Theoretical Abundances in Planetary Nebulae

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A semi-analytical model has been constructed to calculate the TP-AGB evolution of low- and intermediate-mass stars (Marigo et al. 1996), starting from the first thermal pulse until the complete ejection of the envelope by stellar winds. We estimate the changes in the chemical composition of the envelope due to different processes: (i) the intershell nucleosynthesis and convective dredge-up; (ii) envelope burning in the most massive AGB stars ($M \geq 3 - 4 M_{\odot}$); (iii) mass loss by stellar winds.

Following the chemical evolution of the ejecta we are able to predict planetary nebulae abundances for three different values of metallicities ($Z = 0.02$; $Z = 0.008$; and $Z = 0.004$) and for a representative set of initial stellar masses ($0.7 \leq M/M_{\odot} \leq 4$). Our theoretical results are compared with the measured abundances of planetary nebulae detected in the Galaxy and the Magellanic Clouds.

As far as the log(N/O) - He/H diagram is concerned, our results reasonably agree with the observed lower He/H and N/O ratios, whereas we find it difficult to reproduce the high values characterizing Type I PNe (N(He)/N(H) > 0.125 and N(N)/N(O) > 0.5). However, a tendency to fill the discrepancy is clear for the most massive models ($M/M_{\odot} \geq 2.5$) at decreasing metallicity. The increment of nitrogen abundance is due to the combined effect of the second dredge-up and envelope burning. Both these processes together with the third dredge-up concur to increase that of helium. To overcome the problem of nitrogen a higher efficiency of the related mechanisms seems to be required. An improved treatment of envelope burning (Marigo et al. in preparation) and the extension of our analysis to higher mass models ($M/M_{\odot} > 4$ up to 5) may give a significant contribution.

In addition to the chemical analysis, we predict the values of the core mass at the end of the AGB as a function of the initial mass of the star, corresponding to the expected mass of PNNi. The comparison with the semi-empirical calibration for the solar neighbourhood is satisfactory.

REFERENCES

Marigo, P. Bressan, A., Chiosi, C., 1996, Astron. Astrophys., 313, 545.

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