

X-ray outbursts from a candidate black hole binary in NGC 55

V. Jithesh* and Zhongxiang Wang

Shanghai Astronomical Observatory, Chinese Academy of Sciences,
80 Nandan Road, Shanghai 200030, China. *Email: jithesh@shao.ac.cn



Introduction

- X-ray transients are a class of X-ray binaries with a white dwarf, neutron star (NS) or a black hole (BH) as the primary.
- These systems have been primarily discovered when they entered outbursts characterised by an episode of high accretion rates and abrupt increases of X-ray luminosity by several orders of magnitude.
- Accretion instabilities in the disk may increase the mass transfer rate suddenly which resulted in outbursts.
- Several NS and BH systems exhibited the Fast Rise Exponential Decay (FRED) light curves [1] during the outburst, where the source reach peak intensity in < 5 days and followed by exponential decay in few hundred days (See Figure 1).

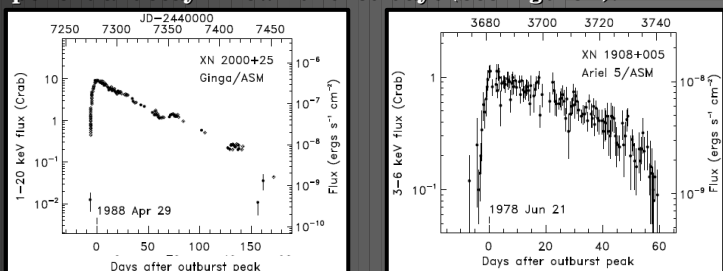


Figure 1: The FRED light curve for NS (left) and BH systems (right) [1].

- The outbursts from BH systems typically last a few months with recurrence period of many years, $\sim 2-57$ yr [1, 2]. NS X-ray binaries also have such outbursts with much shorter recurrence period, $\sim 100-200$ days [3], compared to the BH systems.

Observations and Source Identification

- NGC 55 is a Magellanic-type, SB(s)m galaxy in the Sculptor Group at a distance of 1.78 Mpc [4]. Its X-ray properties has been well studied by two *XMM-Newton* observations taken in 2001 [5].

Mission	ObsID	Date	Exposure ^a
XMM-Newton	0028740201, 0028740101	2001 November	33.6, 31.5
	0655050101	2010 May	127.4
Chandra	2255	2001 September	60.1
	4744	2004 June	9.7
Swift	K01-K07	2013 April-May	4.8-5.6
	K09-K20	2013 June-Aug	4.5-4.7
	L01, L04	2013 September-Nov	3.5, 2.7
	M01, M03, M05	2014 October	2.9, 2.2, 3.7

Note: The prefix K, L and M on Swift denotes 000326190, 000821200 and 000334680, respectively.
^aExposure time is in units of kiloseconds.

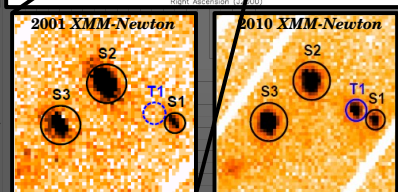
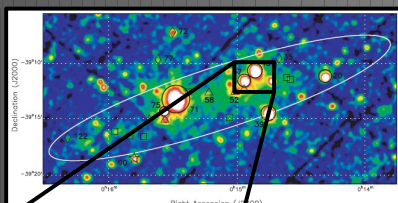


Figure 2: Top: The 0.3 - 6 keV *XMM-Newton* image of NGC 55 adapted from SRW06. Bottom: A 4 arcmin x 4 arcmin EPIC-PN image of the bar region, including the transient source (T1).

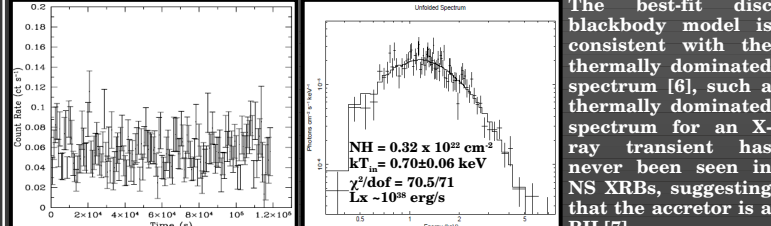


Figure 3: Left: Combined EPIC-PN and MOS 0.3-3 keV light curve of XMMU J001446.81-391123.48 with 800-s binning. The source exhibited a strong short term variability at significance $> 99.99\%$. Right: The 0.3-3 keV *XMM-Newton* EPIC-PN spectrum of the transient source, fitted with an absorbed disc blackbody model.

The best-fit disc blackbody model is consistent with the thermally dominated spectrum [6], such a thermally dominated spectrum for an X-ray transient has never been seen in NS XRBs, suggesting that the accretor is a BH [7].

Swift Follow-up

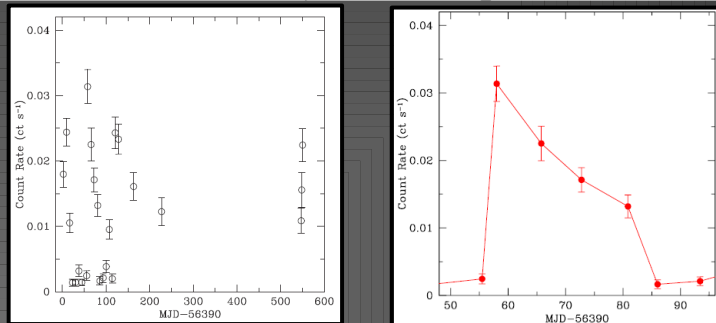


Figure 4: Left: 0.3-3 keV *Swift* XRT count rate for the transient source as function of observation time. The source possibly showed a repeated outburst with recurrence period about a month. Right: The outburst light curve where the source reached peak intensity of 0.03 cts/s, possibly a FRED phenomenon.

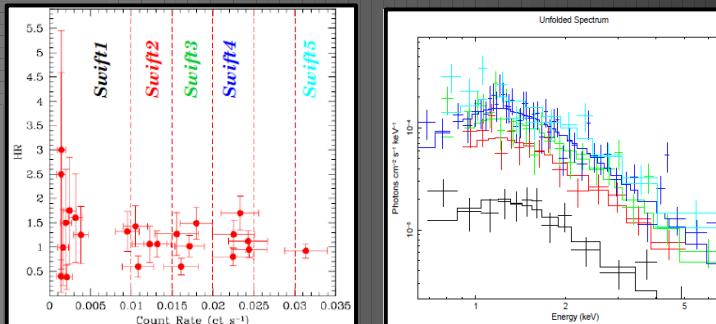


Figure 5: Left: Intensity Vs. Hardness ratio diagram for T1 from *Swift* XRT observations. Right: The stacked spectra of the sources in five count rate range fitted with absorbed disc blackbody model, $NH = 0.32 \times 10^{22} \text{ cm}^{-2}$ (frozen), $kT_{\text{in}} = 0.8-1.0 \text{ keV}$, $L_x = 6 \times 10^{37} - 6 \times 10^{38} \text{ erg/s}$. X-ray luminosity is $\sim 30 - 400\% L_{\text{Edd}}$ for a canonical $1.4 M_{\odot}$ NS, again suggesting that the primary is more likely a BH.

Conclusions

- We serendipitously discovered a new transient source in NGC 55 using the archival *XMM-Newton* observations.
- The source, XMMU J001446.81-391123.48, exhibited a flux change of at least two orders of magnitude from $< 10^{36}$ to $\sim 10^{38}$ erg/s.
- The HR, strong short-term X-ray variability and spectral features suggest the binary nature of the source.
- The follow-up studies with *Swift* XRT revealed the source's outburst activity and it is possibly a FRED phenomenon, with a recurrence period about a month.
- The XRT spectra can be described by a power law or a disk blackbody, and the luminosity was in a range of $10^{38} - 10^{39}$ erg/s, with no evidence showing any significant changes of the spectral parameters in the observations.
- In summary, XMMU J001446.81-391123.48 is a new X-ray transient in the young stellar region of NGC 55, possibly being a black hole X-ray binary.

References and Acknowledgement

- Chen W, Shrader C. R, Livio M, 1997, ApJ, 491, 312
- Kuulkers E, et al, 1997, MNRAS, 291, 81
- Masetti N, 2002, A&A, 381, L45
- Karachentsev I. D, et al, 2003, A&A, 404, 93
- Stobbart A. M. et al, 2006, MNRAS, 370, 25 (SRW06)
- Remillard R. A, McClintock J. E, 2006, ARA&A, 44, 49
- Done C, Gierliński M, 2003, MNRAS, 342, 1041

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