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Antalya astronomers Zeki Aslan and Orhan Gölbaşı arriving at the banquet with their wives and daughters.

Waiting for sushi: Takashi Iijima, Kunio Noguchi, Wako Aoki, and Takashi Tsuji posing before the banquet.

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MOLECULAR OPTICAL AND INFRARED EMISSION FROM THE RED RECTANGLE

Carriers of Diffuse Circumstellar, Nebular and Interstellar Bands

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Abstract. A link between stellar and interstellar molecules is discussed with particular reference to optical and infrared emission from the Red Rectangle.

The diffuse interstellar bands appear in spectra recorded towards stars which are reddened by interstellar dust. They extend across much of the near-UV, visible and near-infrared spectrum and now number over 150. The generally good correlation of band strength with extinction has led to the suggestion that the absorptions arise in or on the dust grains, but recent observations provide strong support for the alternative hypothesis that the carriers are free gas-phase molecules (for a review see Herbig, 1995).

In what way is the diffuse interstellar absorption band problem related to the carbon star phenomenon? First, it is likely that the diffuse interstellar band carriers are carbon-rich and so it is plausible that they are formed by reactions in carbon stars, although there is very little hard evidence that this is the case. It may be that the important chemical structures are built through the chemistry of carbon stars but that the spectroscopic absorptions appear only when the products are subjected to a strong UV radiation field in the interstellar medium, resulting in a change in chemical form. This could be through photoionization, photodissociation leading to hydrogen atom loss, photoisomerization, etc. Secondly, the diffuse band carriers probably bridge a gap in the size distribution of astronomical material, lying between diatomic molecules such as C_2 and dust grains, both of which are abundant in stellar atmospheres and in diffuse interstellar clouds.

R.F. Wing (ed.), The Carbon Star Phenomenon, 407-408.

The Red Rectangle is a unique object which has a strong unidentified optical emission spectrum together with the set of 'unidentified' infrared emission bands (UIBs). It is a biconical nebula with a binary star at the centre and it is probable that the optical emission is excited by the A0–type star which illuminates material emanating from a carbon-rich star. The 'UIBs' are excited by UV excitation of PAH molecules or material. The optical emission bands arise from a subset of the carriers of the diffuse interstellar absorption bands (Sarre et al. 1995b), and the form and evolution of the Red Rectangle spectra as a function of offset from the exciting star strongly suggest a molecular (rather than grain) origin. The emission bands have also been seen in spectra of the R CrB star V854 Cen during minimum light (Rao & Lambert 1993), and the fact that both the Red Rectangle and V854 Cen are carbon-rich gives support to the idea of carbon-rich molecules being responsible for the spectra.

Although not observed in the infrared spectra of circumstellar shells such as IRC+10216, the widespread appearance of the UIBs has led to suggestions that the diffuse interstellar bands also arise from PAHs, possibly in ionised, dehydrogenated or radical form. The unique geometry of the Red Rectangle allows comparison between the spatial distribution of the optical bands and the 3.3 μm emission, attributed to the C–H stretch of PAHs. Comparing our data obtained using CGS4 on UKIRT with those of Schmidt & Witt (1991) for the optical bands, shows that whereas the yellow/red bands are prominent along the interfaces of the bicone, the infrared emission is almost symmetrically distributed in the nebula. While a chemical link between PAHs and the optical bands may well exist, it appears that the optical emission arises from a significantly different chemical form in which the C–H component is not important. Recent ultra-high-resolution studies of diffuse absorption bands falling in the same subgroup have revealed fine structure in the spectra (Sarre et al. 1995a) which further supports a molecular origin. The spectra can be modeled in terms of molecular carriers, and pure carbon rings emerge as good candidates for the carriers of some of the diffuse bands (Kerr et al. 1996).

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