Massive binaries as the source of abundance anomalies in globular clusters

S.E. de Mink, O.R. Pols, N. Langer and R.G. Izzard

Astronomical Institute, Utrecht University, The Netherlands;
Argelander-Institut f"ur Astronomie der Universit"at Bonn, Germany;
Universit'e Libre de Bruxelles, Belgium;

Abundance anomalies observed in globular cluster stars indicate pollution with material processed by hydrogen burning. Two main sources have been suggested: asymptotic giant branch (AGB) stars and massive stars rotating near the break-up limit (spin stars). We propose massive binaries as an alternative source of processed material.

We compute the evolution of a 20 Msun star in a close binary considering the effects of non conservative mass and angular momentum transfer and of rotation and tidal interaction to demonstrate the principle. We find that this system sheds about 10 Msun of material, nearly the entire envelope of the primary star. The ejecta are enriched in He, N, Na, and Al and depleted in C and O, similar to the abundance patterns observed in gobular cluster stars. However, Mg is not significantly depleted in the ejecta of this model. In contrast to the fast, radiatively driven winds of massive stars, this material is typically ejected with low velocity. We expect that it remains inside the potential well of a globular cluster and becomes available for the formation or pollution of a second generation of stars.

We estimate that the amount of processed low-velocity material ejected by massive binaries is greater than the contribution of AGB stars and spin stars combined, assuming that the majority of massive stars in a proto-globular cluster interact with a companion and return their envelope to the interstellar medium. If we take the possible contribution of intermediate mass stars in binaries into account and assume that the ejecta are diluted with an equal amount of unprocessed material, we find that this scenario can potentially provide enough material to form a second generation of low-mass stars, which is as numerous as the first generation of low-mass stars, without the need to make commonly adopted assumptions, such as preferential loss of the first generation of stars, external pollution of the cluster, or an anomalous initial mass function.

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Email: S.E.deMink@uu.nl