THE PHYSICAL NATURE OF WR8 (WN6/WC4)

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Abstract. An analysis of the UV, optical and IR spectra of the composite WN/WC star WR8 is presented using the WR standard model. All spectral features are consistent with formation in the same stellar wind. The stellar parameters are T_*=49kK, log $L/L_\odot$=5.1, log $\dot{M} = -4.2$, v_∞=1590 km s^{-1}. The derived chemistry (C/He=0.025, C/N=3, C/O=4) is intermediate between normal WN and WC stars.

Key words: stars:atmospheres – Wolf-Rayet – abundances – winds – mass-loss

1. Introduction

Conti & Massey (1989) assigned WN/WC classifications to 8 Galactic and LMC Wolf-Rayet stars which showed anomalously strong C IV λ5801–12 relative to He II λ4686 in otherwise normal WN stars. The identification and analysis of composite WN/WC stars, as opposed to WN+WC binaries, have important consequences on single star evolutionary models. Recently, conflicting arguments about the nature of one such star, WR8 = HD 62910 (WN6/WC4), have been put forward. Radial velocity measurements by Niemela (1991) suggest that the nitrogen emission lines marginally move in anti-phase with the carbon spectrum implying a WN+WC system while an analysis by Willis & Stickland (1990) concluded that the carbon and nitrogen emission lines were formed in the same wind. We present a detailed study of this star in an attempt to determine its true physical status.

2. Observations and technique

We use the WR standard model of Hillier (1990) to determine the physical parameters of WR8 assuming it to be single, using UV and optical observations from Willis & Stickland (1990) and new *UKIRT*–CGS4 spectra covering 1.6–2.3μm. Since the carbon content of WR8 is non-negligible, our analysis requires the simultaneous determination of the physical parameters (T_*, log L_*, $\dot{M}$) and carbon abundance of WR8 using diagnostic helium (He I λ5876, He II λ5411) and carbon (C III λ5696, C IV λ5471) lines. We determine an interstellar reddening of E_{b-v}=0.60 towards WR8 implying M_v=−4.5 using a distance of 3.4 kpc (Lundström & Stenholm 1984). Once the temperature structure has been determined, nitrogen and oxygen abundances are then derived.

K. A. van der Hucht and P. M. Williams (eds.), Wolf-Rayet Stars: Binaries, Colliding Winds, Evolution, 152–153.

3. Results and evolutionary status

Our analysis demonstrates that *all* UV, optical and IR spectral features can be simultaneously fitted to within a factor of 2–3 indicating that they are consistent with formation in a single stellar wind. The derived parameters for WR8 are somewhat different from previous Sobolev (Willis & Stickland 1990) and pure helium standard model (Schmutz *et al.* 1989) analyses indicating that it is essential to perform standard model analyses including CNO elements for such stars. We compare the derived physical parameters and chemistry of WR8 with a WN6 and a WC5 star in Table I. The elemental abundances of WR8 are indeed intermediate between WN and WC subtypes implying that WR8 is a genuine transition WN/WC object. Our results broadly support the evolutionary predictions of Langer (1991) for WN/WC stars, although the increase in carbon at the expense of nitrogen appears to be more gradual and oxygen increases more rapidly than predicted. Finally, we note that the WN6/WC4 subtype of this star is misleading since the principal oxygen line spectrum of WR8 is that of O III-IV. Therefore the WC4 classification results from O III $\lambda5592 >$ C III $\lambda5696$, instead of the usual O V $\lambda5590$ feature with the weakness of C III attributable to the low carbon content for WR8 compared with normal WC stars.

TABLE I

Comparison of WR8 with a WN6 (Crowther 1993) and WC5 star (Hillier 1989)

Star	Subtype	T_* kK	log L_* $L_\odot$	log $\dot{M}$ $M_\odot$/yr	v_∞ km/s	log H/He	log C/N	log C/He	log O/He
WR134	WN6	61	5.3	−3.9	1950	< -2.0	−1.5	−4.0	−4.0
WR8	WN6/C4	49	5.1	−4.2	1590	< -2.0	+0.5	−1.7	−2.3
WR111	WC5	59	5.0	−4.4	1800	< -2.0	$\gg 2$	−0.3	−1.0

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