THE EXPANDING ATMOSPHERE OF HD 218393

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Abstract. Visible and far ultraviolet high resolution spectra of the B2 binary star HD 218393 have been obtained at one day interval, shortly before the phase of maximum outwards velocity, adopting the period of 38.908 days. Both spectra show the existence of an extended atmosphere, accelerated outwards. The SiIV resonance lines show some indication of mass loss. With only one set of observations, the origin of the strong and wide (about 130 km/s FWHM) ultraviolet absorption lines of once ionized elements is difficult to determine.

1. INTRODUCTION

The star HD 218393 (KX And) is known since 1930 to show intensity and radial velocity (V_r) variations of the spectral lines (Struve, 1944, Merrill, 1949, Halliday, 1950). The radial velocity variations of the circumstellar lines have suggested a period of 35 to 40 days, but the amplitude and the period are not exactly reproducible. Doazan and Peton (1970) have interpreted the radial velocity variations as caused by an expanding envelope with variable acceleration. More recently, the star has been considered as an interacting binary with strong mass exchange (Kříž and Harmanec,1975). Polidan and Peters (1976) have discovered in the near infrared, lines of neutral elements which can be attributed to a KIIII companion. Photometric variations have also been observed, especially in the (U-B) colour, the star being reddest around maximum velocity (Harmanec *et al.*,1980). The binary period obtained by these authors is 38.908 days.

A visible spectrum has been obtained with the 152 cm telescope of the Haute Provence Observatory on 19th October 1979 (3500-5000 Å, 12.27 Å/mm dispersion). IUE observations of that star have been obtained one day later (1150-2100 Å, 0.15 Å resolution, and 1800-3200 Å, 8 Å resolution). These observations correspond to the phases 0.29 and 0.30 , considering the 38.908 days period, with phase 0.0 at the maximum of radial velocity. There is a good agreement between our values of V_r for the hydrogen lines and those obtained by Struve at the same phase.

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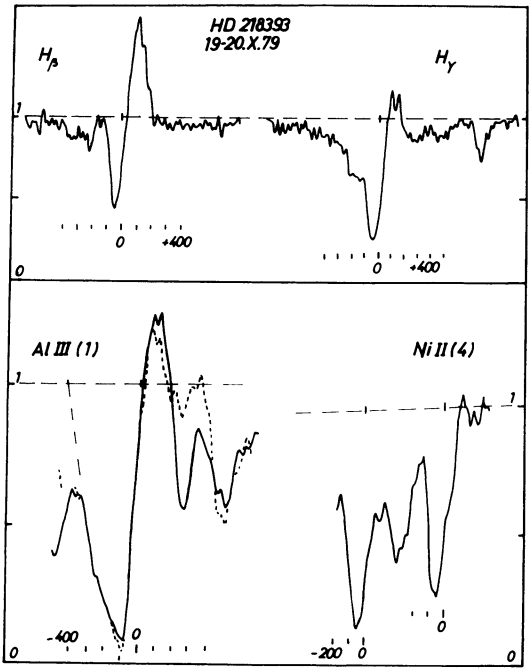

Fig.1 Characteristic profiles of HD 218393; the continuum is indicated by a dashed line; the abscissa is in km/s.

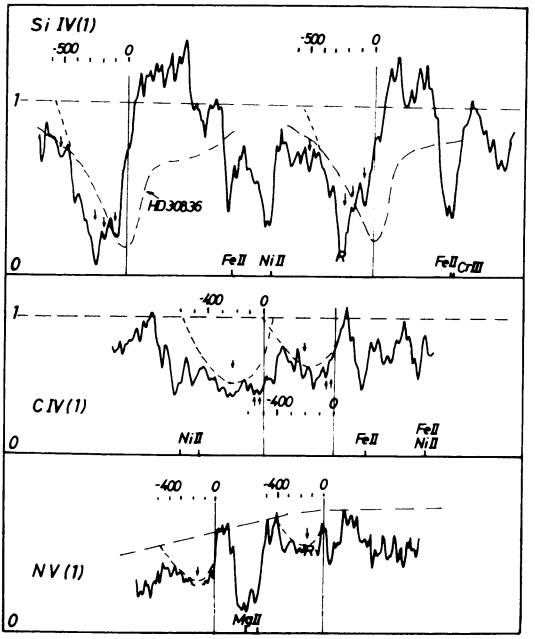

Fig.2 Same as in Fig.1; SiIV profiles of HD 30836(B2III) indicated for comparison; for CIV and NV, possible profiles are indicated by dashed lines.

2. VISIBLE OBSERVATIONS

The good agreement between the Hγ and Hδ photospheric wings of HD 218393, HD 37202 (B2III) and HD 33328 (B2IV) confirms the spectral type B2IV-III already attributed to HD 218393 by Doazan and Peton (1970), from the ratio of the HeI λ4121 and 4144 lines. According to Divan (private comm.) the BCD spectral type is approximately B2.

The visible spectrum has the same characteristics as those corresponding to the same phase (see above references). The first Balmer lines show a P Cyg profile (Figure 1) and the red wing emission is visible to H12; most of the Balmer lines have an extended violet absorption wing. The circumstellar, narrow absorption lines are observed to H29, hence $Ne \cong 2.10^{12} cm^{-3}$ in the inner part of the envelope. The CaII lines are strong and asymmetric. The metallic absorption lines are faint, in agreement with Struve (1944) and Halliday (1959) observations : these lines almost disappear at the minimum of V_r. The strongest FeII lines show emission in the wings.

Almost all the circumstellar absorption lines are blueshifted, as indicated in Table 1. In addition, the Hγ and Hδ lines show a satellite

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Table 1. Radial velocity of visible circumstellar lines.

Hβ	: -50 km/s	MgII	: -7.5 km/s
Hγ, Hδ	: -42 "	FeII,MgI,NiII	: -5 "
H12	: -30 "	TiII	0.5 "
H22-H25	: -15 "	SiII	1.5 "
CaII	: -19 "		

violet absorption, shifted by 140 km/s with respect to the main component. The positive Balmer progression suggests the presence of an outwards accelerated envelope, the highest Balmer lines being formed closer to the star than the first Balmer lines.

3. ULTRAVIOLET OBSERVATIONS

The ultraviolet spectrum of HD 218393, in opposition to the visible one, is very rich in relatively broad absorption lines, most of which are heavily blended, making the line identification very difficult. Wide photospheric features(v sini= 250 km/s in the visible, Doazan and Peton, 1970) are observed for the strongest lines (CII,III,SiIII.IV,AiIII,FeIII).

By comparison with IUE spectra of other B2 stars (HD 36166(B2V), HD 886(B2IV), and HD 30836(B2III), we notice a strengthening of mainly lines of neutral and once ionized elements (OI,NI,CII,SiII.PII,AlII,NiII,

Table 2. Radial velocity of UV absorption lines; asymmetric (edge velocity) and P Cyg profiles are indicated.

Ion	IP (eV)	V_r(max.abs.) EP=0	EP>0	Asym. Vedge	P Cyg	Ion	IP (eV)	V_r(max.abs.) EP=0	EP>0	Asym. Vedge	P Cyg
N V	77.5	-145?		-435?	?	S II	10.4	-53		-350	P
C IV	47.9	-220?		-580?	?	ZnII	9.4	-48		-220	-
SiIV	33.5	-245		-580	x	SiII	8.2	-74		-300	P
AlIII	18.8	-91		-365	x				-35	-	-
NiIII	18.2		-28?	-	-	FeII	7.9	-51		-	-
CrIII	16.5		-45	-	-				-43	-	-
SiIII	16.3	-100		-200?	-	CuII	7.7	-40		-	-
			-96	-	-	MgII	7.6	-34		-	-
FeIII	16.2		UV34:			NiII	7.6	-45		?	-
			-100	-360	x	MnII	7.4		-25	-	-
			UV48:			CrII	6.8	-40		-	-
			-90	-360	x	AlII	6.0	-68		-360	x
			-45	?	-				-50	-	-
TiIII	13.6	?	-60	-	-	O I	0	-44		-	-
C II	11.3	-77		-360	x	N I	0	-30		-	-
P II	10.5	-43		-	-				-30	-	-

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FeII) which cannot be attributed to the faint companion and are relatively wide (FWHM = 100-130 km/s) as compared to classical shell lines (70 km/s in HD 37202). They are all blueshifted (see Table 2, velocity measured with respect to the IUE scale), and several resonance lines have extended violet wings, the edge velocity of which is indicated in Table 2.

Despite the uncertainty on the continuum level, several P Cyg profiles are also observed in the UV for strong resonance lines (Figures 1 and 2, Table 2) and the strongest transitions of FeIII (UV 34 and 48), the intensity of which is connected to that of the resonance lines (Bruhweiler *et al.*,1978). Broad absorption profiles have tentatively been identified with CIV and NV resonance lines (Figure 2); the CIV lines are weak in normal B2V-III stars; here, the features could result from a blend of other circumstellar lines. Hence, the degree of ionization of the envelope is uncertain.

Analysing Table 2 results, we distinguish a group of lines for which, as for other Be stars envelopes (48 Lib, φ Per, HR2142) the outflow velocity increases with the degree of ionization, being maximum for SiIV (column 3, left). The edge velocity of SiIV is equal to the escape velocity at 2 stellar radii. In the binary HR2142, the corresponding lines, formed in the envelope of the B2 primary, are strongly asymmetric but undisplaced (Paterson-Beeckmans,1980).

The lines of the second group (asymmetric or not) have a blueshift of about 45 km/s, as the first Balmer lines. They are too strong for normal B2 photospheric lines, and wider than classical shell lines. Are they formed at the bottom of the expanding envelope, or in a cool disk? Certainly more observations are needed before attempting to make a model.

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DISCUSSION

Peters: We have anlyzed Copernicus U1 observations of the gas stream lines of Fe III 1130 A in HR 2142 and find evidence of multiple components. I will discuss the importance of this analysis tomorrow.

Paterson-Beekmans: We also suspect some substructure in some resonance lines in HR 2142; in KX And, there may be some structure in strong resonance lines (Al III, Si IV, for ex.).

Harmanec: I want to mention preliminary results of our photometry of KX And:
1. There is no pronounced long-term variability.
2. Minimum light in the U colour coincides with maximum RV indicating that there is probably an eclipse of the star by a gas stream.
3. It is possible that the star will turn out to be an eclipsing binary with a partial eclipse.

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