Late Stages of Stellar Evolution: Numerical Tests on AGB Models

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We have calculated numerical models for intermediate mass stars, following the evolution from the MS to the AGB phase. The sequences have been obtained with the Göttingen hydrodynamical code. The Schwarzschild criterion for convection is used. Mass loss is modeled using the formula proposed by Blöcker:

$$\dot{M} = 4.83 \cdot 10^{-9} M_{ZAMS}^{-2.1} \cdot L^{2.7} \cdot \dot{M}_R$$

where $\dot{M}$ is Reimers' mass loss law $\dot{M}_R = 4 \cdot 10^{-13} \eta_R \frac{LR}{M}$, with $\eta = 1$. The strong luminosity dependence leads to a very high mass loss rate on the AGB, to obtain results in agreement with the high observed values and with Weidemann's relation between initial and final mass. Thermal pulses in the AGB phase are explicitly calculated, with the aim of obtaining realistic values for chemical yields and planetary nebulae composition.

At present, we are performing numerical stability tests for the TP-AGB phase, to determine the optimum time and space resolution for our models. In the sequences described here, mass loss has been switched off, in order to study the consistency problem in the simplest conditions.

Studying the stability problem in the H-burning phase, we find that the rate of H consumption varies quite strongly from one sequence to another of different time step, due to errors of interpolation. A time step of $\sim 1\ yr$ or less is needed for an accurate description of the interpulse phase. Space resolution was also tested for sequences with no mass loss, during the H-burning phase. We find that a number of grid points of ~ 750 in the interpulse phase is sufficient to describe an AGB model.

The analysis for the pulse phase has not been completed yet, due to the loss of convergence of our model near the pulse peak. We think that the cause of this instability maybe be physical rather than numerical, since the opacity profile shows a maximum at the instability location, which lies in a superadiabatic zone.

REFERENCES

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