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XMM observations of the long period polar V1309 Ori

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Abstract. We present the first full-orbit X-ray light curve of the remarkable eclipsing magnetic Cataclysmic Variable V1309 Ori obtained with *XMM-Newton.* The photometric behaviour and the extreme soft-to-hard flux ratio of the bright phase emission suggest that accretion occurs entirely via dense blobs.

1. Observations and initial results

With an orbital period of $\sim$ 8 hrs V1309 Ori is longest period system known among the synchronised polars. Information about the accretion region is still sparse, since emission from the UV to infra-red wavelengths is dominated by the accretion stream, as is evident from the orbital and eclipse light curves. We report on a 31 ksec *XMM-Newton* pointing taken in 2001 March, which provides the first X-ray light curve with full-orbital coverage (Figure 1). It is characterised by a relatively short bright phase between $\phi_{ecl} = 0.4. - 0.7$, where countrates up to 15 cts/sec are reached. The phasing of the bright phase is rather peculiar compared to most polars, although it is possibly masked by the non-stationary nature of the accretion or absorption between phase $\phi_{ecl} = 0.7 - 1$. If it is really only of geometrical origin, this would require the accretion region to be located at an azimuth $\psi = 160°$ and a colatitude $\beta \geq 160°$. Only the polar HY Eri (Burwitz et al. 1999) has a primary accretion region at the far side of the white dwarf as seen from the secondary.

Closer inspection of the light curve shows that a large fraction can be resolved into individual X-ray flares. These events have rise and decay times of about 10 sec and are likely to be connected to the subsurface accretion of single gas blobs. The energies measured for 4 typical and well-separated flares range between $2 - 10 \times 10^{34}$erg (assuming a distance of 625 pc and a standard white dwarf of 0.6 $M_\odot$), which correspond to blob masses of $2 - 10 \times 10^{18}$g.

An indirect confirmation of this scenario, is given by the spectral properties of the bright phase. The absence of corresponding flares in the hard X-ray light curve and phase-resolved EPIC PN spectra reveals that the bright phase flux is entirely due to reprocessed, soft thermal emission, with photon energies below 1 keV. The upper limit of the hard/soft flux-ratio implied by the photon statistics

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of the unrelated faint X-ray emission, is $F_{\rm br,0.1-2.4\ keV}/F_{\rm bb,0.1-2.4\ keV} \leq 10^{-3}$. This is an order of magnitude lower than the extremest cases of soft X-ray excess found in a representative *ROSAT* study (Beuermann & Burwitz 1995). The bright phase spectrum can be fitted by a blackbody with a temperature of $T_{\rm bb} = 56 \pm 2$eV. Compared to other polars with well measured soft X-ray spectra (e.g. *EUVE*, Mauche 1999) the blackbody temperature in V1309 Ori appears to be a factor of 2 higher.

Throughout the orbit we detect a persistent, faint (~ 0.1cts sec^{-1}) source of emission which is much harder compared with that during the bright phase. Its X-ray spectrum is rather flat and requires an optical thin plasma model with at least three ($T_{\rm mek} = 0.07, 0.7, 9$ keV) temperature components. In particular the presence of an intermediate temperature plasma ($T_{\rm mek} = 0.7$ keV) is indicated by the observation of iron L-shell line emission at 1 keV.

During eclipse this faint emission component drops to zero. Interestingly, eclipse ingress lasts 15–20 minutes and is prolonged to phases where the white dwarf is already eclipsed (see Staude et al. 2001 for the detection of the white dwarf in the UV). The long duration of the X-ray ingress excludes compact emission areas like a polar accretion spot or the white dwarf itself. Although this picture is not as clear for eclipse egress, possibly due to the low counting statistics or intrinsic variablity, the observed eclipse profile strongly suggests that the source of the faint emission is not located on the white dwarf, but instead in the accretion stream.

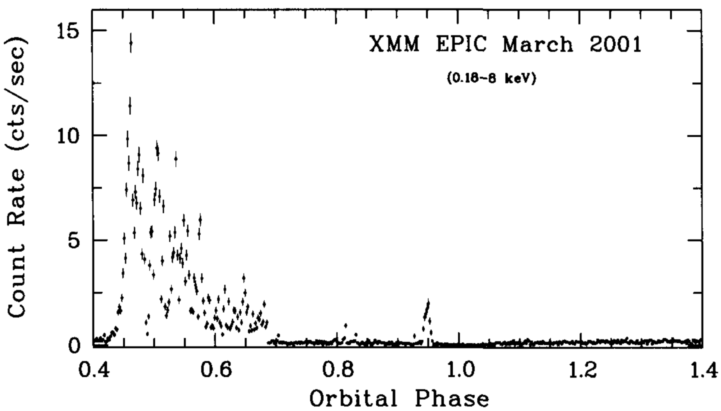

Figure 1. X-ray light curve of V1309 Ori observed with *XMM-Newton*. The data have been binned into intervals of 60 s and folded using the ephemeris of Staude et al. 2001.

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