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A tailored analysis of the WN8 star WR 40

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Abstract. We present the results of a tailored analysis of the spectra of WR 40 (HD 96548, WN8) utilizing new line blanketed non-LTE model atmospheres. Synthetic spectra are compared with observation from 900 to 10,000 Å, with emphasis on far-UV *HUT* observations and the *IUE* regime. We identify the important line complexes in this region and deduce the Fe abundance. Improved stellar parameters and abundances of other metals are determined. A comparison of our new model results with non-line blanketed results is made.

Discussion

We have utilized a non-LTE code (Hillier 1990), which solves the radiative transfer equation in the co-moving frame, to produce a synthetic spectrum of WR 40 (HD 96548). Unlike previous studies (Hamann & Koesterke 1998 - HK; Hamann, Koesterke & Wessolowski 1995 - HKW; Crowther, Hillier & Smith 1995 - CHS) which derived stellar parameters by fitting a small set of line profiles, we consider the entire spectrum. Recent enhancements to the code include the implementation of line-blanketing (Hillier & Miller 1998), which improves UV spectral analysis and allows us to better determine stellar parameters and abundances.

Our model spectrum (dotted line), together with the observational data (solid line), are shown in Figure 1. In the far-UV, *HUT* data ($\Delta\lambda \simeq 3$ Å) taken during the 1995 *Astro-2* mission have been used, scaled by a factor of 0.65. For comparison with observations, the effects of interstellar H I and H_2 absorption have been applied to the model spectrum. In the ultraviolet, *IUE* data ($\Delta\lambda = 0.1$–0.2 Å) are displayed. The optical spectrum from Torres-Dodgen & Massey (1988, $\Delta\lambda \simeq 10$ Å) is shown, scaled to match the v magnitude as listed by Crowther *et al.* (1995). We smoothed the model spectrum to match the observational resolutions.

Table 1. Derived stellar parameters for WR 40

analysis	included species	T_* (kK)	R_* ($R_\odot$)	log L ($L_\odot$)	log $\dot{M}$ ($M_\odot yr^{-1}$)	v_∞ (km s^{-1})
our model	H He C N Si Fe	34.2	18.6	5.6	–3.93	840
CHS (95)	H He C N	35.9	14.4	5.5	–4.01	840
HK (98)	H He N	31.6	15.5	5.3	–3.98	1000
HKW (95)	H He	31.0	20.6	5.5	–4.02	1000

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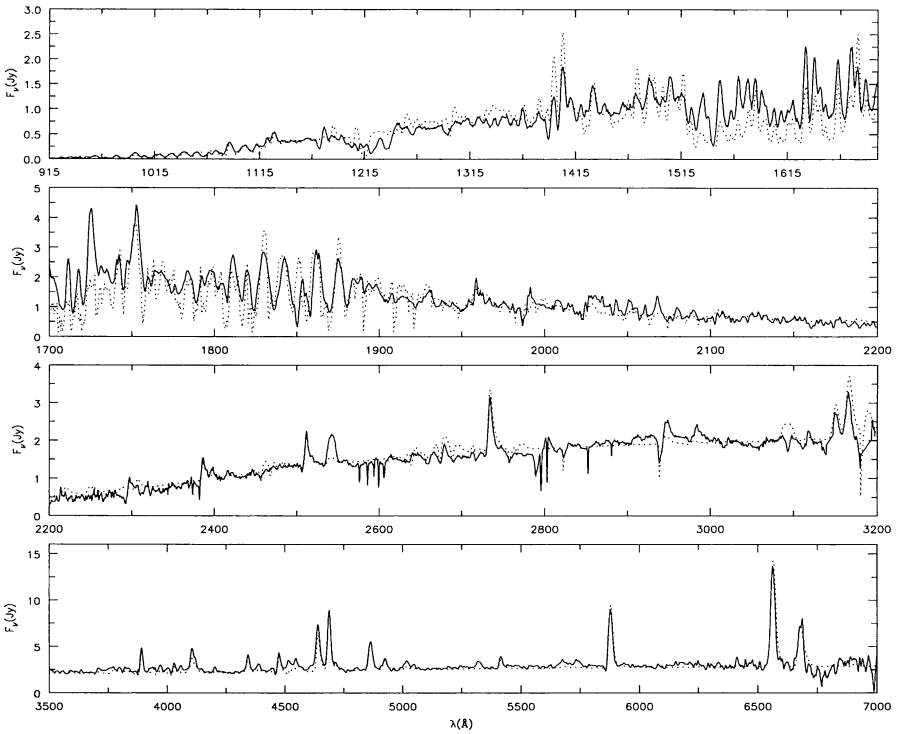

Figure 1. WR 40 – observations (solid line) *vs.* model (dotted line)

Our inferred parameters are shown in Table 1, along with those previously derived by earlier investigations. The results have been scaled to a distance of 3.28 kpc. The elemental abundances of our model are as follows (in mass %): H 15; He 83; C 0.01; N 1.45; Si 0.17; Fe 0.16. The inclusion of line-blanketing due to iron has allowed us to successfully duplicate most of the Fe features in the UV, however difficulty in attaining the correct continuum shape suggests anomalous reddening toward this object. We have used $E_{B-V} = 0.45$ and $R = 3.6$. To illustrate the importance of including even trace elements in the models, the strength of He II λ4686 varies by about 10% between this model and an identical model without silicon.

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