PHOTOMETRIC AND SPECTROSCOPIC VARIABILITY OF THE HYDROGEN-DEFICIENT BINARY CPD-58°2721

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ABSTRACT. The hydrogen-deficient star CPD-58°2721 (=LSS1922) has been observed to show radial velocity variations with a range of 140 km s^{-1}. It shows light and colour variations with amplitudes of 0ᵐ07 on a timescale of about 9 days. The absorption spectrum is nitrogen-rich and is seen to vary on a short timescale (4 days). CPD-58°2721 therefore appears to be a hydrogen-deficient binary similar to KS Per and υ Sgr. The photometric variability is attributed to radial pulsation.

1. INTRODUCTION

CPD-58°2721 (=LSS1922) was found to be a hydrogen-deficient A star by Drilling (1980) with a spectrum very similar to that of υ Sgr. Subsequent ultraviolet spectrophotometry by Schönberner et al (1982) yielded an effective temperature of 11100±500 K, very similar to that of υ Sgr (T_{eff}=10500 K, Drilling et al. 1984a). Unlike υ Sgr, but like KS Per, CPD-58°2721 does not appear to have an infrared excess (Drilling at al. 1984b).

The two known binaries (υ Sgr and KS Per) do not show the large abundance of carbon that is observed in single extreme helium stars (e.g., Heber 1983). The low C:N ratio observed in the photospheres of the former implies that layers of the star depleted in hydrogen via CNO-cycle hydrogen-burning have been revealed. Schönberner and Drilling (1983) have shown that the hydrogen-deficient binaries are the product of case BB mass transfer (Delgado & Thomas, 1981).

Besides the spectroscopic similarity to υ Sgr, no *direct* evidence has previously been found that CPD-58°2721 is a hydrogen-deficient binary. Here we report the discovery of variability in light, colour, radial velocity and spectrum.

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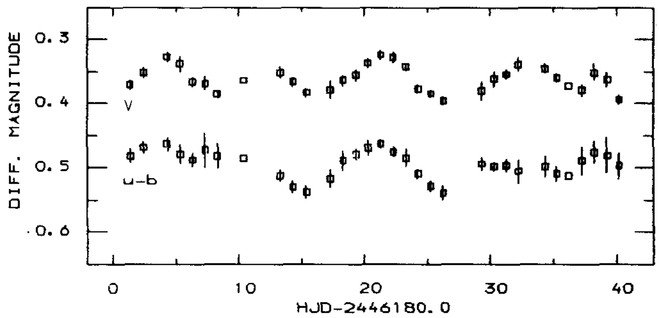

Figure 1. Differential Strömgren photometry of CPD-58°2721 obtained at SAAO in 1985.

2. PHOTOMETRY

Photometry of CPD-58°2721 was obtained during 6 weeks in 1985 May-June with the 0.5m telescope at SAAO. Observing techniques are described by Jeffery et al. (1985). Mean magnitudes and colours of the programme star and two comparison stars were:

	⟨V⟩	⟨b-y⟩	⟨m1⟩	⟨c1⟩
CPD-58°2721	10.349	0.574	-0.047	0.194
LSS 1915	9.990	0.338	-0.026	-0.034
HD93712	8.962	0.010	0.150	0.994

The differential Strömgren V and u-b curves are shown in Fig. 1. Both light and colour traces show variations of 0ᵐ07 on a timescale of between 5 and 12 days with a mean period of about 9 days. Since the colour variations follow the light variations, they probably reflect effective temperature changes produced by radial pulsation.

3. RADIAL VELOCITIES

High resolution spectrograms have been obtained with the AAT, ESO 3.6m and CTIO 4m telescopes in the period 1982 July to 1985 October. A simple comparison of the Ca II H and K line-region shows large variable shifts of the stellar lines relative to the interstellar lines. Stellar radial velocities determined relative to the interstellar medium are given in Table I, where we find the amplitude of the velocity variation to be ~140 km s^{-1}. These velocity changes can only be produced if the star is a member of a binary system. The data of 1985 March and April indicate a period shorter than that of ν Sgr (138 days), but its exact value cannot yet be determined.

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TABLE I.

Date	Relative Velocity (km s^{-1})	Observer	
1982 Jul 2.4	0 ± 10	Hill	AAO
1983 May 30.1	-100 ± 8	Drilling	CTIO
1984 Apr 15.4	0 ± 10	Morrison	AAO
1985 Mar 13.6	-64 ± 11	Morrison	AAO
1985 Apr 6.1	+34 ± 5	Heber	ESO
1985 Apr 9.1	+38 ± 5	Heber	ESO
1985 Oct 7.4	-38 ± 5	Hunger	ESO

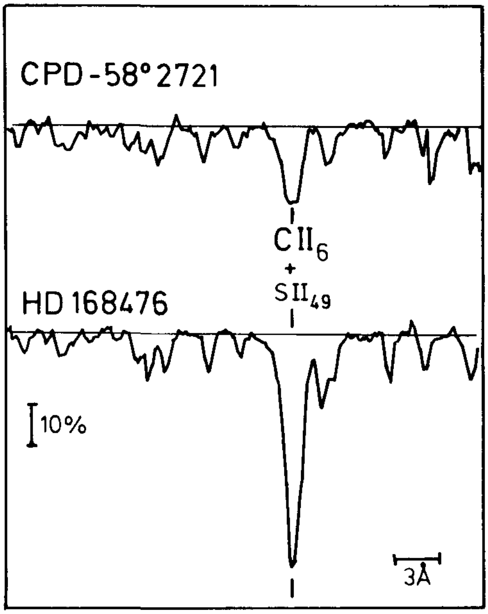

Figure 2. Comparison of the spectra of CPD-58°2721 (top) and the carbon-rich helium star HD168476 in the wavelength region of CII 4267Å.

4. SPECTRUM VARIATION

The spectrum of CPD-58°2721 shows strong lines of NII, while CII is weak. This is in contrast to the C-rich spectra of the extreme helium stars such as HD168476 (Fig. 2) but similar to the N-rich spectrum of KS Per (Wallerstein et al. 1967). Two echelle spectrograms obtained with CASPEC and the ESO 3.6m telescope on 1985 Apr 6 and 9 show marked changes in the strengths of low excitation metallic lines (Fig. 3). However there is no general weakening of the lines, but a clear dependence on the excitation potential.

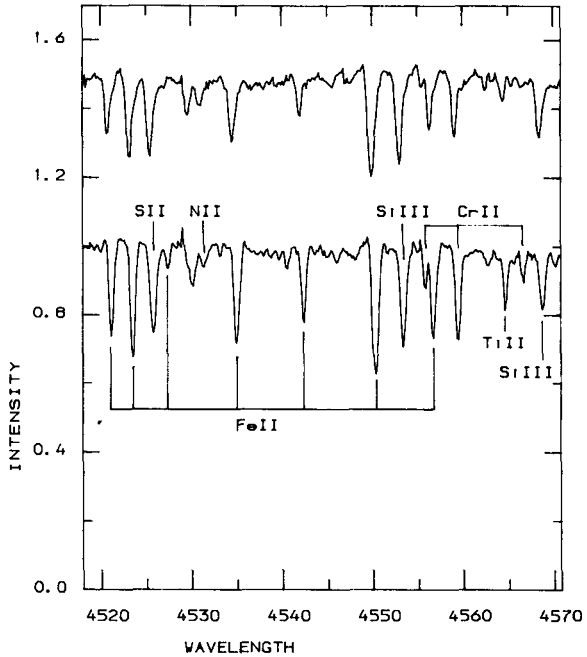

Figure 3. CPD-58°2721. Comparison of two CASPEC spectra taken on 1985 April 6 (top) and April 9 (bottom) in the wavelength region of SiIII (multiplet 1).

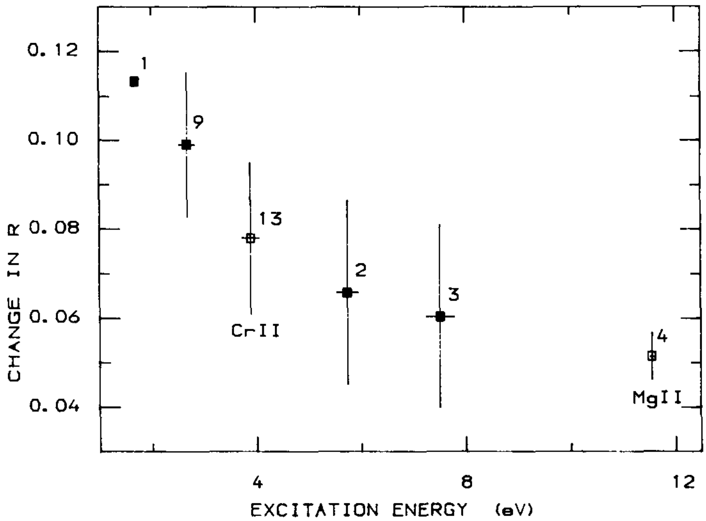

Figure 4. Changes in the residual intensities (R) of FeII lines (numbers given) between the two spectra of Fig. 3, shown as a function of excitation potential. Line-strength changes in MgII and CrII are also shown for comparison.

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Lines with low excitation potentials show the largest changes, while those with high excitation potentials change less. This is demonstrated by the behaviour of the FeII lines shown in Fig. 4. Note also that the high excitation SiIII lines in Fig. 3 have almost identical equivalent widths in the two spectra. Hence we conclude that these spectrum changes are probably related to the effective temperature changes deduced from the colour variations.

The Hα and Hβ line profiles appear to be variable and consist of a photospheric absorption and an additional emission component (Fig. 5). The latter has a radial velocity curve different from the photospheric lines and at some phase, fills in the photospheric absorption line (see Fig. 5). Strong and variable Hα emission has been found in KS Per and υ Sgr and has been interpreted to be due to mass transfer through the Lagrangian point (Nariai 1967,1972). Our observation of variable Hα and Hβ emission suggests that mass transfer may also occur in CPD-58°2721.

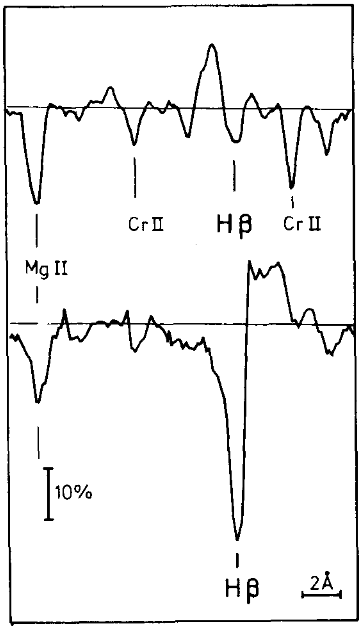

Figure 5. CPD-58°2721. Hβ profiles from two CASPEC spetra taken on 1985 April 9 (top) and October 7 (bottom)

5. DISCUSSION

We have shown that CPD-58°2721 is a single-lined spectroscopic binary which resembles the two other class members in (nearly) all observational respects. Its radial velocity amplitude (≳140 km s^{-1}) is larger than that of KS per and υ Sgr (~100 km s^{-1}). All three objects have variable Balmer line emission indicative of mass transfer in the binary system.

The photometric variability of CPD-58°2721 may also be compared with the photometric variability observed in KS Per (Osawa et al. 1963) and in υ Sgr (Eggen et al. 1950). These variations have been

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variously attributed to pulsation and to eclipses. The observed variablility of the spectrum supports the interpretaion that CPD-58°2721 is pulsating.

Drilling (1986) reports that the absolute magnitude of CPD-58°2721 appears to match those of the single H-deficient stars. Jeffery et al. (1986) report a rough period-temperature sequence for variability in the single H-deficient stars. The mean period of CPD-58°2721 fits the Jeffery et al. sequence quite well and we therefore suggest that the pulsational properties of the H-deficient binaries are likely to be similar to those of the single H-deficient stars.

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