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CHEMICAL DIFFUSION IN STELLAR CONVECTIVE REGIONS

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The aim of this work is to show the evolution of one massive star with a full spectrum of turbulence convective mixing. We present results for one star with mass 5.0 $M_{\odot}$. We compute the evolution from the pre-sequence up the Asymptotic Giant Branch (AGB). Theoretical tracks are discussed. We describe in detail our evolutionary code employed. Several authors use a treatment with an instantaneous mixing for the convective regions, but we use a turbulence convective mixing that takes into account the convective region like a whole. We employed nuclear rates with thirty isotopes and one hundred seventy five reactions. In particular we study the neutron abundances during the thermal pulses and the convective regions where the production rates are significant.

This code has been written following the Kippenhahn, Weigert & Hofmeister (1967) method to resolve the differential equations of stellar structure, independently of other authors. In the envelope, the convective gradient is computed by means the Mixing Length Theory (MLT). The equation of state (EOS) employed in these stars, takes into account an ideal gas with partial ionization, using the Saha's Law. Our evolutive code includes the effects of the relativistic and non-relativistic degeneracy for electrons to a finite temperature. The radiative opacities employed in our code are the OPAL opacities (Rogers & Iglesias 1993; Rogers et al. 1996), with metal abundance $Z = 0.02$. For the conductive opacities we compute the solid phase (Itoh et al. 1984) and liquid (Itoh & Kohyama 1983). In the solid phase it account the contribution by scattering of impurities (Itoh et al. 1993). We consider the photo, para and plasma processes of neutrino emission according to Itoh et al. (1989) and strong degeneration by plasma processes by Itoh et al. (1992).

The chemical composition consists in a gas of hydrogen, helium and heavy elements with $X = 0.70$, $Y = 0.28$ and $Z = 0.02$. We include 30 elements: $neutrons$, ^{1}H, ^{2}H, ^{3}He, ^{4}He, ^{7}Li, ^{7}Be, ^{8}B, ^{12}C, ^{13}C, ^{13}N, ^{14}N, ^{15}N, ^{15}O, ^{16}O, ^{17}O, ^{18}O, ^{17}F, ^{18}F, ^{19}F, ^{20}Ne, ^{21}Ne, ^{22}Ne, ^{23}Na, ^{23}Mg, ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{28}Si and ^{31}P. We consider 175 reactions.

In those regions where the energy is carried by convection or semiconvection, a diffusion equation is considered for the i^{th} element. In this equation we have one term that depends on nuclear reactions and the other on turbulent mixing. The molecular diffusion is negligible with respect to turbulent diffusion.

The problem consists in: let N_{isot} be the number of isotopes (in this case 30 isotopes), then by computing the chemical burning in any shell of the grid, where the transport of energy is by radiation, we have to solve a $N_{isot} \times N_{isot}$ equations system. But for the case where the transport is due to convection or semiconvection, there are M mesh points of stellar grid, we must invert a system of $M \cdot N_{isot} \times M \cdot N_{isot}$ equations.

Solving the diffusion in detail, allows us obtain important results of, for example, the isotopic abundances of Lithium in the stars, while with an instantaneous mixing it is not possible. The Lithium has been an object of investigation for a long time due to its cosmological importance.

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