

A New Route to Phase-Resolved Spectroscopy of Pulsations and QPOs in X-ray Binaries

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Image: NASA

Introduction

Accretion disks in X-ray binaries provide an opportunity to study matter in strong gravitational fields. Using spectral-timing measurements of X-ray emission, we can analyze the inner parts of the accretion disk. Here we present the application of a new spectral timing technique to carry out phase-resolved spectroscopy of the accreting millisecond X-ray pulsar SAX J1808.4-3658.

Method

- Compute the cross-correlation function of an energy channel of interest with a reference band
- Re-create the correlated parts of the signal
- Determine relative phase shift of signal
- Works for periodic and quasi-periodic signals
- Ephemerides not necessary

Data

- 2002 outburst of SAX J1808.4-3658 (see full lightcurve in Figure 1)
- ~170 ks observation time
- RXTE event-mode
- 122 μ s resolution \rightarrow 20 phase bins per pulse period
- Using PCUs 0 and 2
- X-ray bursts filtered out

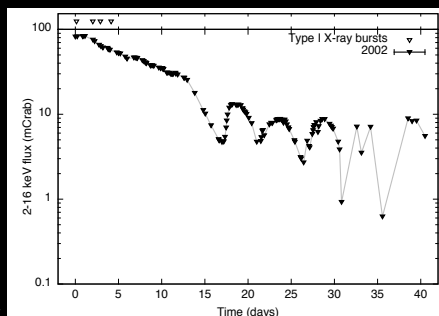


Figure 1.
Courtesy of P.M. Bult

Preliminary Results

- Cross-correlation function (CCF) computed for periodic pulsations from SAX J1808.4-3658 to construct an energy spectrum per phase bin
- Figure 2 shows energy spectra at different times in pulse phase
 - Here 0° is defined at the peak CCF amplitude at 7 keV
- Phase-resolved spectra represent deviations from the mean spectrum

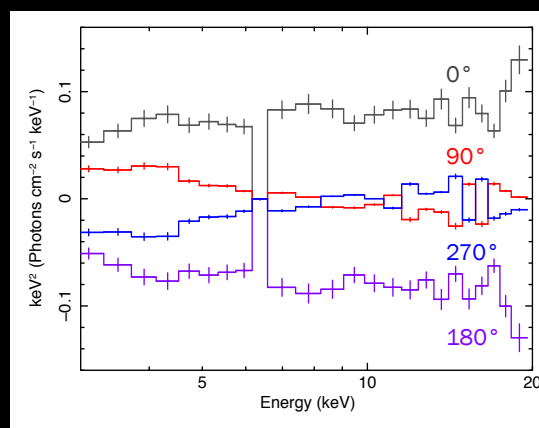


Figure 2. The energy bin at ~6.2 keV has zero counts in this data mode.

Future work

- Fit energy spectra to deduce spectral components
- Compare SAX J1808 results with those from Wilkinson et al. 2011
- Apply method to sources with quasi-periodic oscillations (QPOs)

References:

Hartman, J.M., et al. 2008, ApJ, 675, 1468
van der Klis, M. 1989, in Timing Neutron Stars, ed. H. Ögelman and E.P.J. van den Heuvel, 27
Wilkinson, T., Patruno, A., Watts, A.L., & Uttley, P. 2011, MNRAS, 410, 1513

