Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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γ^2 Velorum, photon loss and the velocity field

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Abstract. The interception of 0.01% of photons (termed photon loss) from the He II Lyα line by Fe VI and Ca V line-opacity can alter substantially the ionization structure of the wind. This is shown to increase the stellar luminosity and hence the wind driving efficiency. Our classical models for WR 11 (the WR component in the γ^2 Vel binary) underestimate the stellar luminosity as compared to the luminosity derived from the mass-luminosity relation. Here we present a model for WR 11 where photon-loss is included. This model succeeds in that it has a higher luminosity for the same spectral appearance and V brightness. Line-blanketing has not yet been added, so that the force-factors and the velocity-law cannot yet be calculated. However, a hydro-dynamical velocity-law derived from a photon-loss model of a WN5 star improves considerably the fit to the narrow He II λ4686 emission line over the use of a β-law.

1. A photon loss model for WR 11

We calculated a classical model which reproduces line-strengths and observed V magnitude of WR 11 (De Marco *et al.*, these Proceedings) and a photon-loss model with the same parameters as the classical model.

The photon-loss model (dashed line in Fig. 1) recombines at a smaller radius (larger ionic density) than the classical model (solid line). We then calculated a photon loss model which reproduces the line strengths and approximately recovers the ionization stratification of the classical model (dotted line). The photon-loss model reaches a hotter temperature (92 000 K *vs.* 75 900 K) for a similar spectral appearance. For equal V magnitude the luminosity of the photon-loss model is higher ($\log(L/L_\odot) = 5.3$ *vs.* 5.0). We find that this value is also higher than $\log(L/L_\odot) = 5.2$, expected from the WR mass and the mass-luminosity relation of Schaerer & Maeder (1992). When applying line-blanketing the model's luminosity is expected to decrease, possibly eliminating the discrepancy.

2. The hydrodynamical wind velocity law

Through the use of a Monte Carlo line-blanketing code, Schmutz (1997) determined the line-force parameters for a photon-loss model which reproduced the lines of the WN5 star WR6. He then calculated a hydrodynamic solution of

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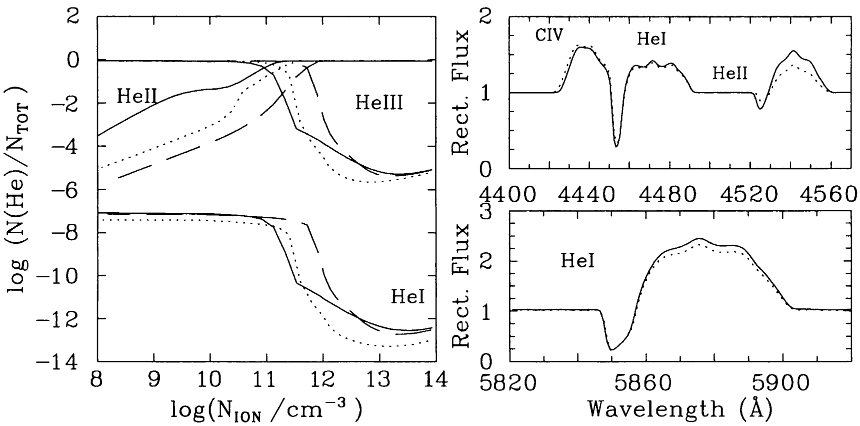

Figure 1. Ionization structure (*left*) and corresponding spectra (*right*). For an explanation of line styles, see text.

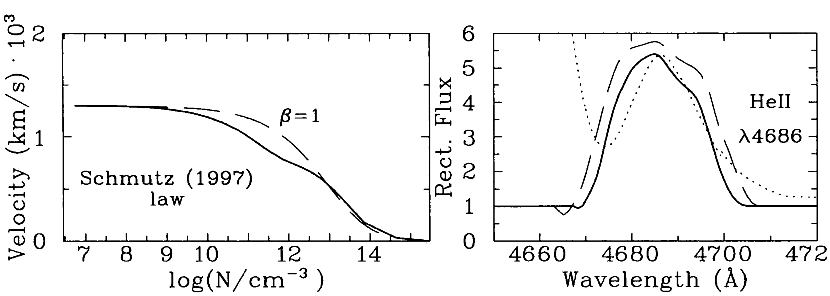

Figure 2. Comparison of two velocity laws (*left:* dashed line for the β-law, solid line for the hydrodynamical law) and corresponding fits to He II $\lambda 4686$ in the spectrum of WR 11 (*right:* dotted line).

the wind's outer part. The He II lines of WR 11 cannot be fitted with a $\beta = 1$ velocity-law (Fig. 2, dashed lines; a lower v_∞ also fails because it acts preferentially on He I lines). Adopting the hydrodynamic velocity-law for WR 6, a substantial improvement is obvious (Fig. 2, solid line). This is such an encouraging result that, after we have determined the force-factors for the WR 11 photon loss model, we will attempt the calculation of the hydrodynamical velocity law.

References

Schaerer D., Maeder A. 1992, A&A 263, 129

Schmutz, W. 1997, A&A 321, 268