THE WR/OB NUMBER RATIO WITHIN 2.5 KPC FROM THE SUN.

D. VANBEVEREN
K.I.H. Group T and Vrije Universiteit Brussel
Campus Blauwput, Vuurkruisenlaan 4, 3000 Leuven, Belgium
Dept. of Physics, Pleinlaan 2, 1050 Brussels, Belgium

ABSTRACT. Comparing the observed and theoretical HR diagram for massive stars, it is concluded that at least 34 % of the stars within 2.5 kpc from the sun with initial ZAMS mass larger than 35 $M_\odot$ have not yet been detected. It is argued that the number of core helium burning pop I WR stars within 2.5 kpc from the sun may be as low as 26. If the progenitors of WR stars have initial ZAMS masses larger than 35 $M_\odot$, one then concludes that the observed number ratio (core helium burning pop I WR stars)/(WR progenitors) within 2.5 kpc from the sun ranges between 0.05 and 0.09.

1. THE NUMBER OF OB STARS WITH $M \geqslant 35\ M_\odot$ WITHIN 2.5 KPC FROM THE SUN.

If the observed HR diagram for massive stars within 2.5 kpc from the sun is compared with the theoretical HR diagram (evolutionary tracks without, respectively with overshooting ; the T_{eff}-spectral type relation given by Humphreys and McElroy (1985, Ap. J. in press) is used), one finds the surprising result that ~ 90 % of the observed stars with initial ZAMS mass $M_i \geqslant 35\ M_\odot$ are older than 2.10^6 yrs (resp. $2.5\ 10^6$ yrs). This means that if stellar evolution represents reality (at least for luminosity class V and IV stars), within 2.5 kpc from the sun we are missing a large number of stars with $M_i \geqslant 35\ M_\odot$ younger than 2.10^6 yrs (resp. $2.5\ 10^6$ yrs). This number can be estimated as follows. The average core hydrogen burning lifetime for stars with $M_i \geqslant 35\ M_\odot \approx 4.10^6$ yrs (resp. 5.10^6 yrs). Within 2.5 kpc from the sun there are 260 stars (resp. 220) with $M_i \geqslant 35\ M_\odot$ older than 2.10^6 yrs (resp. $2.5\ 10^6$ yrs). We then obviously expect to see ~ 260 (resp. 200) younger than 2.10^6 yrs (resp. $2.5\ 10^6$ yrs) and we only observe 60 (resp. 50) stars. I then conclude that there are 520 (resp. 440) OB type stars within 2.5 kpc from the sun with $M_i \geqslant 35\ M_\odot$; 200 (resp. 150) have not yet been observed (some if not most of them may still be hidden in clouds, Mezger, 1976, Proc. 3rd Eur. Astr. Meeting).

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2. THE NUMBER OF WR STARS WITHIN 2.5 KPC FROM THE SUN BURNING HELIUM IN THEIR CORE.

I will use the WR stars within 2.5 kpc from the sun compiled by Conti, Garmany, de Loore, Vanbeveren (1984, Ap. J. 274, 302). Stellar aggregate membership is taken from Lundström and Stenholm (1985, A.A. in press). There are 34 WR stars within 2.5 kpc from the sun which are certainly burning helium in their core (i.e. WNE and WC types). There are 9 WNL stars, however I propose that at least half of them are core hydrogen burning stars. The number 34 then is obtained by assuming that all WR stars which are observed are pop.I WR stars, i.e. we can apply the magnitude calibration obtained from the aggregate members, to all field WR stars. This method however may overestimate the number of pop I WC field stars if a number of them are in reality pop II. In order to have an estimate of this number, let us proceed as follows. Accounting for the fact that the IMF for massive field stars (index f) is steeper than the IMF of aggregate stars (index a), whereas the minimum progenitor mass for the formation of WC stars may be larger than for WNE stars, it follows from evolution that for the number ratio WNE/WC the following theoretical relation should hold :

$$(WNE/WC)_a \leqslant (WNE/WC)_f \qquad (1)$$

If for obvious reasons we only consider single WR stars, the observations tell us that $(WNE/WC)_a \approx 0.5-0.6$ and $(WNE/WC)_f \approx 0-0.1$ (the intervals for each ratio reflect the fact whether or not possible aggregate members in the study of Lundström and Stenholm are considered as real members). It is clear that relation (1) is not fulfilled. There are two possible ways out for this discrepancy, i.e. or at least 7 out of the 12 WC field stars have not yet been recognised as aggregate members, or at least 8 WC field stars which are considered as pop I WR stars are in reality pop II WR stars. In the latter case obviously we only have to consider 26 WR stars within 2.5 kpc from the sun which are pop I core helium burning stars.

3. THE WR/OB NUMBER RATIO WITHIN 2.5 KPC FROM THE SUN.

It has frequently been argued in litterature that WR stars are descendants from OB type stars with $M_i \geqslant 35\ M_\odot$. Using direct number counts, the observed WR/OB ($M_i \geqslant 35\ M_\odot$) number ratio within 2.5 kpc from the sun ≈ 0.13 (resp. 0.17 when overshooting models are adopted). Using the results of section 1, this ratio decreases down to 0.08 (resp. 0.1). Accounting finally for the results of section 2, i.e. the number of core helium burning pop I WR stars ranges between 26 and 38, I conclude that the observed (core He burning pop I WR stars)/(WR progenitors) number ratio within 2.5 kpc from the sun $\approx 0.05-0.07$ (resp. 0.06-0.09).

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