NEW IR-OBSERVATIONS OF POST AGB STARS AND PROTO-PLANETARY NEBULAE

W.E. van der Veen, H.J. Habing, Leiden, The Netherlands
T.R. Geballe, UKIRT, Hawaii

ABSTRACT. A sample was selected from the IRAS Point Source Catalogue based on the following selection criteria: very red ("cold") IRAS-colours: roughly $F_{25}/F_{12} > 2.5$ and $F_{60}/F_{25} < 1.2$; and low IR-variability: VAR < 30. These non-variable IR-sources may be stars that have evolved beyond the AGB (Asymptotic Giant Branch); a large fraction (40%) is associated with known planetary nebulae (Van der Veen and Habing, 1987, *Astron. Astrophys.*, in press). To determine the nature of the other 60% additional observations were made mainly in the infrared: 1-13 μm, during 4 observing runs: ESO (La Silla, Chile) in July 1986 and June 1987; UKIRT (Hawaii) in August 1986 and June 1987. A total number of 58 sources was observed. A summary of the observations: --IR broad band photometry at 1.2, 1.6, 2.2, 3.8 and 4.6 μm for all 58 sources. --IR broad band photometry at 8.4, 9.7 and 12.8 μm for 19 sources. --IR small band photometry for 4 sources in the ranges 2-2.5 μm and 3-3.5 μm. --IR spectroscopy for 10 sources in the ranges 2-2.5 μm and 3-3.5 μm. --V,R, I observations (0.55, 0.7 and 0.9 μm) for 5 sources associated with a star of visual magnitude 8-9. These observations were carried out by D. de Winter (Amsterdam) with the 0.5-m ESO telescope at La Silla (Chile). --Walraven photometry (0.32, 0.36, 0.38, 0.43 and 0.54 μm) for 21 stars brighter than V = 15 and within 10" from the IRAS position. These observations were carried out by M. van Haarlem (Leiden) with the 0.9-m Dutch telescope at La Silla (Chile).

Although all 58 sources have similar IRAS colours, they show large differences at wavelengths shorter than 5 μm. In most of the sources a stellar component and one or two dust components can be distinguished, but the relative strength of the components differs from object to object. A simple model of a star surrounded by one or two optically thin dust shells, all radiating as black bodies, was used for interpretation. The observations are consistent with a central star, temperature typically between 4000 and 20,000 K, that is surrounded by a cold distant dust shell with a characteristic temperature of 80-150 K. This distant shell probably results from the mass loss at a very high rate when the star was at the top of the AGB; the mass of this shell ranges from a few times 0.1 $M_\odot$ to a few times 1 $M_\odot$. Another indication for the AGB origin of the distant dust shell is the double peaked OH 1612 MHz maser profile, which is characteristic for OH/IR stars situated at the top of the AGB, and is still present in about 30% of our sources. If we assume a typical AGB expansion velocity of 15 km/s we find that these distant dust shells are ejected between 1000 and 4000 years ago. A relation between stellar temperature and time elapsed since the ejection of the circumstellar shell is found when the expansion velocity of 15 km/s is assumed: $T_* = 2500 + 5\ (t/yr)$ K. This result suggests a transition time from AGB to the planetary nebula stage ($T_* = 30{,}000$ K) of 5000 yr, in rough agreement with theoretical predictions of 3000-4000 yr (Schönberner, this conference). There is also evidence for a second, relatively hot wind following the cool AGB wind from a gradual increasing IR excess at 12 μm.

S. Torres-Peimbert (ed.), Planetary Nebulae, 445.