Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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Infrared spectroscopic variability of Cygnus X-3

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Abstract. We present four epochs of high-resolution IR spectroscopy of the peculiar X-ray binary Cygnus X-3. The observations cover quiescent, small flaring and outburst states of the system as defined by radio and X-ray monitoring. The underlying IR spectrum of the source, as observed during radio and X-ray quiescence and small flaring states is one of broad, weak He II and N V emission. Spectral variability in this state is dominated by modulation at the 4.8 hr orbital period of the system. *H*-band spectra confirm the significant hydrogen depletion of the mass donor. In outburst, the infrared spectrum is dramatically different, with the appearance of very strong twin-peaked He I emission displaying both day-to-day variability and V(iolet)/R(ed) variations with orbital phase. We argue that the most likely explanation appears to be an enhanced stellar wind from the companion. Thus the X-ray and radio outbursts in this system are likely to originate in mass-transfer, and not disc instabilities. We suggest that the wind in Cyg X-3 is significantly flattened in the plane of the binary orbit. This may explain the observed twin-peaked He I features as well as reconcile the large infrared luminosity with the large optical depth to X-rays if Cyg X-3 is embedded in a spherically symmetric wind.

1. Cygnus X-3

Cygnus X-3 is a heavily obscured luminous X-ray binary in the Galactic plane which displays a unique and poorly-understood combination of observational properties. These include strong radio emission, with a flat spectrum extending to mm wavelengths in quiescence and giant flares which are associated with a relativistic jet (Mioduszewski *et al.* 1988). There is no optical counterpart at wavelengths shorter than ~ 0.8 μm due to heavy interstellar extinction. A clear and persistent (> 20 yr) asymmetric modulation in the X-ray and infrared continuum emission with a period of 4.8 hr is interpreted as the orbital period of the system. IR spectroscopy of the system in 1991 (van Kerkwijk *et al.* 1992) first revealed the presence of broad emission lines and an absence of hydrogen which was reminiscent of Wolf-Rayet stars. The binary is interpreted as comprising a compact object (neutron star or black hole) and helium core of a massive star, embedded within a dense stellar wind. Unfortunately, most models of WR stars do not envisage objects which can be contained within a 4.8 hr orbit.

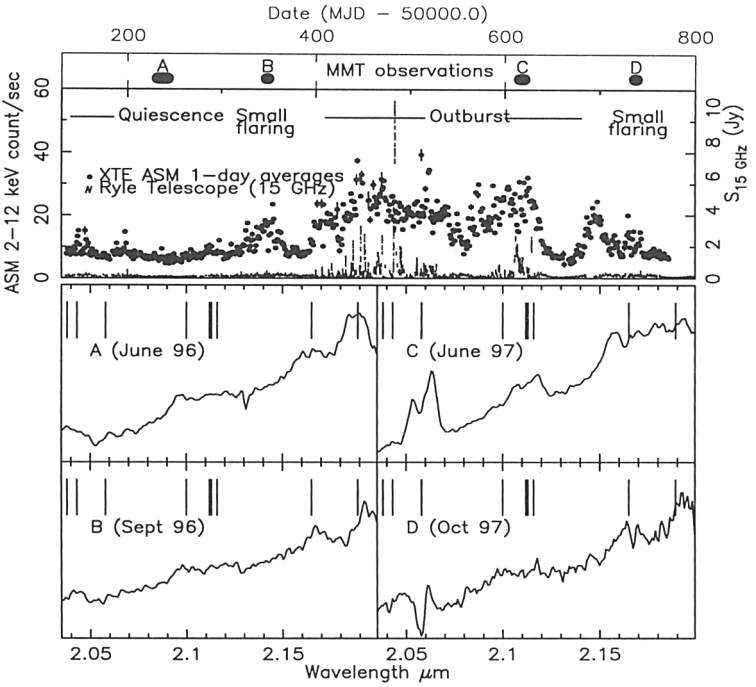

Figure 1. An illustration of our four observing periods, labelled A,B,C,D against a backdrop of X-ray and radio monitoring. We have observed Cyg X-3 in distinct states of quiescence, small flaring and outburst. Spectra characteristics of each epoch are indicated in the lower plane. Tick marks indicate lines in Figure 2 of Fender, Hanson & Pooley (1999)

In this poster we briefly review results from our recent paper which presents four epochs of high-resolution near-infrared spectroscopy of Cyg X-3 with the *Multiple Mirror Telescope* over a two year period (Fender, Hanson & Pooley 1999). These observations cover periods of quiescence, small flaring and major outburst as revealed in radio and X-ray monitoring (see Figure 1). In our paper, we thoroughly outline the clear changes in the spectrum of the source as a function of state and outline a scenario which appears to explain many of the observed properties applying a disc-wind model for the Cyg X-3 system.

References

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