

A study of planetary nebulae

R. Surendiranath

Indian Institute of Astrophysics, Bangalore 560 034

M4-18 has been known to be a low excitation nebula of type WC11 (van der Hucht *et al.* 1981; Goodrich & Dahari 1985). All the nebulae of this WC11 group show spectra dominated by numerous stellar C II and C III lines along with low excitation nebular lines. A large IR excess is typical of these objects. The interpretation of their spectra is complicated due to the fact that cool gas is mixed with dust grains and some of the nebular diagnostic lines are blended with stellar lines. Their evolutionary status is not very clear. They may either be proto-planetary nebulae or they may be objects going through the nebular phase for a second time, *i.e.* "born-again AGB stars". They may be also linked to the RCrB stars. The thesis addresses such main issues by way of combining theory and observation.

A new photoionization model code appropriate for a low excitation nebula having both gas and dust mixed together has been developed. New CCD optical spectra were taken using the 1m and 2.3m telescopes at Vainu Bappu Observatory, Kavalur and observations in other wavelengths were gathered from literature. M4-18 has been modelled interpreting these observations. The mean Te and Ne are 7200 K and 7400/cc respectively. Abundances of He, C, O, Ne, and Ar are normal (relative to solar) while Nitrogen and Sulphur are underabundant by ~ 65% and ~ 30% respectively. The assumed presence of amorphous carbon grains having power law distribution (Mathis, Rumpl & Nordsieck 1977) of sizes in the range of 0.04 to 0.55 micron, explains the 12 and 25 micron IRAS bandfluxes well while failing in the 60 and 100 micron bands as well as in the range from 1 to 10 micron. The young age of the nebula coupled with the fact that the model requires a hotter central star is tentatively interpreted in terms of a 'born-again AGB star' that has ejected a nebula for a second time.

References

- Goodrich R. W., Dahari O., 1985, ApJ, 289, 342.
Mathis J. S., Rumpl W., Nordsieck K. H., 1977, ApJ, 217, 425.
van der Hucht *et al.*, 1981, Space Sci. Rev., 28, 227.