



Searching for coherent X-ray pulsations from Sco X-1

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The motivation

- Firstly, detection of the spin frequency of Sco X-1 would be **pretty important** generally.
- However, the primary motivation (for me) is for **future GW searches**.
- The LSC has published 2 upper-limit results on Sco X-1 (**orders of magnitude** higher than being interesting).
- Detection of a spin frequency would reduce the volume of parameter space by up to **~12 orders of magnitude** in frequency.
- In addition we would also obtain improved estimates of the orbital parameters (and possibly sky position).
- This **could** make Sco X-1 detectable with advanced LIGO.

The source : Sco X-1

- Sco X-1 is an LMXB and is accreting at \sim Eddington Limit.
- It is the brightest X-ray source in the sky (after the sun).
- Coherent pulsations were **expected** by RXTE but have **NEVER** been seen.
- It exhibits (twin) kHz QPOs but **no** Type I X-Ray burts.
- Possible frequency range is therefore 0 - 2 kHz.
- It has a **~ 19 hour** approximately circular orbit ($\Delta P = 0.08$ sec, $e \leq 10^{-3}$, $a \sin(i) = 1.44 \pm 0.18$ sec, $\Delta T_p = 260$ sec).
- It has long been quoted as a **prime GW search target**.
- In practice, this is **incorrect**.

The analysis

- The data spans ~ 12 years and contains $\sim 10^6$ sec of observations divided into ~ 400 ~ 2000 sec segments.
- ComputeFstatistic_v2 has been modified to perform the **demodulated** Fourier Transform computed on a frequency and orbital parameter space template bank.

$$\mathcal{P}_s(\vec{\Lambda}_{sk}) = \frac{2}{r_s T_s} \sum_{j=0}^{N_s-1} |o_j e^{-i\phi_j(\vec{\Lambda}_{sk})}|^2$$

- The power is then stacked/summed **incoherently** as a function of parameter space location using the **metric** as our coincidence measure.

$$\mathcal{S}(\vec{\Lambda}'_k) = \sum_{s=0}^{M-1} \mathcal{P}_s(\vec{\Lambda}_{sk*})$$

Status and outstanding issues

- Currently running on ATLAS (results for the LSC)
- Long term accretion/GW driven frequency drift.
- Follow up.
- Correlations with ASM, Z track, QPO behaviour.
- A deeper search on a shorter data stretch ?
- Other LMXBs.

