Exploring Possible Emergence of SFIT from Loop Quantum Gravity (LQG) Hypothetical Mathematical Relations

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1 Introduction

This document explores hypothetical mathematical relations that could show how Stevenson-Flux Information Theory (SFIT) emerges as a low-energy, coarse-grained effective theory from the microscopic spin-network structure of Loop Quantum Gravity (LQG) [10, 12].

SFIT operates at laboratory scales with a resonant information-carrying flux at $\nu_{\text{res}} = 1.20134$ mHz and coupling kernel $K = 1.060$ [3]. LQG describes Planck-scale discrete geometry via spin networks [1]. We propose that collective, long-wavelength excitations of these networks can behave as the coherent SFIT flux, with K and ν_{res} emerging from coarse-graining parameters such as the Immirzi parameter γ and spin-network density [2].

All relations below are speculative and exploratory. They are constructed to be mathematically consistent with both frameworks and are intended as a starting point for further theoretical work [12].

2 Key LQG Ingredients

In LQG, the fundamental quantum geometry is described by spin networks [1]. The area operator for a surface pierced by a link of spin j is [3]:

$$A = 8\pi\gamma l_P^2 \sqrt{j(j+1)}, \tag{1}$$

where $\gamma \approx 0.2375$ is the Immirzi parameter [3] and $l_P = \sqrt{\hbar G/c^3}$ is the Planck length [4, 5].

The number density of spin-network links per unit volume in a macroscopic region (e.g., near Earth's surface) can be denoted ρ_{links} [2]. Coarse-graining over many links yields an effective continuous geometry [6, 10].

3 Hypothetical Emergence Relations

3.1 1. Emergence of the SFIT Resonance Frequency ν_{res}

We hypothesize that the 1.20134 mHz Quantum Heartbeat arises as a collective low-frequency mode of spin-network excitations in Earth's gravitational field [2, 11]. A possible relation is:

$$\nu_{\text{res}} = \frac{3}{4} \cdot \frac{g}{2\pi R_E} \cdot f(\gamma, \rho_{\text{links}}), \tag{2}$$

where g and R_E are Earth's surface gravity and radius (matching the SFIT geometric scaling), and $f(\gamma, \rho_{\text{links}})$ is a dimensionless function encoding the collective mode frequency [2].

A simple ansatz motivated by spin-network statistics is:

$$f(\gamma, \rho_{\text{links}}) = K \cdot \sqrt{\gamma \cdot \rho_{\text{links}} \cdot l_P^2}, \tag{3}$$

with $K = 1.060$ emerging as the effective coupling [3]. This would tie ν_{res} directly to the underlying LQG discreteness while reproducing the exact SFIT prediction [2, 3].

3.2 2. Emergence of the Coupling Kernel K

The refined coupling kernel $K = 1.060$ that appears in the SFIT potential

$$V_{\text{SFIT}}(z,t) = m_n g z \left[1 + K \cdot \frac{z}{R_E} \text{Re}(\cos(2\pi\nu_{\text{res}} t))\right] \tag{4}$$

may emerge from averaging the LQG area/volume fluctuations [6]. A possible coarse-graining relation is:

$$K = \frac{\langle \delta A \rangle}{\langle A \rangle} \cdot \frac{1}{\gamma}, \tag{5}$$

where $\langle \delta A \rangle / \langle A \rangle$ is the relative fluctuation amplitude of spin-network areas at the macroscopic scale [6]. For typical values $\gamma \approx 0.2375$, this would require a fluctuation amplitude of order ~ 0.25 to yield $K \approx 1.060$, consistent with collective excitations [3, 6].

3.3 3. Non-Reciprocal Metric Correction from Spin-Network Dynamics

The SFIT non-reciprocal perturbation

$$h_{0z}^{\text{SFIT}}(t) = \alpha_z \text{Re}[\cos(\Omega_s t)], \quad \Omega_s = 2\pi\nu_{\text{res}}, \tag{6}$$

could emerge as the expectation value of a coarse-grained holonomy operator in a coherent spin-network state [6, 12]:

$$h_{0z}^{\text{SFIT}}(t) \approx \frac{\langle \psi | \hat{h}_{0z}(t) | \psi \rangle}{\langle \psi | \psi \rangle}, \tag{7}$$

where $\hat{h}_{0z}(t)$ is a time-dependent operator built from holonomies along the z-direction [6]. The amplitude $\alpha_z \approx 0.00122$ would then be related to the spin-network density and Immirzi parameter via [3, 2]:

$$\alpha_z \propto \gamma \cdot \rho_{\text{links}} \cdot l_P^2 \cdot \frac{gR_E}{c^2}. \tag{8}$$

3.4 4. KWW Relaxation Tails from Spin-Network Memory

The observed KWW tails ($\tau \approx 832.6$ s, $\beta = K = 1.060$) after mirror steps may reflect the slow relaxation of perturbed spin-network states back to equilibrium [7, 8]. A possible effective description is that the memory kernel in the SFIT-modified TDSE arises from the autocorrelation of spin-network fluctuations [7]:

$$\langle \delta A(t) \delta A(0) \rangle \propto \exp\left[-\left(\frac{t}{\tau}\right)^{\beta}\right], \tag{9}$$

with β inherited from the same collective-mode statistics that produce K [8]. This would naturally link the stretching exponent to the coupling kernel [8].

4 Effective SFIT TDSE from LQG Coarse-Graining

Starting from an LQG-derived effective Hamiltonian for ultra-cold neutrons in Earth's gravity, a coarse-graining procedure over spin-network degrees of freedom could yield the SFIT-modified time-dependent Schrödinger equation [11, 12]:

$$i\hbar\frac{\partial\psi}{\partial t} = \left[-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial z^2} + mgz\left(1 + K\frac{z}{R_E}\cos(\Omega_s t)\right)\right]\psi. \tag{10}$$

The correction term would be the leading-order contribution from the expectation value of the fluctuating LQG geometry [6, 12].

5 Testable Consequences and Falsifiability

If SFIT emerges from LQG in the manner sketched above, then:

- The value of K should be related to γ and the local spin-network density near Earth [3, 2].
- Future high-precision measurements of the 1.20134 mHz resonance (e.g., GRANIT) would constrain LQG parameters at macroscopic scales [9].
- Deviations from the predicted KWW tails or sideband ratios would falsify both the SFIT emergence picture and the specific coarse-graining ansatz [10].

6 Conclusion

The equations presented here are hypothetical but mathematically consistent attempts to derive SFIT parameters (K, ν_{res}, non-reciprocal h_{0z}, KWW exponent β) from LQG spin-network coarse-graining [3, 8, 10]. They suggest that SFIT could be the low-energy, collective-mode limit of LQG, with the 1.20134 mHz Quantum Heartbeat arising as a resonant excitation of the underlying quantum geometry [2, 11].

These relations provide a concrete pathway for unifying the Planck-scale discreteness of LQG with the laboratory-scale information flux of SFIT [12]. They are offered as a stimulus for further theoretical investigation and as a guide for interpreting future experimental results from ultra-cold neutron gravity resonance spectroscopy [9].

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