

# Spatial evolution of the infrared emission features of the Red Rectangle

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## Abstract.

A major challenge in astrochemistry is to determine the precise identification, formation process(es) and excitation mechanism(s) of the carriers of the ubiquitous Unidentified Infrared (UIR) Bands. A complementary challenge for oxygen-rich environments is to establish the distribution and form of silicates both in circumstellar environments and the ISM.

In this study the emission bands of the Red Rectangle in the near-IR and mid-IR spectral regions have been investigated as a function of distance from the central binary star, HD 44179. The evolution of the spectral profiles with increasing offset provides insight into the nature of the carriers including changes in their chemical structure and form along the biconical interfaces of this unusual protoplanetary nebula.

The 3.3  $\mu\text{m}$  PAH emission feature shows a gradual broadening with increasing offset, with the development of a blue shoulder (shorter wavelength). This has been interpreted as due to the growth of a new 3.28  $\mu\text{m}$  band (Song, Kerr, McCombie *et al.* 2003). Comparison here with laboratory emission data suggests that the new feature arises from acene structures, whereas the main 3.3  $\mu\text{m}$  band is due to condensed PAHs. There is a good correspondence between the wavelength and width of the 3.28  $\mu\text{m}$  emission band and an absorption band seen towards the Galactic centre (Chiar, Tielens, Whittet *et al.* 2000.)

Mid-IR spectra (7 - 13  $\mu\text{m}$ ) of the Red Rectangle nebula have also been recorded as a function of distance from the on-star position out to  $\sim 10$  arcsec offset along the biconical interfaces, and reveal both silicate (CS) and UIR band features. A plot of the UIR band intensity ratios 18.6  $\mu\text{m}$ /11.3  $\mu\text{m}$  *vs.* 17.7  $\mu\text{m}$  /11.3  $\mu\text{m}$  for the Red Rectangle nebula and other objects shows an approximately linear relationship, yielding information on the ionisation and dehydrogenation states of the carriers.

Spectra were obtained using a long slit configuration and the CGS4 (1- 5  $\mu\text{m}$ , R = 1200) and MICHELLE (7 - 25  $\mu\text{m}$ , R = 200) instruments at UKIRT along the North West (NW) and South East (SE) whiskers of the Red Rectangle.

**Keywords.** astrochemistry, line: profiles, molecular data, stars: AGB and post-AGB, ISM: molecules

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## References

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