THE ABUNDANCE ANOMALIES IN A ROTATIONALLY EVOLVED 20 $M_\odot$ OBN STAR MODEL

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Walborn (1970, 1971) observationally found that OB stars showed nitrogen and carbon abundance anomalies in their atmospheres. Schönberner et al. (1988) found that OBN stars had helium enriched atmospheres. Several different suggestions have been made so far to explain the abundance anomalies in these stars (Paczynski 1973; Walborn 1976; Bolton and Rogers 1978). Maeder (1987) and Weiss et al. (1988) call attention to some possible effects of rotation in mixing chemical elements in Wolf-Rayet stars and B-supergiant stars respectively. They suggested that rotational mixing could explain the high He/H ratios and the high N/C and N/O ratios in the progenitor of 1987A Supernova. Saio et al. (1988) in an attempt to explain the nitrogen and helium enhancement in the progenitor of SN 1987A invoked extensive mixing in their models. They pointed out that such an effective mixing may be produced by rapid rotation. Such observations and ideas were the motivation for the present study.

20 $M_\odot$ LMC star has been evolved for both normal and fully mixed cases up to $t_{ev} = 6.56 \times 10^6$ years. It has been shown that rotation has induced mixing and found that He^3 was enriched at the surface.

We also found that helium 4 and nitrogen were enriched and among them the enrichment of nitrogen was found to be the most conspicuous. The enrichment in N^{14} was about two hundred times that of normal rotating model. Besides $He^4/H^1, N^{14}/C^{12}$ and N^{14}/O^{16} ratios were also found to be rather large at surfaces of fully mixed star models compared to the normal star models. As a result of rotational mixing it has become possible to increase H^4 at the surface by about 61% and thus the surface abundance value of Helium-4 was obtained as 0.423 at $t_{ev} = 6.56 \times 10^6$ years, while the corresponding value of the abundance was 0.260 for the normal rotating star. The fully mixed models showed enrichments of helium and nitrogen and depletion of carbon and oxygen.

L. A. Balona et al. (eds.), Pulsation, Rotation and Mass Loss in Early-Type Stars, 149–150.

https://doi.org/10.1017/S0074180900214745 Published online by Cambridge University Press

Schönberner et al. (1988) have observed and analyzed four galactic OBN stars and found significant helium enrichment amounting to as mass fraction of about 0.4 which agrees well with our finding $He^4 = 0.423$ quoted above. High values that we have found in relation to N/C and N/O do agree well with Walborn's results (1988). Although evolutionary positions of our last model and the 1987A Supernova are not the same, the trend in our results seemed to contribute to the explanation of the chemical abundance analysis in the above mentioned supernova. Early UV observations of the circumstellar material around SN 1987A (Panagia et al. 1987; Fransson et al. 1989) already indicated that nitrogen was overabundant with respect to carbon and oxygen which is also in good agreement with our finding in this work. It has also been claimed (Allen et al. 1989) that IR observations gave the fractional abundance of helium as 0.4 in the circumstellar envelope of SN 1987A, which also matches with our findings.

Conclusion has been that we could transport CNO processed material to the surface of the star, by a mixing mechanism resulted from rotation, and thus contributing to the explanation of chemical abundance anomalies in the atmospheres of OBN stars which are almost all on the main sequence; and our results might have some implications on the observed chemical abundances in SN 1987A.

References

Allen D.A., Meikle W.P.S., Spyromillio J., 1989, *Nature*, **342**, 403
Bolton C.T., Rogers G.L., 1978, *ApJ.*, **222**, 234
Fransson C., 1989, *ApJ*, **336**, 429
Maeder A., 1987, *A& A*,**178**, 159
Paczynski B., 1973, *Acta Astr.*, **23**, 191
Panagia N., et al., 1987, *IAU Circ.*, **4514**
Saio H., Nomoto K., Kato M., 1988, *Nature*, **334**, 508
Schönberner D., Herrero A., Becker S., et al., 1988, *A& A*, **197**, 209
Walborn N.R., 1970, *ApJ*, **161**, L149
Walborn N.R., 1971, *ApJ*, **164**, L67
Walborn N.R., 1976, *ApJ*, **205**, L419
Walborn N.R., 1988, Atmospheric diagnostics of stellar evolution., In: K-Nomoto (ed.), *Proc. IAU Collowq.*,**108**. Springer, Berlin, pp. 70-78
Weiss A., Hillebrandt W., Truran J.W., 1988, *A& A*, **197**, L11 Hauck B., Maeder A., (eds.) p. 253