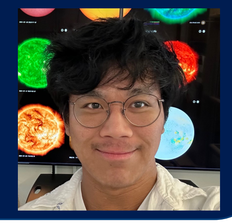
GOFAST–XRB: The Gemini Optical FAST Timing of X-Ray Binaries Survey

Efren James R. Elomina, Alexandra J. Tetarenko, and the GOFAST-XRB Team
Department of Physics and Astronomy, University of Lethbridge



Introduction

Different regions of an X-ray binary (XRB) emit in different wavelengths; infalling matter dominates the X-rays [1, 2, 3], while the jets dominate radio through infrared emission (*Fig. 1*; [4, 5, 6]). Optical probes the interface between inflow and outflow. The ***GOFAST-XRB*** program aims to utilize optical and X-ray time-domain observations to track how variations in the accretion flow propagate into the jet, and how this might change with accretion state and between systems with different compact objects.

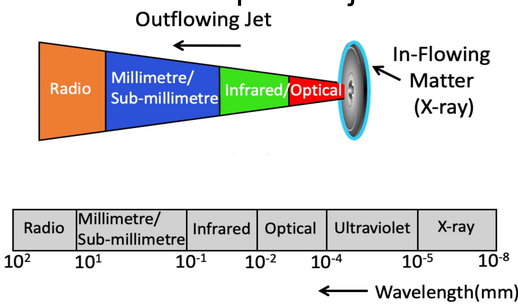
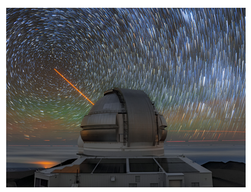


Fig 1. A schematic of the emission regions of an XRB.

Observations

Target	Hours Observed	Hours Remaining
Cyg X-2	9.69	20.31
Aql X-1	9.81	20.19
GX 339-4	0	30
Sco X-1	9.24	20.76
4U 1608-52	15.32	14.68



Optical observations are taken with Gemini's `Alopeke and Zorro, while X-ray observations are taken from NICER, HXMT, NuSTAR, and EP.

Developing a Gemini Pipeline

To track the flow of matter from the accretion flow to ejection via a jet outflow, a light curve of the XRB must first be constructed. The Gemini data is structured as a series of 30-sec observations, consisting of 1000 sequential frames with 30-ms exposure times (*Fig. 2*), in two filters simultaneously (*g and i/z*). The pipeline performs the following tasks:

1. Frame rejection (e.g., blank frames, hot pixels).
2. Background subtraction.
3. Differential aperture photometry.
4. Light curve construction (*Fig. 3*).

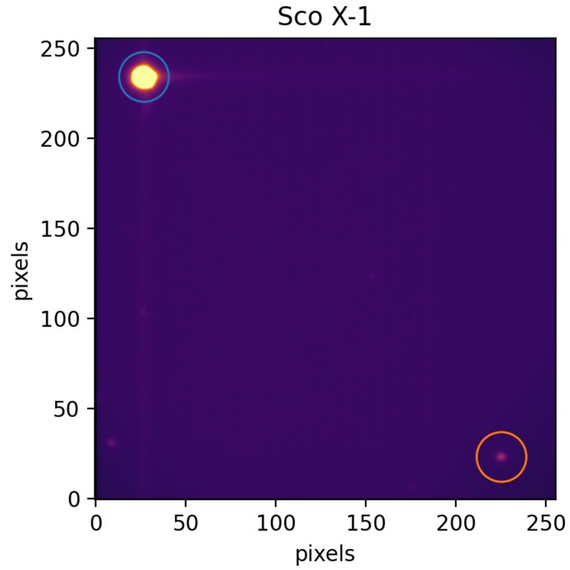


Fig 2. A 30-sec average image (*i*) of the Sco X-1 field. The target is shown in the blue aperture, and a comparison star is shown in the orange aperture.

Next Steps & Future Work

- ***Characterizing the optical variability properties.*** Using Fourier analysis methods, we will measure the amplitude of the variations over different timescales.
- ***Linking optical and X-ray variability.*** Through cross-correlation analysis, we will characterize any time delays between signals, and place constraints on emission mechanisms and physical jet properties.
- ***Securing a long-term X-ray partner for the program.*** Currently, we use a mix of X-ray facilities on a best effort ToO basis.

Work in progress!

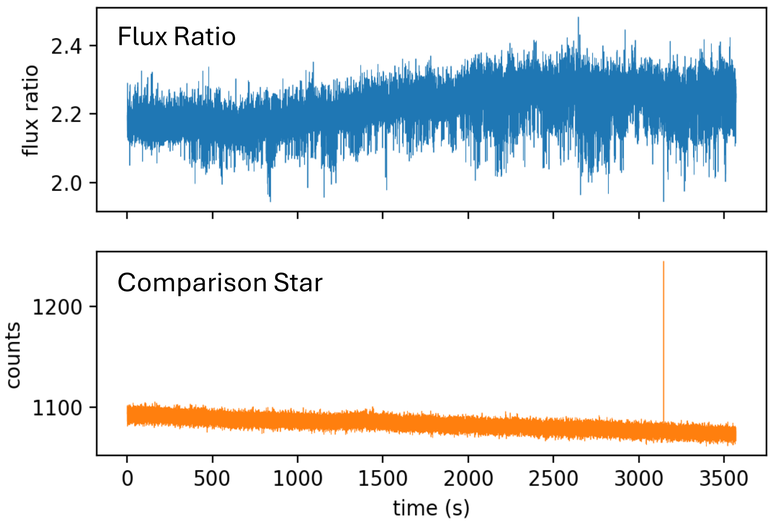


Fig 3. Example pipeline output for Sco X-1.

References

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Acknowledgments

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