AM HER – CAUGHT IN THE ACT WITH XMM-NEWTON!

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ABSTRACT

AM Herculis, the prototype of the strongly magnetic cataclysmic variables, escaped observations with XMM-Newton so far due to visibility constraints. We report on a very preliminary analysis of the first XMM-Newton observations of this classical polar performed in July 2005. AM Herculis recovered shortly for a two-weeks period from an extended low state lasting 1.8 years and was found in an intermediate (close to high) accretion state. It was accreting in its normal or regular one-pole mode. This observation yielded spectra and light curves with extraordinary high quality. We discuss briefly the X-ray and UV light curves as well as X-ray spectra obtained with EPIC-pn and the RGS.

Key words: AM Herculis.

1. XMM-NEWTON OBSERVATIONS

AM Herculis as the key object for magnetically controlled accretion has been observed with every high-energy observatory so far. It was foreseen for a long RGS-prime observation in the GTO program but never observed since it was situated in the XMM-Newton blind spot. The visibility changed over the years and we could conduct a first unconstrained observation with XMM-Newton in AO4 (July 2005). Due to severe visibility constraints the whole observation which was planned to cover at least three binary cycles ($P_{\rm orb} = 186\,{\rm min}$) was broken in a total of 5 visits of length 9 ksec each.

XMM-Newton observations were performed in the period July 19–27, 2005 (revs. 1027–1031). Two observations were affected by high background resulting in the complete loss of X-ray data of one visit. EPIC-MOS was defined as detector for a possible low state and used in large window mode. These are strongly affected by pile-up and not considered here further. The detector for the high state was EPIC-pn and used in timing mode with the thick filter. The OM was used in timing mode with filter UVW2. This is the filter operating at the shortest wavelengths ($\lambda_c \sim 2200$ Å) and has the smallest effective area. The OM is in particular sensitive for reprocessed radiation from the accretion process proper and contains line emission from the accretion stream and continuum emission from the white dwarf's photosphere (accretion-heated and undisturbed).

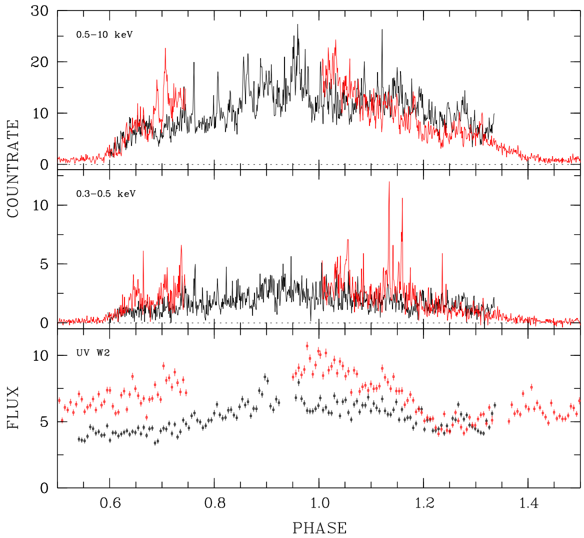

Figure 1. EPIC-pn light curves in soft and hard bands and OM-UVW2 ultraviolet light curve of AM Her obtained during two visits of the source in July 2005. Bin size is 60 s for the OM, 10 s for EPIC. Phase zero corresponds to inferior conjunction of the secondary. OM flux is given in units of $10^{-14}\,{\rm erg\,cm^{-2}\,s^{-1}}$.

The EPIC-pn and OM-UVW2 timing mode photons were extracted from the raw data with SAS 6.1. Phase-folded EPIC-pn X-ray and OM-UVW2 ultraviolet light curves are displayed in Fig. 1. The X-ray band was subdivided in soft and hard bands comprising the two main spectral components, a black-body like heated photosphere and

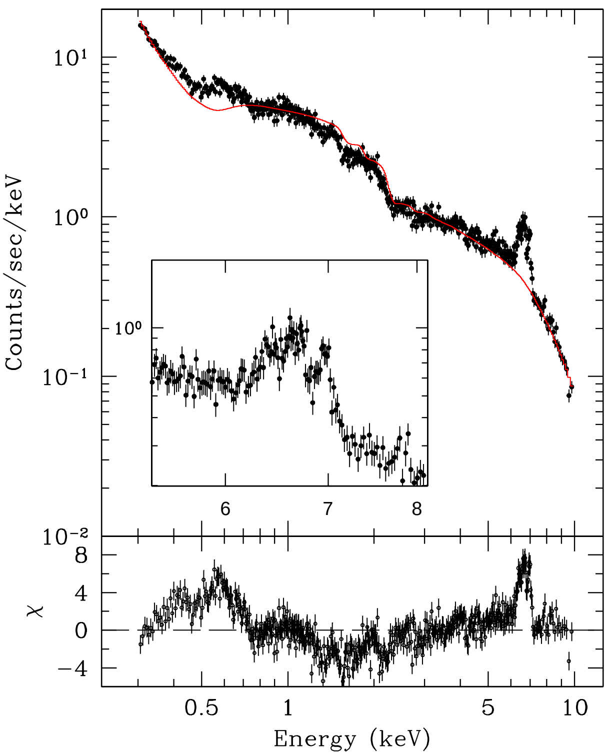

Figure 2. Mean EPIC-pn spectrum of AM Her. The red line is the result of a simple fit invoking only bremsstrahlung and blackbody components. The inset shows a zoom focusing on the Fe-line complex between 6 and 7 keV.

a bremsstrahlung-like cooling plasma, respectively. The source reached a mean-bright phase count rate with the EPIC-pn camera of about 15 s^{-1}. Individual soft flares without hard X-ray counterpart are reflecting the impact of dense blobs of matter on the accretion region. They reached about 15 s^{-1} just in the soft band, i.e. they contain several hundred photons, sufficient for a spectral analysis, the determination of the temperature and an estimate of the mass of individual blobs of matter. The whole EPIC-pn observation yielded more than 250000 photons which will allow phase-dependent spectral studies of all the components.

The mean EPIC-pn spectrum is displayed in Fig. 2 together with a model fit representing the broad continuum slope. It includes a cold absorbed superposition of a 29 eV blackbody and a 15 keV thermal bremsstrahlung component and has been chosen to highlight the main line emission features which appear as strong residuals around 0.6 and 6.7 keV, respectively. They indicate a more complex spectrum from a stratified cooling plasma, a reflection component from the surface of the white dwarf, and a possible warm or partial absorber (see e.g. Beardmore et al. 1994, Done & Magdziarz 1998, Ishida et al. 1997). These spectral components are currently investigated by phase-dependent X-ray modeling. The soft X-ray excess seems to be mild with $F_{\rm bb,bol}/F_{\rm tb,bol} \simeq 6$. The faint phase is dominated by

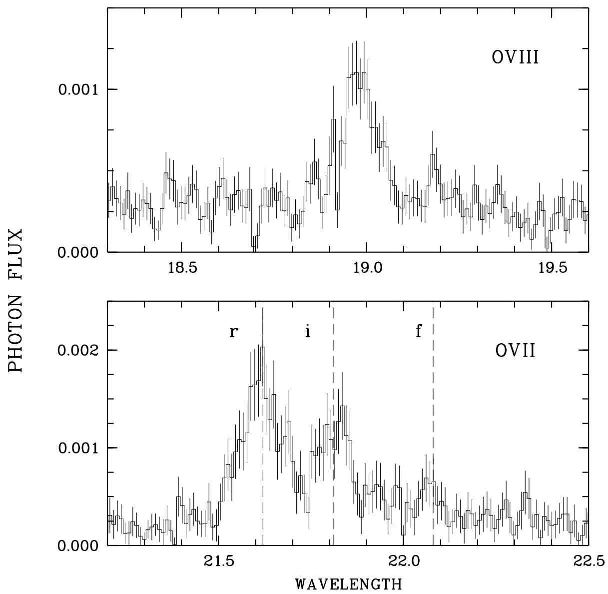

Figure 3. Cutout of the mean RGS-spectrum of AM Her centering on the He- and H-like oxygen lines.

hard emission. The measured ultraviolet flux indicates that the source was encountered in an intermediate state of accretion (see IUE-spectroscopy in different accretion states by Gänsicke et al. 1995).
The Fe-line complex between 6 and 7 keV consists of an Fe fluorescence line at 6.4 keV and He- and H-like species at 6.7 and 7.0 keV. The H/He line ratio hints to a temperature of about 10 keV. The phase-dependent line flux and flux ratios (He/H) of the Fe-lines will be combined with those of other species to make an attempt to constrain the temperature stratification of the cooling plasma directly from observations. The RGS-spectrum contains a weak continuum and several emission lines, most prominent are Oxygen lines from H- and He-like ions (Fig. 3). The lines in the average spectrum appear to be resolved, the H-like line has a width of 0.07 Å (corrected for the instrumental profile) indicating a Doppler width of about 1200 km s^{-1}. This number represents an upper limit due to velocity smearing. The low f/i-ratio of the He-like triplet is typical of a plasma in the high-density limit. However, the strong underlying radiation field might mimic line ratios of a high-density plasma (cf. Mauche 2002 and references therein).

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