The optical counterpart of the double degenerate Polar RX J1914+24

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Abstract. Cropper et al. presented X-ray observations of RX J1914+24 and claimed that the most likely interpretation of their data was that of a double degenerate Polar. Here we show the preliminary results of optical and further X-ray observations. We identify the optical counterpart and show that no other period apart from the 569 sec period seen in X-rays is identified. Although the optical counterpart has no significant polarised flux in the I band, our *ASCA* spectrum (which is typical of a Polar) together with our photometric result adds weight to the conclusion that RX J1914+24 is the first double degenerate Polar to be discovered.

1. Introduction

Cropper et al. (1998) reported X-ray observations obtained using *ROSAT* of the X-ray source RX J1914+24 discovered by Motch et al. (1996) and attribute the 569 sec period they detected to the binary orbital period. This would make it the shortest orbital period of any known binary system. From the absence of any other X-ray period and the shape of the folded X-ray light curve, they suggest that RX J1914+24 is the first double degenerate Polar to be discovered, rather than the other possibility that it is an Intermediate Polar. This paper gives the preliminary results of our search for the optical counterpart of RX J1914+24 and our initial analysis of our *ASCA* X-ray spectrum of RX J1914+24.

2. Photometry

Cropper et al. (1998) found that RX J1914+24 was closest to star H in the finding chart of Motch et al. (1996). Motch et al. indicate that star H is heavily reddened and not visible in V. We therefore obtained a service image of RX J1914+24 in K taken using UKIRT in Oct 1997 and found that star H is made up of more than 1 star. Follow-up observations were obtained between 25–27 June 1998 using the NOT on La Palma. Polarimetry observations were made in the I band: o and e rays were separated by $\sim 12''$ on the same CCD (fig 1).

Photometry of stars in the field was obtained using profile fitting. As the profiles of the stars in the two rays were different, photometry was obtained on each set of images. Our NOT photometry showed that the brightest of the stars making up star 'H' was the optical counterpart of RX J1914+24. The mean

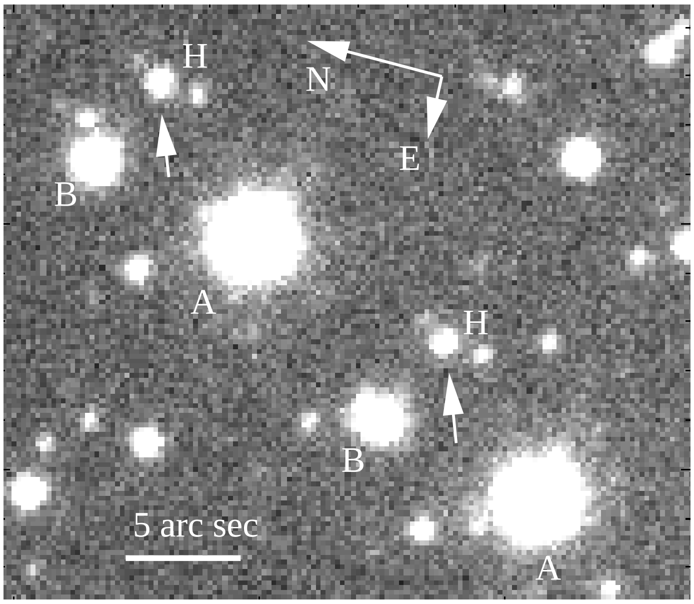

Figure 1. An I band image of the field of RX 1914 taken in June 1998 using NOT. Two images of the each object in the field are recorded - one from each polarised ray. Stars A and B in the finding chart of Motch et al. (1996) are shown. RX J1914+24 is marked by an arrow. Star H of Motch et al. is thus a blend of more than 1 star (including RX J1914+24).

magnitude was I ~18.2: ~1.6 mag fainter than found by Motch et al. (1996) in June 1993. There is no evidence that RX J1914+24 is significantly circularly polarised. In addition to these I band data, J band data taken using UKIRT the following week have still to be analysed.

3. The folded data

Cropper et al. (1998) showed *ROSAT* data from 3 distinct epochs. Since then we have obtained another set of *ROSAT* data. We have been able to derive an accurate ephemeris using the start of the increase in X-ray flux to define ϕ=0.0 (T_o= HJD 2449258.03941(6) + 0.0065902334(4)). Fig 2 shows all our *ROSAT* data folded on this ephemeris. This shows that there has been a gradual decrease in X-ray flux from Sept 1993 to Oct 1997 (fig 2). In other respects the light curves are similar in that they all show zero flux for ~ half the 569 sec period.

A power spectrum of our I band photometry indicates that only one period (the 569 sec period seen in X-rays) is present (fig 3). We show the I band data folded using all 3 nights of data in the bottom panel of fig 2 using the above ephemeris (which is sufficiently accurate to match the phasing to within 0.02 cycles). The folded data is roughly sinusoidal in shape. Interestingly, the peak precedes the X-ray peak by ϕ ~0.4.

4. The *ASCA* spectrum

We obtained a 20ksec observation of RX J1914+24 in April 1998. RX J1914+24 was detected only in the SIS and only below 1keV. Its spectrum (fig 4) could be

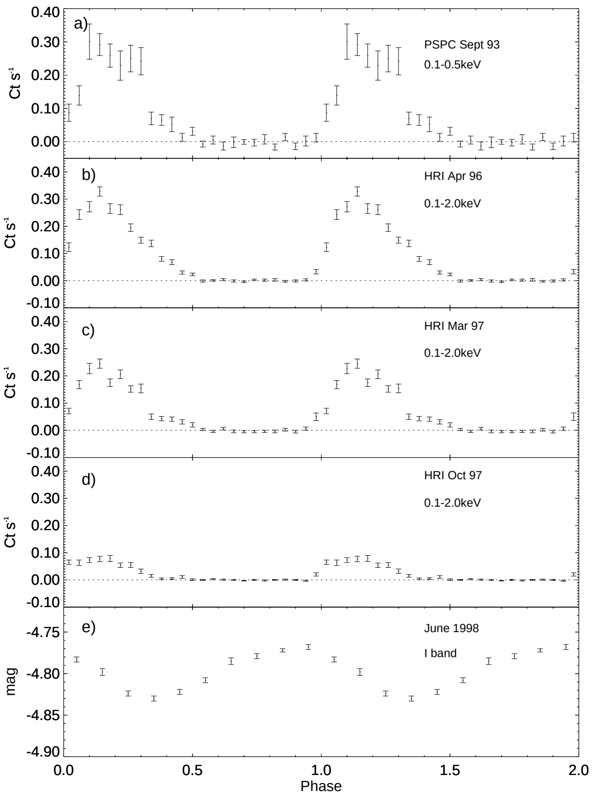

Figure 2. The *ROSAT* X-ray data from different epochs together with the I band photometry taken in June 1998 folded on the ephemeris T_o= HJD 2449258.03941 + 0.0065902334.

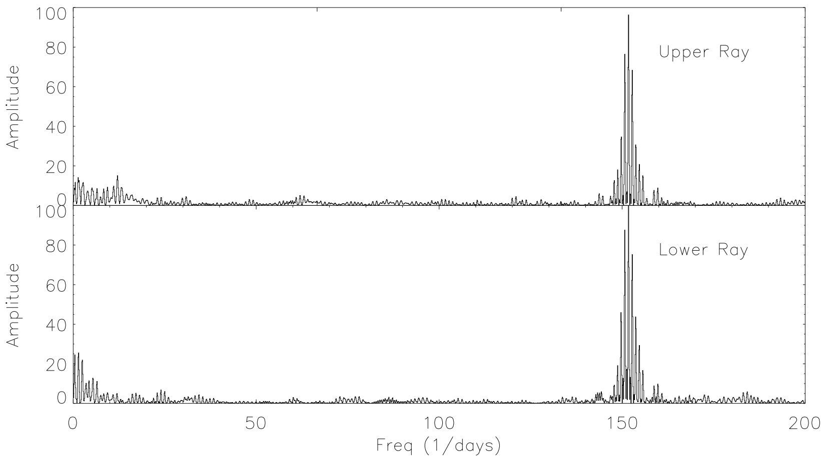

Figure 3. The amplitude spectra of RX J1914+24 covering 3 nights of *I* band photometry obtained using NOT in June 1998. Since both polarised rays were recorded we obtained two amplitude spectra. The prominent peak near Freq=150 is the 569 sec period seen in X-rays.

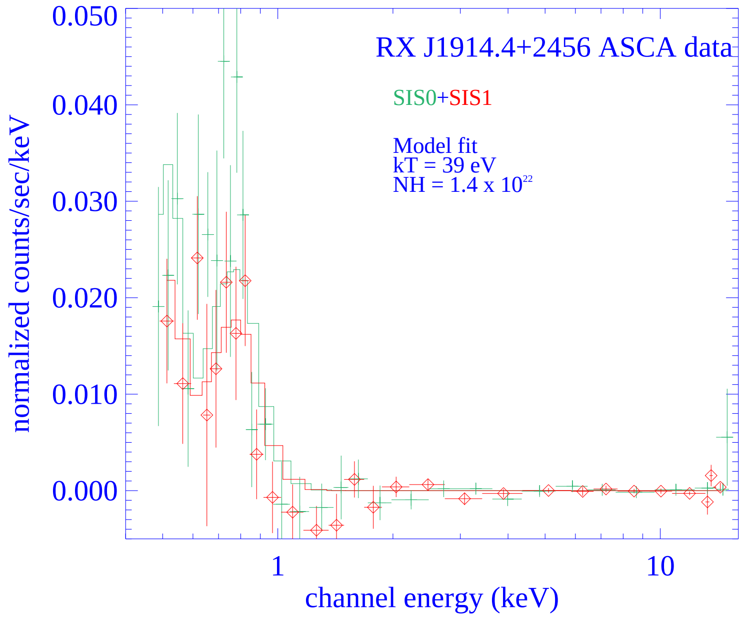

Figure 4. The integrated *ASCA* SIS-0 and SIS-1 spectra. The fit to an absorbed blackbody model is shown together with their fitted parameters.

well fitted with a low temperature (kT ~40eV) blackbody plus interstellar absorption ($N_H \sim 1 \times 10^{22}$ cm^{-2}). The 4σ upper limit to a thermal bremsstrahlung component (assumed temperature 20keV) corresponds to a $2 - 10$ keV flux of 3.2×10^{-13} erg/cm^2/s (4×10^{29} erg/s at 100 pc). This is typical of a Polar. X-ray spectra of Intermediate Polars are typically much harder.

5. Conclusion

We have detected the optical counterpart of RX J1914+24. We find only one period in its I band folded optical light curve (the same 569 sec period we find in X-rays). When we folded this data on the 569 sec period we obtain a quasi-sinusoidal modulation offset in phase compared with the X-rays. The fact that we detect only one period, together with the very soft *ASCA* spectrum is further evidence in favour of the interpretation that RX J1914+24 is a double degenerate Polar. A detailed paper is in preparation.

References

Cropper, M., et al., 1998, MNRAS, 293, L57

Motch, C., et al., 1996, A&A, 307, 459