Clumping in Hot Star Winds
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Clumping in [WC]-type Central Stars from electron-scattering line wings

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While there is strong evidence for clumping in the winds of massive hot stars, very little is known about clumping in the winds from Central Stars. We have checked [WC]-type CSPN winds for clumping by inspecting the electron-scattering line wings. At least for three stars we found indications for wind inhomogeneities.

Clumping in Central Star winds

Hillier (1991) showed for WR atmospheres that clumpiness can be estimated from the strength of electron-scattering line wings. Clumps are defined by an enhanced density, so that $\varrho_{\mathsf{clump}} = D \cdot \overline{\varrho}$ with the clumping factor D. The empirical mass-loss rates scale with the adopted $D^{-1/2}$. Hamann & Koesterke (1998) found $D \approx 4$ for WN stars and even higher values of D for WC stars.

Although the spectra of [WC] Central Stars resemble those of massive WC stars, the clumping of their winds is not well investigated. Koesterke & Hamann (2003) derived $D \gtrsim 4$ for Sand 3, which is assumed to be a former Central Star with a dissolved nebula. For O-type, hydrogen-rich CSPN Kudritzki et al. (2006) found $D = 1 \ldots 50$ from the relative strength of Hα and He II 4686Å lines. Furthermore, Grosdidier et al. (2002) observed large-scale inhomogeneities, so-called blobs, via the line profile variability at a time scale of hours, which is comparable with the flight time of the clumps.

[WC] Central Star spectra

Electron-scattering (e.s.) wings in [WC] spectra are difficult to measure. The stellar spectra are contaminated with nebular lines which often outshine the e.s. wings. The uncertainty of the stellar continuum is often comparable with the strength of e.s. wings. Moreover the e.s. wings in [WR] CSPN spectra are weaker than for massive stars of same spectral type due to the different scaling properties of the line emission and the e.s. wings (providing a potential way to discriminate between [WR] CSPN and massive WR stars).

Results

In spite of the problems mentioned before, we found evidence for wind clumping in the three early-type [WC] stars NGC 6751, NGC 5189, and NGC 1501. For these stars, homogenous wind models yield e.s. wings that are definitely stronger than observed. The clumping contrast D seems to be higher than 4, but its precise value cannot be determined.

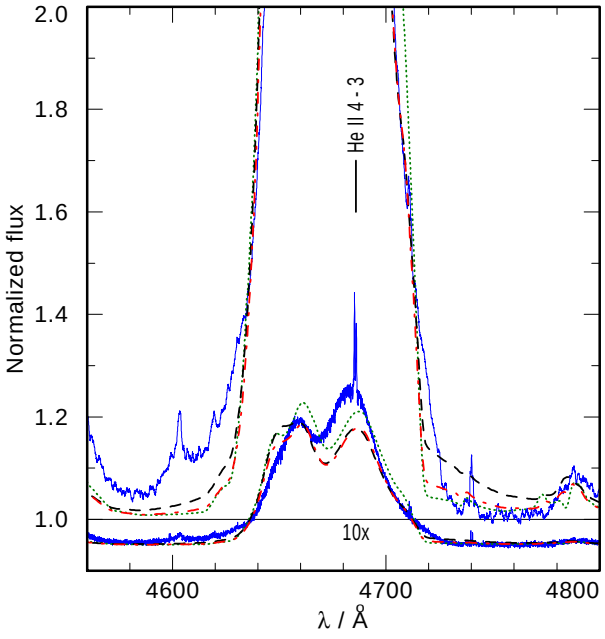

Figure 1: NGC 5189: observation (blue solid) and PoWR models: no clumping (black dashed), $D = 10$ (red dashed-dotted) and $D = 16$ (green dotted)

References

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