Stellar mass black holes in the nearby elliptical galaxy NGC 4472

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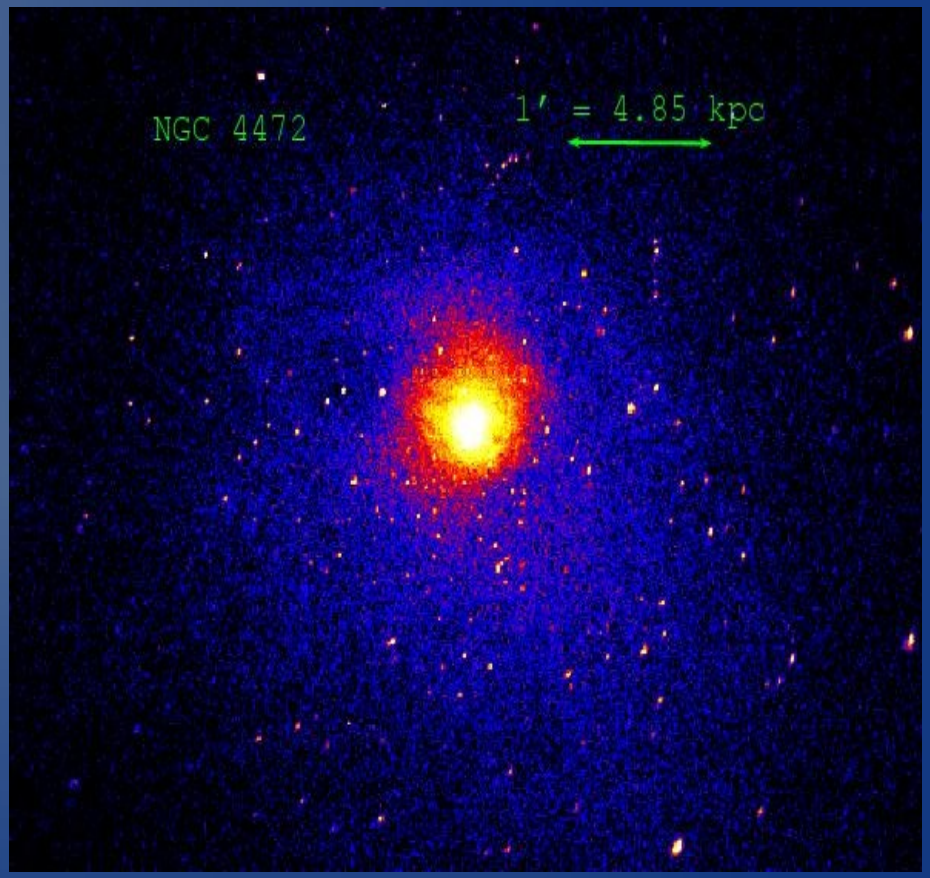
Background and context

- Binary star evolution is of great interest because
  - progenitors of SNIa, pulsars, other exotic systems
  - fundamental to e.g. cosmology, gravitational wave physics
- XRBs particularly useful because can be observed at large distances
- XRBs formed in two ways:
  - end point of stellar evolution
  - N-body capture/ direct collision in globular clusters (GCs)

NGC 4472

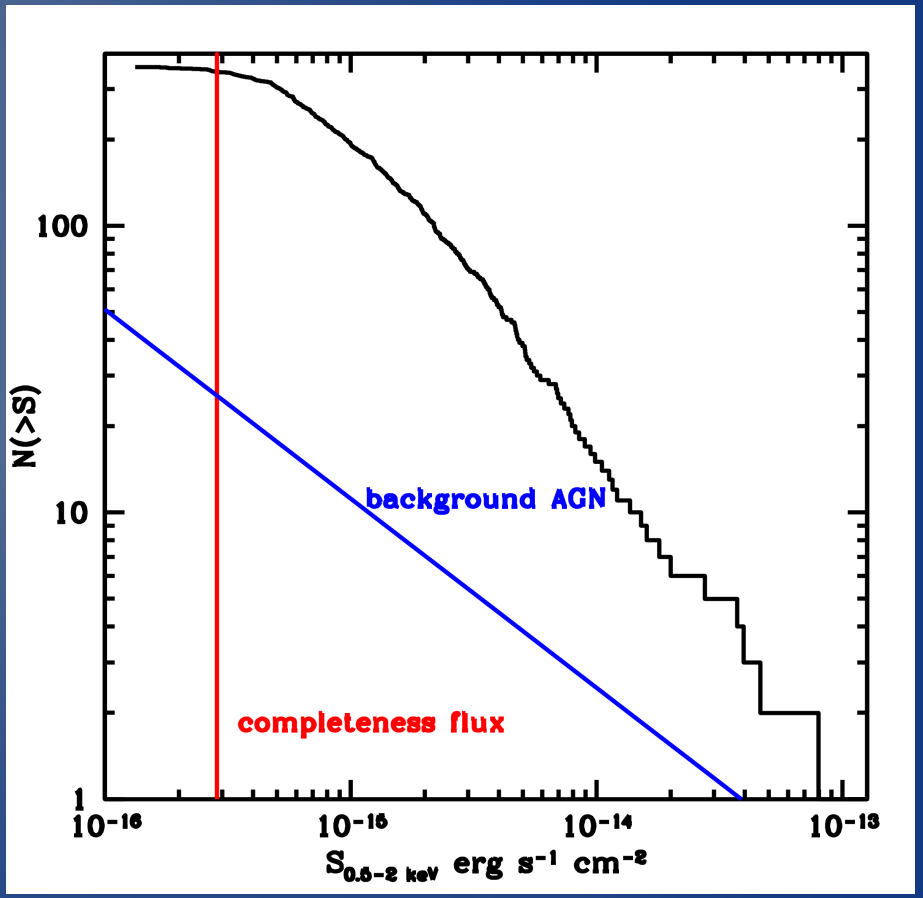
- NGC 4472
  - massive, nearby elliptical galaxy falling into Virgo cluster
  - most optically luminous galaxy in Local Universe
  - ~ 6000 GCs, good place to study XRB-GC relationship
- Kundu et al. (2002) found 144 X-ray point sources, 30/72 in HST fields in GCs
- Used 380ks data set to study the X-ray point sources in NGC 4472



Central region of NGC 4472

Our results

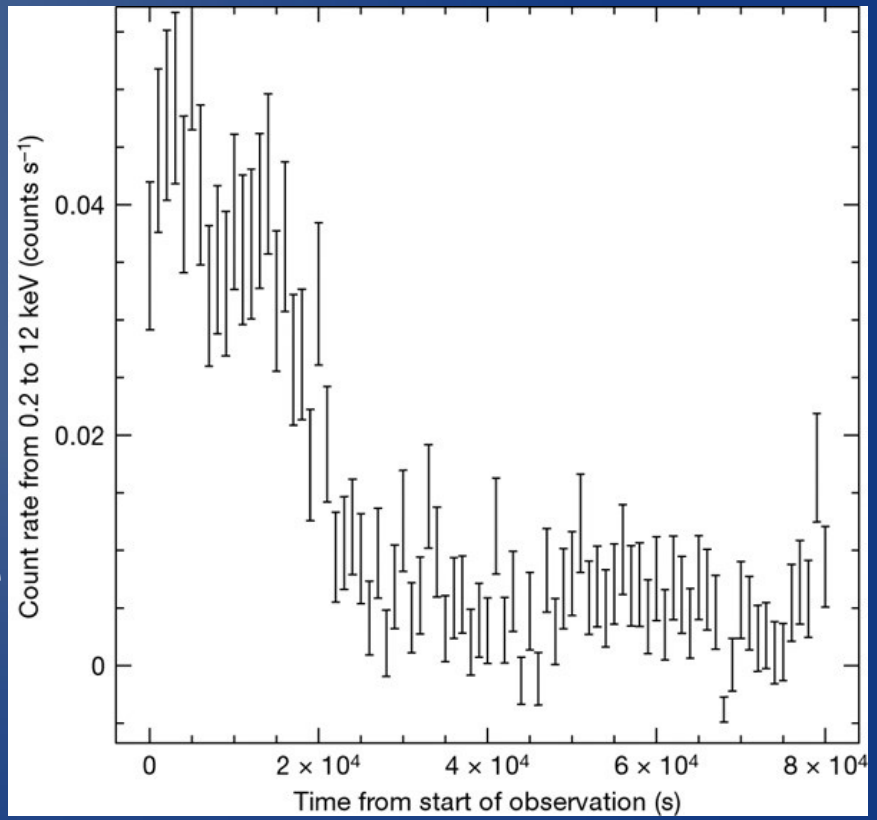
- Detected 343 X-ray sources within central 4.5' of galaxy
  - Fluxes > S_{min} = 2.9×10^{-16} ergs s^{-1} cm^{-2} or
    - $L_x = 2.3 \times 10^{37}$ ergs s^{-1}
- 71 sources are in GCs, but HST field doesn't cover entire source detection region
- 25 background AGN down to S_{min}



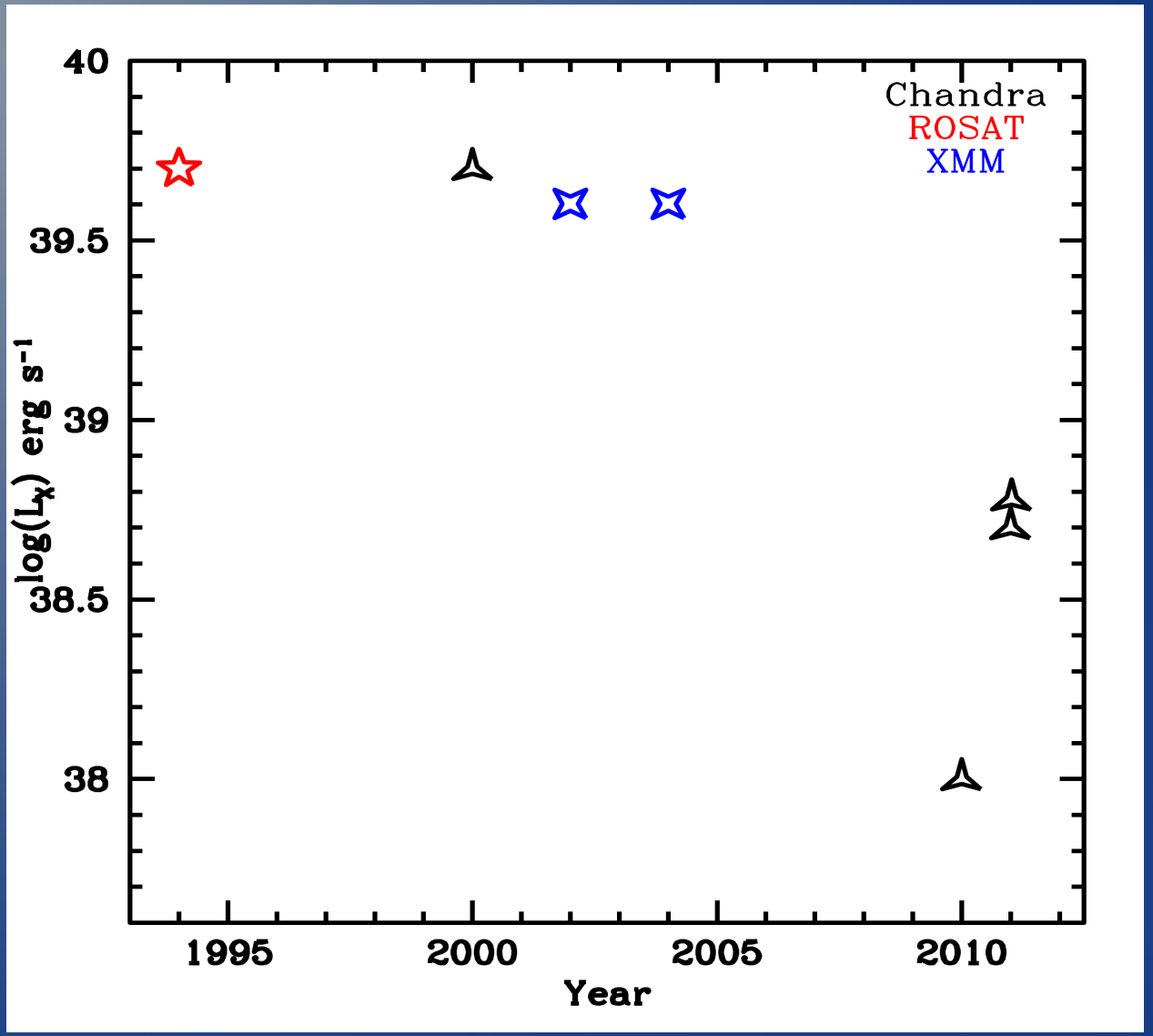
LogN-logS plot for our sources (black line), estimated number of background AGN (blue line) and completeness flux (red line)

Point sources of interest

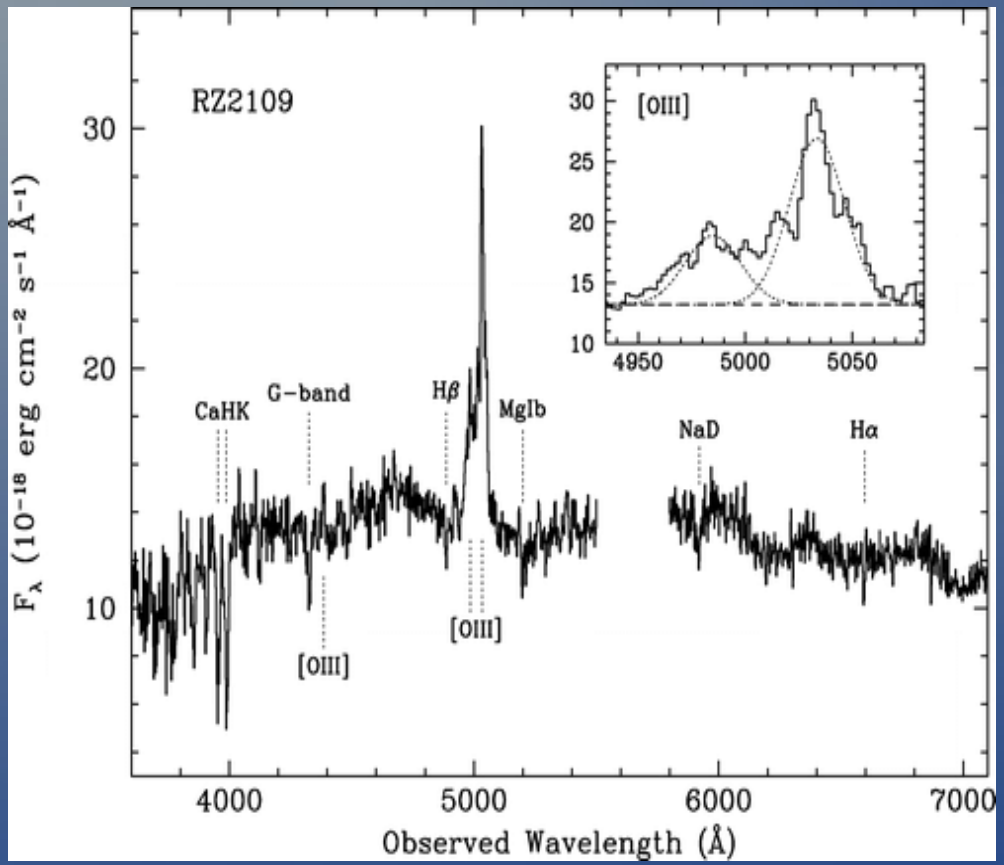
- GC BH XMMU J122939.7+075333 (Maccarone et al. 2007) showed flaring activity on time scales of hours
- New transient BH candidate found
  - L_X increased from 8.8×10^{37} to 7.7×10^{38} ergs s^{-1} in a week
- Other GC BH, CXOU1229410+075744, has same L_X as reported by Maccarone et al. (2010) and no spectral changes seen



GC BH XMMUO122939.7+075333

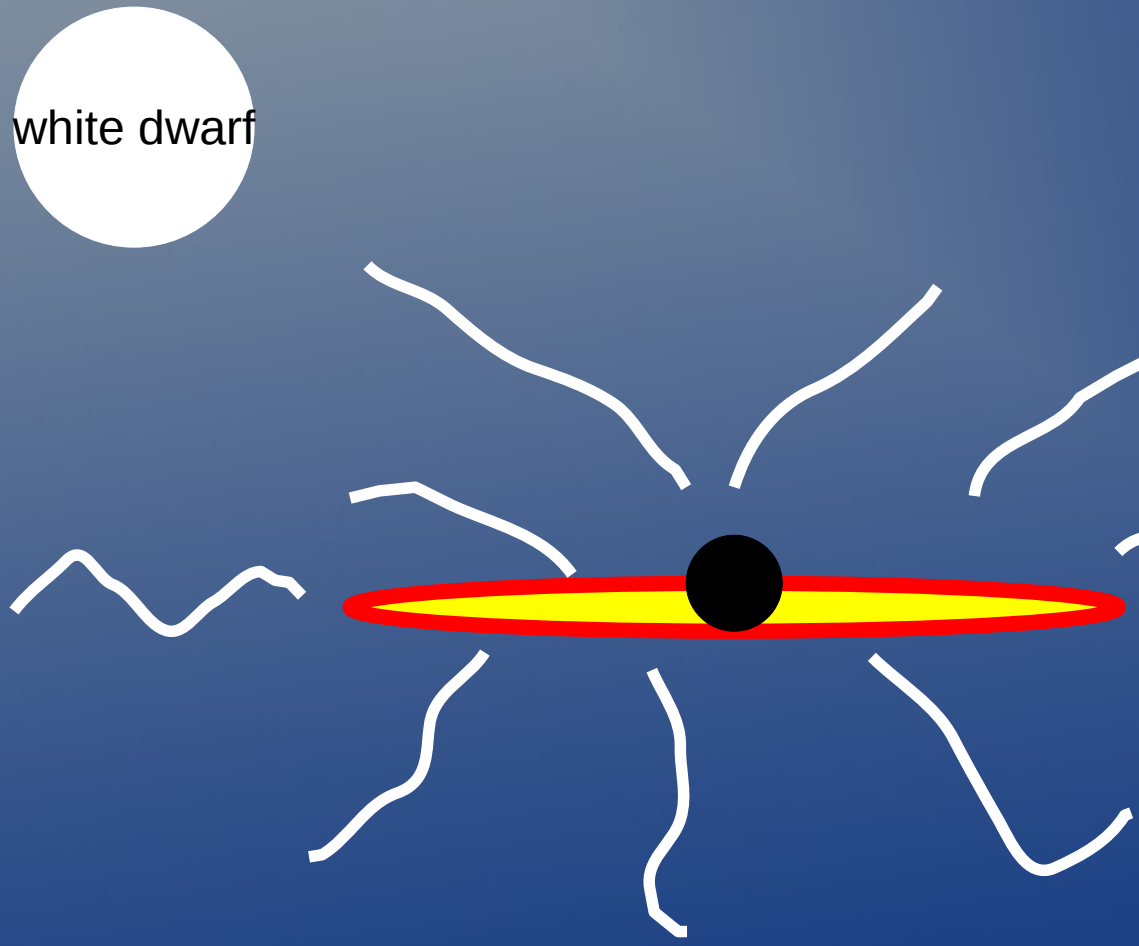


GC BH XMMUO122939.7+075333



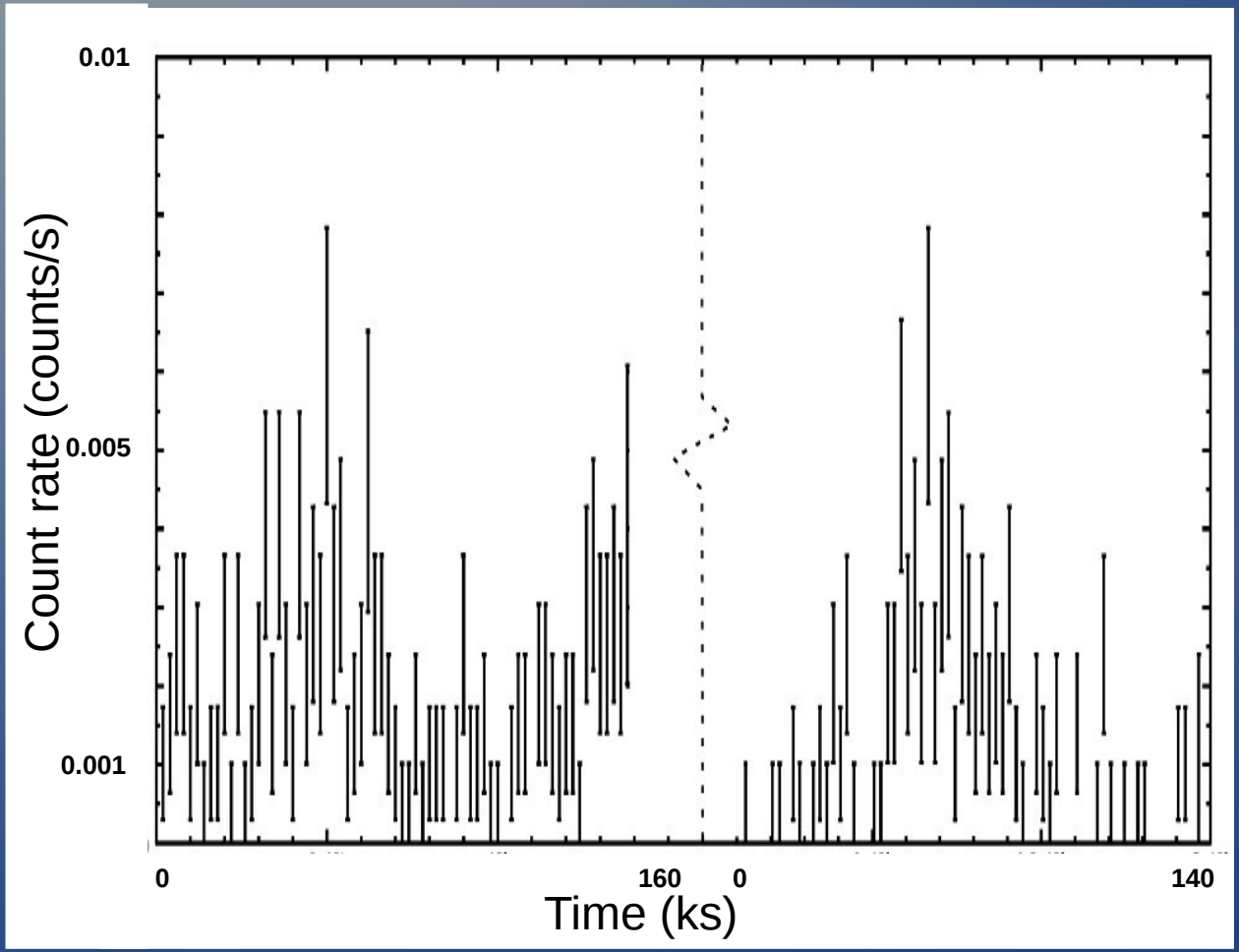
- We think the companion is a white dwarf
- Why?
  - Persistently high X-ray luminosity (see e.g. King, Kolb & Burderi 1996; Dubus, Hameury & Lasota 2001)
  - High O[III] to H_α ratio

GC BH XMMU J122939.7+075333



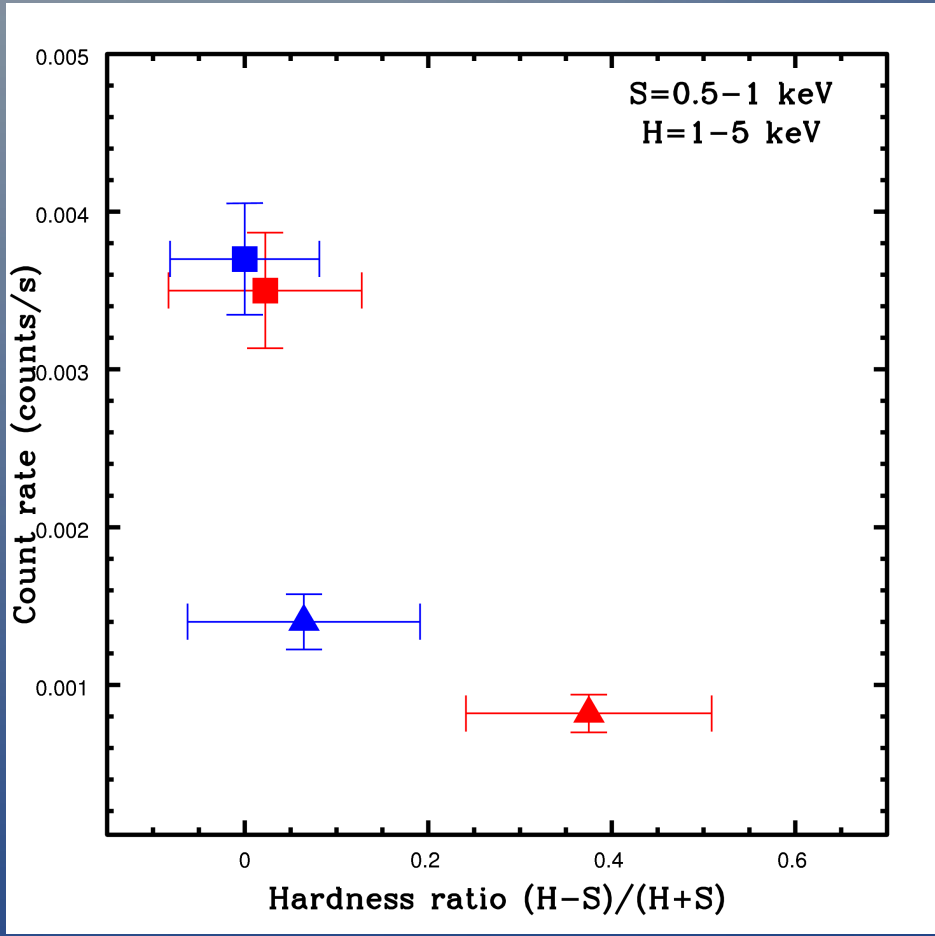
- Chemically enriched (from WD companion) accretion disk wind
  - Variable absorption column
  - Expect aperiodic modulation of luminosity (Proga and Begelman 2003)
  - Expect spectrum softer when source is more luminous

GC BH XMMUO122939.7+075333



Aperiodic brightening favours disk wind scenario

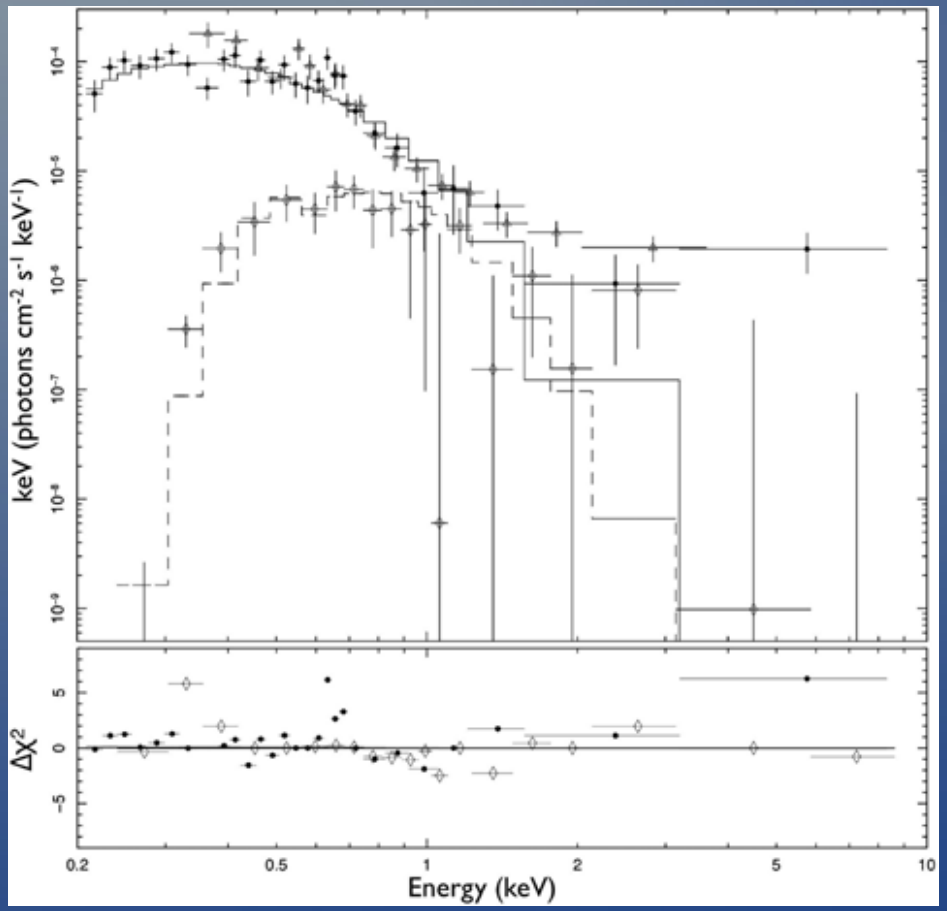
GC BH XMMU J122939.7+075333



Hardness ratio changes significantly (0.02 to 0.36) between bright and faint epochs in at least one observation

- Probability = 0.006 for chance occurence

GC BH XMMUO122939.7+075333



Hardness variation is similar to spectral changes seen in 2004 XMM spectra (Shih et al. 2008)

Summary and future work

- We detect 343 X-ray point sources
  - Largest such population found with $L_X > 2.3 \times 10^{37}$ erg s^{-1}
- XMMU J122939.7+075333
  - White dwarf companion
  - Variability due to disk wind
  - Statistical analysis of the light curve variability, e.g. Bayesian block analysis, to determine aperiodicity