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XMM-Newton reveals a dipping black-hole X-ray binary candidate in NGC 55

A.-M. Stobbart, T. P. Roberts, R. S. Warwick

X-Ray & Observational Astronomy Group, Dept. of Physics & Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, U.K.

Abstract. *XMM-Newton* EPIC observations of the nearby (1.78 Mpc) Magellanic-type galaxy NGC 55 reveal a remarkably luminous extra-nuclear source, XMMU J001528.9-391319 that possesses an X-ray luminosity in excess of 10^{39} erg s^{-1} in its highest flux state. The source exhibits complex and rapid variability including a gradual increase in flux and pronounced dips. The dipping episodes occur in the higher states, with timescales as short as 100s, and with some reaching almost 100% reduction of the X-ray flux. We suggest that the dips are a consequence of viewing the accretion disc edge-on with some obscuring material, orbiting in the plane of the disc, blocking and scattering the X-ray flux. Thermal disc emission is blocked by this material, while softer emission (likely from a coronal source) remains comparatively unaffected. The proximity of NGC 55 coupled with the exceptional sensitivity of *XMM-Newton* make this one of the highest quality datasets of an extragalactic black hole binary candidate to date.

Key words. accretion, accretion discs – stars: individual (XMMU J001528.9-391319) – X-rays: binaries

1. Introduction

It is only in the modern era of X-ray astronomy, with the unprecedented capabilities of *XMM-Newton* at our disposal, that we can extend the study of X-ray binaries (XRBs) outside the Local Group in sufficient detail to reveal good black hole binary candidates. Using new, high quality *XMM-Newton* observations we have investigated the spectral and temporal behaviour of such a source (albeit one at the very top end of the luminosity range for "ordinary" XRBs) located in the nearby Magellanic-type galaxy NGC 55 (1.78 Mpc; Karachentsev et al. 2003). NGC 55 is a member of the Sculptor group of galaxies and is viewed edge-on with its bar pointing towards us (i = 90°, Tully1988). The observations reveal the object to be both extremely luminous (observed $L_X \sim 10^{39}$ erg s^{-1}, 0.3 – 10 keV) and highly variable on short timescales, most notably in the form of several dipping features evident in its lightcurve over the course of the new observation.

2. Results

Two separate observations of NGC 55 were made, offset from the centre of the galaxy by $\sim 7'$ in opposite directions. Fig. 1 shows the background subtracted lightcurve (0.3-10.0 keV) based on the combined EPIC data from

Send offprint requests to: A.-M. Stobbart, ams27@star.le.ac.uk

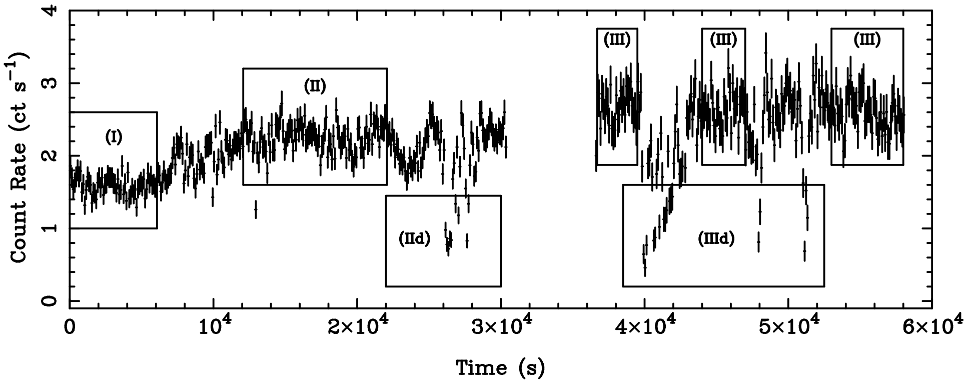

Fig. 1. The lightcurve of XMMU J001528.9-391319 in the 0.3–10 keV band in 100 s time bins. This lightcurve is based on the combined data from the MOS-1, MOS-2 and pn EPIC cameras. The different segments considered in the spectral analysis are identified by the labelled boxes.

each observation. The corrected count rate of the source varies from 0.5-3.5 count s^{-1} with considerable temporal structure including underlying chaotic activity, an upperward drift in flux and pronounced dips. The dip activity is present on timescales as short as ~100s and some of the dips reach almost 100% diminution of the source flux. Investigation of the lightcurve in different energy bands (soft: 0.5–1.0 keV, medium: 1.0–2.0 keV and hard: 2.0–4.5keV) revealed that the initial count rate increase is most significant above 1 keV, implying a constant soft spectral component. Although the dips are present in the three different bands they appear deeper in the harder bands.

Fig. 1 also illustrates the different data segments used for spectral extraction. The X-ray spectra of state (I) was best fitted with a simple absorbed powerlaw model whereas states (II) and (III) required a second component in the form of a disc blackbody. In practice we have fitted states (I), (II) and (III) simultaneously keeping the normalisation of the powerlaw continuum fixed throughout, but allowing the normalisation of the disc blackbody to vary. The spectral fits yielded a soft powerlaw with $\Gamma \approx 4$, and a hot disc blackbody $kT_{in} \sim 0.9$ keV (applicable to the two higher flux states).

The dips are best fitted with the powerlaw plus disc blackbody model describing the non-dip data but with reduced contributions from both components. We find that the dips are more pronounced at higher energies with the disc blackbody (hard) component reduced more than the powerlaw (soft) component, consistent with evidence from the lightcurves that the depth of the dips is greater at higher energies. This dipping behaviour can be explained if the harder thermal emission comes from the inner accretion disc, and is thus blocked by an intervening material orbiting in the plane of the disc, while the softer emission (modelled by the powerlaw and likely from an extended coronal source) remains comparatively unaffected.

These spectral fit results are firmly in the observed regime for Galactic black hole systems in the steep powerlaw state, also known as the very high state (McClintock & Remillard 2003), such that our source is spectrally indistinguishable from known Galactic stellar-mass black hole binaries.

References

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