

THE MOLECULAR FEATURES IN THE OPTICAL SPECTRA OF THE PROTO-PLANETARY NEBULAE

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An AGB star evolves into the proto-planetary nebula (PPN) phase, when the stellar surface temperature is hotter than 5000K (Schönberner, 1983). But the remnant of AGB dust/gas envelope is still thick in the early stages of PPN evolution. The observed optical spectrum of PPN is a spectrum of central star (T^* hotter than 5000K, the spectral type earlier than G5) overlapped with molecular features formed by molecules in the envelope. The features are changing during the envelope turns to optical thin. Based on our systematic observations of IRAS selected PPN candidates (Hu et al. 1990) we found that molecular features in the spectra evolve as following:

1. When object just exposes from dust shell, the column density of molecules in the envelope is very high. The molecular absorption bands are dominant in the spectra, which are resemble to the M supergiant. There are 6 objects from our 62 PPN candidates sample in this stage.

2. When column density of molecules decreases, the spectra mainly show F-(or G-)type supergiant features from photosphere and partly also from envelope (especially the neutral atomic lines). But we still can detect the molecular bands such as C_2 , CN in the spectra of carbon-rich objects (3 objects in our sample, IRAS23304+6147, 20000+3239 and 19477+2401), TiO of oxygen-rich object (one object, IRAS20406+2953), and ZrO and LaO of S-type transit object (one object, IRAS19454+2920).

3. The envelope becomes optical thin and molecules absorb photons from central star then radiate by fluorescence process. In the spectrum appear the molecular emission bands resemble to the cometary spectra. A well known object in which spectrum C_2 Swan bands in emission is CRL 2688 (Crampton et al. 1975). We found another object, IRAS14429-4539, in the sample showing similar features.

Crampton, D., et al. 1975, ApJ, 198, L135.

Hu, J. Y., de Jong, T., Slijkhuis, S., 1990, in 'From Miras to Planetary Nebulae', p487.

Schönberner, D., 1983, ApJ, 272, 708.