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ROSAT Observations of 4 Draconis: AM Her or Symbiotic?

Peter J. Wheatley

Astronomical Institute, Utrecht University, Postbus 80 000, NL-3508 TA Utrecht, The Netherlands

Abstract. I present the first X-ray observations of the red giant, 4 Draconis—thought to have an AM Her companion. I find evidence for absorption by the ionised wind of the red giant, but no sign of the soft X-ray emission typical of (high-state) AM Hers.

1. Introduction

Reimers (1985) reports the discovery of a blue companion to the M3 III giant, 4 Draconis. He finds an ultraviolet spectrum reminiscent of high-accretion-rate cataclysmic variables: broad high-excitation emission lines, and a continuum which decreases slowly between 3000 & 1500 Å before rising steeply in the far ultraviolet. He also finds narrow low-excitation emission lines which he attributes to the ionised wind of the giant.

More detailed observations are presented by Reimers, Griffin & Brown (1988). They determine the orbit of the giant, and find a 4 h period in the ultraviolet flux. This period, together with the ultraviolet spectrum, suggests that the blue companion is an AM Her-type cataclysmic variable.

Eggleton, Bailyn & Tout (1989) point out that the orbit of the wide pair in 4 Draconis (P_{orb}=1703 d) would have been a tight squeeze for the progenitor of a cataclysmic variable. Provided the presence of the AM Her can be confirmed, this places unique constraints on the evolution of cataclysmic variables.

2. ROSAT observations

4 Draconis has been observed twice with the ROSAT PSPC: once as the target (April 1991, 15 ks exposure) and once serendipitously (June 1993, 5.7 ks). It is detected in both pointings, with count rates of 0.014 ± 0.001 and 0.90 ± 0.02 cts/s respectively. Both spectra are plotted in Fig. 1. The 1993 spectrum shows no sign of the ultra-soft emission typical of AM Hers, and is well fitted with an optically-thin thermal plasma model (kT$\sim$4 keV; $N_H \sim 10^{19}\,\mathrm{cm}^{-2}$; $L_{100\,pc} \sim 2\times10^{31}\,\mathrm{erg\,s^{-1}}$). The 1991 spectrum also shows no ultra-soft component, but is complex, and cannot be fitted with any reasonable pure-emission model (the best single-component fit is plotted in Fig. 1). I do, however, find a good fit with the ionised-absorber model of Cropper, Ramsay & Wu (1996). The warm material absorbs strongly around 1 keV, yet allows soft photons to leak through. An obvious candidate for the absorbing material is the ionised wind of the red giant.

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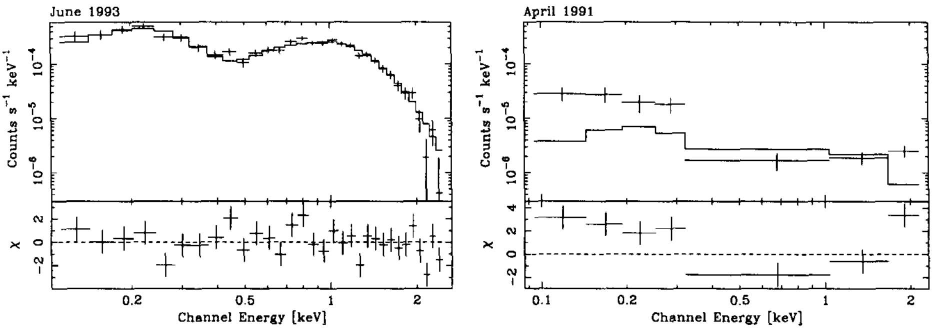

Figure 1. ROSAT spectra of 4 Draconis fitted with an optically-thin thermal plasma model. There is no evidence for the ultra-soft emission expected from an AM Her. The 1991 spectrum cannot be described with any physically-plausible pure-emission model.

3. Discussion

The ROSAT observations of 4 Draconis show that the companion of the giant is a luminous X-ray source. The spectra, however, cast doubt on its identification as a AM Her, since all known AM Hers exhibit strong ultra-soft X-ray emission (kT~20 eV). However, Ramsay, Cropper & Mason (1995) find that the strength of this component drops dramatically as AM Hers enter their low states. Indeed, the low-state spectrum of AM Her itself (kT~4 keV, unpublished) is remarkably similar to that of 4 Draconis in 1993. It is possible, then, that the companion of 4 Draconis is an AM Her, observed in its low state with ROSAT. As such it would be a spectacular soft X-ray source in a high state—probably brighter than AM Her itself.

The presence of variable, warm absorption in the system can be, most probably, attributed to the ionised wind of the red giant. From the radial-velocity curve of Reimers, Griffin & Brown (1988), I find that the *unabsorbed* 1993 ROSAT spectrum was taken soon after inferior conjunction of the X-ray source: when one might expect absorption by the wind to be at a minimum. On the other hand, this is where one might expect to detect the accretion wake of a compact object accreting from the wind. Resolving the variation in absorption through the 1703 d orbit of 4 Draconis should prove powerful in determining the structure of the wind of the giant, and may provide the key to distinguishing between a companion accreting from the wind of the giant and a cataclysmic variable transferring material internally.

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