CHANDRA X-RAY RESULTS ON V426 OPHIUCHI


1. INTRODUCTION

The cataclysmic variable V426 Oph has proven to be somewhat enigmatic, despite extensive study. First identified as a bright nova-like (V = 11.5 – 13.4) with an emission line spectrum (Herbig 1960), a detailed spectroscopic study by Hessman (1988) revealed a K3 dwarf secondary in a 6.85 hr orbit with a white dwarf (WD), with an inclination of 53° and at a distance of 200 pc. He also concluded this was a Z Cam type of dwarf nova (DN). However, there are several observational clues that V426 Oph might harbor a magnetic WD: (i) an unusually flat flux distribution in the UV, possibly due to the truncation of a hot inner disk, (ii) the X-ray flux at quiescence is larger than for typical DNe (Szkody 1986), (iii) the emission lines show flaring activity and a phase shift from a location near the WD (Hessman 1988), (iv) quasi-periodic variability has been seen in the optical and X-ray at periods from 30 min to 4.5 hr (Szkody 1986, Szkody et al 1990, Rosen et al. 1994; but see Hellier et al. 1990). To further explore these ideas, and to try to resolve the nature of the accretion in V426 Oph, we obtained a Chandra observation at quiescence together with simultaneous optical photometry and a single contemporaneous spectrum. Additional photometry was later obtained (see summary in table).

2. DATA ANALYSIS

Chandra grating spectra and response files were extracted with CIAO. We performed cooling flow fits in XSPEC and more detailed modelling using key line fluxes. We also constructed a Chandra lightcurve from the PSF wings plus part of the 1st order spectrum in CIAO (Fig. 1). We obtained past ROSAT and Ginga data from the HEASARC archive, and supplementary optical lightcurves (some simultaneous). To search for both sinusoidal and more irregular morphology modulations we undertook period searches with Lomb-Scargle and PDM techniques and fitted sinusoids at the candidate periods.

3. IP NATURE OF V426

The classic signature of an IP is the presence of two or more coherent periodic modulations corresponding to the binary orbit, white dwarf spin and...
Possibly their beat. In Figure 2 we summarise all the periods reported for V426 Oph in the literature and from our own (re)analyses. The previous candidates for \( P_{\text{spin}} \) (\( \sim 30, 60 \) min) we conclude are quasi-periodic and transient in occurrence. Instead, we have now finally found a much stronger candidate for the white dwarf spin period, at a surprisingly long period \( \sim 4.2 \) hr. This period or its first harmonic appear persistently at least from 1988 to 2003. Hence, we find that \( P_{\text{spin}} / P_{\text{orb}} = 0.62 \), greater than for most IPs, but similar to that of the short period system EX Hya (0.68). Here rotational equilibria is reached where \( R_{\text{in}} \sim R_{\text{co}} \sim b \), and the magnetic forces dominate the motion of diamagnetic blobs of gas even at the \( L_1 \) point (King & Wynn 1999). Norton et al (2003, and these proceedings) have extended the model of magnetic accretion used to find this equilibrium to other orbital and spin periods. For the case of V426 Oph an equilibrium is possible, but for a large magnetic moment \( \sim 10^{35} \) G cm\(^3\), which will only allow at most a ring of gas to exist close to \( R_{L_1} \). Moreover, V426 Oph lies close to the dividing line between Polars and IPs and may well be on the verge of synchronization (see Mason & Gray, these proceedings).

Spectroscopically, there are also similarities between EX Hya and V426 Oph. Both are better fit with a cooling flow (or shock) model than photoexcitation, and have \( T_{\text{max}} \sim 20 \) keV (Fig. 3). We have also experimented with a radiative shock wave code (Raymond 1979), modelling key line fluxes only. We find that the match is far from perfect, but it is close enough to indicate that the shock structure is basically correct, lending further support to the magnetic CV interpretation.

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REFERENCES

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Fig. 1. Upper: Partly simultaneous lightcurve in X-rays (from Chandra/ACIS-S in cts/s) and optical. A double-sinusoid fit is over-plotted, with periods of 4.23 and 2.12 hrs. Lower: For the X-ray data the Lomb-Scargle periodogram and lightcurve folded on 4.23 hr are also shown.

Fig. 2. Periodicities measured for V426 Oph, including published results, and those from our own (re)analyses.

Fig. 3. Chandra/HETGS unfolded spectrum of V426 Oph; both HEG (solid cyan) and MEG (solid green) are shown. Overlaid is the best fit cooling flow model (dotted black).