SFIT Data Analysis Toolkit

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Abstract

This toolkit provides practical instructions and code to test Stevenson-Flux Information Theory (SFIT) predictions using ultra-cold neutron data. It includes steps for re-binning, Fourier analysis, phase-locked overshoot detection, and statistical tension calculation.

1 Overview

SFIT predicts a 1.2 mHz geometric resonance that should appear as a phase-locked signal in long-duration qBounce or GRANIT-style experiments. This document helps you search for that signature in your data.

2 Key SFIT Predictions

- **Resonance frequency:** 1.201 34 mHz (±0.000 05 mHz)
- **Period:** 833.3 s
- **Phase of maximum overshoot:** 416.65 s after mirror step
- **Expected contrast modulation:** 0.122% ± 0.01%[cite: 25]
- **Sideband ratio:** $J_1^2/J_0^2 \approx 0.0152$[cite: 25]
- **Relaxation tail:** 832.6 s KWW decay[cite: 25]

3 Step-by-Step Analysis Pipeline

3.1 1. Data Preparation

- Use event-mode timestamp data (preferred)[cite: 25]
- Re-bin to 1-second intervals[cite: 25]
- Subtract monitor counts to remove reactor noise[cite: 25]
- Apply Non-Local Correlation (NLC) veto if available[cite: 25]

3.2 2. Fourier Analysis

Use the following Python code to search for the 1.2 mHz peak[cite: 25]:

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.fft import fft, fftfreq

# Load your rebinned count rate data (1 s bins)
t = np.arange(len(counts))  # time in seconds
signal = counts - np.mean(counts)  # residuals

# Fourier transform
yf = fft(signal)
xf = fftfreq(len(t), d=1.0)  # frequency in Hz

# Plot zoomed to sub-mHz range
plt.plot(xf, np.abs(yf))
plt.xlim(0.0005, 0.0025)
plt.axvline(0.00120134, color='r', linestyle='--',
            label='SFIT 1.20134 mHz')
plt.xlabel('Frequency (Hz)')
plt.ylabel('Magnitude')
plt.legend()
plt.grid()
plt.show()
```

3.3 3. Phase-Locked Overshoot Analysis

Look for 4.5% count-rate jumps at mirror steps, with maximum amplitude at 416.65 s after the step.

3.4 4. Statistical Tension Calculation

$$\Sigma^2 = \sum_{k=1}^{N} \frac{(A_{\text{obs}} - A_{\text{SFIT}})^2}{\sigma_k^2} \tag{1}$$

4 Expected Signatures Table

Signature	**SFIT Prediction**
Resonance frequency	1.201 34 mHz[cite: 25]
Overshoot phase	416.65 s after mirror step[cite: 25]
Contrast modulation	$0.122\% \pm 0.01\%$[cite: 25]
Sideband ratio	$J_1^2/J_0^2 \approx 0.0152$[cite: 25]
Relaxation tail	832.6 s KWW[cite: 25]
Aggregate significance	$\geq 5\sigma$ in a single long run[cite: 25]

Table 1: Expected SFIT experimental signatures[cite: 25].

5 Recommended Run Parameters

- **Duration:** 15–30 days continuous[cite: 25]
- **Mirror step synchronization:** aligned with 833.3 s cycle[cite: 25]

- **Binning:** 1-second intervals[cite: 25]
- **Detector cutoff:** $\leq 28.5\,\mu\mathrm{m}$[cite: 25]

6 Repository & Contact

All code and updates are available at:
https://www.stevensonfluxinformationtheory.com[cite: 25]
Questions or data sharing: `douglasgstevenson (at) your email`[cite: 25].

References

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