OPTICAL SPECTROSCOPY OF SIX CARBON-RICH PROTO-PLANETARY NEBULAE

B.J. HRIVNAK

Dept. of Physics & Astronomy, Valparaiso University, Valparaiso, IN 46383, USA

We are engaged in a program of optical spectroscopy of proto–planetary nebulae (PPN). The objects were initially selected from the IRAS database on the basis of their strong infrared excesses, indicating dust temperature of 150 – 250 K. Spectra have been obtrained at medium resolution for the purpose of obtaining the spectral type, luminosity class, and to search for chemical peculiarities resulting from the post–AGB nature of the objects. We found our PPN candidates to typically display F–G supergiant spectra.

In this paper, we discuss in particular 6 PPN which show molecular carbon, IRAS 04296+3429, 05113+1347, 20000+3239, 22223+4327, 22272+5435 and 23304 +6147. From our spectra, we find the following results:

1. all 6 show C_2 λ4735, 4717 (and λ5165 when spectra cover this wavelength);
2. 4 of 6 also show C_3, which had previously been reported only in AFGL 2688 and late N–type carbon stars;
3. all 6 show strong BaII λ4554 and strong SrII and YII (s–process elements).

Those carbon and s–process enhancements are in accord with the general expectations of the effect of thermal pulses and mass loss on the AGB, and support the post–AGB nature of the objects.

These 6 carbon–rich PPN have several other properties in common, some of which are quite rare.

1. 5 are among the small group of 9 known IRAS sources which display an unidentified emission feature at 21μm
2. 3 of them have been observed spectroscopically in the 3μm region, and all 3 show the 3.3μm emission feature.
3. 2 of these 3 are among the few sources with an unusually strong 3.4μm feature, comparable in strength to the 3.3μm feature.
4. Molecular line observations detect CO and HCN in these objects.

These and other common properties are summarized in the table. We suggest that the carbon richness and low stellear temperatures (T=4500–6000 K) are important parameters in relating these properties.

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