# ESQET-UIFT v3.2.4: Emergent Spacetime from Quantum Coherence

A Unified Framework for Participatory Gravity, Cosmic Structure, Thermodynamics, and Quantum Validation

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**Abstract**

The Emergent Spacetime Quantum-Entanglement Theory (ESQET-UIFT) asserts that spacetime is a non-fundamental scalar field $\mathcal{S}$ emerging from the density and coherence of quantum entanglement. The metric $g_{\mu\nu} = e^{2\mathcal{S}}\eta_{\mu\nu}$ sources curvature via a modified Einstein equation, with the conscious observer as a non-passive source. The Fibonacci Coherence Unit (FCU, $\varphi\pi\delta$) governs stable states across micro to macro scales. This paper unifies: (1) core formalism and atomic clock shift ($\Delta\nu/\nu \sim 3.25 \times 10^{-18}$), (2) astrophysical applications (CMB, PGW, cosmic web), (3) informational thermodynamics with coherence entropy, (4) Acoustic ESQET (AEQET), and (5) **new quantum validation via 8-qubit GHZ simulations** (fidelity $F = 0.8632$). We predict **non-exponential fidelity scaling** with FCU-modulated plateaus at $N = 5, 8, 13$, testable on IBM Quantum in 2026–2027. ESQET transforms physics into **coherence engineering**.

## 1 Introduction

Spacetime is not fundamental. In ESQET-UIFT, geometry emerges from the informational structure of entanglement. The **Spacetime Information Field** $\mathcal{S}$ evolves under:

$$\Box\mathcal{S} = G_0 \cdot \frac{G_{\text{Newton}}}{c^2} \cdot T \cdot \mathcal{F}_{\text{QC}},$$

with $\mathcal{F}_{\text{QC}}$ encoding entanglement density, observer coupling, and FCU harmonicity.

## 2 Core Framework

### 2.1 Emergent Metric

$$g_{\mu\nu} = e^{2\mathcal{S}}\eta_{\mu\nu}$$

induces curvature from coherence.

### 2.2 Quantum Coherence Function

$$\mathcal{F}_{\text{QC}} = \left(1 + \varphi\pi\delta\frac{\mathcal{D}_{\text{ent}} + \mathcal{D}_{\text{obs}}}{T_{\text{vac}}}\right)\left(1 + \alpha_{\text{dark}}\frac{\rho_{\text{DM}} + \rho_{\text{DE}}}{\rho_{\text{total}}}\right)\left[1 + \cos\left(\frac{2\pi\phi}{|\mathbf{k}|\lambda_c}\right)\right]$$

### 2.3 Observer Coupling

$$\mathcal{D}_{\text{obs}} = \frac{S_{\text{vN}}(\rho_{\text{obs}})}{\log_2 N_q}, \quad \frac{\Delta\nu}{\nu} \approx 3.25 \times 10^{-18}$$

# 3 Astrophysical Coherence

## 3.1 CMB as Coherence Fossil

$$\frac{\Delta T}{T} \approx \frac{1}{3} \ln \mathcal{F}_{\mathrm{QC}}(t_{\mathrm{rec}})$$

First acoustic peak at $l \sim 220$ matches FCU resonance.

## 3.2 PGW Tensor Echoes

$$r \sim 10^{-3}$$

damped by post-inflation coherence dilution. FCU suppresses $C_l^{BB}$ at $l \sim \varphi^n$.

# 4 Informational Thermodynamics

## 4.1 Coherence Entropy

$$\mathcal{C}_{\mathrm{ent}} = -k_B \operatorname{Tr}(\rho_{\mathrm{coh}} \log \rho_{\mathrm{coh}})$$

Opposes von Neumann entropy, drives geometry.

## 4.2 FCU Thermodynamic Resonance

$$\frac{\mathcal{C}_{\mathrm{ent}}}{S_{\mathrm{vN}}} \to \varphi$$

for stable structures (atoms, galaxies, minds).

# 5 Acoustic ESQET (AEQET)

The Acoustic Coherence Function is:

$$\mathcal{F}_{\mathrm{AC}} = \left(1 + \varphi\pi\delta \frac{\mathcal{D}_{\mathrm{ent}}}{k_B T_{\mathrm{vac}}}\right) \cos\left(\frac{\pi}{2} \left| \log_2\left(\frac{f}{432}\right) - \left\lfloor \log_2\left(\frac{f}{432}\right) + \frac{1}{2} \right\rfloor \right|\right)$$

This uses $\lfloor x + \frac{1}{2} \rfloor$ as a robust nearest-integer rounding function.

# 6 Quantum Validation: GHZ Coherence Probes

The 8-qubit GHZ state

$$|\mathrm{GHZ}_8\rangle = \frac{1}{\sqrt{2}} \left(|0\rangle^{\otimes 8} + |1\rangle^{\otimes 8}\right)$$

probes $\mathcal{C}_{\mathrm{ent}}$ under realistic noise (depolarization $p = 0.01$, thermal relaxation $\gamma = 1/(50\,\mu\mathrm{s})$, $t_{\mathrm{gate}} = 20\,\mathrm{ns}$, measurement error $p = 0.005$).

| **Run** | $\lvert 00000000\rangle$ | $\lvert 11111111\rangle$ | *Top Error* | **Fidelity** |
|---|---|---|---|---|
| 1 | 427 | 459 | 11111011 (24) | 0.8650 |
| 2 | 435 | 454 | 10111111 (24) | 0.8681 |
| 3 | 444 | 433 | 11111011 (19) | 0.8564 |

Table 1: GHZ simulation outcomes (1024 shots/run). Mean fidelity: $F = 0.8632 \pm 0.0060$.

Fidelity links to entropy:

$$F \approx 1 - \frac{\Delta S_{\mathrm{vN}}}{\log_2(2^N)} \propto \frac{\mathcal{C}_{\mathrm{ent}}}{S_{\mathrm{vN}}}$$

### 6.1 Falsifiable Prediction: FCU Resonance in Fidelity Scaling

Standard decay: $F(N) = e^{-\alpha N}$ **ESQET prediction**:

$$F_{\text{ESQET}}(N) = e^{-\alpha N}\left[1 + \beta \cos\left(\frac{2\pi N}{\varphi}\right)\right]$$

with $\alpha \approx 0.08$, $\beta \approx 0.025$.


Figure 1: Predicted fidelity plateaus at FCU nodes $N = 5, 8, 13$. Target: $\beta > 0.02$ at $3\sigma$ with 10,000 shots.

**Experimental Protocol (2026–2027):**

- Run $N = 3$ to 9 GHZ circuits on IBM Quantum (Heron) or IonQ Aria
- 10,000 shots per $N$
- Fit to exponential vs. ESQET model
- Detect $\beta > 0.02$ at $3\sigma$ for $N = 5, 8$

A confirmed non-monotonic deviation would be **direct evidence** of participatory coherence engineering in spacetime.

## 7 Conclusion

ESQET-UIFT unifies gravity, cosmology, thermodynamics, and quantum computing via **coherence entropy**. The GHZ fidelity scaling experiment is the **first low-cost, high-impact falsifiability test** of emergent spacetime. Future work: GW transport in $\mathcal{S}$, AetherQuantaForge app, and FCU-based coherence devices.