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PHYSICS AND CHEMISTRY OF PLANETARY NEBULAE WITH *ISO*-SWS

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Ionized Gaseous Nebulae (Mexico City, 21-24 November 2000)
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Infrared spectra of the four planetary nebulae, NGC 7027, BD+30 3639, NGC 6153 and NGC 6543 have been taken by the *ISO* Short Wavelength Spectrometer (SWS). These *ISO* data have been complemented with the already existing optical and ultraviolet observations. By comparing the nebular abundances for NGC 7027 and BD+30 3639 with those given by new theoretical evolutionary models, the mass of the progenitor star of these nebulae has been constrained.

The infrared SWS data avoid many problems usually encountered when deriving abundances, as noticed by Pottasch & Beintema (1999). These infrared data has been complemented with optical and ultraviolet (*IUE*) data. The electron temperature T_e and electron density N_e for the four planetary nebulae has been derived. The average temperature and density found are shown in Table 1.

For NGC 7027 a correlation between T_e and the ionization potential, IP, has been found. Ions with high IP, that are formed close to the nebula, exhibit high temperatures (around 15 000 K). Those with low IP, formed in the outer parts have a low temperature. No clear correlation of N_e with IP is found, although a tendency of the density to decrease in regions where high IP ions occur seems to be present. This could mean that the ejection of the nebula is now at lower rates than at previous stages.

We have derived the chemical abundances for NGC 7027 and BD+30 3639. The errors in the derived abundances are about 20–30%, plus the error in the collisional strengths, which is a great improvement thanks to the data used. By comparing the abundances obtained with the semi analytical model of Marigo et al. (1996), the mass of NGC 7027 progenitor star can be constrained.

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TABLE 1

AVERAGE ELECTRON DENSITY AND TEMPERATURE

PN	$\langle N_e \rangle$ (cm^{-3})	$\langle T_e \rangle$ (K)
NGC 7027	51 800	13 700
BD+30 3639	12 200	8600
NGC 6543	5400	8300
NGC 6153	3700	9000

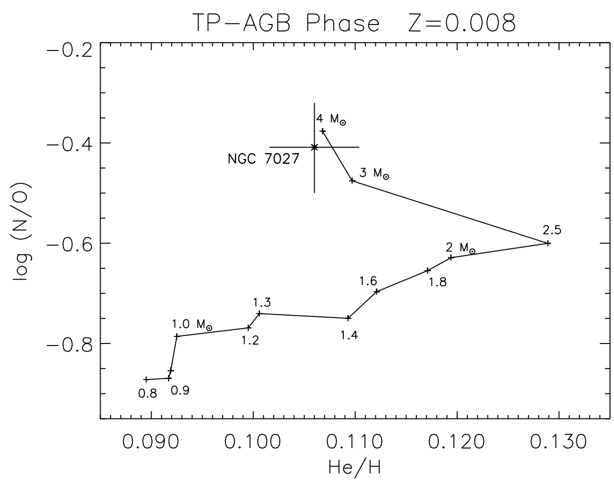

Fig. 1. The logarithm of N/O ratio versus He/H. Abundance ratios by number, expected in PNe taken from the semi analytical models of Marigo et al. 1996 (metallicity of $Z = 0.008$) are shown. The numbers in the figure indicate the mass of the progenitor star in solar units. The position of NCG 7027 is plotted.

Figure 1 shows that the mass of the star can be constrained to be between 3 and $4 M_{\odot}$. Although not plotted, the same mass range for the progenitor star of BD+30 3639 has been found.

REFERENCES

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