

XMM-Newton's View of the Eclipsing Burster Low-Mass X-ray Binary AX J1745.6-2901

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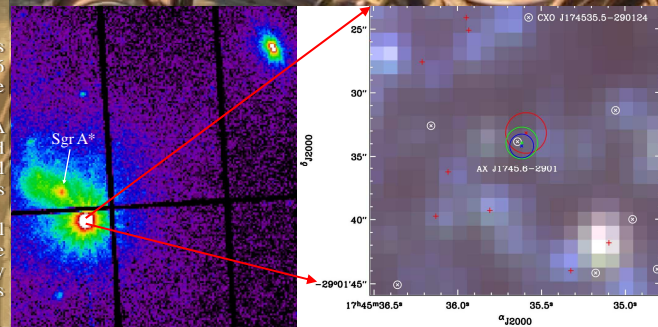
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Abstract. From March 31 to April 4, 2007, three observations were performed by XMM-Newton as part of a multi-wavelength observation campaign of Sgr A* and its neighboring X-ray transient sources. Two bright transient sources in outburst were detected during these observations. We focus here on the transient source in outburst located at about 1.5 arcmin South-West from Sgr A*, which exhibited deep eclipses and type-I X-ray bursts. We identify this source with the eclipsing burster low-mass X-ray binary discovered by ASCA, AX J1745.6-2901. These XMM-Newton observations allow us to refine the period of the eclipse and the position of AX J1745.6-2901. Finally, we observed with XMM-Newton for the first time several dips. AX J1745.6-2901 is therefore the first dipper of the Galactic Center region.

Astrometry

The X-ray transient source in outburst located at about 1.5 arcmin South-West from Sgr A* is inside the 6"-radius error box of Swift J174535.5-290135.6, which was detected by the Swift X-Ray Telescope in late February 2006 (ATel #753), and simultaneously detected with JEM-X aboard INTEGRAL (ATel #756). The error boxes of the XMM-Newton source hosts the 0.2"-radius error box of CXOGC J174535.6-290133 (Muno et al. 2003). AX J1745.6-2901 (with an estimated positional uncertainty of 24" in radius) is located at only 36". This ASCA source is an eclipsing X-ray burster with an eclipse period of 8.356 ± 0.008 h (Maeda et al. 1996). A renewed activity of Swift J174535.5-290135.6 has been reported by Swift and INTEGRAL on mid-February 2007 (ATel #1005, #1006). Therefore, these XMM-Newton observations would indicate an outburst duration of at least 7 weeks for this X-ray transient.

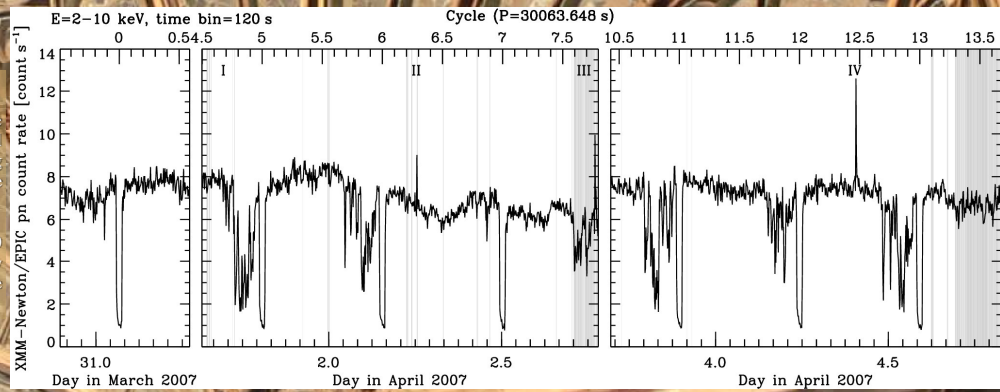
Fig. 1. Left panel: X-ray image of the Galactic Center in the 2-10 keV energy range obtained with EPIC pn on April 4, 2007 (PI: D. Porquet) showing two X-ray transients in outburst. Right panel: red, green, and blue circles indicate the position error boxes of the brightest transient. White crosses and circles mark the position of Chandra X-ray sources (Muno et al. 2003). Red crosses are 2MASS sources. The background image shows mid-infrared sources from 3.6 to 5.8 μ m (Spitzer/IRAC 1, 2, and 3 images are coded with blue, green, and red, respectively).



X-ray Light Curves

We observed seven deep eclipses from this XMM-Newton source with a period consistent with the period of AX J1745.6-2901, as well as four type-I X-ray bursts. Therefore, we identify it with the eclipsing X-ray burster AX J1745.6-2901. Several dips are also observed for the first time.

Fig. 2. EPIC pn X-ray light curve of AX J1745.6-2901 in the 2-10 keV energy range. The flaring background was subtracted. The grey vertical stripes show the lost of exposure. Type-I X-ray bursts are labelled with Roman numbers.



Orbital Period

We evaluate using a light curve folding method an orbital period of 30063.8 s with a 90% confidence interval of 0.5 s. This level of accuracy allows us to track back the eclipse phase down to the epoch of the first observation of the X-ray eclipse with ASCA in 1994 (Maeda et al. 1996). We find that it corresponds to cycle -13162, which helps us to refine the orbital period to: 30063.648 s (i.e., 8.351013 h) with an uncertainty of 0.004 s. This latter value was used to fold the light curve in phase. Our improved linear ephemeris of the eclipse allows us to identify an unnoticed egress in a short Chandra observation of CXOGC J174535.6-290133 in June 2006. Therefore, we have unambiguously identified the Chandra source with the ASCA source.

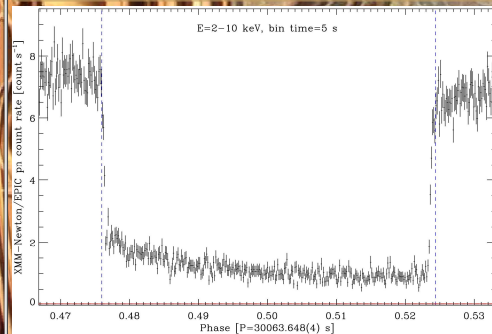


Fig. 3. Average of the EPIC pn light curve folded in phase centered on the X-ray eclipse. The blue dashed lines indicate the beginning and the end of the ingress and the egress phases, respectively. The red horizontal line shows the (low) level of contamination from other sources of X-ray emission inside our extraction region, estimated from an XMM-Newton observation where AX J1745.6-2901 was not in outburst. The depth of the eclipse maximum is about 90%.

Dipping X-ray Activity

A dipping X-ray binary is an X-ray binary viewed under an inclination of $\sim 70^\circ$, close to edge-on. The bulge of the accretion disk passes in the line-of-sight at each orbital rotation and produces dips in the light curve, observed before the eclipse of the compact object by its low-mass companion.



Fig. 5. Artist's view of the dipping activity in a low-mass X-ray binary.

Conclusions

- We have unambiguously identified AX J1745.6-2901 with CXOGC J174535.6-290133 (ATel #1058), which provides a better determination of the position of this low-mass X-ray binary for multi-wavelength follow-up observations.
- We have improved the accuracy of the orbital period, and the linear ephemeris of the eclipse center: $\text{MJD}(\text{Cycle}) = 54190.06739(3) + 0.34795889(5) \times \text{Cycle} \text{ [TDB]}$.
- AX J1745.6-2901 is the first dipper of the Galactic center region.

Type-I X-ray Bursts

Type-I X-ray burst are thermonuclear flashes, caused by thermal instabilities, in the accreted matter on the surface of a weakly magnetized neutron star (Joss 1977, 1978).

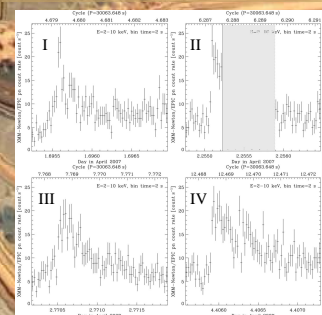


Fig. 4. Enlargements of the EPIC pn light curve centered on the four Type-I X-ray bursts observed from AX J1745.6-2901. The bin time is 2 s. The grey box shows the lost of exposure.

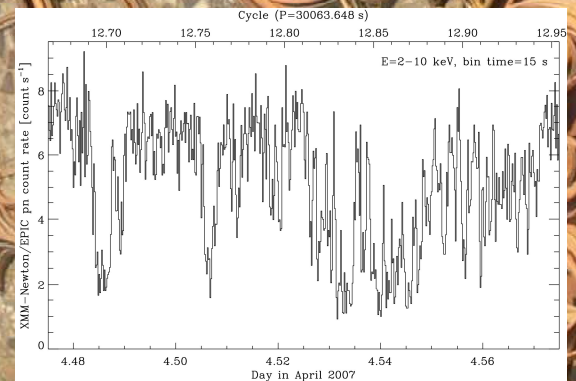


Fig. 6. Enlargement of the EPIC pn light curve centered on an extended dip showing rapid variation of depth on time scale of 15 s.

References

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