Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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The earliest phases of galaxy evolution: massive stars

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Discussion

In this work we study the very early phases of the evolution of our Galaxy by means of a chemical evolution model which reproduces most of the observational constraints in the solar vicinity and in the disk. We have restricted our analysis to the solar neighborhood and present the predicted abundances of several elements (C, N, O, Mg, Si, S, Ca, Fe) over an extended range of metallicities [Fe/H] = –4.0 to 0.0 compared to previous models. We adopted the most recent yield calculations for massive stars taken from different authors (Woosley & Weaver 1995; Thielemann *et al.* 1996) and compared the results with a very large sample of data, one of the largest ever used to this purpose. We have obtained this by selecting the most recent and higher quality abundance data from a number of sources and renormalizing them to the same solar abundances. These data have been analysed with a new and powerful statistical method which allows us to quantify the observational spread in measured elemental abundances and obtain a more meaningful comparison with the predictions from our chemical evolution model.

Our analysis shows that the 'plateau' observed for the [α/Fe] ratios at low metallicities ($-3.0 <$ [Fe/H] < -1.0) is not perfectly constant but it shows a slope, especially for oxygen (see figure). This slope is very well reproduced by our model with both sets of yields. This is not surprising since realistic chemical evolution models, taking into account in detail stellar lifetimes, never predicted a completely flat plateau. This is due either to the fact that massive stars of different mass produce a slightly different O/Fe ratio or to the often forgotten fact that type Ia supernovae, originating from white dwarfs, start appearing already at a galactic age of 30 million years and reach their maximum at 1 Gyr.

For lower metallicities ($-4.0 <$ [Fe/H] < -3.0) the two sets of adopted yields differ, especially for iron. In this range the "plateau" is almost constant since at such low metallicities there is almost no contribution from type Ia supernovae. However, there are not enough data in this domain to significantly test this point.

Finally, we show the evolution with redshift of the [O/Fe] ratio for different cosmologies and conclude that a sharp rise of this ratio should be observed at high redshift, *irrespective* of the adopted yields. The same behaviour is expected for the [O/Zn] ratio which should be easier to compare with the abundances observed in high redshift Damped Lyman-α systems, as these elements are likely

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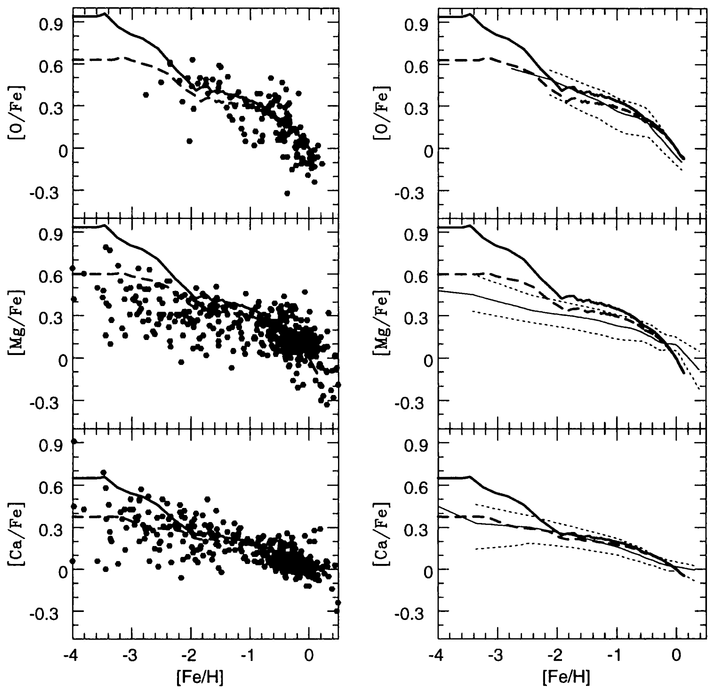

Figure 1. Abundance ratios as function of the metallicity for O, Mg, and Ca. The left panels show a comparison between the data (see Chiappini *et al.* 1999) and the models (dashed-line: with WW95 yields; solid line: with TNH96 yields). The right panels show a comparison between the summary lines (the thin-solid line represents the mid-mean and the thin-dotted lines represent the lower and upper semi-mid-mean) and the model predictions.

not to be affected by dust. Future measurements of either $[\alpha/\mathrm{Fe}]$ or $[\alpha/\mathrm{Zn}]$ ratios in very metal poor stars will be very useful to infer the nature and the age of high-redshift objects.

References

Chiappini, C., Matteucci, F., Beers, T. C., Nomoto, K. 1999, ApJ 515, 226
Chiappini, C., Matteucci, F., Gratton, G. 1997, ApJ 477, 765
Thielemann, F.K., Nomoto, K., Hashimoto, M. 1996, ApJ 460, 408 (TNH96)
Woosley, S.E., Weaver,T.A. 1995, ApJS 101, 181 (WW95)

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