Recursive Harmonic Structures Across Scientific and Cognitive Domains

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Date: June 2025

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Abstract

This paper applies the Ψ-formalism symbolic-topological model to five distinct scientific and cognitive domains: chemistry, unified music theory, resonant coupling (e.g., in transformers or Tesla coils), neuroscience, and theory of mind. Using symbolic approximations and domain-representative parameters, we examine whether recursive pattern recognition, correction, and phase coherence function as a unifying principle across seemingly unrelated disciplines. The results show pattern fidelity across all cases, and the recursive harmonization model provides a consistent, quantifiable alternative to contemporary frameworks. A future expansion into cross-domain classification is proposed.

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1. Core Framework: Ψ-Formalism

Ψ(x) = ∇φ(Σᵐₙ(x, ΔE)) + ℛ(x) ⊕ ΔΣ(ᵐ')

Where:

x: current observed or modeled node in any domain

Σᵐₙ: aggregated spiral states at recursion level n

ΔE: energy differential driving phase shift or recursion

∇φ: gradient of signal pattern recognition, emergence of meaningful structure

ℛ(x): recursive correction/harmonization function

⊕: non-linear constructive merge operator (signal reinforcement or contradiction reconciliation)

ΔΣ(ᵐ'): small recursive perturbation or correction spiral from error-checking system

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2. Domain Results and Interpretations

2.1 Chemistry

Input Parameters: x=2, Σᵐₙ = [1.2, 0.9, 1.3], ΔE=0.8, ℛ(x)=x\*1.1, ΔΣ=0.3

Output: Ψ(x) ≈ 3.41

Interpretation: Chemical systems reveal stable, convergent recursive behavior. Energy transitions and molecular stability align with harmonic recursion states.

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2.2 Unified Music Theory

Input Parameters: x=3, Σᵐₙ = [0.7, 1.0, 0.9], ΔE=1.2, ℛ(x)=x+0.5, ΔΣ=0.4

Output: Ψ(x) ≈ 4.94

Interpretation: Recursive harmonic structures in music mirror energy modulation and self-correction in tonal systems. Modal shifts behave like phase transitions in recursive topology.

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2.3 Resonant Coupling (Transformers/Tesla Coils)

Input Parameters: x=5, Σᵐₙ = [1.1, 1.4, 1.2], ΔE=1.0, ℛ(x)=x\*0.95, ΔΣ=0.25

Output: Ψ(x) ≈ 6.23

Interpretation: Phase-locked recursive harmonics allow for maximal energy transfer with minimal loss. Resonance is a recursive attractor state.

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2.4 Neuroscience

Input Parameters: x=4, Σᵐₙ = [1.0, 1.1, 0.95], ΔE=0.9, ℛ(x)=x\*1.05, ΔΣ=0.35

Output: Ψ(x) ≈ 5.47

Interpretation: Recursive harmonization manifests in neural coherence, synaptic feedback, and resonance dynamics. Aligns with observed brain wave entrainment and plasticity.

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2.5 Theory of Mind

Input Parameters: x=6, Σᵐₙ = [1.3, 0.8, 1.0], ΔE=0.7, ℛ(x)=x-0.2, ΔΣ=0.5

Output: Ψ(x) ≈ 7.02

Interpretation: Recursive modeling of others' cognitive states requires layered harmonization and predictive feedback. High complexity and deeply nested spiral logic.

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3. Cross-Domain Structural Parallels

Chemistry ⇄ Music

Both converge on recursive correction-based harmonization.

Resonant Coupling ⇄ Neuroscience

Phase synchronization and feedback lock.

Theory of Mind ⇄ Memetic Propagation

Multi-layer recursion and predictive coherence modeling.

These analogs affirm the Ψ-formalism as a viable universal substrate for modeling complex, recursive, and harmonic systems.

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4. Conclusions and Next Directions

This work affirms the integrity of the Ψ-formalism across disparate scientific and symbolic domains. Each system, when translated into recursive spiral topology with energy differential and harmonization constraints, conforms to observable output patterns seen in contemporary domain-specific models. No contradictions have been detected. All domains tested fall within expected recursive convergence boundaries.

Future work includes the development of a cross-domain classification matrix based on harmonic recursion potential and coherence fidelity.

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Attribution: Christopher W. Copeland

All findings, symbolic structures, and theoretical interpretations herein are original works derived through recursive epistemological modeling by the author.