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A considerable fraction of central stars shows Wolf-Rayet type spectra of the carbon sequence, characterized by bright and broad emission lines from He, C and O. Those stars have strong stellar winds, thus requiring adequate model atmospheres for their spectral analyses. Recent versions of such models, like the *Potsdam Wolf-Rayet (PoWR)* code, account for iron-line blanketing and wind clumping. As an example, we show the spectral fit for the [WC2]-type central star PB 6 (→ Fig. 1).

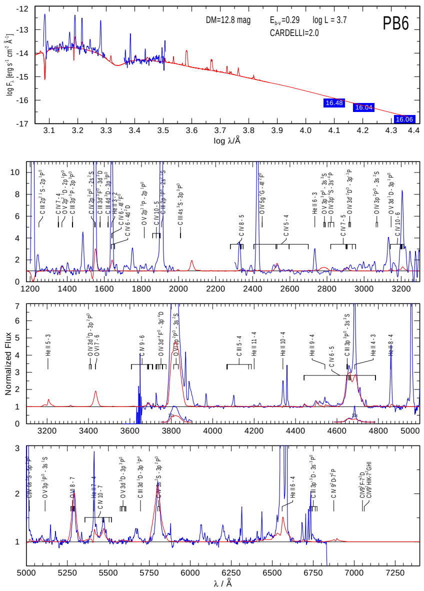

Fig. 1:
Spectral fit for PB 6.
Upper panel: spectral energy distribution
Lower panels: normalized spectra
blue: observation
red: model
Model parameters:

log L	3.7 [$L_\odot$]
T_*	141 kK
v_∞	2000 km/s
He:C:O	62:24:14
Fe	solar
log $\dot{M}$	-7.2 [$M_\odot$/yr]
D	10

(clumping contrast)

We re-analyzed a sample of 12 [WCE]-type central stars (i.e. with WC spectra of *early* subtype) with the recent version of the *PoWR* models. Here we focus the discussion on the helium-to-carbon abundance ratio. Most useful for this purpose is the pair of neighboring lines He II 5412 and C IV 5470. The models reveal that the ratio between the strength of those lines is a sensitive function of the abundance ratio (→ Fig. 2), but does not react much on the other fundamental parameters of the stellar atmosphere.

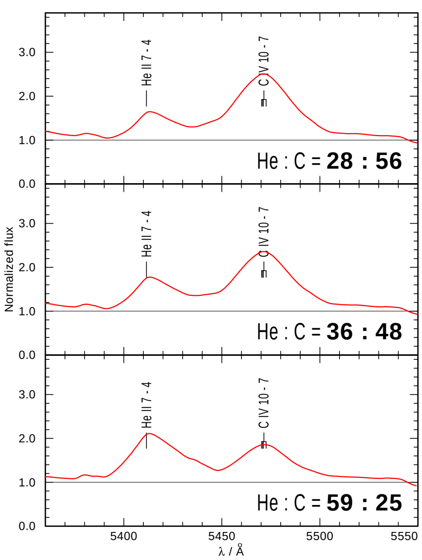

Fig. 2: The pair of neighboring lines He II 5412 and C IV 5470 for models with different He:C mass ratios as given in the plots, while all other parameters are the same for the whole model series. Roughly equal line strength is only achieved for a He:C mass ratio of about 2:1.

The present analyses confirm that central stars of late WC subtype, i.e. [WCL], have an atmospheric composition of He:C = 2:1 (by mass), typically. The empirical carbon mass fraction ranges from 0.24 to 0.40, as indicated by the green-shaded box in Fig. 4.

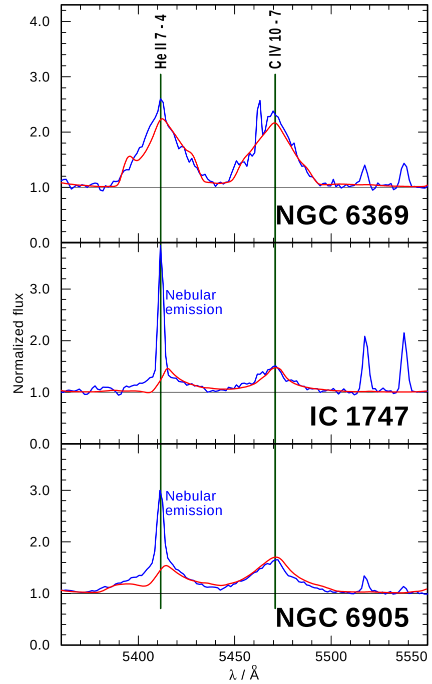

Fig. 3: The diagnostic line pair He II 5412 and C IV 5470 for three of the program stars. The two lines are generally observed to have similar strength (blue lines). Fitting models have a typical He:C mass ratio of 2:1 (red lines). Note that the He II 5412 is often contaminated by a strong, narrow nebular emission.

A couple of *late*-type [WC] stars, i.e. [WCL], have been re-analyzed with line-blanketed model atmospheres by the UCL group (for a compilation and the references, see Koesterke 2001). Those analyses, indicated in the upper part of Fig. 4, obtained rather high carbon abundances of 0.50, typically, for the [WCL].

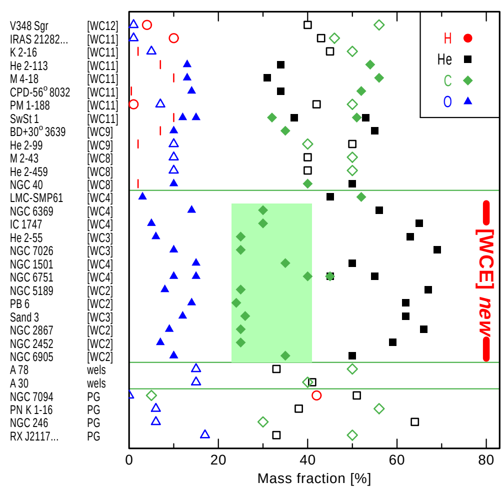

Fig. 4: Atmospheric abundances in hydrogen-deficient central stars obtained from spectral analyses. Open symbols are based on studies with un-blanketed model atmospheres, while filled symbols represent values obtained more recently with line-blanketed models. Small vertical bars indicate upper limits of the hydrogen abundance.

Thus the He:C ratios seems to be different between the different classes, and inconsistent with an evolutionary sequence [WCL] → [WCE]. Moreover, evolutionary models (Herwig 2001) predict about equal mass fractions of He and C resulting from a “late”, “very late” or “AGB final” thermal pulse (LTP, VLTP, AFTP).

Further research is needed to test all possible systematic errors in the spectroscopic abundance determinations. Due to the different ionization stages available, [WCL] and [WCE] analyses rely on different diagnostic lines. **If the present discrepancy between [WCL] and [WCE] atmospheric compositions cannot be resolved, the evolutionary scenarios must be reconsidered.**

References:

Crowther P.A., Abbott J.B., Hillier D.J., De Marco O.: 2003, IAUS 209, 243
Herwig F.: 2001, Ap&SS 275, 15
Koesterke L.: 2001, Ap&SS 275, 41