A Massive Star Odyssey, from Main Sequence to Supernova
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Wolf-Rayet populations in starburst galaxies

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Abstract. Recent advances in atmosphere codes now permit the calculation of realistic grids of hot star atmospheres. Here we use the new O and WR star atmosphere of Smith, Norris & Crowther (2002) with an updated version of the evolutionary synthesis code STARBURST99 to predict the population of WR stars in a variety in astrophysical conditions. We present a series of synthetic starburst spectra in the optical region which shows the time evolution of the WR-bumps at $\sim$4650 Å and $\sim$5800 Å.

Wolf-Rayet populations are important indicators of the age, metallicity and Initial Mass Function (IMF) of a particular starbursting system. Creating a synthetic spectrum of WR-bumps at 4686 Å and 5808 Å could directly probe the underlying WR population of a starburst. We have updated the population synthesis code STARBURST99 of Leitherer *et al.* (1999), by including a new set of O-type star atmospheres and replacing the unblanketed WR models of Schmutz *et al.* (1992). These new grids were calculated using the non-LTE line-blanketed atmosphere codes of Pauldrach *et al.* (2001, WM-BASIC) and Hillier & Miller (1998, CMFGEN), respectively, as described by L.J. Smith (these Proceedings) and Smith *et al.* (2002). Here we concentrate on the applications of the WR grid, which spans 5 metallicities from 0.05 to 2 $Z_{\odot}$, with the inclusion of WN and WC stars modelled over a range of effective temperatures from 40 to 140 kK. These new atmosphere grids represent a significant improvement over the pure helium WR models of Schmutz *et al.* (1992).

Using the original high-resolution CMFGEN grid to represent both the WN and WC subspecies in the STARBURST99 code, we have generated synthetic spectra to represent the Wolf-Rayet phase of a starburst. We include the WR and O-type supergiant contributions, since the latter have a significant effect on the blue WR-bump at early ages ($<$ 3.0 Myr) due to their strong winds.

It is also possible to create time series, to model the evolution of the WR bump profiles over time. Figure 1 shows the WR contribution to the spectra for the first 4.5 Myr of an instantaneous, solar metallicity burst with an IMF with $M_{\rm up} = 100\,{\rm M}_{\odot}$ and a Salpeter α exponent. This figure shows the narrow emission line contribution from the dominant O-type supergiant population creating strong N IV λ 4057 and N III λ 4640 features in the starburst continuum. These supergiant models were calculated using CMFGEN to take advantage of its co-moving frame geometry, which can accurately model emission-line formation in dense stellar winds. At later times, the narrow absorption and emission line contribution disappears with the O-type supergiants, and the broader features

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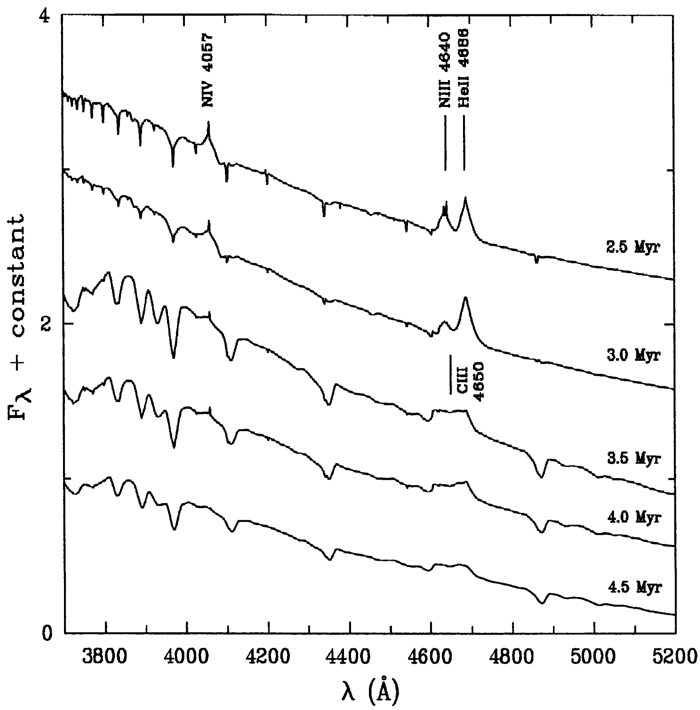

Figure 1. The time evolution of the blue WR-bump from 2.5 to 4.5 Myr for a solar metallicity instantaneous burst.

of the WR population appear. The blue WR-bump shown at ages < 3.5 Myr is a blend of He II λ 4686 and N III λ 4640, arising mainly from the late type WN population. At later ages, the WC population dominates the starburst and the blue WR bump is mainly due to C III λ 4650.

In the future,we intend to compare our synthetic spectra with WR galaxy observations to derive ages, WR/O and WC/WN number ratios, and metallicities. This technique should be more accurate than the current WR-bump equivalent width method (*e.g.*, Schaerer & Vacca 1998).

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