ATMOSPHERIC DIAGNOSTICS OF WOLF-RAYET STARS

C. Doom*
Astrophysical Insitute, Vrije Universiteit Brussel,
Pleinlaan 2, 1050 Brussel, Belgium

1. Introduction

Wolf-Rayet (WR) stars are the descendants of massive stars that have lost their hydrogen rich envelope. Recently more accurate data on WR stars have become available: mass-loss rates (van der Hucht et al. 1986), radii and luminosities (Underhill 1983, Nussbaumer et al. 1982).

It may therefore be worthwhile to investigate if combinations of observed parameters shed some light on the structure of the extended stellar wind of WR stars.

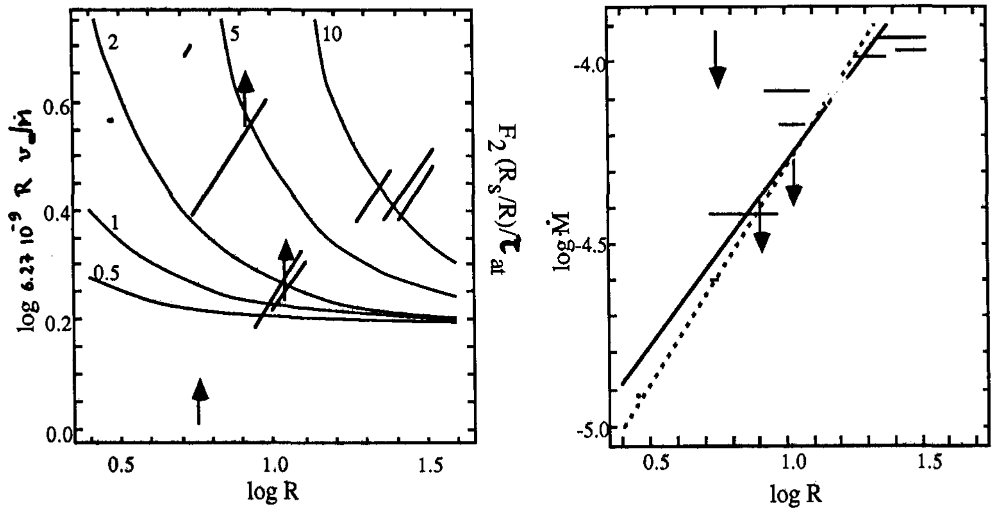
2. The wind model

In many WR stars the photosphere is situated in the stellar wind. We assume that the wind is stationary and isotropic. Further we assume a velocity law $v(r)=v_\infty(1-R_s/r)^\beta$ where v_∞ is the terminal velocity of the wind in km/s, R_s is the radius where the wind acceleration starts and $\beta > 0$ is a free parameter. We can then easily compute the level R in the wind where the photosphere is located (de Loore et al. 1982): R is the solution of the equation $6.27\ 10^{-9}\ \tau_{at}\ R\ v_\infty / \dot{M} = f_\beta(R_s/R)$ where τ_{at} is the optical depth at the photosphere (2/3 or 1), $\dot{M}$ (>0) is the mass loss rate in $M_\odot$/yr and $f_\beta > 1$ is a slowly varying function (Doom 1987).

If Fig.1 confront the observed parameters to the theory for $\beta = 2$. We can conclude that (1) all observations are consistent with the wind model; (2) WR stars with radii larger than 10 $R_\odot$ must exist: the skew lines in Fig.1 reflect the uncertainties on the radius; if we continue the lines down to the left, the condition $f_\beta > 1$ implies that $R > 10\ R_\odot$ for several WR stars and (3) the values for R_s are larger than expected from stellar evolution theory ($R_s = 0.8 - 1.5\ R_\odot$, Doom et al. 1986).

* senior research assistant, NFWO Belgium

https://doi.org/10.1017/S0252921100093659 Published online by Cambridge University Press



3. The mass-loss rates of WR stars.

Considering again the simple wind model we see that the quantity R $v_\infty/\dot{M}$ must be nearly constant since τ_{at} is fixed and f_β is slowly varying. Both the observed radii and mass-loss rates vary by a factor of 10. If they were random we would expect variations of v_∞ of at least a factor 20. Since only a factor of 4 is observed some positive correlation between R and $\dot{M}$ may exist.

The relation between R and $\dot{M}$ is given in Fig.2 (Doom 1988). One indeed finds a significant correlation with a slope of 1 to 1.2.

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https://doi.org/10.1017/S0252921100093659 Published online by Cambridge University Press