

Optical Studies of the X-ray Transient XTE J2123–058 – II. Doppler Tomography. Echoes of the SW Sex Phenomenon?

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1. Introduction

XTE J2123–058 is a transient low-mass X-ray binary with a neutron star primary. Its 17th mag. optical counterpart shows strong optical modulation on a 6-hr period from heating of the companion and possible partial eclipses (see Zurita et al. this proceedings, henceforth Paper I) High Galactic latitude implies a possible origin in the halo.

We obtained 28 spectra over two 6-hr orbits on 1998 July 19–20 using WHT/ISIS. These covered $\sim 3700\text{--}6700\text{ \AA}$ at $2.9\text{--}4.1\text{ \AA}$ resolution. Flux calibration used another star on the slit. Our extensive photometry is described in Paper I.

2. Spectral lines

Several spectral lines can be identified. He II 4686 \AA is very prominent and other He II lines can be identified. C III/N III (Bowen blend) at $\sim 4640\text{ \AA}$ is also strong, Balmer lines show a complex profile with broad absorption and a complex emission core (blended with coincident He II lines) and C IV emission may also be present from the 5801/5812 \AA doublet. The 4640:4686 equivalent width ratio is typical of Galactic plane objects (Motch & Pakull 1989) suggesting that XTE J2123–058 did not originate in the halo but instead was kicked out of the Galactic plane when the neutron star was formed.

He II reveals complex orbital line profile and flux changes, with multiple S-wave components present in the trailed spectrogram. We used maximum entropy Doppler tomography (Marsh & Horne 1988) as implemented in DOPPLER to identify emission sites in velocity space. As the integrated line flux varies with phase, we have normalised the line profiles to constant flux before applying tomography. Note that the position of the Roche lobe of the companion (teardrop shape), the centres of the two stars (marked with crosses), the accretion stream (arc to the upper left) and the edge of the disc (large circle) are based on uncertain system parameters; see Paper I.

3. Interpretation

Doppler tomography has been used extensively in studies of CVs. Common emission sites are the companion star, accretion disc, stream and hot spot. We appear to see weak emission on the ballistic stream trajectory, but the bright spot in the lower left quadrant is not consistent with any of these sites. This pattern is probably not unique to XTE J2123–058. Amongst other LMXBs, both 4U 2129+47 (Thorstensen & Charles 1982) and EXO 0748–676 (Crampton et al. 1986) show He II radial velocity

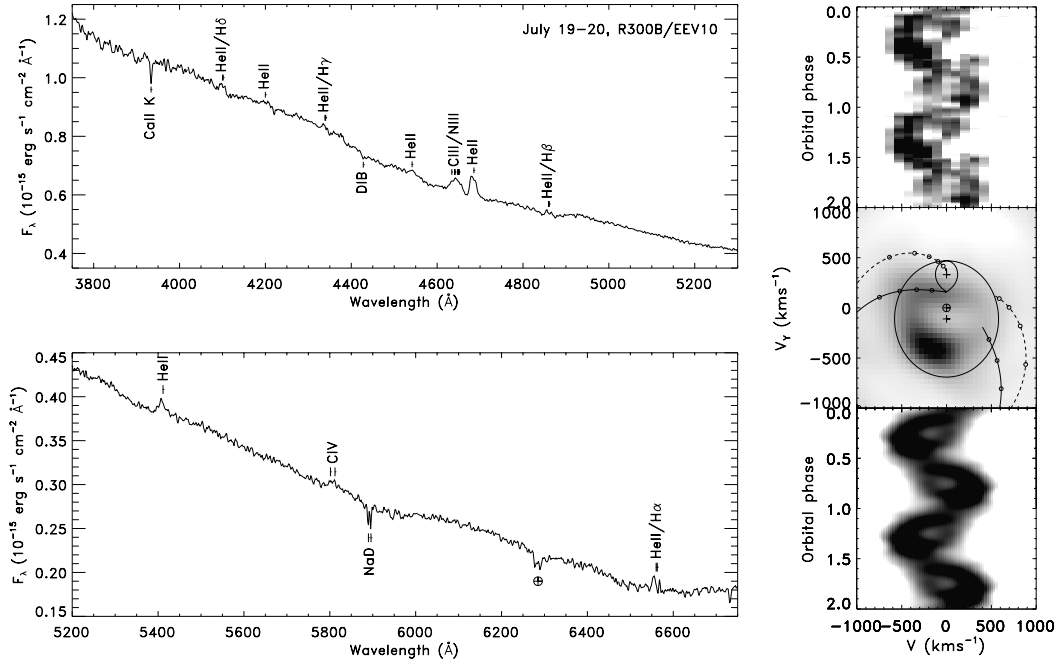


Fig. 1. Left: average spectra. Right: Doppler tomography of He II 4686 Å. Upper panel is normalised spectrogram, middle panel is tomogram and lower panel is a spectrogram reconstructed from the tomogram.

modulations with similar amplitude and phasing. The closest CV analogue appears to be SW Sex systems, which often show a bright spot in the lower left quadrant of the tomogram. We suggest that a common mechanism may be at work in both SW Sex stars and LMXBs such as XTE J2123–058. Currently favoured models for SW Sex systems include variations on an accretion stream overflow and reimpact (Hellier 1988 and references therein) or ejection of material by a disc anchored magnetic propeller (Horne 1999). Initial tests suggest that a propeller model can provide a quantitative explanation for XTE J2123–058.

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