Very low metallicity massive star models: Pre-SN evolution and primary nitrogen production.

Raphael Hirschi

University of Basel, Switzerland

CONTEXT:
Precise measurements of surface abundances of extremely low metallicity stars have recently been obtained and provide new constraints for the stellar evolution models.

AIMS:
Compute stellar evolution models in order to explain the surface abundances observed, in particular of nitrogen.

METHODS:
Two series of models were computed. The first series consists of 20 $M_\odot$ models with varying initial metallicity ($Z=0.02$ down to $Z=10^{-8}$) and rotation ($\rm \upsilon_{ini}=0-600$\,km\,s^{-1}). The second one consists of models with an initial metallicity of $Z=10^{-8}$, masses between 9 and 85 $M_\odot$ and fast initial rotation velocities ($\rm \upsilon_{ini}=600-800$\,km\,s^{-1}).

RESULTS:
The most interesting models are the models with $Z=10^{-8}$ ([Fe/H]~-6.6). In the course of helium burning, carbon and oxygen are mixed into the hydrogen burning shell. This boosts the importance of the shell and causes a reduction of the CO core mass. Later in the evolution, the hydrogen shell deepens and produces large amount of primary nitrogen. For the most massive models ($M\gtrsim 60$\,$M_\odot$), significant mass loss occurs during the red supergiant stage. This mass loss is due to the surface enrichment in CNO elements via rotational and convective mixing. The 85 $M_\odot$ model ends up as a WO type Wolf-Rayet star. Therefore the models predict SNe of type Ic and possibly long and soft GRBs at very low metallicities.

The rotating 20 $M_\odot$ models can best reproduce the observed CNO abundances at the surface of extremely metal poor (EMP) stars and the metallicity trends when their angular momentum content is the same as at solar metallicity (and therefore have an increasing surface velocity with decreasing metallicity). The wind of the massive star models can also reproduce the CNO abundances of the most metal-poor carbon--rich star known to date, HE1327-2326.

Reference: A&A accepted
Status: Manuscript has been accepted

Weblink: http://quasar.physik.unibas.ch/~hirschi/work/lowz.pdf

Comments: 18 pages, 13 figures

Email: raphael.hirschi@unibas.ch