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Wolf-Rayet stars of the carbon sequence

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Abstract. We established a grid of model atmospheres for WC stars with the Potsdam Wolf-Rayet (PoWR) code. Clumping and iron line blanketing are taken into account. The models are employed to analyze Galactic WC stars with subtypes WC 5–8.

In the latest stage of their evolution, massive stars may become Wolf-Rayet stars with a carbon-rich atmosphere before they explode as a supernova or gamma-ray burst. Spectral analyses of these WC stars require adequate modelling of their expanding atmosphere. The recent generation of the Potsdam Wolf-Rayet (PoWR) models accounts for iron line blanketing (Gräfener et al. 2002).

The efficient analysis of a large number of stars must be based on model grids (for WN grids, see Hamann & Gräfener 2004). We established a grid of WC models for the intermediate subtypes (WC5-8). The following parameters are kept fixed for the whole grid: luminosity $\log L/L_\odot = 5.3$, terminal wind velocity $v_\infty = 2000\,\mathrm{km/s}$, clumping contrast $D = 10$, chemical composition He/C/O = 55/40/5 (by mass). The two parameters which are varied in the grid are the stellar temperature T_* and the "transformed radius" R_t. With the help of $R_t \propto R_*\, v_\infty^{2/3}\, \dot{M}^{-2/3}\, D^{-1/3}$ the models can be scaled to different luminosities.

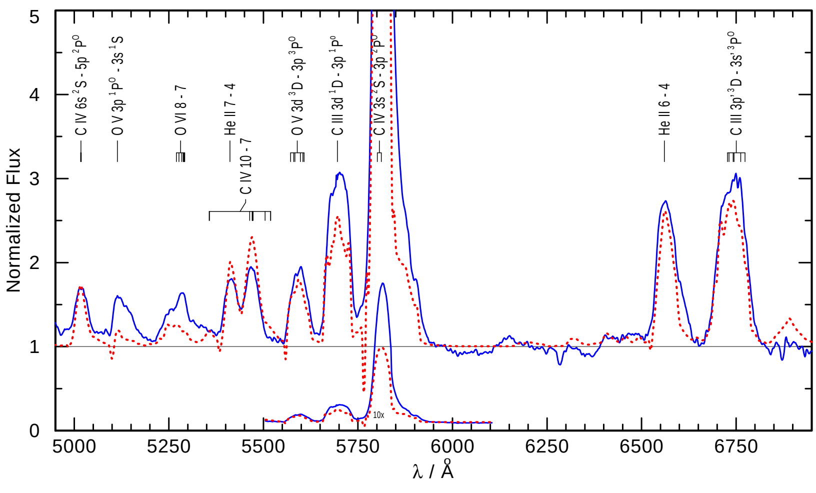

Figure 1. Example fit of a grid model (dotted) to the observed spectrum of the WC6 star WR 154 (solid).

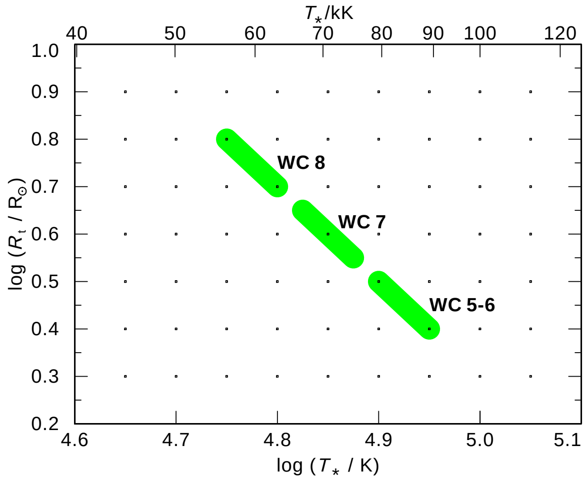

Figure 2. Location of the different subtypes in the R_t-T_* parameter plane. Lower R_t correspond to denser winds. Points mark grid models.

The grid models provide a reasonable fit to the observed spectral energy distribution (UV to IR) and the emission-line spectra (cf. Fig. 1). The stars of different subtype arrange themselves in a linear sequence in the $\log T_*$-$\log R_t$-plane (Fig. 2). We presently apply the grid for coarse analyses of the Galactic WC stars. Preliminary results are given in Table 1 for WC5-8 stars with distances known from cluster/association membership.

Table 1. Parameters of Galactic single WC5-8 stars. Distances and final velocities were taken from the WR catalog (van der Hucht 2001). All other entries result from our spectral analyses.

Subtype	Object	E_{b-v}	DM [mag]	R_* [$R_\odot$]	T_* [kK]	v_∞ [km/s]	$\log L_*$ [$L_\odot$]	$\log \dot{M}$ [$M_\odot$/yr]
WC 5	WR 111	0.33	11.00	2.1	89.1	2300	5.40	-4.6
	WR 114	1.15	11.50	1.9	79.4	2000	5.12	-4.9
WC 6	WR 23	0.47	12.55	4.1	79.4	2250	5.77	-4.4
	WR 154	0.78	12.20	2.1	79.4	2050	5.20	-4.8
WC 7	WR 14	0.65	11.50	4.5	70.8	1900	5.65	-4.5
	WR 68	1.40	12.57	3.0	70.8	2050	5.30	-4.8
WC 8	WR 135	0.50	11.20	5.3	63.1	1525	5.60	-4.7

References

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van der Hucht, K.A. 2001, 7th Catalog of Galactic Wolf-Rayet stars, NewAR, 45, 135