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The "21" μm and "30" μm Emission Features in Planetary Nebulae with Wolf-Rayet Central Stars

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Abstract. We present mid infrared spectra of two planetary nebulae with H poor central stars that exhibit the "21" and "30" μm emission features. These features are found in carbon rich dust surroundings. The presence of these features shows that these sources have suffered an extended period of carbon rich mass loss before becoming H poor. We discuss the occurrence of both O-rich and C-rich dust in the sample of planetary nebulae observed with the Infrared Space Observatory.

1. Introduction

The evolutionary path leading to the formation of planetary nebulae (PNe) with poor central stars (CS) ([WC]-PNe) is not well understood. The hydrogen is believed to be removed from the atmosphere during a thermal pulse (TP). When the envelope mass is low the TP may cause the remaining envelope to be mixed downward into the H burning layer. The timing of this thermal pulse along the evolutionary track from the asymptotic giant branch to PNe is uncertain. We have studied the composition of the circumstellar envelope (CSE) in the infrared (IR). The composition of the CSE reflects the conditions during the preceding phases when the envelope was formed. The composition of the dust formed is very sensitive to the C/O ratio. When this ratio is smaller than unity silicate dust is formed, called O-rich dust. When the C/O ratio is large than unity carbon based dust species are formed. Thus the composition of the CSE reflects (in principal) a history of the elemental composition of the star.

There are [WC]-PNe that simultaneously exhibit features from C-rich dust and O-rich dust (Waters et al., 1998; Cohen et al., 1999). These observations suggest that in these sources a recent transition from the production O-rich to C-rich dust has occurred.

2. "21" and "30" μm features in [WC]-PNe

We present two ISO/SWS spectra of the [WC]-PNe NGC 6369 and NGC 40 that show the "21" and "30" μm features (Hony et al., 2001). We show the identification of the features in Fig. 1. These features are exclusively found in

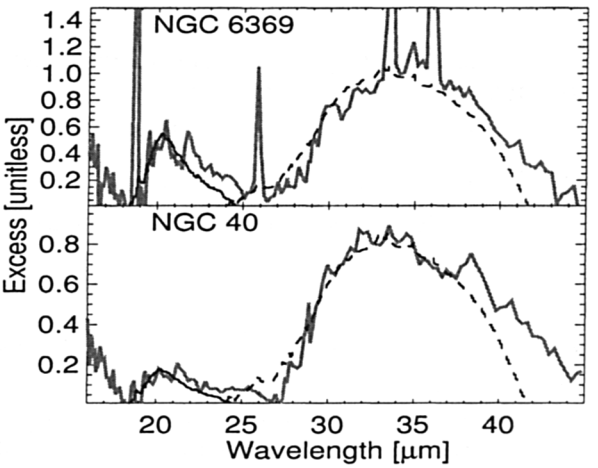

Figure 1. The features found in the spectra of NGC 6369 and NGC 40. We over-plot the profiles of the "21" μm feature and the "30" μm feature as found in HD 56126 and NGC 7027 respectively.

C-rich evolved stars. Therefore, these detections show that these sources have had a C/O ratio larger than unity long before they became H poor.

3. The occurrence rate of both O-rich and C-rich dust

We investigate PNe observed with ISO to quantify the occurrence rate of both O-rich and C-rich dust. Unfortunately, the ISO/PNe sample is not statistically representative but is biased to bright or specific types of PNe . We use the PAH features as indicators of C-rich dust and the silicate features for the O-rich dust. There are 79 PNe of which 49 are bright enough to reliably determine the presence of features. There are 13 [WC]-PNe and 36 PNe with H-rich CS. In the [WC]-PNe sample there are 4 sources with only C-rich dust features, 0 with only O-rich dust, 8 sources with a both dust types and 1 source without any features. In the H-rich sample these numbers are 7, 13, 4, 12 respectively. In the H-rich sample there are many PNe with O-rich CS. They never switched to making C-rich dust. Therefore, they should not be compared to the [WC]-PNe sample. Comparing the two samples with PAH emission we find the occurrence rates of both dust types [WC]-PNe: 8/12 = 67 per cent and H-rich CS: 4/12 = 33 per cent. We conclude that the occurrence rate of both dust chemistry is higher in the [WC]-PNe. However, we note that 1/3 of the [WC]-PNe show no evidence for a recent O-rich, i.e., a recent transition to C-rich.

References

Cohen, M., Barlow, M. J., Sylvester, R. J., et al. 1999, ApJ, 513, L135
Hony, S., Waters, L. B. F. M., & Tielens, A. G. G. M. 2001, A&A, 378, L41
Waters, L. B. F. M., Beinteman, D. A., Zijlstra, A. A., et al. 1998, A&A, 331

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