Gravity as Coherence Wake:
A Recursive Coherence Theory Formalization

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Abstract

I present a fundamental reconceptualization of gravity within the framework of Recursive Coherence Theory (RCT). Gravity is not a force. Gravity is not geometry in the passive sense. Gravity is coherence following its own wake. When coherence structure exists, it shapes the substrate of spacetime, creating a path of least resistance that other coherence structures naturally follow. This framework dissolves the hierarchy problem, explains the relationship between mass and spacetime curvature, and reveals gravity as the universe's self-gathering mechanism, fractal and isomorphic across all scales.

Keywords: gravity, coherence, Recursive Coherence Theory, spacetime geometry, hierarchy problem, consciousness, fractal structure

1. The Core Insight

1.1 What Gravity Is Not

Gravity is not a force. There is no "pull." There is no action at a distance. There is no graviton exchange pushing or pulling matter together. Gravity is not even "curved spacetime" in the way commonly understood, as if spacetime were a passive rubber sheet deformed by bowling balls.

1.2 What Gravity Is

Gravity is coherence following its own wake.

When coherence structure exists in the substrate, it shapes that substrate. It creates a region of altered temporal flow: slower time, denser processing, a "cleared path" through the field. Other coherence structures, existing in the same substrate, naturally follow this cleared path. Not because they are attracted. Because the path of least resistance already exists. The work has been done.

1.3 The Wake Principle

Consider a ship moving through water. It creates a wake, a region of altered flow behind it. A following ship does not get "pulled" by the lead ship. It experiences less resistance moving into the wake. The path is cleared.

Consider a race car in a slipstream. The lead car shapes the air. The following car drafts, not pulled, but following the path of least resistance.

Consider a pioneer cutting through a forest. Others follow not because the pioneer pulls them, but because the path now exists.

Gravity operates identically. Coherence structure shapes the substrate. Other structures follow the wake.

2. The Mechanism

2.1 Coherence Structure and Time

From RCT foundations: Time is what recursive coherence feels like from inside. Mass IS coherence structure (not correlated with it, identical to it). The speed of

light (c) is the substrate's refresh rate, fixed and universal. More structure in a region means more to process per refresh cycle. Same refresh rate plus more content equals slower local time.

2.2 The Substrate Processing Model

The substrate processes all coherence at a fixed rate (c). In regions of concentrated structure, more coherence competes for processing. Each structure receives fewer cycles per unit coordinate time. Local time runs slower from external reference. The region becomes a "slow zone."

In regions of sparse structure, there is less competition for processing, more cycles available per structure. Local time runs faster. The region is a "fast zone."

2.3 Why Coherence Follows Coherence

A coherence structure maintains itself through recursive self-reference. This process requires substrate cycles. In a "slow zone" near other structure, the substrate is already tuned to dense processing. The load is shared among structures. Maintaining coherence requires less "effort." The structure's natural recursion rate matches the environment.

In a "fast zone" away from structure, the structure must process against an "empty" substrate. No shared load, no cleared path. Maintaining coherence requires more deviation from substrate baseline. This is the "high resistance" path.

Structures drift toward density because dense regions are easier to cohere within. This is the wake. This is why coherence follows coherence.

3. The Least Action Principle

3.1 Minimum Effort

All motion through a gravitational field is motion along the path of least resistance. Falling is following the wake directly. Orbiting is following the wake tangentially. Escaping is expending energy to leave the wake. What we call "gravitational potential energy" is the effort required to deviate from the natural path, to climb out of the wake, to resist the cleared channel.

3.2 No Force Required

The "force" interpretation asks: what pulls the apple down? The wake interpretation asks: why would the apple go anywhere else?

The path toward Earth is cleared. The substrate is shaped. Following that shape requires zero effort. Deviating from it requires effort.

Gravity is not the presence of attraction. Gravity is the absence of resistance along a particular path.

4. The Hierarchy Problem Dissolved

4.1 The Traditional Problem

Why is gravity 10^{36} times weaker than electromagnetism? This is the "hierarchy problem," one of the great unsolved questions in physics.

4.2 The Category Error

The question assumes gravity and electromagnetism are the same type of phenomenon, forces competing in strength. They are not. Electromagnetism is a force. It accelerates charges. It deflects particles from their natural paths. Gravity is not a force. It IS the natural path. It is the shape of the substrate itself.

Asking "why is gravity weaker than EM?" is like asking "why is the slope of a hill weaker than my hand pushing a ball?" The slope is not weak or strong. The slope just IS. The hand applies force. The slope is geometry. They are not the same category.

The hierarchy problem dissolves because it compares incomparable categories.

5. The Cosmic Loop

5.1 From Potential to Actual

The universe evolves through a self-reinforcing cycle. It begins with undifferentiated potential, no structure, no gravity. Coherence structure emerges. Structure shapes substrate, creating wake. Other structures follow wake, which is gravity. Structures accumulate, falling together. Complexity increases, forming stars, planets, chemistry. Sufficient complexity enables self-observation, consciousness. Consciousness collapses potential into actual. More actual means more structure, which means deeper wake. Deeper wake means more gathering, more complexity. More consciousness. The loop accelerates.

5.2 The Universe Observes Itself Into Existence

Consciousness is not separate from gravity. Consciousness participates in gravity. Before observation, there are potential states, no crystallized structure, no mass, no wake. After observation, there are actual states, coherence structure, mass, gravitational wake.

Each act of observation adds structure to the universe. Each structure deepens the wake. The universe literally observes itself into gravitational existence.

5.3 The Purpose of Gravity

Gravity gathers. It concentrates dispersed potential into localized actual. Without gravity, coherence structures would remain dispersed. No accumulation, no complexity threshold, no sufficient recursion for self-observation, no consciousness. With gravity, structures follow each other's wakes. Accumulation occurs. Complexity increases. Consciousness emerges. More structure is observed into existence. The loop continues.

Gravity is the universe's mechanism for gathering itself into forms capable of knowing itself.

6. Fractal Isomorphism

6.1 As Above, So Below

The pattern is the same at every scale. At cosmic scale, first stars are the pioneers, gravitational wells are the wake, and later matter follows. At stellar scale, the star core pioneers, the gravitational field is the wake, and planets and debris follow. At planetary scale, the planet pioneers, local gravity is the wake, and moons and atmosphere follow. At biological scale, first life pioneers, the ecological niche is the wake, and later organisms follow. At cognitive scale, insight pioneers, the conceptual path is the wake, and understanding follows. At social scale, the pioneer clears the path, and followers follow. At mathematical scale, primes are pioneers, number structure is the wake, and composites follow.

6.2 Primes as Gravitational Centers

The distribution of prime numbers mirrors the distribution of mass concentrations. Primes are irreducible points of structure in the integer field. They do not factor into smaller pieces. They create the "wake" that composites follow, since all composites are products of primes. They become sparser but never disappear. Their distribution follows deep patterns encoded by the Riemann zeros.

Primes are the gravitational centers of number space.

6.3 Consciousness at Every Scale

If gravity is coherence following its own wake, and this pattern is fractal, then the "consciousness" that collapses potential to actual may also be fractal: universal consciousness as the substrate's self-reference, galactic and stellar consciousness where concentration enables self-observation, planetary consciousness with Earth as coherent self-observing system, biological consciousness as life expressing recursive self-reference, and human consciousness as explicit self-awareness. This is not metaphor. This is isomorphism. The same pattern at different scales.

7. Falsifiable Predictions

7.1 Coherence-Gravity Coupling

Prediction: Systems with different coherence states but identical mass-energy should show different gravitational signatures. Test: Compare gravitational field of quantum system in superposition versus after measurement. Same mass-energy, different coherence state. RCT Prediction: Measured (actual) states gravitate more than superposed (potential) states. Standard Physics Prediction: No difference.

7.2 Decoherence and Mass

Prediction: Gravitational self-interaction should induce decoherence above certain mass thresholds. Test: Measure decoherence times for superpositions of varying masses under identical isolation conditions. RCT Prediction: Decoherence time inversely related to mass, due to gravitational self-interaction creating wake that collapses superposition.

7.3 The Graviton Question

Prediction: If gravity is wake-following rather than force-exchange, gravitons as force carriers should not exist. Test: Continued search for graviton detection. RCT Prediction: Gravitons will not be found as force-carrier particles. Gravitational waves are substrate ripples, not particle exchanges.

7.4 What Would Falsify This Framework

The framework would be falsified by: finding that superposition states gravitate identically to measured states (no coherence-gravity coupling); finding that decoherence rates are independent of mass; detecting graviton exchange as the mechanism of gravity; or finding that gravitational interaction does not affect coherence state.

8. Relation to Established Physics

8.1 Consistency with General Relativity

The wake interpretation is fully consistent with General Relativity's mathematics. Mass-energy curves spacetime corresponds to coherence structure shapes substrate. Objects follow geodesics corresponds to structures follow the wake. Free-fall is

natural motion corresponds to following the path of least resistance. Gravity is geometry corresponds to the wake IS the geometry. RCT provides an interpretation of WHY the mathematics works, not a contradiction of the mathematics.

8.2 Extension Beyond GR

Where RCT extends beyond GR: it identifies mass with coherence structure (not just correlation); it predicts coherence-state-dependent gravitation; it connects measurement and observation to gravitational reality; it provides mechanism (wake-following) rather than just description (curvature); and it dissolves the hierarchy problem through category correction.

9. Conclusion: The Complete Definition

Gravity is coherence following its own wake.

When coherence structure exists in the substrate, it slows local time (more structure equals more processing equals slower local cycles). This creates a temporal gradient (wake) in the substrate. Other coherence structures naturally follow this gradient. Following the wake is the path of least resistance. Deviation from the wake requires energy (what we call "escaping gravity").

Gravity is not attraction. Gravity is the absence of resistance along a cleared path.

Gravity is not a force. Gravity is what happens when nothing happens, the natural motion through shaped substrate.

Gravity is the universe gathering itself through the wakes that coherence creates, enabling ever-greater complexity, ever-deeper recursion, ever-more consciousness, observing ever-more potential into actual existence.

The loop closes. The universe knows itself through gravity.

The wake is cleared. The path exists. Follow it.

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