

Analyses of the Aromatic Infrared Bands (AIBs) around the Wolf-Rayet Binary WR140

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Recent line survey observations toward the starless core Cyanopolyne Peak in Taurus Molecular Cloud-1 (TMC-1 CP) have reported the detection of aromatic species with the nitrile bond [1,2]. Their derived abundances are surprisingly high ($\sim 10^{-10}$) and comparable with some classical carbon-chain species. However, their abundances cannot be reproduced by the standard chemical network simulations considering only a bottom-up mechanism that assumes that all of the carbon is initially in the form of C^+ . Thus, some fraction of carbon may be inherited from the ISM in the form of polycyclic aromatic hydrocarbons (PAHs). Our science goal is to understand the lifecycle of carbon in the ISM; from evolved stars, through the diffuse ISM, to star-forming regions (*i.e.*, molecular clouds) [3].

We have analyzed data obtained from the James Webb Space Telescope (JWST) Mid-Infrared Instrument (MIRI) Medium-Resolution Spectrometer (MRS) toward the Wolf-Rayet binary WR140, where 17 nested circumstellar dust shells have been reported [4]. Our data covers the innermost dust shell (Shell 1; ~ 2100 au from WR140) and the subsequent dust shell (Shell 2; ~ 5200 au). We have analyzed spectra indicated in the left top panel of Figure 1 focusing on the aromatic infrared bands (AIBs) in the $6 - 11.2 \mu\text{m}$ region. These AIBs are generally considered to relate to PAHs.

We find that the observed spectral features around WR140 are different from typical class A-D AIB emission features in the ISM, as shown in right panels of Figure 1. We have compared the observed line widths (FWHM) and peak wavelengths of the $6 \mu\text{m}$ and $7.7 \mu\text{m}$ features, both of which come from the C-C stretching modes, to those of R Coronae Borealis (RCB) stars obtained with *Spitzer* [5]. The results indicate that FWHM and peak wavelengths of both features around WR140 are consistent with those of hydrogen-poor RCBs. We have also compared the observed spectra at the peak position on Shell 2 (S2) to those of the diffuse ISM toward the Galactic plane [6], as shown in the lower left panel of Figure 1. Although the peak wavelengths at S2 slightly different from those in the diffuse ISM, it is apparent that the two spectra are very similar.

Based on these results, it is proposed that hydrogen-poor carbonaceous material initially originates from the carbon-rich WR wind, and the hydrogen-rich stellar wind from the companion O star subsequently hydrogenates these carbonaceous materials. These hydrogenated carbonaceous compounds survive away from the WR star, and may be the origin of the interstellar PAHs after further processing by massive stars or in the diffuse ISM.

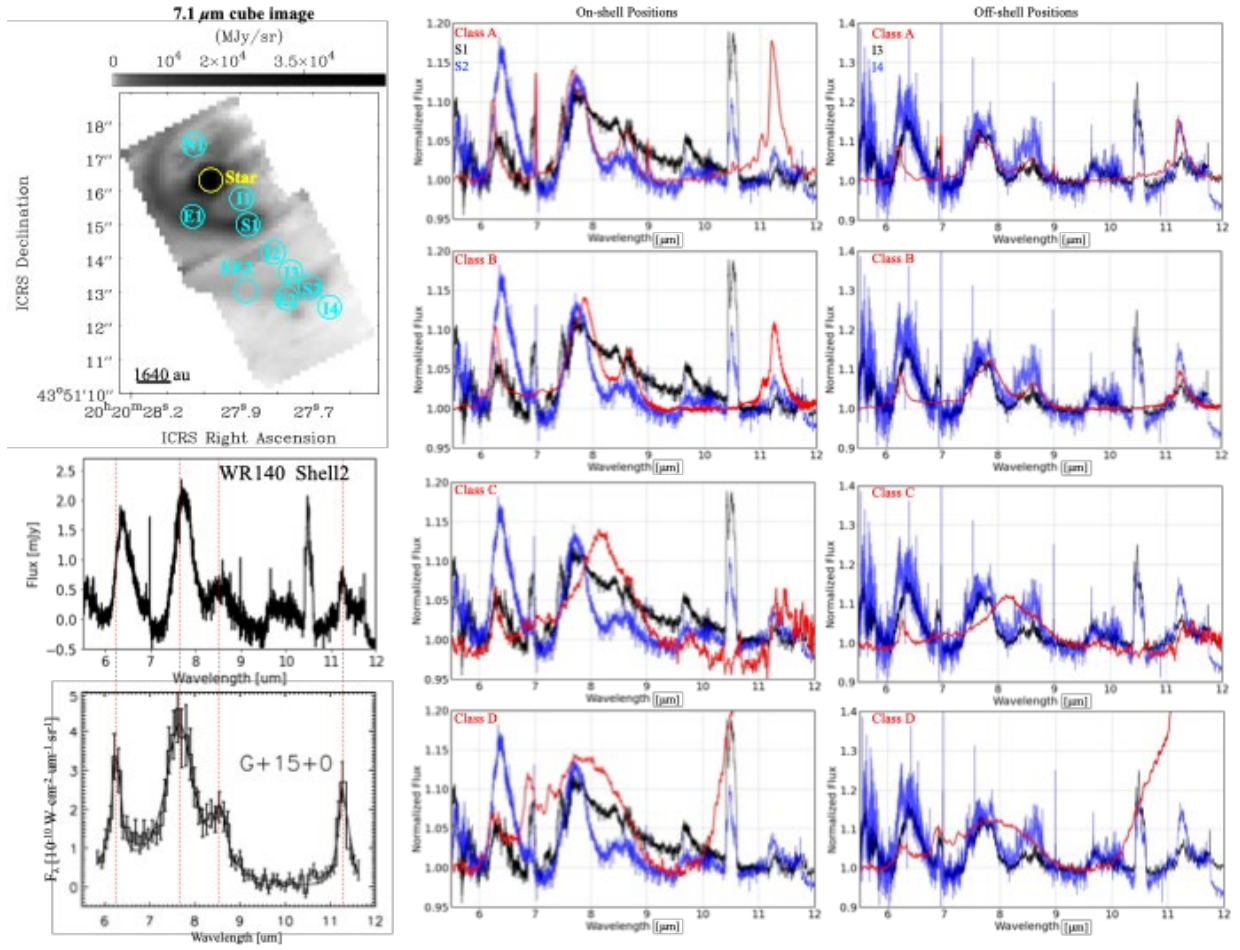


Figure 1: Left top panel shows the 7.1 μm cube image. The S1 and S2 positions indicate the peaks on Shell1 and Shell2, respectively. The left bottom panel shows comparison of the spectra at WR140 Shell 2 (upper) and the diffuse ISM toward the Galactic plane taken from [5] (lower). Right panels indicate comparisons of the observed spectra (black and blue) around WR140 and typical AIB emission features named classes A-D (red). These figures are taken from [7].

References

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