The early star generations: the dominant effect of rotation on the CNO yields

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We examine the role of rotation on the evolution and chemical yields of very metal--poor stars. The models include the same physics, which was applied successfully at the solar Z and for the SMC, in particular, shear diffusion, meridional circulation, horizontal turbulence, and rotationally enhanced mass loss. Models of very low Z experience a much stronger internal mixing in all phases than at solar Z. Also, rotating models at very low Z, contrary to the usual considerations, show a large mass loss, which mainly results from the efficient mixing of the products of the 3α reaction into the H--burning shell. This mixing allows convective dredge--up to enrich the stellar surface in heavy elements during the red supergiant phase, which in turn favours a large loss of mass by stellar winds, especially as rotation also increases the duration of this phase. On the whole, the low Z stars may lose about half of their mass. Massive stars initially rotating at half of their critical velocity are likely to avoid the pair--instability supernova. The chemical composition of the rotationally enhanced winds of very low Z stars show large CNO enhancements by factors of 10^3 to 10^7, together with large excesses of ^{13}C and ^{17}O and moderate amounts of Na and Al. The excesses of primary N are particularly striking. When these ejecta from the rotationally enhanced winds are diluted with the supernova ejecta from the corresponding CO cores, we find [C/Fe], [N/Fe],[O/Fe abundance ratios that are very similar to those observed in the C--rich, extremely metal--poor stars (CEMP). We show that rotating AGB stars and rotating massive stars have about the same effects on the CNO enhancements. Abundances of s-process elements and the ${12}$C/^{13}C ratio could help us to distinguish between contributions from AGB and massive stars.

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