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MASSIVE STARS IN TRANSITION: SPECTROSCOPIC ANALYSIS OF HR CARINAE

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We analysed the high-resolution data of the LBV (or S Dor variable) HR Carinae, taken with the FEROS spectrograph in the wavelength range 3900 to 8200 Å. We performed a spectral analysis of the Balmer lines with a non-LTE expanding atmosphere code in order to derive its stellar parameters and to infer its evolutive status.

Recently we obtained high-resolution spectroscopic data of the LBV HR Car (Machado, de Araújo, & Pereira 2002). One of the main characteristics of this object is the Balmer lines showing P Cygni profiles. In Hα there is a clear structure in the absorption component. These kind of structures were also observed by Hutsemékers & Van Drom (1991) and may be interpreted as an indication of different shells forming around HR Car. Almost all Fe II lines present in the spectra of HR Car also exhibit P Cygni profiles. We clearly see two main components that correspond to radial velocities of 30 km s^{-1} and 100 km s^{-1}. Hutsemékers & Van Drom (1991) refer to these two components with practically the same values of radial velocity.

The direct comparison of our data with the spectra obtained by Nota et al. (1997) in two different epochs (1995 May and 1996 Jan), reveals clear spectral variations in HR Car. The Si II $\lambda\lambda$ 6347, 6371 lines, which were absent in the first spectra of Nota et al. (1997), arise in their second spectra and are stronger in our spectra. On the other hand, the N II $\lambda\lambda$ 6379, 6482 lines decrease in intensity from the first of Nota's data to our spectra (1999). These two phenomena are described by Nota et al. (1997) as an indication of decrease in temperature. Further, they have estimated the temperature using an atmospheric model, and obtained 20,000 K and 15,000 K for the first and second sets of data, respectively.

In the present work we have used a non-LTE model (Machado 1998) in order to fit the Balmer lines. The intensities and widths of the emission components are well reproduced and the fits can be considered reasonable. The best model corresponds to $\dot{M} = 6.5 \times 10^{-5}\, M_\odot\,\mathrm{yr}^{-1}$, $T_\star = 10{,}000$ K, $L_\star = 5 \times 10^5\, L_\odot$, $R_\star = 350\, R_\odot$, and $A_{\mathrm{He}} = 0.4$. This model locates HR Car near the 40 $M_\odot$ evolutionary track in the HR diagram, in a region occupied by the LBVs, as is shown in Figure 1.

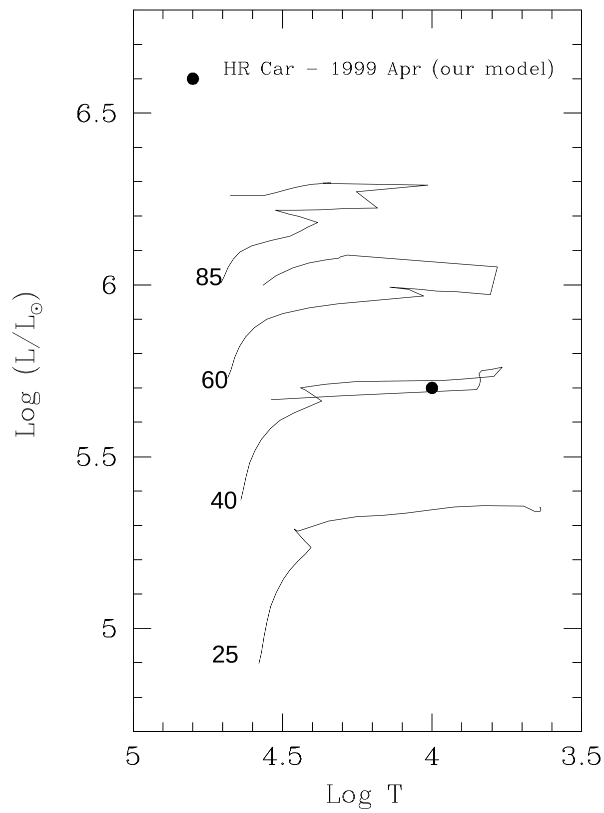

Fig. 1. Theoretical evolutionary tracks of 25 $M_\odot$, 40 $M_\odot$, 60 $M_\odot$ and 85 $M_\odot$ initial main-sequence mass. The full circle locates HR Car according to our result.

Our temperature values, when compared to those obtained previously by Nota et al. (1997), give strong evidence that HR Car is moving redward across the HR diagram due to the onset of a new S Dor phase.

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