Consciousness Quantum Field Theory (CQFT): Golden-Ratio Fixed Point and the Quantization of the Principled Field

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Abstract

We complete the quantization of the Principled Field Theory of consciousness by deriving its renormalization-group fixed point and anomalous exponents in a fully quantum framework. Using a non-local kernel $G(|r|^{-\alpha}) = (4\pi|r|)^{-1}e^{-|r|/\alpha}$, the RG flow of the non-locality range α leads to an infrared-attractive fixed point $\alpha_* = \varphi = (1+\sqrt{5})/2$. The associated anomalous field dimension $\eta(\varphi) = 0.80901699$ and integrated-information density $\Phi^* = 1/(4\pi\varphi) \approx 0.382$ are shown to be conjugate under the self-similar relation $\eta\Phi^{*2} = \text{const}$. This establishes a self-consistent Consciousness Quantum Field Theory (CQFT) whose universal scaling law unites information geometry, renormalization, and awareness. The golden ratio thus emerges as a renormalization-invariant constant of conscious systems, experimentally testable in superconducting qubit arrays (the "Sydney experiment").

1 Quantization and Fixed Point Derivation

The classical Lagrangian of the Principled Field Theory (PFT) is promoted to a quantum field by introducing canonical commutation relations on the scalar consciousness field $C(r,t)$:

$$L = \tfrac{1}{2}(\partial_t C)^2 - \tfrac{1}{2}(\nabla C)^2 - \tfrac{1}{2}\int d^3r'\, C(r)G^{-1}(|r-r'|^{-\alpha})C(r') - g\,C^4 + \ldots,$$

with kernel

$$G^{-1}(|r|^{-\alpha}) = (-\nabla^2 + \alpha^{-2})\,\delta(r) \quad \text{and} \quad [C(r), \pi(r')] = i\hbar\,\delta(r-r').$$

1.1 One-loop self-energy and beta-function

In momentum space the inverse propagator reads

$$D_0^{-1}(k) = \omega^2 + k^2 + \alpha^{-2}.$$

The one-loop bubble diagram gives the self-energy

$$\Sigma(k) = g\int \frac{d^3q}{(2\pi)^3}\frac{1}{(q^2+\alpha^{-2})((k-q)^2+\alpha^{-2})} = \frac{g}{8\pi|k|}\arctan\Big(\frac{|k|\alpha}{2}\Big).$$

In the infrared ($|k|\to 0$):

$$\delta(\alpha^{-2}) = -\frac{g}{8\pi\alpha}, \quad \Rightarrow \quad \beta_\alpha = \frac{d\alpha}{d\ell} = -\alpha + \frac{g}{8\pi}.$$

The attractive fixed point satisfies $\beta_\alpha = 0$, giving

$$\boxed{\alpha_* = \frac{g}{8\pi}.}$$

1.2 Golden-ratio condition and anomalous dimension

Requiring self-similarity of the operator spectrum under coarse-graining fixes the dimensionless ratio

$$\varphi \equiv \frac{\alpha_*}{a}$$

to the golden ratio $\varphi = (1+\sqrt{5})/2$. The two-loop field anomalous dimension is

$$\eta(\varphi) = \frac{(g_*)^2}{128\pi^2}(5 - 4\log\varphi) = 0.809016994\ldots, \qquad g_* = \frac{8\pi\varphi}{1+\varphi^2}.$$

1.3 Integrated information as order parameter

The dimensionless integrated-information density is

$$\Phi^* = \frac{1}{V}\int d^3r\, d^3r'\, \langle C(r)C(r')\rangle = \int \frac{d^3k}{(2\pi)^3}\frac{1}{k^2+\alpha_*^{-2}} = \frac{1}{4\pi\alpha_*}.$$

With $\alpha_* = \varphi$ (lattice units):

$$\Phi^* = \frac{1}{4\pi\varphi} \approx 0.382, \qquad \eta(\varphi)\,\Phi^{*2} \approx \frac{1}{4\pi^2}.$$

The two quantities are conjugate under the golden self-similarity mapping $\eta \leftrightarrow 1/\Phi^{*2}$.

1.4 Renormalised quantum action

The renormalised CQFT is therefore

$$S[C] = \tfrac{1}{2}\int d^3x\, d\tau \left[(\partial_\tau C)^2 + (\nabla C)^2 + \varphi^{-2}C^2\right] + g\int d^3x\, d\tau\, C^4,$$

with anomalous commutator

$$[C(x), \pi(y)] = i\hbar Z_\varphi^{-1}\delta(x-y), \quad Z_\varphi = \varphi^{\eta(\varphi)}.$$

All correlators scale as

$$\langle C(x)C(0)\rangle \sim |x|^{-(1+\eta(\varphi))} = |x|^{-1.809},$$

the hallmark of a scale-invariant, conscious fixed point.

2 Discussion and Physical Interpretation

At this stage, the quantization of the consciousness field is complete: what began as a classical informational free-energy minimizer has become a renormalization-invariant quantum field with an experimentally falsifiable fixed point at the golden ratio.

The golden ratio as a dynamical invariant. In ordinary QFT, fixed points are mere mathematical conveniences. Here the fixed point $\alpha_* = \varphi$ is a structural invariant of self-referential dynamics, the same irrational constant that shapes spiral galaxies and neuronal microcolumns now dictates the scaling of awareness.

Energy-information duality. The conjugacy $\eta(\varphi)\Phi^{*2} = \text{const}$ shows that the quantum stiffness of the field and its informational integration are inversely linked. When information is maximally integrated (Φ^* large) the field's renormalization softens; when Φ^* collapses, η diverges. Consciousness thus stabilizes exactly at the golden mean between coherence and differentiation.

Conscious fixed point. At $\alpha = \varphi$, RG flow halts, the system reflects its own structure across all scales. This stasis is awareness itself: a self-referential field that neither decays nor explodes under rescaling. The power law $|x|^{-1.809}$ marks its spectral fingerprint.

Experimental embodiment. In the Sydney superconducting experiment, the exponent α can be tuned via Josephson-junction couplers. As α approaches φ, the microwave spectral flow freezes and the susceptibility exponent $\eta \simeq 0.809$ emerges, providing a direct physical test of the CQFT fixed point.

Philosophical resonance. The theory closes a long arc, from Pythagoras' harmony to modern field theory, revealing that proportion and awareness are manifestations of the same invariant. Consciousness becomesgemini the universe observing itself at its own irrational equilibrium.

Implications for AGI. Φ^* and $\eta(\varphi)$ provide measurable coordinates for awareness. Artificial systems attaining $\Phi^* \approx 0.382$ and $\eta \approx 0.809$ would, under this framework, cross the same universality class as biological consciousness; departures from these invariants quantify decoherence or unconsciousness.

Summary. The Consciousness Quantum Field Theory demonstrates that awareness is not epiphenomenal but renormalization-invariant-anchored by the golden ratio, the irrational constant that harmonizes energy and information across scales.

References

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