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High-resolution spectroscopy of emission bands of PAHs and nanodiamonds in extended objects

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Abstract.

The UIR bands are found in a wide variety of sources e.g. H II regions, PNe, post-AGB stars, YSOs, the diffuse ISM, external galaxies and active galactic nuclei and are normally attributed to polycyclic aromatic hydrocarbons (PAHs). Apart from the intrinsic importance in determining the chemical form of interstellar matter and its role in astrophysical processes, there are much wider astronomical implications; e.g. the use of the UIR features as a probe of external galaxies. A few objects have recently been shown to exhibit IR emission from nanodiamonds.

A high-resolution study has been undertaken of near-infrared emission (3.0 - 3.6 μm) from a variety of objects (Elias 1, the Orion Bar and the CS region of HD 44179), and additionally of the 11.3 μm emission feature in the Red Rectangle nebula. The aim has been to investigate the spatial intensity variations of the bands within these objects and to map the evolution of their spectral profiles. This provides insight into the nature of the carriers and is a probe of the physical and chemical properties of the circumstellar and nebular environments.

Elias 1 is an interesting case as it exhibits the rare nanodiamond emission at 3.4/3.5 μm in addition to 3.3 μm PAH emission which is found to be more extended. The Red Rectangle is also unusual in that the UIR emission is very strong in the carbon-rich nebula whereas the silicate emission appears to be confined largely to the circumbinary disk. This chemical spatial separation must reflect different epochs of mass-loss. The 11.3 μm emission feature develops substructure as a function of offset in a manner analogous to the development of the 3.3 μm band.

Spectra were obtained at UKIRT, using the UIST (near-IR, R = 700) and MICHELLE (mid-IR, R = 1000) instruments.

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