Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
Proceedings IAU Symposium No. 193, ©1999 IAU
K.A. van der Hucht, G. Koenigsberger & P.R.J. Eenens, eds.

Ultraviolet spectral libraries of massive stars at low metallicity

Carmelle Robert

Département de Physique and Observatoire du Mont Mégantic, Université Laval, Québec, Qc, G1K 7P4, Canada

Abstract. Three new ultraviolet spectral libraries of massive, hot stars using high and medium resolution spectra of objects located in the solar neighbourhood and the Magellanic Clouds are presented. Massive stars display unique wind signatures which are relatively easy to study in the ultraviolet. These libraries are crucial tools when investigating the massive stellar population of distant star-forming galaxies.

1. Ultraviolet signatures from the massive, hot stars

Numerous ultraviolet features in the integrated spectrum of a distant galaxy are ideal direct indicators of the massive, hot star population (OB stars and WR stars — the evolutionary descendents of the more massive O stars). These features are mainly P-Cygni profiles (of N V 1240, Si IV 1400, C IV 1550, among others), which are formed in the dense and fast winds of the massive stars (*e.g.*, Walborn & Panek 1984). The key point is that the strength and width of the wind profiles change with the stellar temperature, luminosity, and metallicity (Plante *et al.* in preparation). Stronger P-Cygni profiles are seen in high temperature and high luminosity objects. WR stars show an extreme behavior. In cooler B stars, where stellar winds are weak, broad photospheric absorptions show up. Another important feature is the He II 1640 line which develops a strong emission in hot O supergiants and WR winds.

2. New ultraviolet libraries

A new UV library was built with spectra of ~200 O-type stars, 250 B stars, and 30 WR stars observed with *IUE* at high dispersion (~0.25 Å) in the solar environment. The spectrum representing each spectral type is a combination of 3 to 20 individual stars. Only in a few cases, an interpolation in spectral type was needed. An old version of this library, without high dispersion B star spectra, was presented in Leitherer *et al.* (1995).

About 30 O-type stars in the Magellanic Clouds have been observed in the UV with *HST* (at a resolution of ~2 Å). These spectra have been combined (after some interpolations and extrapolations in spectral type, luminosity class, and metallicity) to create two new libraries at a metallicity of $0.1\,Z_\odot$ (with the SMC stars) and $0.3\,Z_\odot$ (LMC stars). Spectra of B and WR stars in the solar library were used at low metallicities. The final libraries contain normalized spectra (with a continuum equal to unity). For more details see Robert *et al.* (in preparation).

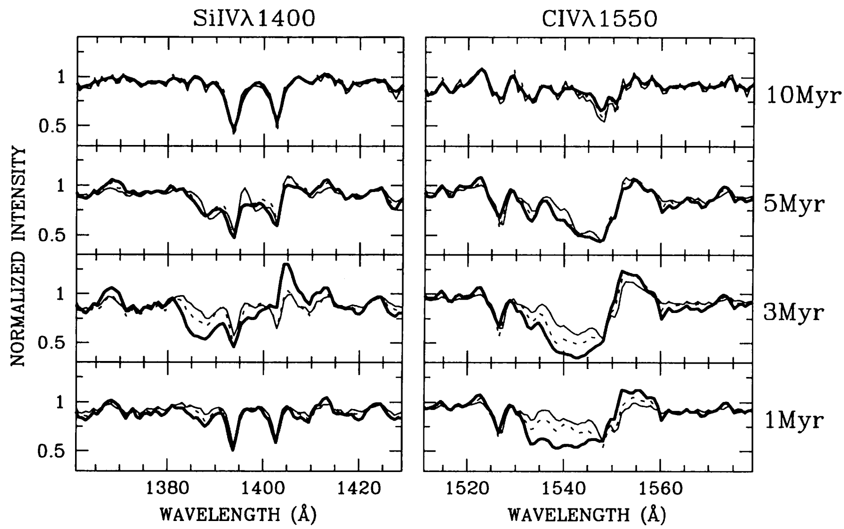

Figure 1. Synthetic UV lines for an instantaneous burst. A Salpeter IMF slope with stars between 1 and 80 $M_\odot$ was used. Three models are superposed for: the evolutionary tracks and library at $Z_\odot$ (thick line); tracks at 0.25 $Z_\odot$ + LMC library (dotted line); and tracks at 0.1 $Z_\odot$ + SMC library (thin line).

3. Ultraviolet spectral synthesis

Figure 1 shows part of synthetic spectra for a young starburst. It was computed using an updated version of the evolutionary synthesis code of Leitherer *et al.* (1992) which is now based on the 1992–1993 Geneva evolutionary tracks. By 3 Myr, C IV gets stronger and narrower as the O supergiants and WR population is peeking. Si IV develops a strong P-Cygni profile at the same time in dense stellar winds. By ~10 Myr, the B stars dominate the population and broad photospheric absorption doublets are seen. The strength of the P-Cygni profiles is correlated with the metallicity. At lower metallicity, stellar winds are less important, and only the most massive stars become WR stars.

4. Conclusion

High-resolution UV spectra of massive, hot stars combined with a population-synthesis code is an indisputable tool to study the star formation process in galaxies (*e.g.*, IMF, metallicity effect), to understand galaxy evolution and formation, and also to test stellar evolutionary models.

References

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Walborn, N., Panek, R.J. 1984, ApJ 186, 718