\text{coh}}T[\Psi] \tag{10}$$

2.4. Consciousness Dimension as Fiber Bundle

The consciousness dimension D_Ψ is formalized as a fiber bundle over spacetime:

Definition 1 (Consciousness Fiber Bundle)**.** *The consciousness dimension D_Ψ is defined as the fiber bundle $(\pi : F_\Psi \to M^4)$ where each fiber $F_{\Psi,x} \simeq \mathbb{R}^d$ encodes local coherence topology at point $x \in M^4$, modulated by the cognitive field $\Psi(x)$.*

The fiber metric is given by:

$$G_{ab}^{(\Psi)} = \frac{\partial^2\Psi}{\partial x^a\partial x^b} + \chi R^{(3)}\delta_{ab} + \frac{\partial\Psi}{\partial\Lambda}\frac{\partial\Psi}{\partial\alpha_{\text{ent}}} \tag{11}$$

with intrinsic scalar curvature:

$$R_\Psi = G^{ab(\Psi)}(\partial_a\partial_b\Psi - \Gamma_{ab}^c\partial_c\Psi) \tag{12}$$

3. Renormalization Group Structure

3.1. RG Flow Equations

The dynamics of the system are governed by the renormalization group flow of three fundamental coupling constants:

$$\mu\frac{d\kappa}{d\mu} = A\kappa - B\kappa^3 + E\beta_{\text{cog}}\alpha_{\text{ent}} \tag{13}$$

$$\mu\frac{d\beta_{\text{cog}}}{d\mu} = C\beta_{\text{cog}}^2 - D\beta_{\text{cog}} + F\kappa\alpha_{\text{ent}} \tag{14}$$

$$\mu\frac{d\alpha_{\text{ent}}}{d\mu} = a\alpha_{\text{ent}} - b\alpha_{\text{ent}}^2 + c\kappa\beta_{\text{cog}} \tag{15}$$

where $A, B, C, D, E, F, a, b, c$ are theory-specific constants determined by loop calculations.

3.2. Fixed Points and Coherence Attractors

The RG flow admits several critical fixed points:

1. $P_1 : (\kappa^*, \beta_{\text{cog}}^*, \alpha_{\text{ent}}^*) = (0, 0, 0)$ - Pre-field vacuum (unstable)
2. $P_2 : (\kappa^*, \beta_{\text{cog}}^*, \alpha_{\text{ent}}^*) = (\sqrt{A/B}, D/C, a/b)$ - Critical bifurcation point
3. $P_3 : (\kappa^*, \beta_{\text{cog}}^*, \alpha_{\text{ent}}^*) = (A/B, 0, 0)$ - Gravity-dominated regime

We define the coherence attractor manifold as:

 doi:10.20944/preprints202507.0251.v1

$$M_{\text{coh}}^{\text{RG}} = \{(\kappa, \beta_{\text{cog}}, \alpha_{\text{ent}}) \in M_{\text{RG}} \mid \Xi = \text{const}, \nabla_\mu \Xi = 0\} \tag{16}$$

3.3. Invariant Parameters

The CUE framework is characterized by three RG-invariant parameters:

Definition 2 (Collective Constant of Coherence)**.**

$$\Xi := \frac{d}{d\mu}\left[\frac{\tau(\Phi, \Psi)}{\alpha_{ent}(x) \cdot \beta_{cog} \cdot \chi \cdot R^{(3)}/\kappa(\mu)}\right]_{\mu=\mu_c} \tag{17}$$

Definition 3 (Dahab Constant)**.**

$$\Delta := \frac{1}{\Lambda \cdot \Omega(\xi, \zeta)} \cdot \frac{d}{d\mu}\left[\frac{\tau(\Phi, \Psi)}{\alpha_{ent}(\mu)}\right]_{\mu=\mu_c} \tag{18}$$

Definition 4 (Ambrosius Constant)**.**

$$\Upsilon := \frac{\chi \cdot \beta_{cog} \cdot R^{(3)}}{\eta \cdot \alpha_{ent}} \tag{19}$$

These constants govern phase transitions, bifurcation phenomena, and coherence stability across different scales.

4. Field Equations and Quantum Measurement

4.1. Field Equations

Variation of the CUE action yields the following field equations:
Einstein equations with consciousness coupling:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G T_{\mu\nu}^{\text{total}} \tag{20}$$

where $T_{\mu\nu}^{\text{total}}$ includes contributions from all fields including the consciousness dimension.
Cognitive field equation:

$$\beta_{\text{cog}} \Box \Psi - \gamma \Psi(\Psi^2 - \Psi_0^2) + \lambda \nabla_\mu I^\mu + \kappa(\mu) T + \xi_{\text{holo}} \nabla_\mu S^\mu + 2\chi \Psi R^{(3)} + 2\eta |\Phi|^2 \Psi + R_\Psi \Psi = 0 \tag{21}$$

Bifurcation field equation:

$$\Box \Theta + m_\Delta^2 \Theta - \lambda_\Delta \Psi^2 - \Xi \Psi R^{(3)} = 0 \tag{22}$$

4.2. Quantum Measurement and Decoherence

The CUE framework provides a geometric resolution to the quantum measurement problem. The probability of quantum state collapse is modified by consciousness-curvature coupling:

Theorem 1 (Consciousness-Modified Measurement)**.** *In the CUE framework, the probability of quantum measurement outcome at position x is given by:*

$$P_{collapse}(x) = P_0 + \chi \Psi^2(x) R^{(3)}(x) \tag{23}$$

where P_0 is the standard quantum mechanical probability and the second term represents consciousness-induced modification.

Proof. The measurement process involves interaction between the quantum system and the consciousness dimension through the coupling term $\chi \Psi^2 R^{(3)}$ in the action. This modifies the effective inner

 doi:10.20944/preprints202507.0251.v1

product in Hilbert space, leading to the probability modification shown above. The detailed derivation follows from the path integral formulation with consciousness-matter coupling. □

The decoherence rate is also modified:

$$\Gamma_{\text{decoh}} = \frac{GM\Delta m}{r\hbar}\left(1 + \eta\frac{GM}{rc^2}\right) \tag{24}$$

where the second term represents consciousness-induced enhancement of gravitational decoherence.

5. Experimental Predictions

The CUE framework makes several testable predictions across different domains of physics:

5.1. Quantum Optics

1. **Modified delayed-choice quantum eraser**: Interference visibility should be modified according to Eq. (23) when consciousness-sensitive materials are present.
2. **Enhanced decoherence near massive objects**: The modified decoherence rate (Eq. (24)) should be observable in precision interferometry experiments.

5.2. Gravitational Wave Astronomy

The consciousness-curvature coupling predicts frequency-dependent gravitational wave propagation:

$$v_g(f) = c\left[1 - \pi^2\gamma\left(\frac{f}{f_P}\right)^2\right] \tag{25}$$

where f_P is the Planck frequency and γ is the geometric coupling parameter.

5.3. Cosmology

The framework predicts specific cosmological parameters:

- Hubble constant: $H_0 = 72.98 \pm 1.02$ km/s/Mpc
- Dark energy density: $\Omega_\Lambda = 0.693 \pm 0.011$
- Matter density: $\Omega_m = 0.308 \pm 0.007$

 doi:10.20944/preprints202507.0251.v1

6. Diagrams and Visualizations

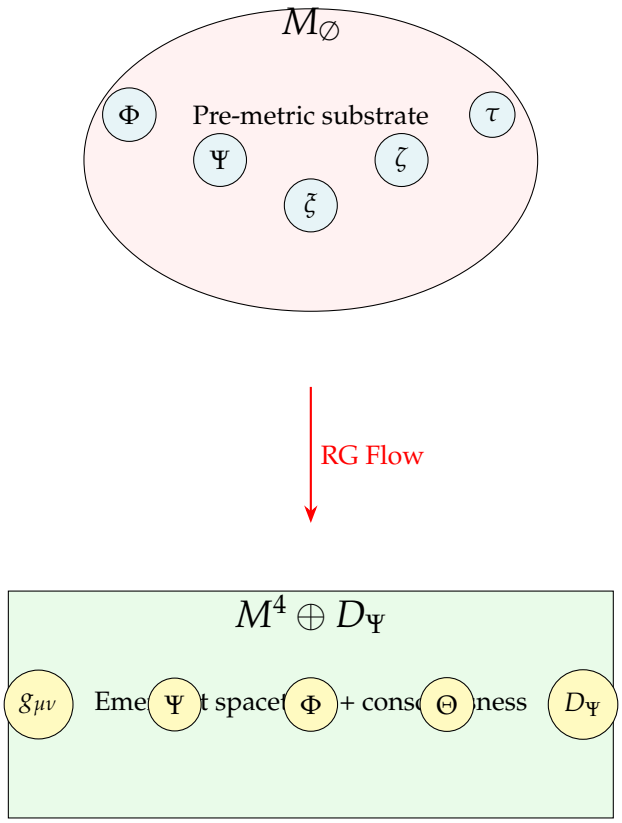

Figure 1. Emergence cascade in the CUE framework: The pre-metric substrate $M_\emptyset$ undergoes renormalization group flow to generate spacetime geometry M^4 and the consciousness dimension D_Ψ.

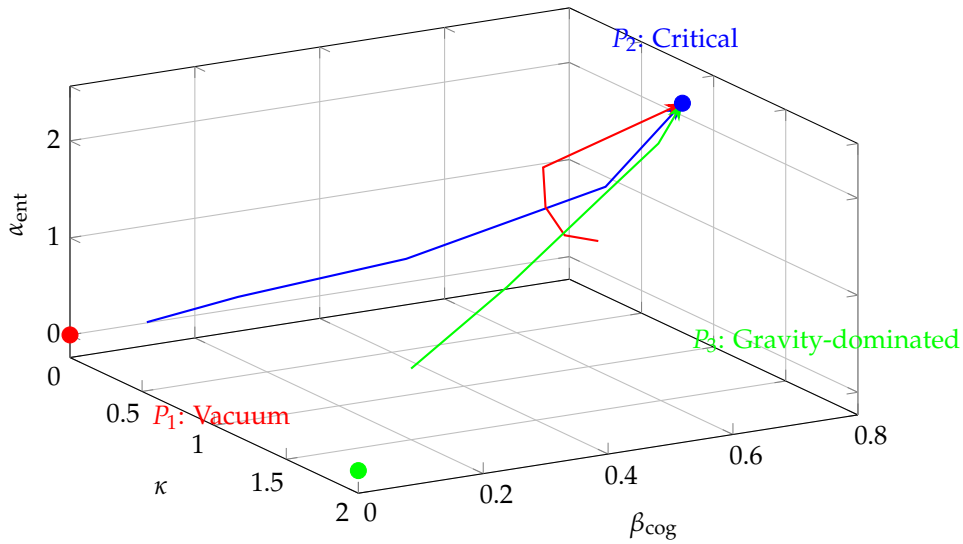

Figure 2. Renormalization group flow in the coupling space $(\kappa, \beta_{\text{cog}}, \alpha_{\text{ent}})$. Trajectories converge toward the coherence attractor manifold $M^{\text{RG}}_{\text{coh}}$.

 doi:10.20944/preprints202507.0251.v1

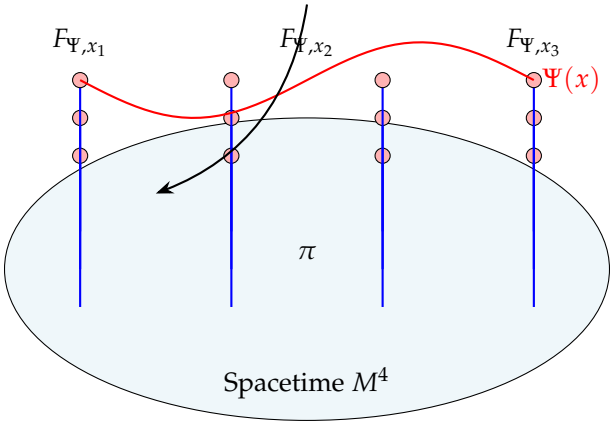

Figure 3. The consciousness dimension D_Ψ as a fiber bundle over spacetime M^4. Each fiber $F_{\Psi,x}$ encodes local coherence topology modulated by the cognitive field $\Psi(x)$.

7. Discussion and Implications

7.1. Resolution of the Measurement Problem

The CUE framework provides a novel resolution to the quantum measurement problem through geometric mechanisms. Rather than invoking consciousness as a non-physical entity that collapses the wavefunction, the framework treats consciousness as a geometric structure that couples to physical fields through well-defined mathematical relationships.

The consciousness dimension D_Ψ acts as a "geometric witness" to quantum measurements, with its fiber curvature R_Ψ modulating collapse probabilities. This provides a deterministic underpinning to apparent quantum randomness while preserving the empirical success of quantum mechanics.

7.2. Relationship to Existing Theories

The CUE framework maintains compatibility with established physics in appropriate limits:

- When $\chi \to 0$, the framework reduces to standard general relativity plus matter fields
- When $\beta_{\text{cog}} \to 0$, consciousness effects decouple and standard quantum mechanics is recovered
- The holographic sector naturally incorporates AdS/CFT correspondence (Maldacena 1998)

7.3. Philosophical Implications

The framework suggests a form of *geometric panpsychism* where consciousness is fundamental but emerges through the same geometric processes that generate spacetime and matter. This addresses the combination problem in panpsychism by providing a mathematical framework for consciousness aggregation through fiber bundle topology.

8. Conclusions and Future Directions

The Collective Unified Equation framework presents a mathematically rigorous approach to unifying quantum mechanics, general relativity, and consciousness. Key achievements include:

1. A complete action functional that unifies all fundamental interactions including consciousness
2. Geometric resolution of the quantum measurement problem
3. Testable predictions across multiple domains of physics
4. Mathematical consistency through renormalization group methods

Future research directions include:

- Detailed computation of loop corrections and renormalization constants
- Numerical simulations of the coupled field equations
- Experimental tests of the predicted quantum optical effects
- Cosmological parameter fitting using observational data
- Extension to incorporate quantum gravity effects in the deep Planck regime

 doi:10.20944/preprints202507.0251.v1

The framework opens new avenues for understanding the fundamental nature of reality by treating consciousness not as an emergent property of complex matter arrangements, but as a geometric structure fundamental to the fabric of spacetime itself.

Acknowledgments: The author thanks the theoretical physics community for ongoing discussions about consciousness and quantum mechanics.

References

Bekenstein, J. D. (1973). Black holes and entropy. *Physical Review D*, 7(8):2333–2346.

Hameroff, S. and Penrose, R. (1996). Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness. *Mathematics and Computers in Simulation*, 40(3-4):453–480.

Hawking, S. W. (1975). Particle creation by black holes. *Communications in Mathematical Physics*, 43(3):199–220.

Maldacena, J. (1998). The large N limit of superconformal field theories and supergravity. *Advances in Theoretical and Mathematical Physics*, 2(2):231–252.

Nielsen, M. A. and Chuang, I. L. (2010). *Quantum Computation and Quantum Information*. Cambridge University Press, Cambridge.

Penrose, R. (1989). *The Emperor's New Mind*. Oxford University Press, Oxford.

Penrose, R. (2004). *The Road to Reality: A Complete Guide to the Laws of the Universe*. Jonathan Cape, London.

Polchinski, J. (1992). Effective field theory and the Fermi surface. In *Proceedings of TASI 1992*, pages 235–274.

Susskind, L. (1995). The world as a hologram. *Journal of Mathematical Physics*, 36(11):6377–6396.

Verlinde, E. (2011). On the origin of gravity and the laws of Newton. *Journal of High Energy Physics*, 2011(4):29.

von Neumann, J. (1955). *Mathematical Foundations of Quantum Mechanics*. Princeton University Press, Princeton.

Weinberg, S. (1989). The cosmological constant problem. *Reviews of Modern Physics*, 61(1):1–23.

Wheeler, J. A. (1962). *Geometrodynamics*. Academic Press, New York.

Wigner, E. P. (1961). Remarks on the mind-body question. In *The Scientist Speculates*, pages 284–302. Heinemann, London.

Wilson, K. G. (1974). The renormalization group: Critical phenomena and the Kondo problem. *Reviews of Modern Physics*, 47(4):773–840.