# CHEMICAL EVOLUTION AND MIXING PROCESSES IN MASSIVE STARS

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**Abstract.** The first results of new evolutionary calculations of massive stars are presented. The calculations cover ZAMS masses from 20–200 $M_\odot$. Yields and abundances throughout the stars are presented.

**Key words:** stars: massive stars – evolution – nucleosynthesis – mixing

As shown by a number of authors in recent years, the details of massive star evolution are still rather uncertain. The problems are mainly related to uncertain input physics, in particular mass loss rates and various convective phenomena. This work is part of a project that intends to study chemical and structural evolution of massive stars up to late stages, emphasising the input physics used. The computations include: (i) A large and flexible nu-

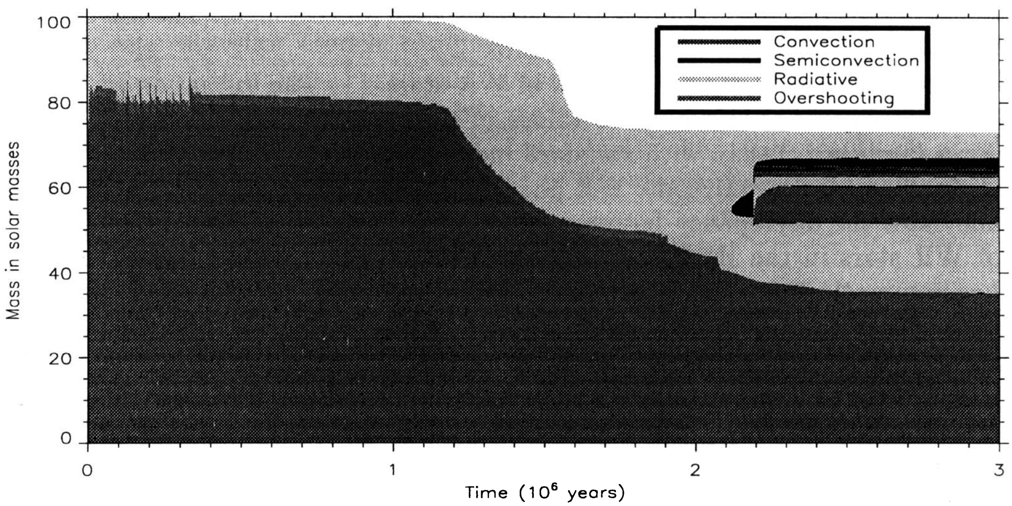


Fig. 1. Mixing in a star with $M_{ZAMS} = 100$ $M_\odot$. The very complex patterns of semiconvective and convective zones that arise from the end of core H burning are not completely resolved in this plot.

clear network consisting of 177 nuclear species from n and $^1$H to $^{71}$Ge in addition to $e^-$, $e^+$ and $\gamma$. Initial metallicity $Z = 0.02$. Simultaneous solution of nuclear network, diffusion equation and stellar equations during the whole evolution; (ii) Modern rates for both strong and weak interaction processes. (Caughlan & Fowler 1988; Thielemann *et al.* 1987; Fuller *et al.* 1982)



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as well as neutrino emission (Itoh *et al.* 1989, 1992); (iii) Semi-convection, overshooting (0.2 $H_p$) and mass loss. The semi-convective diffusion parameter $\alpha$ (Langer *et al.* 1985) was set to 0.04; (iv) Time steps mostly restricted by changes in the abundances. The evolutionary sequences are started just before the ZAMS and the abundances are not assumed to be in equlibrium initially. The mass loss rate has been made large enough to prevent the star from becoming a red supergiant if $L$ is above the HD limit. The grid distribution takes into account both the standard gradient method (GM) and the curvature method (CM) proposed by Wagehuber & Weiss (1993).

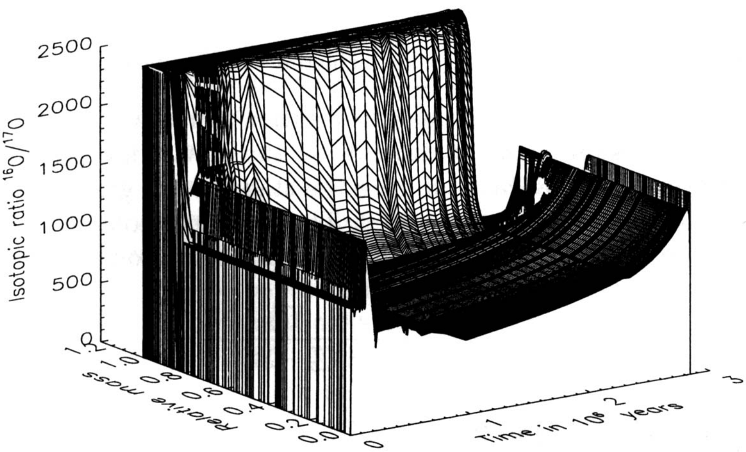


Fig. 2. The evolution of the ratio $^{16}O/^{17}O$ ($M_{ZAMS} = 100$ $M_\odot$).

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