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The hot R Coronae Borealis star DY Centauri: nebular and photospheric lines

N. Kameswara Rao[1], **S. Giridhar**[1], **and D.L. Lambert**[2,★]

[1] Indian Institute of Astrophysics, Bangalore - 560034, India
[2] Department of Astronomy, University of Texas, Austin, TX 78712, USA

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Abstract. High resolution spectra in the red region of the hot R CrB star DY Cen show the following characteristics: a strong absorption line spectrum dominated by lines of C II, N II, and Ne I, inverse P-Cygni type profiles of some C II and He I lines, and emission lines of [N II], [S II], and [O I]. The star also seems to possess an expanding chromosphere or stellar wind region. The forbidden lines indicate the presence of a low excitation nebula with an electron temperature of ≤10 000 K and an electron density of 450 cm^{-3}. The presence of low excitation nebulae may be a common property of the hotter R CrB stars.

Key words: Helium stars – R CrB stars – DY Cen – emission lines

1. Introduction

R Coronae Borealis variables are a small group of hydrogen-deficient irregular-variable supergiants. Most of them are F-type supergiants. Only three hot R CrB stars are presently known and DY Cen, the subject of this paper, is one of the trio. DY Cen was classified by Hoffleit (1930) as a R CrB star on the basis of its light variations: a detailed light curve appears not to have been published, but minima occurred in 1897, 1901, 1924, and 1929. The star has not shown a deep minimum in recent years (Bateson 1975, 1978). Feast & Glass (1973) and Glass (1978) thought DY Cen might not be a R CrB star because it did not appear to have an infrared excess. However, the *UBVRIMNQ* photometry of Kilkenny & Whittet (1984) shows an infrared excess corresponding to a black body at a temperature of about 800 K. Kilkenny & Whittet (1984) suspected variation in the infrared fluxes over a period of 10 yr. IRAS observations confirm the presence of infrared excess, and show the presence of a 350 K black body dust shell (Walker 1986). Small amplitude light variations at maximum light, a characteristic of R CrB stars, are also seen to be present in this star (Pollacco & Hill 1991). In addition, Bateson (1978) pointed out that the visual light curve of DY Cen suggests a gradual fading in maximum light from 1958. This suggestion seems to be confirmed by a comparison of the *BV* magnitudes obtained by Sherwood (1975) in 1972 summer to those obtained by Pollacco & Hill (1991) during 1987 May, June showing a change in V from 12.39 $B-V=$ 0.31 to $V=12.784\pm0.071$, $B-V=0.326\pm0.015$.

Two of the hot R CrB stars (V 348 Sgr and MV Sgr) are associated with nebulae of ionized gas. V 348 Sgr ($T_{\mathrm{eff}}\sim 20\,000$ K) is surrounded by optical nebulosity of diameter about 30 arcsec (Herbig 1958; Dahari & Osterbrock 1984; Pollacco 1989; Pollacco et al. 1990). Nebular lines have been detected in the spectrum of MV Sgr ($T_{\mathrm{eff}}\sim 15\,400$ K) (Rao et al. 1990). In this paper, we report on our successful search for nebular emission lines from DY Cen. Hα emission from DY Cen was already known (Herbig 1983; Rao 1986).

DY Cen has another distinction to set it apart from the other hot R CrB stars: the presence of hydrogen lines at a strength comparable to the helium lines (Rao 1986; Pollacco 1989). Recently from a high resolution spectroscopic study, Jeffery & Heber (1992) estimated $n_{\mathrm{H}}/n_{\mathrm{He}}\sim 0.1$.

The origins of the R CrB stars are unknown. It would appear that the present surface layers being H-poor and He-rich were once part of a stellar core that had experienced H-burning and He-burning. The chief puzzle is to account for the loss of the star's H-rich envelope. Proposals involving a single star include the ejection of the envelope from the red giant to expose the He-rich core (Schönberner 1977) and the consumption of the H in the envelope by deep mixing (Wheeler 1978). On the other hand, Iben & Tutukov (1985) suggested that the (now single) R CrB stars are the result of a merger of a pair of white dwarfs with neither star having more than a very thin H envelope.

Send offprint requests to: N. Kameswara Rao

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The observer's hope is that clues to the evolutionary origin of the R CrB stars may be uncovered by a thorough spectroscopic study. For DY Cen, we set out to search for emission lines from surrounding nebulosity that may be part of the ejected envelope of the progenitor, and to determine the chemical composition of the stellar photosphere that was presumably once the core of one or a pair of stars.

2. Observations

High resolution ($\lambda/\Delta\lambda \sim 20\,000$) spectra of DY Cen near maximum light were obtained with the Cassegrain echelle spectrograph and a CCD detector (GEC 11) attached to the 4-m telescope of the Cerro Tololo Inter-American Observatory on 16 July 1989. A 31.6 line/mm echelle grating was used. The spectral range covered was from 5475 Å to 6830 Å. Two exposures of 30 min duration were obtained. An exposure of a thorium argon hollow cathode lamp was obtained immediately after the stellar observations. An additional blue exposure with 4 m CTIO telescope was obtained on 10 July 1990 by A. McWilliams at our request. However, this was with an experimental set up and was used in the limited wavelength region 4295 Å–4490 Å. The data reduction was done at the Vainu Bappu Observatory, Kavalur, using the RESPECT Software (Prabhu et al. 1987).

3. Description of the spectrum

The spectrum of DY Cen in the visual-red region shows several emission lines both permitted and forbidden, in addition to a strong photospheric absorption spectrum. Although DY Cen is at a galactic latitude ~8°, the spectrum shows several interstellar diffuse features (DIBs).

3.1. *The absorption line spectrum*

The stellar absorption spectrum is dominated by the photospheric lines of C II, N II, Ne I, He I, and O II (Figs. 1, 2). A census of the spectrum shows a similarity to that of a normal B5-6 supergiant. However, the strengths of C II, N II, and Ne I lines are very much enhanced. Table 1 summarizes the measured equivalent widths. The C II lines from the low-lying levels of the doublet system show emission components (inverse P-Cygni type – Fig. 3a) as does He I 5876 Å, and even the Si II lines at 6347 Å appear to have an emission component. The line identifications were made using the line list given by Lynas-Gray et al. (1981) for the helium star HD 168476, and that of Dahari & Osterbrock (1984) for V 348 Sgr. The list in Table 1 is not a complete list of the photospheric lines in our spectrum. A complete list will be published later.

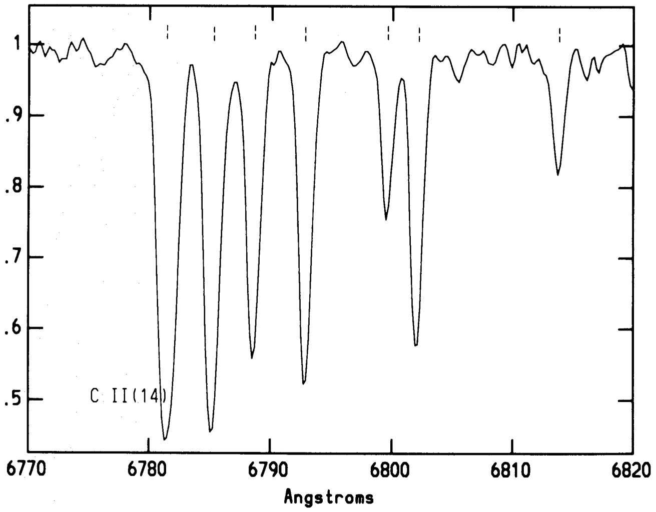

Fig. 1. Spectrum showing the region of strong C II (multp. 14) absorption lines

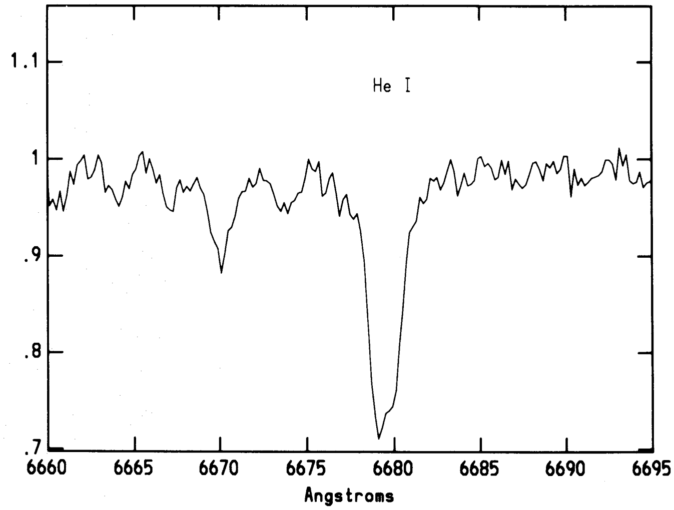

Fig. 2. The profile of He I λ 6678

3.1.1. Radial velocity

The radial velocity measured from the absorption lines that have no obvious emission component is given in Table 2. The mean radial velocity is 41 ± 4 km s^{-1} which, we assume, represents the stellar velocity. The few higher ionization lines Al III, Si III, etc. agree with this velocity within the errors of measurement. The radial velocity determined from our blue CTIO spectrum obtained on 10 July 1990 is $+41$ km s^{-1}. However, Pollacco & Hill (1991) from a low resolution spectrum in the blue gave 15.1 ± 2.5 km s^{-1} as the radial velocity. Herbig (1990) measured a mean value of 29 km s^{-1}from four plates (with a spread from 35 to 25 km s^{-1}) obtained in April 1982. The difference between their and our measurements shows that DY Cen is a velocity variable.

Table 1. Equivalent widths of selected absorption lines in the spectra of DY Cen and HD 168476

Species	λ(Å)	$\log gf$[a]	W_λ (mÅ)	
			DY Cen	HD 168476[b]
He I	6678.15	0.329	758	1325
C II	5640.55	−0.68	422	
	5648.07	−0.381	507	224
	5662.47	−0.205	544	271
	5843.61	−1.68	90	84
	5856.01	−1.03	139	119
	6151.43	0.243	337	192
	6461.95	0.408	307	243
	6622.05	−1.58	221	138
	6783.90	0.310	843	669
	6787.22	−1.373	552	454
	6791.47	−0.268	603	408
	6798.11	−1.074	277	
	6800.68	−0.341	487	423
	6812.29	−1.292	215	193
C I	5793.51	−2.08	64	
	5801.17	−2.35	65	
	5805.76	−2.70	27	
N II	5530.27	0.083	35	
	5666.64	0.008	379	281
	5676.02	−0.347	317	166
	5679.56	0.278	496	305
	5686.21	−0.473	218	164
	5710.77	−0.475	300	177
	5730.67	−1.65	69	118
	5747.29	−1.02	109	104
	5947.65	0.320	218	83
	5952.39	−0.429	69	99
	6167.76	0.124	115	
	6482.07	−0.162	312	353
	6629.80	−0.253	151	164
O II	6640.90	−0.89	230	
	6721.35	−0.59	304	
O I	6156.78	−0.731	132	164
	6158.19	−0.445	155	165
Ne I	5764.42		83	349
	5852.49	−0.433	118	414
	5881.89	−0.701	102	369
	5944.83	−0.556	107	400
	6029.99	−0.989	67	187
	6074.34	−0.467	181	471
	6128.45	−1.258	59	
	6143.06	0.214	315	575
	6163.59	−0.563	119	307
	6217.28	−0.869	65	290
	6266.49	−0.405	268	433
	6334.43	−0.388	233	328
	6382.99	−0.291	281	543
	6402.25	+0.270	421	792
	6506.53	−0.133	215	648
	6532.88	−0.610	91	
	6598.95	−0.308	196	713
	6717.04	−0.323	81	581
Al III	5696.47	0.235	490	
	5722.65	−0.069	270	
Al II	6006.42	−0.89		
	6226.18	0.04	58	
	6696.39		40	
Si III	5739.76	−0.16	327	74
S II	5509.67	−0.14	46	177
	5564.94	−0.34	62	217
	5606.11	0.04	52	367
	5664.73	0.44	43	176

[a] *References*: Wiese et al. (1966) for He I, C I, C II, N II, O I, O II and Ne I; Dahari & Osterbrock (1984) also for C II; Wiese et al. (1969) for Al II, Al III, Si III and S II.

[b] From Lynas-Gray et al. (1981).

3.1.2. Surface composition

The equivalent widths of a selection of photospheric lines are given in Table 1 along with the equivalent widths for the helium star HD 168476 (Lynas-Gray et al. 1981). A plot of the equivalent widths of HD 168476 versus DY Cen for C II, N II, and Ne I line shows that the strong lines (≥ 200 mÅ) of C II and N II are much stronger in DY Cen, but the weaker lines (≤ 200 mÅ) have comparable strength in both stars. The He I λ6678 appears as a strong (Fig. 2b) sharp line without extended wings and is consistent with the low surface gravity inferred by Pollacco and Hill. Recently the surface composition has been determined by Jeffery & Heber (1992) from a model atmosphere based analysis. They determine $T_{\rm eff} = 19\,500$ K and $\log g = 2.15$. They find $n_{\rm H}/n_{\rm He} \simeq 0.1$, $n_{\rm C}/n_{\rm He}$ as well as $n_{\rm Ne}/n_{\rm He} \simeq 0.01$ and surprisingly the Fe abundance is down by a factor of 2.6 in log relative to the solar value, although Si and P are enhanced; S is of solar composition. Since their analysis is a thorough one we do not propose to redetermine the abundances. Their neon abundance is based on the equivalent widths listed in Table 1.

3.2. *Diffuse interstellar features and reddening*

The equivalent widths (W_λ) of the DIBs are given in Table 3. The comparison of the strength of DIBs in DY Cen with those in stars in the Per-Cas region (see Table 3) gives using Herbig's (1975) relationships between $E(B-V)$ and equivalent widths of DIB, the estimate $E(B-V) \sim 0.3$–0.45. Jeffery & Heber (1992) estimate

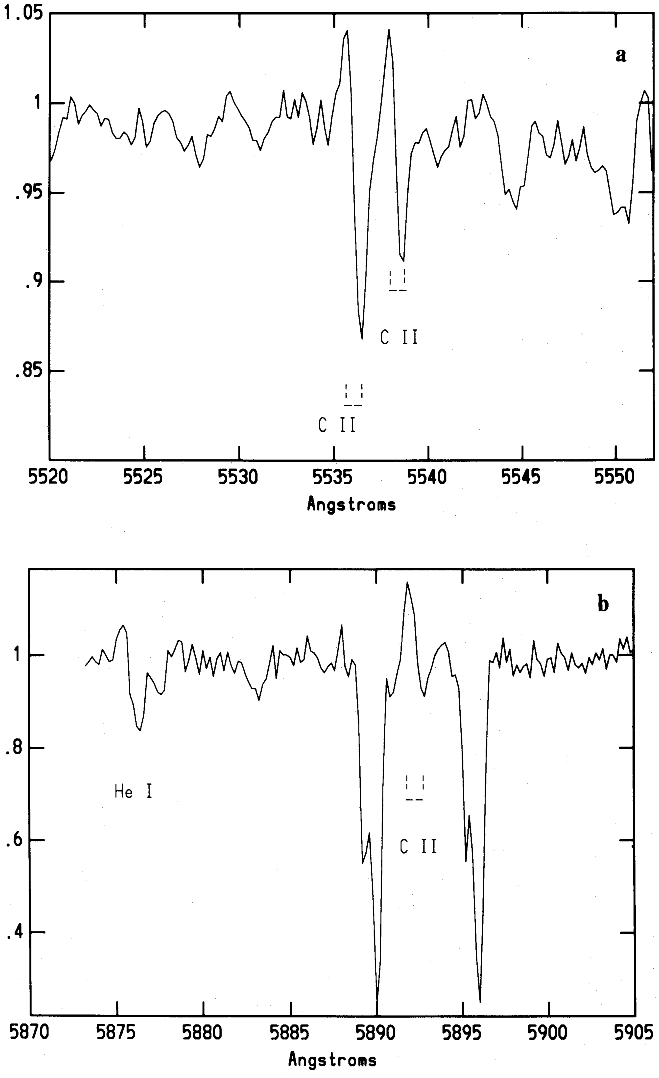

Fig. 3a and b. The blueward emission to the C II absorption lines. **a** λλ 5535.4, 37.6; **b** λ 5891.6 and He I λ 5876

$E(B-V)=0.5$ by fitting the observed energy distribution (*UBV* and IUE spectrum from 2000 to 3000 Å) to the one computed from an atmospheric model of $T_{\rm eff}=19\,100$ K and log g of 2.15.

There are two bright B supergiants within 2° of DY Cen: HD 116084, a B2.5Ib and HD 115482, a B0.5Iae star. These are reddened by $E_{B-V}=0.27$ and 0.51 respectively. From the luminosity calibration given by Corbally & Garrison (1983), a distance of about 1.4 kpc can be estimated for this pair. If HD 115842 happens to be a hypergiant of $M_v \sim -9$, then the distance is about 4.8 kpc. Since the inferred reddening for DY Cen is in between that of these two field stars, these estimates put some limits on the distance and luminosity of DY Cen: at a distance of 4.8 kpc, DY Cen has log $L/L_\odot=3.2$.

Our spectrum of DY Cen shows strong NaD absorption from interstellar or circumstellar gas. The Na I D lines are resolved into two components: the stronger one is at -5 km s^{-1} and the other is at -43 km s^{-1} (Fig. 3b). The stronger component coincides in velocity with the predicted 21 cm H I velocity for the longitude and latitude of DY Cen ($l=307\overset{\circ}{.}95$, $b=8\overset{\circ}{.}3$; *Kerr et al.* 1986). *The weaker component may come from circumstellar material. The* 5890 Å line is blended with the C II lines near 5889.8 Å. The equivalent width of the NaD at 5896 Å is 399 mÅ.

Table 2. Radial velocity from photospheric lines

Species	λ(Å)	Radial velocity (km s^{-1})	
		Absorption	Emission peak
C II (25)[a]		41.6 ± 3.9	
N II (14)		42.0	
Ne I (20)		39.5	
He I	5875.6	14.2	−33.3
C II	6578.05	17.5	−52.3[b]
	6482.85	15.2	−34.4
	5891.59	37.7	−9.7
	6095.29		8.2
	6098.51	59.7	8.2
	6102.56	57.7	18.4
	6257.18	50.5	8.9
	6259.59	51.2	1.3
	5535.35	47.4	1.4
	5537.61	42.0	3.0

[a] The number in parentheses is the number of lines used.
[b] Might have been effected by the terrestrial OH emission.

4. The emission lines

Both permitted (C II, He I, Hα) and forbidden ([O I], [S II], [N II]) lines are present in the spectrum.

4.1. *The permitted lines*

Some of the C II absorption lines have emission in their blue wing as shown in Fig. 3a, b. This emission may fill in the absorption component. The He I 5876 Å line shows a similar inverse P-Cygni profile (Fig. 3b). Even the Si II lines 6347 and 6371 Å a lines appear to be filled in since they appear too weak for the spectral type. The emission in C II lines is confined to the transitions involving lower doublet levels of the singly excited configuration (which are normally expected to be strong in absorption). DY Cen shows a spectroscopic similarity with the extreme helium star BD −9° 4395 in displaying inverse P-Cygni profiles in C II and He I lines (Heber 1986; Jeffery 1986). These profiles are variable in BD −9° 4395, but we do not know whether such a variability exists for DY Cen. Jeffery (1986) proposes that the emision spectrum in BD −9° 4395 is due

1993A&A...280..201R

Table 3. The diffuse interstellar bands (DIBs)

DY Cen					10 Per, $E(B-V)=0.48$		κ Cas, $E(B-V)=0.31$	
λ(Å)	V(km s^{-1})	W_λ(mÅ)	A_c^a	$E(B-V)^b$	W_λ(mÅ)	A_c	W_λ(mÅ)	A_c
5780	12.3	374	10.0	0.46	342	12.9	282	12.1
5797	9.7	95	7.3		166	9.2	89	7.0
6203		96						
6269	10.4	116	6.4	0.30	185	7.5	64	4.2
6283	16.4	425	15.7		530	15.0	365	9.0

[a] A_c is the percentage central depth of the DIB.
[b] Estimated from W_λ and Herbig (1975) relations between W_λ and $E(B-V)$.

to non-uniform mass loss related to g-mode non-radial pulsations.

The radial velocity of the emission peaks and the absorption dips of these lines are given in Table 2. For the lines with weak emission the radial velocity of the absorption dip corresponds to that of photosphere as measured from the pure absorption lines. The lines with strong emission have their absorption dips displaced redward relative to the photospheric velocity. Thus, blue shifted emissions appear to be superposed on the strong photospheric absorption lines. A comparison with the C II emission line strengths in V 348 Sgr suggests that this emission line region in DY Cen may be cooler and less dense than the V 348 Sgr chromosphere.

A comparison of the absorption equivalent widths determined from our blue spectrum, obtained on 10 July 1990, with the equivalent widths measured by Jeffery & Heber (1992) shows that O II, Fe III and N II have roughly the same equivalent widths (for 8 O II lines, one Fe III and one N II line, our equivalent widths are smaller by 18 mÅ on the average) whereas seven C II lines which are in common show that our equivalent widths are smaller by 73 mÅ on the average indicating that C II lines are effected by variable line emission.

Hα, which is strongly in emission (Fig. 4) in DY Cen may come from the C II emission region and/or the nebular (forbidden line) region. The radial velocity (Table 4) suggests that Hα is formed with the nebular lines. The Hα is not a symmetrical emission profile, but appears to have two (or more) components. It is unclear from the profile whether the emission is superposed on a strong absorption line but the progressive appearance and strengthening of absorption down the Balmer series from Hα to Hδ (Jeffery & Heber 1992) suggests that Hα emission has an underlying absorption component.

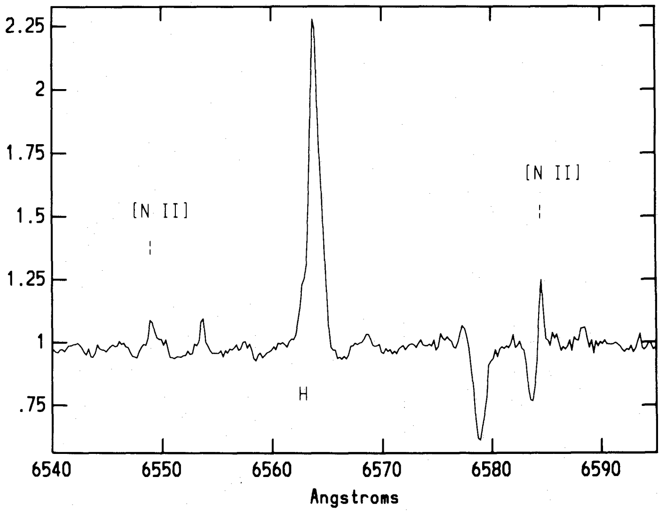

Fig. 4. The region of Hα emission. Also shows the [N II] lines at $\lambda\lambda$ 6548, 84

Table 4. The nebular emission lines

	λ(Å)	Radial velocity (km s^{-1})	W_λ (mÅ)	FWHM^a (km s^{-1})
[O I]	6300.32	23.3	87	26
[N II]	6548.06	25.8	47	
	6583.6	20.2	126	25
[S II]	6716.42	22.2	82	34
	6730.78	22.4	83	34
Hα	6562.82	23.6	1473	
[Fe II]	6729.85	3.2	45	

[a] FWHM is the full width at half maximum corrected for the instrumental profile.

There is a strong emission line at 6729.8 Å which seems to correspond to a [Fe II] line from multiplet 31F (Fig. 5). Of the other lines from the same multiplet, only a weak line at 6829.0 Å occurs in our spectral region, although there is weak emission present, this might have been blended with terrestrial OH line. Thackeray (1953) identified these lines in η Car. Apart from these lines, no other [Fe II] or Fe II lines can be firmly identified in the spectrum. The width of the [Fe II] feature is the instrumental width. If the identification of [Fe II] is correct, a relatively high electron

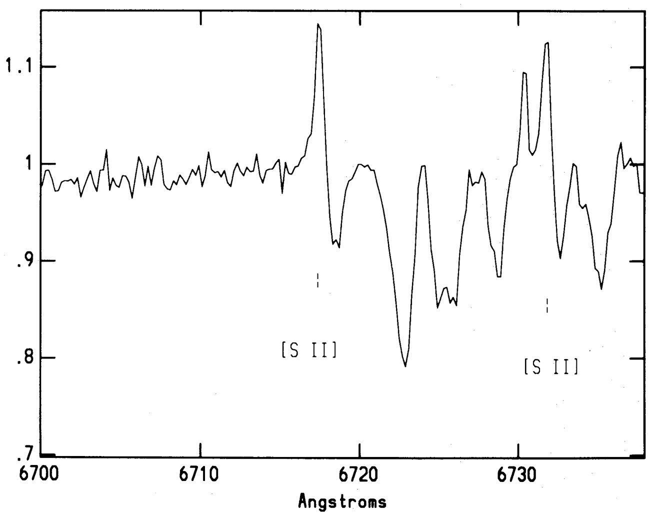

Fig. 5. The region of the [S II] forbidden lines λλ 6717, 31

density (10^6 cm^{-3} is suggested for the emitting region (Stahl & Wolf 1986), since this is the only line indicating higher electron density further confirmation is required.

4.2. *Forbidden lines*

The few nebular lines which can clearly be identified are representative of a very low excitation planetary nebulae: [O I] 6300, 6363 Å, [N II] 6548, 6583 Å, [S II] 6717, 6731 Å. The [N II] 5755 Å line is undetectable. The forbidden lines in the direction perpendicular to the dispersion do dot extend beyond the strip recording the stellar continuous spectrum and, hence, the nebula's diameter is less than about 2 arcsec. The radial velocities, equivalent widths and the line widths (FWHM) are given in Table 4. These emission line radial velocities are clearly different (+23 km s^{-1}) from the absorption line velocity given in Table 2. If we take the radial velocity range exhibited by the star as 15 km s^{-1} to 41 km s^{-1} then the systemic velocity is expected to be +28 km s^{-1}, same as the emission line velocity (within the errors). The emitting gas is symmetrically located relative to the star.

The widths of nebular lines are larger than the instrumental widths as obtained from the comparison spectrum. The corrected line widths correspond to an expansion velocity of 13–17 km s^{-1} (assuming Gaussian profiles). These estimates are slightly smaller than that obtained from a comparison of the absorption and emission line radial velocities. Since the star has a variable radial velocity, the widths of the emission lines may provide the more reliable estimate of the expansion velocity.

Using the forbidden line ratios and assuming that all lines come from the same volume, estimates of the electron density n_e and an upper limit to electron temperature T_e can be made with help of relations developed in Aller (1984). The electron density can be estimated from the line ratio [S II] 6717 Å to 6731 Å, which is 0.99 ± 0.07 (as estimated from the equivalent widths) in DY Cen: this yields n_e of about 450 cm$^{-3} \pm 100$ (for the likely range of T_e 5000–20 000 K). The electron temperature can be estimated from the [N II] line ratio of (6548 Å + 6584 Å) to 5755 Å. The 5755 Å line could not be detected in our spectrum, but the upper limit to its flux corresponds to the [N II] ratio ≥ 80 and indicates a value of $T_e \leq 10\,000$ K, $n_e = 450$ cm^{-3}. Thus, the nebula is cool and of low electron density. The V 348 Sgr nebulae is similar with $T_e \leq 7000$ K, $n_e = 160$ cm^{-3} with an upperlimit of 400 cm^{-3} (Pollacco et al. 1990). The ionic ratio of N^+, S^+ and O^0 in DY Cen nebula can be estimated from the above values of n_e and T_e. They are $\log N^+/S^+ \simeq 0.83$ and $\log O^0/N^+ = 1.0 \pm 0.08$ (for T_e is 7000–10 000 K). The photospheric abundances as estimated by Jeffery & Heber (1992) show that log N/S = 0.9 and log O/N = 0.8.

Although the n_e and T_e of DY Cen's nebula are similar to the optical nebula around V 348 Sgr, no extended nebula has been detected around DY Cen. A star of $T_{\rm BB} \sim 20\,000$ K and $L \simeq 2300\ L_\odot$ at a distance of 4.8 kpc is expectec to produce a H II region of about 7″ diameter for an average $n_e \simeq (n_{\rm H})$ 400 cm^{-3}. Thus the lack of visible nebulosity (compared to V 348 Sgr) might indicate a quick dispersal of the nebula. A search for the nebula when the star is faint might be useful in this respect.

5. Discussion

DY Cen and the two other hot R CrB stars (V 348 Sgr and MV Sgr) would seem to represent a link between the hot extreme He stars and the warm to cool R CrB stars including the eponymous star itself. At present, the link is provided by two tenuous pieces of observational support.

The low density warm nebula that seems characteristic of the hot R CrB stars is also a feature of some warm R CrBs too. The nebula's faint emission lines are revealed only on spectra taken during faint minima when the much brighter photosphere is obscured by dust. Herbig (1949) provided the first evidence of a nebula when he found the [O II] 3727 Å emission lines from R CrB at a deep minimum. Recently we have discovered broad emission lines of [N II], [O I], [S II] and C_2 in a spectrum of V 854 Cen (= NSV6708) during this R CrB's deep minimum in mid-1992 (Rao & Lambert 1993). Pollacco et al. (1991) discovered a nebula, apparently a reflection nebula, with jet-like structures around UW Cen, also observed at minimum light. If three R CrBs observed adequately at deep minima show evidence of nebulae, it is possible that a nebula is a common property of the class. It is possible that the expansion velocities for V 854 Cen and R CrB are roughly an order of magnitude higher than for DY Cen and the "crossing time" of the nebula is about a decade and, hence, may dissolve at intervals greater than about a decade. Noting that the nebular size (and the cold dust shell) around V 348 Sgr is less extended than R CrB's cold dust shell, Rao & Nandy (1986) suggested that V 348 Sgr will evolve to a cooler R CrB star. Pollacco's (1989) estimate of the nebula's size and distance of V 348 Sgr supports this contention.

At first glance the strong Balmer lines seem to set DY Cen apart from the R CrB stars. Jeffery & Heber (1992) find $n_{\mathrm{H}}/n_{\mathrm{He}}=0.1$, and $n_{\mathrm{C}}/n_{\mathrm{He}}=0.01$ and a remarkable deficiency of Fe: the mass fraction of Fe is a factor of 300 below the solar value. Equally remarkable is the fact that other investigated "metals" –Mg, Al, Si, P, S and Ar – have mass fraction within a factor of 4 of their solar values. Some aspects of this unusual composition do find a parellal among the R CrBs. In particular, V 854 Cen is quite H-rich and Fe-poor: the strength of the Balmer absorption lines was noted by Kilkenny & Marang (1989) and the low Fe abundance is apperent in our unpublished abundance analysis. In short, the composition of DY Cen which seems quite unusual even for a R CrB star does have similarities with at least one warm R CrB star. On the basis of the tenuous evidence offered by the presence of nebulae and some similarities in composition, we suggest that the search for an evolutionary link between the warm and hot R CrBs be continued.

6. Conclusions

Our discovery of forbidden lines shows that DY Cen is associated with a low density expanding nebula with $T_{\mathrm{e}}\sim 10\,000$ K and $n_{\mathrm{e}}\sim 450\ \mathrm{cm}^{-3}$ and a velocity of expansion of $\sim 15\ \mathrm{km\ s}^{-1}$. DY Cen's photosphere is the source of the ultraviolet photons that ionize the nebular gas. This detection of nebular lines in DY Cen shows that all the three known hot R CrB stars (V 348 Sgr: $T_{\mathrm{eff}}\simeq 20\,000$ K; MV Sgr: $T_{\mathrm{eff}}\sim 16\,000$ K and DY Cen: $T_{\mathrm{eff}}\sim 19\,000$ K) possess low density nebular envelopes. Selected lines of C II and He I show inverse P Cygni profiles suggesting that they are formed above the photosphere where a stellar wind is fed.

DY Cen's photosphere is He-rich, but may not be typical of the class of hot He stars and the cool R CrB stars. In particular, we note Jeffery & Heber (1992) estimate of a high (for a R CrB star!) H abundance ($n_{\mathrm{H}}/n_{\mathrm{He}}\simeq 0.1$ with $n_{\mathrm{C}}/n_{\mathrm{He}}\sim 0.01$), DY Cen's photospheric composition is similar to that of the hot extreme He stars and the R CrBs, except for its retention of more than a typical amount of H. In this respect, DY Cen is similar to the R CrB star V 854 Cen. Determination of the abundances of critical elements for a larger sample of R CrB stars and extreme He stars might provide clearer clues to the origins of DY Cen and the other 2 hot R CrBs, the extreme He stars and the warm and cool R CrBs.

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