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Carbon-enhanced metal-poor stars as probes of early Galactic nucleosynthesis

O. R. Pols[1], R. G. Izzard[2], E. Glebbeek[3] and R. J. Stancliffe[4]

[1]Sterrekundig Instituut Utrecht, P.O. Box 80000, NL-3584 TA Utrecht, The Netherlands
email: O.R.Pols@uu.nl
[2]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, CP226, Boulevard du triomphe, B-1050 Bruxelles, Belgium
[3]Dept. of Physics and Astronomy, McMaster University, Hamilton, Ontario, L8S 4M1, Canda
[4]School of Mathematical Sciences, Monash University, P.O. Box 28M, Victoria 3800, Australia

A large fraction, between 10 and 25%, of very metal-poor stars in the Galactic halo are carbon-rich objects, with enhancements of carbon relative to iron exceeding a factor 10. The majority of these carbon-enhanced metal-poor (CEMP) stars show enhancements of heavy s-process elements and have been found to be spectroscopic binary systems. Many of their properties are well explained by the binary mass transfer scenario, in which a former asymptotic giant branch (AGB) companion star has polluted the low-mass star with its nucleosynthesis products. The same scenario predicts the existence of nitrogen-rich metal-poor (NEMP) stars, with [N/C] > 0.5, from AGB companions more massive than about 3 solar masses. In contrast to CEMP stars, however, such NEMP stars are very rare. Recent studies suggest that the high frequency of CEMP stars requires a modified initial mass function (IMF) in the early Galaxy, weighted towards intermediate-mass stars. Such models also implicitly predict a large number of NEMP stars which is not seen.

Here we investigate whether the observed incidence of CEMP and NEMP stars among metal-poor stars and their abundance patterns can be understood *without* invoking a change in the IMF. We study the formation and evolution of CEMP stars by means of a binary population synthesis technique, in which we simulate the evolution of 2×10^6 binaries at metallicity [Fe/H] $= -2.3$, following the evolution and surface abundances of both binary components as well as their mutual interactions. This approach allows us to explore uncertainties in the CEMP-star formation scenario by parameterization of uncertain input physics. In particular, we consider the uncertainty in the physics of third dredge up in the AGB primary, binary mass transfer and mixing in the secondary star. We confirm earlier findings that with current detailed AGB models, in which third dredge up is limited to stars more massive than about 1.25 $M_\odot$, the large observed CEMP fraction cannot be accounted for. We find that efficient third dredge up in low-mass (less than 1.25 $M_\odot$) metal-poor AGB stars may offer at least a partial explanation to the large observed CEMP frequency, while remaining consistent with the small observed NEMP frequency. Our models show that most CEMP stars are also expected to be enriched in fluorine, of which the recent detection of a large F abundance in the CEMP star HE 1305+0132 is a clear example. For full details we refer to the paper by Izzard *et al.* (2010).

Reference

Izzard, R. G., Glebbeek, E., Stancliffe, R. J., & Pols, O. R. 2010, *A&A* in press (arXiv:0910.2158)