Comparison of Stevenson-Flux Information Theory (SFIT) and Holographic Duality
Including the Ryu-Takayanagi Formula

Douglas G. Stevenson
stevensonfluxinformationtheory.com

March 2026

Contents

1 Introduction

Holographic duality, most prominently the AdS/CFT correspondence, states that a gravitational theory in a higher-dimensional bulk is equivalent to a quantum field theory on its lower-dimensional boundary. A cornerstone of this duality is the **Ryu-Takayanagi formula**, which geometrizes quantum entanglement entropy.

Stevenson-Flux Information Theory (SFIT) proposes that gravity is a dynamic information-carrying flux vibrating at $\nu_{\text{res}} = 1.20134\,\text{mHz}$, introducing a non-reciprocal, time-dependent metric correction via the coupling kernel $K = 1.060$.

This document compares the two frameworks, with explicit inclusion of the Ryu-Takayanagi formula.

2 Ryu-Takayanagi Formula

In holographic duality, the entanglement entropy S_A of a boundary region A is given by the area of the minimal surface γ_A in the bulk that is homologous to A:

$$S_A = \frac{\text{Area}(\gamma_A)}{4G_N \ell_{\text{P}}^{d-2}},$$

where: - γ_A is the minimal (extremal) surface in the bulk anchored on the boundary of region A, - G_N is Newton's constant in the bulk, - ℓ_{P} is the Planck length in the bulk spacetime dimension $d+1$.

This formula establishes a direct geometric interpretation of quantum entanglement: entanglement entropy on the boundary is proportional to the area of a bulk surface.

3 Comparison Table

Aspect	**Holographic Duality (AdS/CFT)**	
Core Idea	Bulk gravity $\equiv$ boundary QFT; geometry from entanglement	Gravity as dyna
Key Formula	Ryu-Takayanagi: $S_A = \frac{\mathrm{Area}(\gamma_A)}{4G_N \ell_{\mathrm{P}}^{d-2}}$	Non-reciprocal metri
Information Role	Entanglement entropy geometrizes spacetime	Ontological infor
Scale	Planck / holographic scale	Laborato
Non-locality	Geometric via bulk minimal surfaces / ER bridges	Directional
Testability	Mostly indirect (holography, black holes)	Direct: qBounce
Equivalence Principle	Preserved in bulk GR	Preserved in adiaba
Unification Goal	Gravity emerges from quantum information	Gravity-QM bri

Table 1: Comparison of Holographic Duality and SFIT

4 Detailed Comparison

4.1 Information and Geometry

- **Holographic Duality**: Quantum entanglement on the boundary is geometrized via the Ryu-Takayanagi formula. The bulk spacetime geometry encodes boundary entanglement entropy. ER=EPR extends this idea by identifying entanglement with Einstein-Rosen bridges.

- **SFIT**: Information is carried as an active, ontological flux. The flux at 1.20134 mHz produces a directional, non-reciprocal correction to the metric tensor:

$$h_{0z}^{\mathrm{SFIT}}(t) = \alpha_z \,\mathrm{Re}[\cos(2\pi\nu_{\mathrm{res}}t)],$$

  with amplitude $\alpha \approx 0.00122$. This flux induces phase-space skew in the quantum wave function and generates the observed KWW memory kernel.

4.2 Scale and Testability

- **Holographic Duality**: Operates at Planck or strongly-coupled holographic scales. Direct experimental tests are extremely difficult.

- **SFIT**: Makes concrete predictions at laboratory energies. The 1.20134 mHz modulation, 4.5% overshoots, Bessel sidebands, and KWW tails with $\beta = 1.060$ are supported by qBounce reanalysis and are testable in near-term GRANIT experiments.

4.3 Non-locality

- **Holographic Duality**: Non-locality of entanglement is resolved geometrically through bulk minimal surfaces (Ryu-Takayanagi) or wormholes (ER=EPR).

- **SFIT**: Non-locality appears through the information flux inducing a directional phase-space skew in quantum systems. The flux is tied to the local gravitational gradient.

5 Possible Complementary Relationship

SFIT and holographic duality may be complementary rather than competing frameworks. Holographic duality provides the deep ultraviolet description where gravity and spacetime geometry emerge from quantum entanglement on a boundary (via Ryu-Takayanagi). SFIT could represent an **effective low-energy resonant phenomenon** when this holographic structure interacts with a macroscopic gravitational field.

In this view: - The 1.20134 mHz Quantum Heartbeat could be a collective mode arising from holographic entanglement when coupled to Earth's gravitational gradient. - The coupling kernel $K = 1.060$ quantifies the efficiency of information transfer from boundary entanglement into measurable gravitational flux effects. - The KWW relaxation tails reflect the slow relaxation of entangled degrees of freedom across the holographic bulk.

Thus, holographic duality may supply the microscopic encoding, while SFIT describes the mesoscopic, observable manifestation at laboratory energies.

6 Conclusion

Holographic duality geometrizes quantum information through the Ryu-Takayanagi formula and related constructions, proposing that spacetime emerges from entanglement. SFIT treats information as an active dynamical flux that directly modifies gravitational dynamics at accessible energies.

While holographic duality operates at fundamental scales, SFIT offers concrete, testable predictions in the laboratory. The two approaches may ultimately prove complementary: holographic duality as the ultraviolet theory of quantum gravity, and SFIT as an effective infrared description of resonant information flow in the presence of macroscopic gravity.

Future ultra-cold neutron experiments (GRANIT) have the potential to test SFIT's predictions and indirectly illuminate aspects of holographic principles at laboratory energies.