THE X-RAY SPECTRA OF SYMBIOTIC STARS

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ABSTRACT  Symbiotic stars are thought to show distinct X-ray emission from the accreting object and from the colliding winds of the two stars. I show that the colliding wind component is unnecessary. Instead, the spectra can be interpreted as emission only from the compact object that is strongly absorbed by the partially-ionised wind of the red giant. There remains no evidence of any X-ray emission from colliding winds, and thus no need for a substantial wind from the compact object.

KEYWORDS: binaries: symbiotic — stars: winds, outflows — white dwarfs — X-rays: stars

1. INTRODUCTION

Symbiotic stars are binary stars in which usually a white dwarf accretes from the wind of a red giant (e.g. Luthardt 1992). Their X-ray spectra are apparently dominated by distinct soft and hard X-ray components (I do not discuss the third “supersoft” case – usually interpreted as steady nuclear burning of accreted material). As an example I take the ASCA GIS2 spectrum of the bright symbiotic CH Cyg, plotted in Figure 1. The emission is seen to peak at 1 keV and at 5 keV. In Figure 1 I have also overlaid a simple 10 keV bremsstrahlung spectrum that has been folded through the response of the telescope. The dip in the observed spectrum (at 2 keV) corresponds to a maximum in the effective area of ASCA, and thus must be a true minimum in the X-ray emission of the CH Cyg.

The ASCA observation of CH Cyg was analysed by Ezuka, Ishida & Makino (1998). To achieve an acceptable fit they required three emission components (kT= 0.2, 0.7, 7.3 keV), each with a different absorption column, plus an additional partial-covering absorber. Usually the hard emission is attributed to the accreting compact object and the soft emission to colliding winds of the two stars. In this paper I demonstrate that the spectrum can be understood with a far more simple model, and that there is no need for a separate soft component.

2. IONISED ABSORPTION

The key to this new interpretation is to allow the absorbing medium to be partially ionised. This is reasonable because the wind of the red giant — the obvious candidate absorber — is strongly illuminated by ionising radiation from the accreting
white dwarf. Fitting the ASCA spectrum with a single-temperature emission model \( (mekal) \) absorbed by a photoionised medium \( (absori) \) I readily achieve a fairly good fit (reduced \( \chi^2 \)=2.4 with 172 d.o.f.; top panel of Figure 2). The residuals are dominated by narrow features at 0.9 keV and 6.4 keV. Adding narrow lines to the model I find an acceptable fit (reduced \( \chi^2 \)=1.4 with 168 d.o.f.; bottom panel of Figure 2). Best fitting parameters are \( kT=11 \) keV, \( N_H = 4 \times 10^{23} \) cm\(^{-2} \), \( \xi=840 \) (ionisation parameter).

3. LINE EMISSION
The 6.4 keV emission line is most likely due to K\( _\alpha \) fluorescence of weakly-ionised iron. Since the absorbing medium is strongly ionised, this fluorescence must arise elsewhere, probably through reflection from the surface of the compact object. The 0.9 keV line is more difficult to identify because its energy is less well constrained and there are a large number of emission lines in this portion of the X-ray spectrum. However, its proximity to the strong OVIII absorption edge (see Figure 3) suggests it is most likely the recombination continuum emission of OVIII. The emission spectrum of the absorbing medium is neglected in the ionised absorption model \( (absori) \).
FIGURE 2. The ASCA GIS2 spectrum of CH Cyg fitted with an ionised absorption model and a single emission component (top panel). Narrow emission lines have been added to the model for the lower panel (at 0.9 & 6.4 keV), resulting in an acceptable fit to the spectrum (reduced $\chi^2=1.4$ with 168 d.o.f.).
4. NO NEED FOR COLLIDING WINDS

The consequence of my fit to the ASCA spectrum of CH Cyg is that a separate low-temperature emission component is no longer needed. Thus there is no need to invoke X-ray emission from colliding winds in this system, and indeed, no longer any need for a substantial wind from the white dwarf.

The model spectrum (Figure 3) shows how the partially ionised absorber cuts deeply at intermediate energies but allows soft photons to leak through. Most evidence taken to support X-ray emission from colliding winds has come from soft X-ray observations, e.g. ROSAT (Mürset, Wolff & Jordan 1997). Clearly the ROSAT spectrum (0.1-2.5keV) of an absorbed system will reveal only the soft X-ray leak, and this could be mistaken for a low temperature emission spectrum. I believe that all the ROSAT spectra of symbiotic stars previously interpreted as emission from colliding winds may be reinterpreted as absorbed hard X-ray spectra.

REFERENCES

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