HIDDEN MAGNETIC ACCRETORS: XMM-NEWTON OBSERVATIONS OF LS PEGASI

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ABSTRACT

Cataclysmic variables (CVs) are close binary stars in which a white dwarf accretes material from a Roche-lobe filling late-type companion. If the magnetic field of the white dwarf is strong enough, it can dominate the accretion flow from the inner accretion disk directly onto the magnetic poles of the white dwarf.

A surprising result emerged from our analysis of the entire sample of non-magnetic cataclysmic variables observed with ASCA (Baskill, Wheatley & Osborne , 2005). We found that two extremely hard systems appeared spectrally distinct from the rest of the sample (V426 Oph & LS Peg; see figure 1). These are probably weakly magnetic accretors, but there is no strong evidence of periodic variability - currently the only accepted method of identifying such a system (Patterson , 1994).

Here we report the results of the 45ks XMM-Newton observation of LS Peg. V426 Oph will be observed by XMM-Newton in 2006.

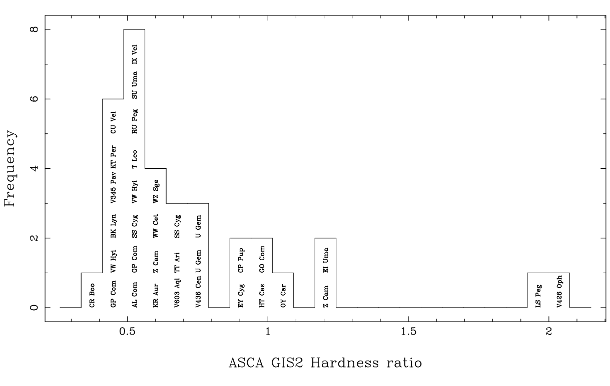

Figure 1. Hardness ratios of all the non-magnetic cataclysmic variables observed with the ASCA GIS2 instrument. Two systems stand out as having an unusually hard spectra: LS Pegasi and V426 Ophiuchi.

Key words: stars, dwarf novae, novae, magnetic, non-magnetic, cataclysmic variables, X-rays.

1. ASCA OBSERVATIONS OF LS PEGASI

Although the ASCA spectra of LS Peg contain few counts (<1000 counts in the combined GIS instruments) it was surprisingly difficult to model, requiring strong X-ray absorption by highly ionised material and a temperature distribution weighted towards high temperatures (Baskill, Wheatley & Osborne , 2005). However, fitting such a complex model is abiguous at such low signal-to-noise.

A possible 30.9±0.3 minute modulation was detected in the ASCA power spectra (figure 2). Fitting the folded SIS0 light-curve with a sine function yielded an amplitude of 32±5 per cent. Rodríguez *et al.* (2001) independently report a detection of a period at 29.6±1.8 min in the circular polarisation of LS Peg. The coincidence of these detected periods leads us to believe that the modulation detected in the ASCA light-curve may be periodic, and that the modulation in X-rays and circular polarisa-

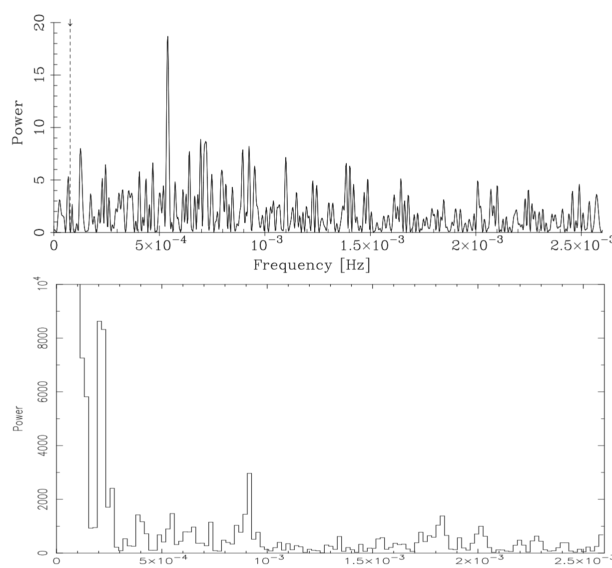

Figure 2. The ASCA SIS0 (top) and XMM-Newton EPIC-MOS1 (bottom) power spectra of LS Pegasi.

tion have a common physical origin. Hence, we proposed an XMM-Newton observation in an attempt to confirm the modulation and so resolve the true nature of LS Peg.

2. XMM-NEWTON OBSERVATIONS OF LS PEG

Our temporal analysis of the XMM-Newton observation of LS Peg has failed to confirm the existence of the modulation detected in the ASCA observation (figure 2).

We began our spectral modelling of the XMM-Newton EPIC-MOS1 data by fitting a hot optically thin gas emission model at a single (7.5keV) temperature (the MEKAL model in *XSPEC*) above 3.5keV, which reveals the need for a significant amount of absorption (see figure 3). Including simple photo-electric absorption (WABS*MEKAL) also cannot reproduce the spectral shape between 1-3keV. Using a partial covering absorbing model instead (PCFABS*MEKAL) results in a much better fit, being able to reproduce the flat low-energy spectrum. This is also consistent with the spectral models expected of intermediate polars e.g. Norton & Watson (1989), Ishida, Mukai & Osborne (1994), Ezuka & Ishida (1999).

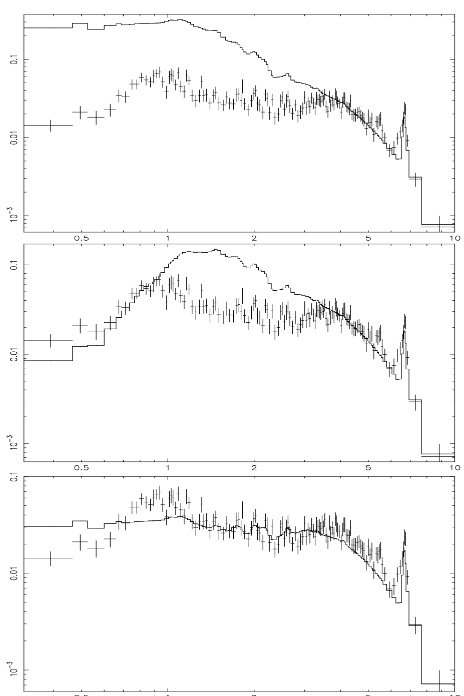

Figure 3. Fitting the XMM-Newton spectrum of LS Peg in XSPEC, using a single temperature hot diffuse gas model alone (top), with a simple photo-electric absorption model (middle), and with a partial covering absorbing model (bottom).

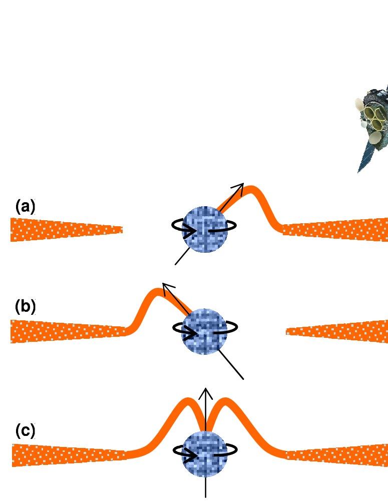

Figure 4. Geometry around the white dwarf in an intermediate polar. If the magnetic field axis of the white dwarf is not perpendicular to the accretion disk, the system (and so X-ray emission) modulates between **(a)** *and* **(b)***, as observed by XMM-Newton. However, if the magnetic axis of the white dwarf is aligned perpendicular to the accretion disk* **(c)***, no such modulation exists.*

3. THE NATURE AND POSSIBLE GEOMETRY OF LS PEGASI

Although no periodic modulation is detected in the XMM-Newton observation of LS Peg, the spectrum indicates that this system is an intermediate polar. Such a result might be expected if the white dwarf's magnetic axis is inclined almost perpendicular to the accretion disk.

When the magnetic axis of the white dwarf is inclined to the accretion disk plane, the accretion flow is modulated at the rotational frequency of the white dwarf (a modulation between geometry **a** & **b** in figure 4). However, if the magnetic field axis is aligned close to perpendicular to the accretion disk plane, no such modulation would be observed (figure 4**c**). In such a case, there would be only a small variation of the accretion stream with viewing angle (which changes as the white dwarf rotates). With such a geometry, even a strongly magnetic system would only be detected via spectroscopy.

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