WOLF-RAYET STARS IN STARBURSTS

Effects of a change of mass loss rate

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Abstract. We present here starburst models based on the most recent grids of stellar evolutionary tracks obtained by the Geneva group. These new models, computed with *enhanced mass loss rates* during the main sequence and the Wolf-Rayet WNL phases, very well reproduce the luminosities, surface abundances and statistics of WR stars (Maeder & Meynet 1994). This change of the mass loss rates considerably affects *the way the WR stars, born in a starburst's episode, are distributed among the different WR subtypes.*. We compare the theoretical predictions with recent observations and conclude that: (1) to reproduce the high observed ratios of WNL to O-type stars, a *flat IMF* seems to be required; and (2) the models which reproduce the best the observed characteristics of WR stars, *i.e.*, those computed with an enhanced mass loss rate, *can also account for the observed properties of the WR populations observed in starbursts.* Moreover, the possible presence of numerous WC stars found in the low metallicity He2-10 A starburst by Vacca and Conti (1992), *can only be accounted for when the high mass loss rate stellar models are used.*

Key words: stars: Wolf-Rayet – evolution – starbursts

The relative number of WNL to O-type stars observed in various starbursts by Vacca & Conti (1992) and Conti (1994) are given in Fig. 1 and compared with the predictions of population synthesis models using the new high mass loss stellar models. A great number of observed points are above the line computed for an IMF's slope $X = -2$ (where $dN/dM \propto M^X$). Since the instantaneous starburst represents an extreme case, there is no hope, by changing the star formation rate alone to push up this line. If the slope of the IMF is flatter, then the situation is significantly improved. Indeed most of the observed points are below the line obtained with $X = -1$.

It is interesting to mention here that, at this time, in most (if not all) the starburst galaxies in which a WR population has been detected (see Vacca and Conti 1992), only WNL stars have been observed. If really there is no WC stars in these galaxies, this would mean in view of the present population synthesis models that: (1) the observed starbursts have their whole WR-rich phase dominated by WNL stars, with no or very few other WR subtypes. This implies quite low metallicities ($Z \leq 0.001$); and (2) the observed starbursts are all younger than about $3 \cdot 10^6$ yr. This second condition is certainly more realistic than the first one in view of the different metallicities inferred for the observed starbursts. If, for the moment, we only have a sample of young starbursts, it may be due to the fact that only the most recent starbursts still present strong observational signatures of a starburst episode.

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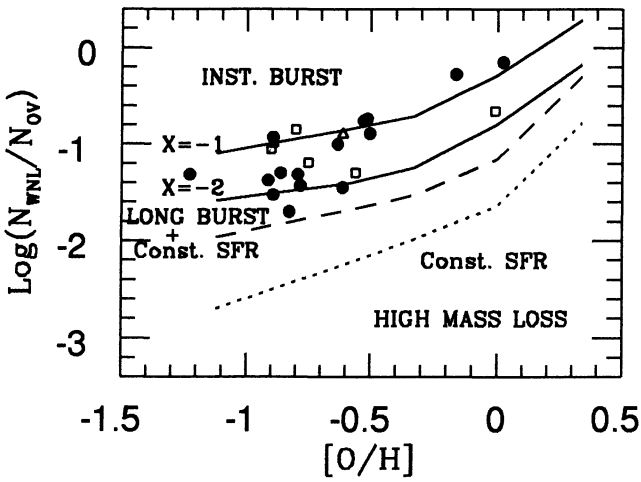

Fig. 1. Relative number of WNL to O-type stars as a function of the relative abundance of oxygen expressed in terms of [O/H]. Filled circles are observed values as given by Vacca and Conti (1992). The open triangle represents 30 Doradus (from Vacca 1991) and open boxes are observations from Vacca as reported by Conti (1994). The dotted line presents the theoretical values obtained in the case of a constant star formation rate with an IMF's slope $X = -2$. The dashed line corresponds to a long burst superposed to a constant star formation rate (see text). The continuous lines are the predictions for an instantaneous burst with an IMF's slope $X = -2$ and $X = -1$. In each case we have represented the maximum value of the WNL/O ratio occuring between 2.5 and $3.5 \cdot 10^6$ yr.

One burst studied by Vacca & Conti (1992) seems to present a numerous WC star population. Indeed these authors have estimated from the observed luminosity in the line CIVλ5808 of the integrated spectrum of He2–10 A, a number of WC stars equal to about 400, implying a WC over WN number ratio of $\sim$ 1.4. As noticed by Vacca & Conti (1992), this is a surprisingly large number, given the low metal abundance in He2-10 A, estimated to be [O/H] = – 0.86. However, if we consider our population synthesis models using the high mass loss rate stellar models, we predict, even at such a low metallicity, a significant WC population, while the standard mass loss rate models do not show any WC star population for this metallicity. Thus, if confirmed, this observation clearly favours high mass loss rates undergone by the stars either as a result of strong stellar winds or due to Roche Lobe Overflow in close binary systems.

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