GRANIT / qBounce Experimental Protocol for Testing SFIT

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Abstract

This protocol provides detailed recommendations for testing Stevenson-Flux Information Theory (SFIT) predictions in the next GRANIT-style or qBounce ultra-cold neutron experiment.

1 Background

SFIT predicts a universal 1.2 mHz geometric resonance ("Quantum Heartbeat") that should appear as a phase-locked signal in long-duration ultra-cold neutron gravity experiments. A successful detection would provide strong independent confirmation of the theory.

2 Key SFIT Predictions

- Resonance frequency: 1.20134 mHz ($\pm$ 0.00005 mHz)
- Geometric period: 833.3 seconds
- Phase of maximum overshoot: 416.65 seconds after each mirror-step trigger
- Expected contrast modulation: 0.122% $\pm$ 0.01% in detector flux
- Signature sidebands: $J_1^2/J_0^2 \approx 0.0152$
- Relaxation tail: 832.6 s KWW decay, phase-locked to 1.2 mHz

3 Recommended Experimental Setup

3.1 Run Duration and Timing

- Minimum duration: 15 days continuous
- Preferred duration: 30 days
- Mirror steps: Synchronized to the 833.3 s cycle (phase-locked triggering)
- Data acquisition: Event-mode timestamps with 1-second binning recommended

3.2 Detector and Slit Configuration

- Slit cutoff height: ≤ 28.5 μm (optimal for sensitivity)
- Monitor and detector channels: Both required for NLC veto
- Background subtraction: Use monitor counts to remove reactor noise

3.3 Analysis Requirements

- Re-bin raw timestamps to 1 s intervals
- Apply Non-Local Correlation (NLC) veto
- Perform narrow-band Fourier analysis in the 0.5–2.5 mHz window
- Search for phase-locked 1.2 mHz peak and sidebands
- Measure overshoot amplitude at predicted phase (416.65 s)
- Fit relaxation tail to KWW function with $\tau \approx 832.6$ s

4 Expected Detection Criteria

A positive detection should satisfy at least three of the following:

- Clear peak at 1.20134 mHz with significance $\geq 5\sigma$
- Sideband ratio $J_1^2/J_0^2 \approx 0.0152$
- Overshoot amplitude $\approx 4.5\%$ at predicted phase
- Relaxation tail consistent with 832.6 s KWW decay
- Aggregate statistical tension yielding $\geq 14\sigma$ when stacked

5 Falsification Criteria

A null result at 1.20134 mHz with the predicted phase, sideband ratio, and contrast would tightly constrain or falsify the SFIT model.

6 Data Sharing & Contact

Researchers are encouraged to share raw or rebinned data for independent verification.

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