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Spitzer/IRS observations of OHPNe

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Abstract. We present Spitzer/IRS spectra of a small sample of galactic OHPNe. This is a rare class of transition sources displaying both radio continuum and OH maser emission at 1612 MHz. Our observations show that they are heavily obscured O-rich stars whose mid-infrared spectra are dominated by the simultaneous presence of strong and broad amorphous silicate absorption features together with crystalline silicate emission features which sometimes appear also in absorption. Three of the sources observed are non-variable, confirming their post-AGB status, while another two seem to be still strongly variable. We propose that OHPNe represent the youngest population of high-mass PNe in the Galaxy.

Keywords. Stars: AGB and post-AGB, OH/IR

1. Introduction

OHPN stars are a very small group of heavily obscured transition sources showing both the characteristics of standard OH/IR stars (strong infrared emission accompanied by the detection of OH maser emission at 1612 MHz) and of PNe (radio continuum emission at centimeter wavelengths). These sources were suggested to represent the 'missing link' between O-rich AGB stars and PNe by Zijlstra *et al.* (1989), although this was never confirmed observationally. These stars are so heavily obscured that they cannot be studied at optical wavelengths. However, they are among the brightest sources in the sky in the mid- and far-infrared, where they show spectral features which can provide crucial information on their chemistry, evolutionary stage and recent mass loss history. Here we present Spitzer/IRS spectra ($\sim$5$-$38 μm) of a selected sample of 5 OHPNe.

As we can see in Fig. 1, the O-rich chemistry of these stars is confirmed by the simultaneous detection of strong and broad amorphous silicate absorptions at 9.7 and 18 μm in all sources together with crystalline silicate features, generally attributed to olivine and pyroxenes with various mixtures of Mg and Fe (e.g. Koike *et al.* 1993; Sylvester *et al.* 1999). The three stars in the left panel show spectra which are very similar to those usually associated to extreme OH/IR stars (e.g. Sylvester *et al.* 1999). The two other sources shown in the right panel display extremely thick circumstellar envelopes. Remarkably, IRAS 17393 shows a strong [Ne II] nebular emission at 12.8 μm, which suggests that the onset of the ionization has already taken place. By comparing our Spitzer/IRS spectra with the available IRAS and MSX photometry, we confirm the non-variability status for those objects with a low IRAS variability index (IRAS 17168, IRAS 17393 and IRAS 17580). However, IRAS 17418 and IRAS 17443, for which the IRAS variability index is high, seem to be strongly variable and may still be evolving as AGB stars.

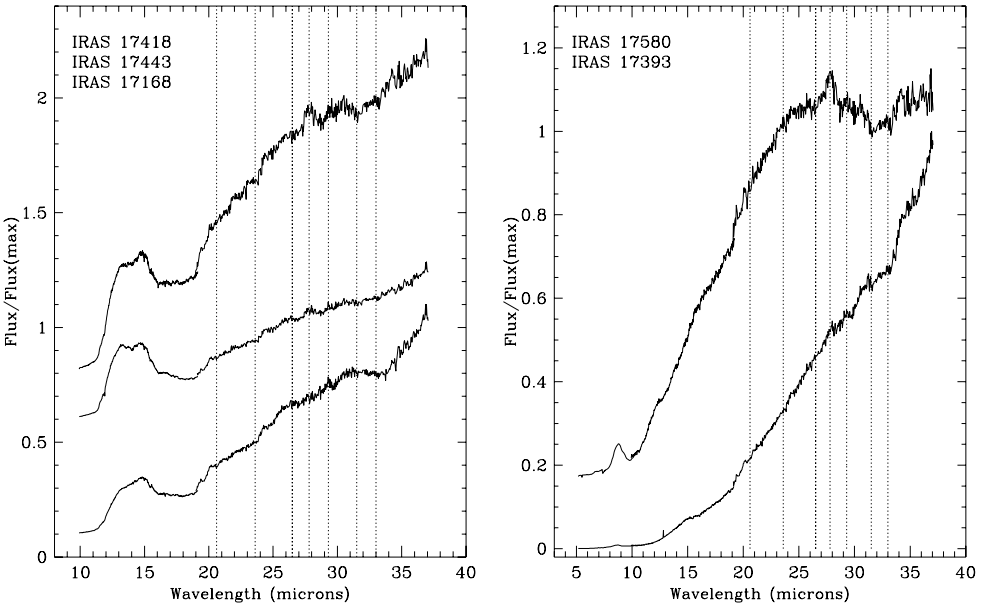

Figure 1. Spitzer/IRS spectra of the OHPNe observed where the positions of some crystalline silicate features are indicated.

2. OHPNe: the early stage of high-mass PNe?

It is well known that the more massive AGB stars ($M > 3-4\ M_{\odot}$) can evolve all the way from the AGB phase to the PN stage as O-rich stars as a consequence of the activation of the "hot bottom burning" (e.g. Mazzitelli *et al.* 1999), which prevents the formation of C-rich AGB stars. Most of these massive O-rich AGB stars are heavily obscured by their thick circumstellar envelopes, being totally invisible in the optical domain (García-Hernández *et al.* 2006). The few obscured O-rich AGB stars with available ISO spectroscopy display also strong absorption bands of amorphous silicates together with crystalline silicate features (see e.g. Sylvester *et al.* 1999), resembling the OHPNe studied here. Our observations show that at least three of the observed OHPNe are non-variable O-rich stars which may have already left the AGB. They must be rapidly evolving towards the PN stage. The detection of [Ne II] in the heavily obscured OHPN star IRAS 17393 indicates that the evolution of some of these massive post-AGB stars can be so fast ($\sim$100$-$1000 yr) that the ionization of the circumstellar envelope takes place at least in some cases well before the star becomes visible again in the optical range. We propose that these OHPNe may represent the youngest population of high-mass PNe in the Galaxy. It is more difficult to explain, however, why some of these stars show still strong photometric variations, and this is still an open issue which deserves further analysis.

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