Rev. Mexicana Astron. Astrof., 15, 29-52 (1987)

Hα ECHELLE SPECTROSCOPY OF Be STARS: AN ATLAS

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Received 1986 November 5

RESUMEN

Del análisis de 78 placas espectroscópicas de la línea Hα en emisión de 15 estrellas Be y con envolvente (shell), conocidas como variables a partir de estudios espectroscópicos y fotométricos, presentamos en este trabajo un Atlas de la línea Hα.

Hacemos énfasis en los cambios espectroscópicos de esta línea, con el fin de obtener criterios para estudiar posteriormente la variabilidad de corto periodo de estos interesantes objetos. Como esperabamos, podemos fácilmente detectar la variabilidad de largo periodo al comparar nuestras observaciones de Hα con trabajos previos de estas estrellas.

De este estudio, encontramos que todas las estrellas observadas muestran variabilidad en escala de tiempo de 2 hasta 14 días. En una escala de tiempo menor, la variación en Hα está presente en HD 37202, H 184279, HD 200120, HD 217050, HD 224559, HD 174638 y HD 183656.

Se requiere un trabajo posterior efectuando observaciones simultáneas en espectroscopía y en fotometría para tratar de entender de manera más completa el comportamiento de estas estrellas.

Incluimos en este Atlas, 3 espectros de la línea Hα en absorción de 2 estrellas tipo β CMa observadas durante esta campaña.

ABSTRACT

From the analysis of 78 spectroscopic plates of the Hα emission line of 15 Be and shell stars, known to be variable from spectroscopic and photometric studies, we present an Atlas of the Hα line. We emphasize the spectroscopic changes of the line to obtain criteria to further study the short-term variability of these interesting objects. As expected, we can easily detect the long-term variability comparing our Hα line observations to previous work.

From this study, we found that all the stars observed show variability on a time scale from 2 to 14 days. On a shorter time scale, Hα line variability is present in HD 37202, HD 184279, HD 200120, HD 217050, HD 224559, HD 174638 and HD 183656.

A further simultaneous spectroscopic and photometric study is necessary to fully interpret their behaviour.

We include in this Atlas 3 spectra of the Hα absorption line of 2 β CMa stars observed during the campaing.

Key words: **Be STARS-SPECTROSCOPY-Hα – LINE PROFILE-VARIABILITY**

I. SPECTROSCOPIC AND PHOTOMETRIC VARIATIONS OF Be AND SHELL STARS

Most and probably all Be and shell stars show irregular variations both in photometric and spectroscopic studies; this fact is well illustrated in the literature. Long-term variability has been the subject of the Meudon Program on the spectroscopic studies of Be and shell stars. Jaschek *et al.* (1980) reported that 58% of the Be stars in their sample show long-term variations in the observed emission lines –groups I and V in their paper. Alvarez and Schuster (1981), in a 13-color photometric survey carried out at the Observatorio Astronómico Nacional of San Pedro Mártir, in the following called OAN or SPM observatory, reported that 78% of the stars in their sample show long-term variability. Short term of generally small amplitude variations have been reported for several Be and shell stars, although some authors have questioned many of these reported variations which in some cases are at the limits of detection. An extensive survey for rapid line variability (Lacy 1977), concluded that fewer than 5% of the Be stars may show this kind of variability. However, the existence of this phenomenon may be measurable in some stars mostly from *UV* studies.

Only a few attempts have been made to study simultaneously the photometric and spectroscopic behaviour of these stars, although the need for such studies has clearly been shown by many authors. The modeling of these interesting stars requires the detailed knowledge of the continuum at different wavelengths as well as the shape and intensity of absorption and emission lines present in them. With this fact in mind, we have selected a sample of stars in order to determine the simultaneous behaviour in photometry and spectroscopy. Many of the stars studied in this work have been shown to have irregular and relatively large variations during the Meudon and SPM surveys.

In the present study, we report the observations obtained during a campaign done at the SPM observatory between the groups of the Meudon observatory and the Institute of Astronomy of México working on Be and shell stars. This study was based on the Hα line and we present an atlas of our results. The photometric data and results obtained during this campaign will be published in a separate paper (Alvarez *et al.* 1986).

II. OBSERVATIONS AND REDUCTIONS

The material reported in this paper was obtained in two observational periods: from September 27 to October 4 and from October 9 to October 15, 1983, at the SPM observatory in Baja California, México. We used an Echelle spectrograph mounted on the 212-cm telescope with a cross dispersion varying linearly between 5 A mm^{-1} at 3450 A to 10 A mm^{-1} at 6500 A. The spectra were obtained on 098-01 spectroscopic plates covering the wavelength range from 5800 A to 6850 A, approximately. A He-A lamp was used for the wavelength calibration. We obtained 81 plates of eleven early Be and shell stars, four late-type Be and shell stars and two β CMa type stars.

The plates were traced with the digitized microdensitometer in the Institut d'Optique d'Orsay (France) and the data reduction performed by means of computer programs written in FORTRAN 77 for the VAX computer of Meudon observatory. With the microdensitometer available in Orsay, we made the tracings with a 20 micron square slit as shown in Figure 1. The position of the different inclined lines are added by a special program which restores for inclination and giving us the corrected photographic density spectrum. The wavelengths are then computed by a polynomial fit using the He-A comparison spectrum, and a photometric calibration allows us to get the intensities in a relative scale. The noise is then filtered out by means of a Fourier transform

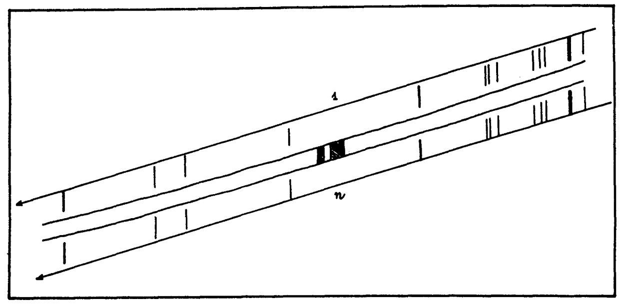


Fig. 1. Procedure to record the star's and He-A comparison spectra with a 20 micron square slit. Echelle spectrograms are inclined and hence it is necessary to reconstruct the spectral features in such a way to avoid distortion and to keep precision in the measurements. (See text).

smoothing (Chauville 1985). Other programs are used to trace the profiles and to measure the different parameters of the lines (continuum, equivalent widths, radial velocities, etc.)

The accuracy of the wavelength measurements is 0.025 A according to the standard deviation of the polynomial least square fit. This means, for radial velocities, a 1.1 km s^{-1} uncertainty for all the quantities called V 1, V 2,..., V G and 2.2 km s^{-1} for dV 1, dV 2,... Concerning full widths of half maximum, the uncertainty also depends on the continuum determination, which in turn depends on the signal to noise ratio. The latter varies between 40 and 50 according to the spectrum. This means approximately 3% error in the continuum determination, and 8 to 10 km s^{-1} approximation for the quantity called FWHM, if we take into account the mean slope of the line profile. The base 'AB' of the line may be estimated with about 20 km s^{-1} accuracy. Lastly, the photometric calibrations allow typically a 7 to 10% approximation on intensity (and possibly better, according to plate quality).

Table 1 gives the list of the 17 program stars grouped into early Be-type stars (11), late Be-type stars (4) and β CMa stars (2), with their magnitude, spectral type, V sin i, Jaschek *et al's* group (1980), and number of plates taken during each observational period. This table shows that several stars were followed more frequently than others: HD 184279 (15 spectra) HD 37202, HD 217050 (10 spectra), HD 224559 (9 spectra), HD 24534 (8 spectra), HD 218393 (6 spectra), HD 200120 (5 spectra). For the remaining stars less than 3 spectra were taken, and we include them also in this work. The data gathered permit us to follow night-to-night radial velocity variations more accurately.

Tables 2 to 18 give the parameters measured on the plates taken during the two observational periods for each star. In each table, we have the plate number, date and Julian day, equivalent width of Hα lines (negative for emission lines, with a relative error of 6%), radial

TABLE 1

THE PROGRAM STARS

Star HD	Name	Magnitude	Spectral Type	v sin i (km/s)	Jaschek et al.'s Group (1980)	N1	N2
			EARLY TYPE STARS				
24534	X Per	6.10	09.5ep	135	+ (580.7d)	3	5
32343	11 Cam	5.08	B2.5Ve	130	I =		1
37202	ζ Tau	3.00	B4IIIpe	320	I + (132.91d)	6	4
45910	AX Mon	6.77	B2IIIp	430	I + (232.5d)		3
184279	V1294 Aql	6.94	B0.5IV	245	V	7	8
193237	P Cyg	4.81	B2pe	65			2
200120	59 Cyg	4.74	B1ne	375	I	2	3
202904	υ Cyg	4.43	B2Vne	255	I =		2
217050	EW Lac	5.43	B4IIIpe	340	I	4	6
218674	KY And	6.74	B3IV	270	II	1	
224559	LQ And	6.54	B4Vne	-	I	1	8
			LATE TYPE STARS				
23862	28 Tau	5.09	B8Vpe	345	III		1
174638	β Lyr	3.45	B7Ve+A8p	120	+ (12.9138d)	2	
183656	V923 Aql	6.05	A0eShell	210	III	2	1
218393	KX And	7.02	Bpe	-	+ (37d)	3	3
			β CEPHEI TYPE STARS				
21803	KP Per	6.41	B2IV	-		1	1
216916	16 Lac	5.59	B2IV	25	+ (12.096d)	1	

Magnitudes and spectral types from BS Catalogue, when available
v sin i from Uesugi and Fukuda (1982)
N1 = number of plates (first period) N2 = number of plates (second period)
+ Spectroscopic binary star
= Pole-on star

velocity of the centre of gravity of the emission line (V,G), radial velocity and intensity of the emission and absorption features (Vi, Ii), distance between extreme red and violet emission peak (V, $R-V$, V), violet-to-red emission peak intensity ratio V/R and Full Width at Half Maximum (FWHM) when variable. At the bottom of each table, we sketch a profile of the line with the emission and absorption features numbered 1, 2,...,i for identification. Also given are the time exposures, FWHM when non-variable, the wing-to-wing full width AB) and the largest variations of the following parameters: equivalent width, radial velocities, intensities, distance between emission peaks, V/R intensity ratio and FWHM, when variable.

The spectral line profiles obtained during our observing sessions are reproduced for each star in Figures 2 to 18. The horizontal scale covers from 6520 A to 6610 A. The vertical scale gives intensity with an arbitrary scale which allows us to see some of the main features that are described in the following section.

III. RESULTS

In this section, for each star observed in our program, we give the bibliographic references available to us, concerning mainly the Hα profile. We comment also on the visual inspection of photographic spectra taken at the Observatoire de Haute-Provence (OHP observatory). Finally, we report our observations and measurements of the Hα profiles obtained during this campaign. We will emphasize on the observed variations found in our spectra.

Some authors have intensively observed Hα profiles of Be stars, mostly in the northern sky. The Be Star Atlas of Hubert-Delplace and Hubert (1979), lists 148 Be star line variations and presents 51 photographic prints of 36 stars. Hereafter it will be cited as the "Atlas". Another survey of Hα profiles of northern Be stars is the one undertaken by Andrillat and Fehrenbach (1982) and Andrillat (1983) at the Observatoire de Haute-Provence. They give intensity profiles of 127 stars, sometimes at two or three epochs. Slettebak and Reynolds (1978), during five observational periods (1975-1977), followed Hα profile variations of 35 Be stars and detected variations in total emission for most of them. Other Hα surveys have been carried out by Fontaine *et al.* (1982, 25 stars, some of them including Hβ); Lacy (1977, 23 stars); Gray and Marlborough (1974, 14 stars). In the southern sky, the most complete survey of Be star Hα profiles has been done by Dachs *et al.* (1977, 1981, 1986). Hanuschik (1986) has published a high-resolution Hα spectroscopic study on 24 Be and shell stars. In the literature, we also find many papers which display Hα profiles of one or several Be stars. These references will be given for each star with a short description, in order to obtain a general picture of the spectroscopic status of the stars.

a) *Early-type Be stars*

1) *HD 24534: BS 1209, X Per (Figure and Table 2).*

This star has been identified as a X-ray source by Giacconi *et al.* (1972), a binary with a massive companion and a radial velocity periodicity of about 584 days (Hutchings *et al.* 1974). Another possible 13.9 minute periodicity was found by Hutchings and Walker (1976).

From the Atlas, we find that from 1953 to 1956, Hα is a strong, broad emission line. From 1957 to 1960, the hydrogen emission lines become stronger and remain very strong until 1974, and show only a moderate emission until 1976. Andrillat (1983) observed this line (October 22, 1981): Hα was seen as a narrow single-peaked emission line having a highly asymmetric profile, with the violet side very sharp.

Meudon-Group plates (i.e., plates taken by the group of astronomers at Meudon) display a double peaked Hα emission profile with a change of $V/R > 1$ to $V/R < 1$ within two months in 1976. On December 1979, $V/R = 1$.

From Table 2 and Figure 2 we note the following relative changes in the profile of Hα line. The equivalent width varies about 20% in 8 days from −8.99 A to −10.98 A. *VG* shows a change of 6.6 km s^{-1} in 13 days while the two emission peaks show larger variations in their relative position within shorter time scales. (see Table 2). The separation between these two peaks changes by 25.3 km s^{-1} in 9 days. The *V/R* ratio changes by 8% within 8 days from 0.90 to 0.83. Within our temporal resolution (60 min. exposure time), we can easily detect the day-to-day variations. Variability on a shorter time scale is also present. As noted by Hutchings and Walker (1976) in Hβ, the blueward peak appears to be the most active feature.

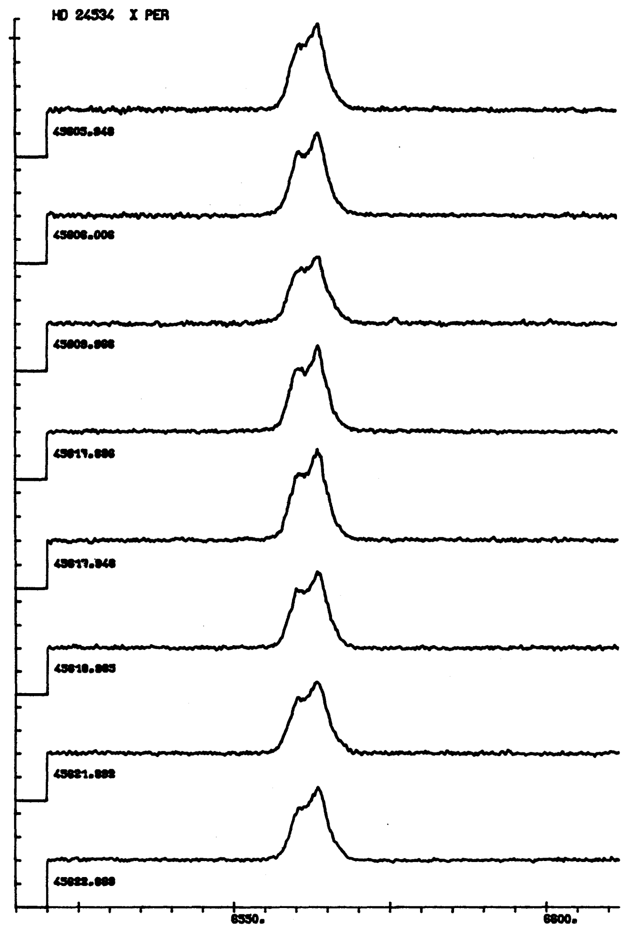


Fig. 2. Hα line profiles for HD 24534 (X Per).

2) *HD 32343: BS 1622, 11 Cam (Figure and Table 3).*

This star is a well-known Be pole-on star whose hydrogen emission lines have exhibited several outbursts in the past. Line profiles of Balmer series were calculated by Burbidge and Burbidge (1953) and Kogure (1969). Schild (1973) classified this star as 'extreme pole-on' and Luud (1978) found rapid variability of the Hα and Hβ profiles on a time scale of several minutes.

From the Atlas, Hα displays a strong emission from 1955 to 1974, with a minimum in 1961. Andrillat and Fehrenbach (1982) give two single peaked emission profiles (April 1 and December 12, 1980) whose structures are different at the top: the first one shows an inflexion on the violet side, while in the second such a feature is

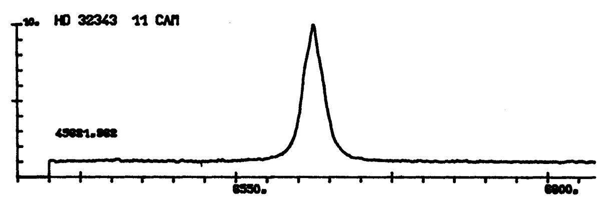


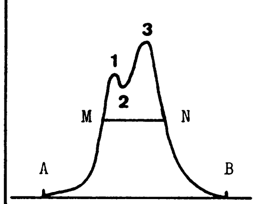
Fig. 3. Hα line profiles for HD 32343 (11 Cam).

TABLE 2

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 24534 (X Per)

HD 24534 X Per

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R
EA 207	27/28 sep	45605.948	10.35	-17.7	-98.3 2.36	-80.1 2.32	34.1 2.77	132.4	0.85
EA 209	27/28 sep	45606.006	10.42	-17.0	-106.1 2.37	-68.5 2.29	34.0 2.76	140.1	0.86
EA 221	1/2 oct	45609.966	8.99	-22.9	-84.1 2.16	-61.3 2.11	31.9 2.40	116.0	0.90
EA 242	9/10 oct	45617.886	10.47	-23.5	-97.8 2.31	-56.6 2.21	34.5 2.78	132.3	0.83
EA 244	9/10 oct	45617.946	10.98	-19.2	-97.0 2.37	-63.2 2.35	33.8 2.84	130.8	0.83
EA 256	10/11 oct	45618.985	9.84	-23.6	-109.5 2.23	-70.2 2.19	31.8 2.59	141.3	0.86
EA 291	13/14 oct	45621.892	9.61	-21.9	-111.2 2.20	-89.3 2.15	25.3 2.53	136.5	0.87
EA 300	14/15 oct	45622.889	9.01	-18.4	-102.6 2.12	-90.2 2.10	31.1 2.53	133.7	0.84



Time exposure = 60mn
MN = 277 km/s
AB = 762 km/s
d(W(Å))= 1.99 Å
dV_G = 6.6 km/s

dV1 = 27.1 km/s
dI1 = 0.25
dV2 = 33.6 km/s
dI2 = 0.25

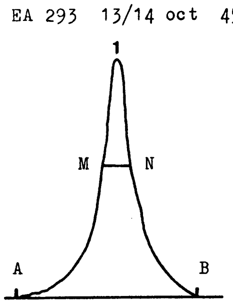
dV3 = 9.2 km/s
dI3 = 0.44
d(V3 - V1) = 25.3 km/s
d(V/R) = 0.07

TABLE 3

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 32343 (11 Cam)

HD 32343 11 Cam

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1
EA 293	13/14 oct	45621.962	40.26	-18.6	-17.8 9.88



Time exposure = 60 mn
MN = 171 km/s
AB = 1188 km/s

shown on the red side. Gray and Marlborough (1974), give an Hα profile with an important inflexion on the red side also. The Meudon-Group plate collection has two plates (November 30, 1979 and March 1, 1982) showing single peaked symmetric Hα profiles and about 10 Fe II emission lines. Chauville *et al.* (1986), in a study of the Hβ profiles (and some photospheric lines), detected significant variations on the line shape of the order of one or two hours.

The Hα profile shown in Figure 3 is symmetrical, with two slight inflexions on the red and blue sides. The equivalent width calculated here, –40.26 A, is very close to the one determined by Briot (1971, –40 A).

3) *HD 37202: BS 1910, ζ Tau (Figure and Table 4).*

This bright Be star is a binary system, of period 132.91 days, with a variable shell spectrum and long-term V/R variations (Delplace 1970*a,b*). Several authors have given Hα line profiles, showing two emission peaks and a ratio $V/R < 1$: Underhill (1953, one profile); Aydin *et al.* (1965, five profiles between 1961 and 1964); Andrillat and Houziaux (1967) (March 3, 1967, one profile with three emission peaks); Van der Wel (1970, between 1964 and 1966, four profiles); Delpace (1970*b*, ten profiles regularly recorded along a whole cycle, with very important changes detected at different epochs); Baliunas, Ciccone, and Guinan (1975) observed long-term Hα and Hβ photoelectric variations.

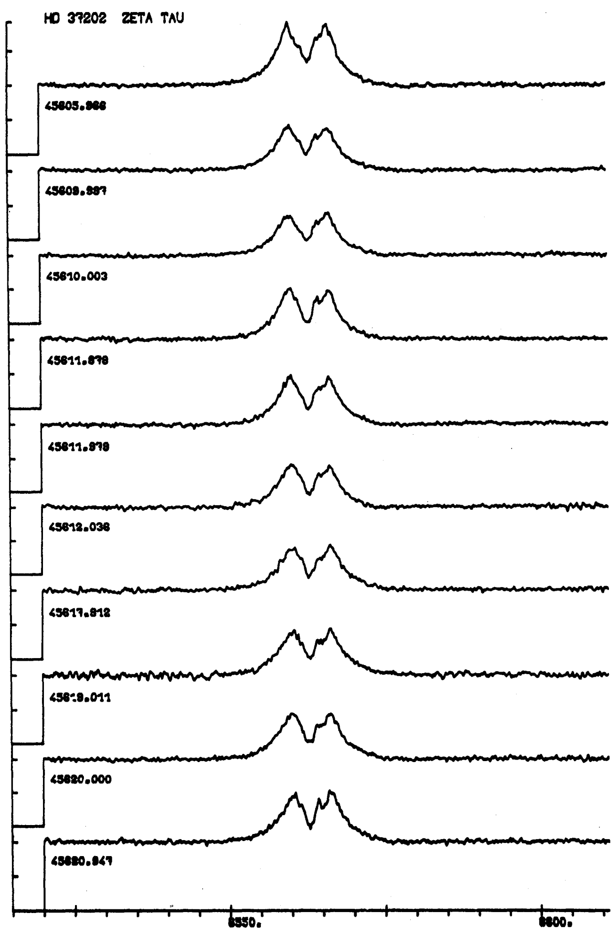


Fig. 4. Hα line profiles for HD 37202 (ζ Tau).

From the Atlas, Hα always presents an emission profile, strong and wide with a sharp core. Gray and Marlborough (1974) give a two peaked emission Hα profile with $V/R = 1$. The three Hα profiles given by Slettebak and Reynolds (1978: December 1975, November 1976 and January 1977), display intensity variation of the maximum emission. Fontaine *et al.* (1982) give a Hα profile date December 18, 1976 with one emission peak and an inflexion on the violet wing. The two Hα profiles recorded by Andrillat and Fehrenbach (1982, March 3 and April 5, 1980), display two emission peaks separated by a strong absorption core, the violet peak seeming to vary in intensity between the two epochs. It shows $V/R < 1$.

The Meudon-Group plate collection has a set of ten red series of plates displaying important profile variations showing $V/R \gg 1$ on 1976 with two clear emission peaks. Around 1978, 1979 the ratio V/R diminished and remained = 1 until 1982. At different epochs, a third and even a fourth emission peak is present in these plates.

The ten Hα profiles observed by us and displayed in Figure 4, have two main emission features approximately equal, with a third one, smaller, on the blue wing of the main red component. The development and evolution of the variable emission featûre is clearly seen. Important changes are observed on a daily basis and probably with a characteristic time of a few hours. The equivalent width varies about 33% in 6 days: from –8.50 A to –6.08 A. These values are smaller than those reported by Bahng (1976: –19.90 A to –23.21 A). The radial velociy of the centre of gravity changes from -12.5 km s^{-1} to $+18.2$ km s^{-1} in 7 days. The blueward peak (No. 1 in Table 4) appears more active than the redward one (No. 5), showing dV 1 = 20.9 km s^{-1} and dV 5 = 10.7 km s^{-1}. The separation between these two extreme peaks changes by 23.6 km s^{-1} in 9 days. The V/R ratio continually changes between 0.97 and 1.03. We note very extended emission wings 'AB' = 1249 km s^{-1}, more prominent than the one measured by Doazan (1970; 822 km s^{-1}).

4) *HD 45910: AX Mon (Figure and Table 5).*

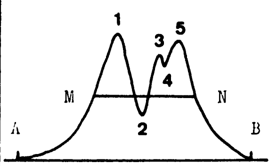
This star consists of a binary system (B3 and fainter K giant, period 232.5 days) intensively studied by Cowley (1963) and Peton (1974). Merrill (1952*c*) gives two Hα tracings, while the Atlas gives a detailed evolution of the spectrum between 1955 and 1973: Hα is a bright line, very strong and wide. The other Balmer lines often show a 'P Cygni' profile. Towards 1960 (phase ≈ 0.30), the hydrogen and metallic shell lines reach their maximum.

TABLE 4

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 37202 (ζ Tau)

HD 37202 Zeta Tau

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V5 I5	V5 - V1	V/R
EA 208	27/28 sep	45605.966	8.50	-7.4	-129.7 1.89	17.1 1.35			151.7 1.87	281.4	1.01
EA 222	1/2 oct	45609.997	6.63	-3.0	-120.9 1.63	7.0 1.24	79.3 1.50	96.1 1.48	156.5 1.59	277.4	1.03
EA 223	1/2 oct	45610.003	6.15	1.4	-121.8 1.57	4.4 1.23	84.4 1.49	91.4 1.48	157.0 1.62	278.8	0.97
EA 233	3/4 oct	45611.878	7.32	-0.1	-121.9 1.74	5.5 1.26	77.3 1.59	100.6 1.55	161.7 1.70	283.6	1.02
EA 235	3/4 oct	45611.979	6.61	1.1	-122.4 1.69	6.9 1.23	90.1 1.52	95.1 1.52	160.1 1.67	282.5	1.01
EA 237	3/4 oct	45612.036	6.08	-12.5	-116.9 1.63	8.4 1.20	81.9 1.49	96.9 1.47	161.9 1.60	278.8	1.02
EA 243	9/10 oct	45617.912	6.64	13.2	-118.6 1.60	0.7 1.20	83.5 1.46		161.0 1.65	279.6	0.97
EA 257	10/11 oct	45619.011	6.80	18.2	-111.6 1.63	8.5 1.25	69.0 1.48	95.0 1.48	157.0 1.66	268.6	0.98
EA 269	11/12 oct	45620.000	7.12	-5.8	-124.6 1.67	0.5 1.26	62.9 1.50	73.2 1.49	154.8 1.65	279.4	1.01
EA 280	12/13 oct	45620.947	7.36	6.5	-108.8 1.69	1.4 1.23	66.4 1.60	92.7 1.51	151.2 1.74	260.0	0.97



Time exposure = 3 mn
MN = 478 km/s
AB = 1249 km/s
d(W(Å)) = 2.42 Å
dV_G = 30.7 km/s
dV1 = 20.9 km/s
dI1 = 0.32
dV2 = 16.6 km/s
dI2 = 0.15
dV3 = 27.2 km/s
dI3 = 0.14
dV4 = 27.4 km/s
dI4 = 0.08
dV5 = 10.7 km/s
dI5 = 0.28
d(V5 - V1) = 23.6 km/s
d(V/R) = 0.06

At phase 0.5, the metallic shell lines are easy to distinguish. They disappear towards phase 0.75 but the hydrogen shell lines are still visible. This shell disappears towards phase 0.0. There are noticeable changes between the cycles. Andrillat and Fehrenbach (1982) observed this star on February 12, 1981 (at phase 0.93) with a very bright emission line, a very strong red peak and a faint blue peak ($V/R \ll 1$).

The three Hα profiles shown in Figure 5 have strong red and fainter blue peaks. On the first profile (JD 2′445, 618.018), a small inflexion appears near the top of the red peak. Equivalent width varies slightly, from −24.89 A to −22.90 A (≈ 8%). A similar small change of the radial velocity of the centre of gravity as well as the radial

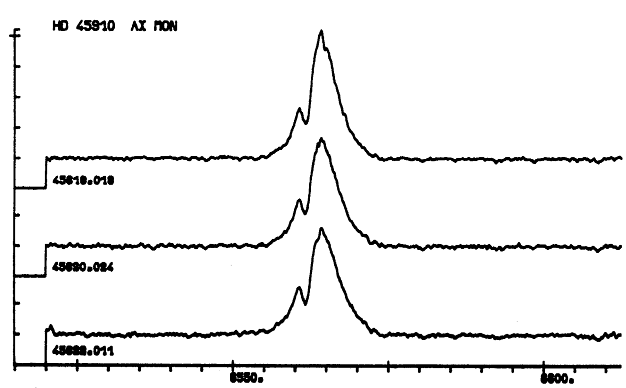


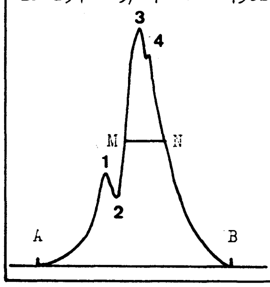
Fig. 5. Hα line profiles for HD 45910 (AX Mon).

TABLE 5

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 45910 (AX Mon)

HD 45910 AX Mon

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V3 - V1	V/R	MN (km/s)
EA 246	9/10 oct	45618.018	24.89	66.9	-99.7	-53.8	58.6	98.1	158.3	0.51	210
					2.61	2.19	5.13	4.62			
EA 270	11/12 oct	45620.024	22.90	71.3	-100.0	-57.8	63.7		163.7	0.56	226
					2.51	2.10	4.52				
EA 294	13/14 oct	45622.011	23.73	61.0	-100.4	-53.7	66.1		166.5	0.57	228
					2.53	2.05	4.45				



Time exposure = 60 mn
MN = see column 12
AB = 997 km/s
d(W(Å)) = 1.99 Å
dV_G = 10.3 km/s

dV1 = 0.7 km/s
dI1 = 0.10
dV2 = 4.1 km/s
dI2 = 0.14
dV3 = 7.5 km/s

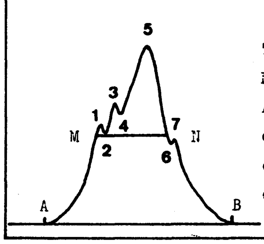
dI3 = 0.68
d(V3 - V1) = 8.2 km/s
d(V/R) = 0.06
d(MN) = 18.0 km/s

TABLE 6*a*

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 184279 (V1294 Aql), FIRST PERIOD

HD 184279 V 1294 Aql First Period

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V5 I5	V6 I6	V7 I7	V5 - V1	V/R	MN (km/s)
EA 210	28/29 sep	45606.669	15.44	9.6	-199.5	-159.9	-65.1	-28.0	77.6	180.7	190.9	277.1	0.67	395
					1.84		2.32		2.74		1.95			
EA 215	29/30 sep	45607.658	19.17	15.4	-211.9	-156.2	-87.4	-64.6	71.5			283.4	0.70	434
					2.07		2.54		2.94					
EA 216	30/1 oct	45608.658	16.54	-2.1	-199.0	-152.7	-92.7	-42.8	81.4	181.0	186.0	280.4	0.70	427
					2.00		2.35		2.87		2.03			
EA 217	1/2 oct	45609.685	14.86	-3.8	-185.2	-142.0	-94.9	-57.8	73.7		184.1	258.9	0.69	407
					1.88		2.20		2.74		1.89			
EA 224	2/3 oct	45610.644	13.52	6.4	-203.6	-140.1	-92.2	-29.1	66.8		192.0	270.4	0.69	407
					1.81		2.05		2.61		1.83			
EA 226	2/3 oct	45610.753	17.03	-8.0	-172.4	-133.8	-101.8	-65.5	65.6	194.4	202.5	238.0	0.72	365
					2.12		2.35		2.96		1.91			
EA 228	3/4 oct	45611.651	16.51	14.6	-176.1	-141.1	-97.1	-70.4	69.9		184.3	246.0	0.66	290
					1.93		2.14		2.93		1.79			



Time exposure = 90 mn
MN = see column 15
AB = 1354 km/s
d(W(Å)) = 5.65 Å
dV_G = 23.4 km/s
dV1 = 39.5 km/s

dI1 = 0.31
dV2 = 26.1 km/s
dV3 = 36.7 km/s
dI3 = 0.49
dV4 = 42.4 km/s
dV5 = 15.8 km/s

dI5 = 0.35
dV6 = 13.7 km/s
dV7 = 18.4 km/s
dI7 = 0.24
d(V5 - V1) = 45.4 km/s

d(V/R) = 0.06
d(MN) = 144 km/s

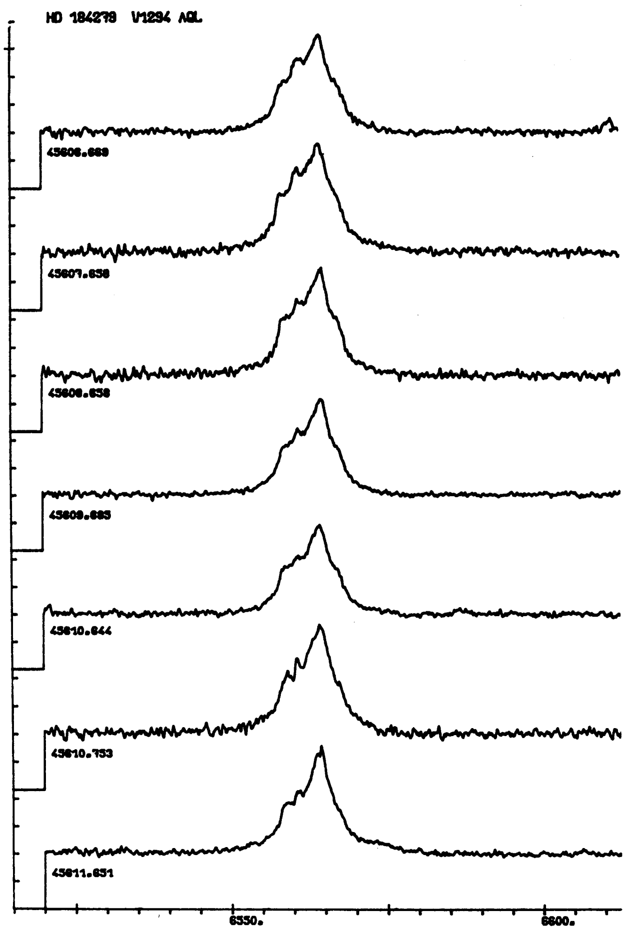


Fig. 6a. Hα line profiles for HD 184279 (V1294 Aql). First period.

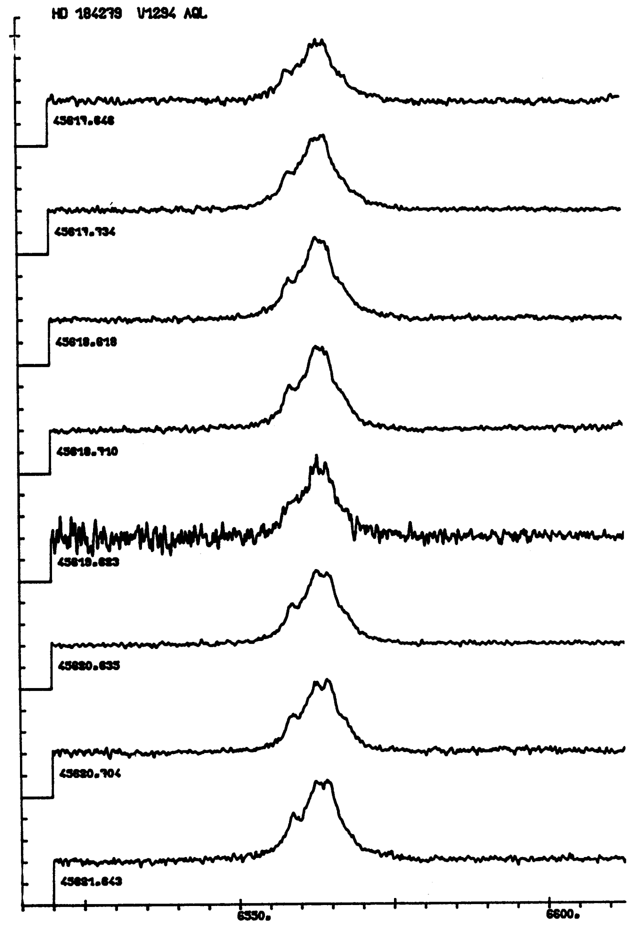


Fig. 6b. Hα line profiles for HD 184279 (V1294 Aql). Second period.

velocity and intensity of each emission and absorption features is observed as shown on Table 5. These profiles have been recorded at about phase 0.10. FWHM increases by about 8% in 4 days, from 210 km s^{-1} to 228 km s^{-1}.

5) *HD 184279: V 1294 Aql (Figures and Tables* 6a,b*)*

This star has been randomly observed by several authors: Merrill (1952*a*); Merrill and Lowen (1953); Svolopoulos (1975) among others, studied the spectra of this star. Ballereau and Chauville (1986) give evidence of long-term V/R variations from 1976 to 1984, with a 'characteristic time' of 66 months. Since 1973 this star presents a permanent shell of hydrogen and neutral helium. Svolopoulos (1975) gave an Hα profile with $V/R \approx 1$. From the Atlas, we know that this star has shown a B phase followed by a Be phase along with a shell of hydrogen, neutral helium and Fe III. From 1953 to 1957, Hα was a weak absorption line. Between 1963 and 1970, a complete fill-up of Hα occurred. From 1973 to 1976, a strong Hα line was present together with a strong shell of hydrogen, helium and metals. During the maximum of this shell phase, occurring in 1975, Hα and Hβ exhibited a 'reversed P Cygni' profile. The 13-color photometry of this star (Alvarez *et al.* 1986) and the *UBV* photometry (Horn *et al.* 1982), shows also the 'characteristic time' of 66 months. The Meudon-Group plate collection has one plate taken on July 4, 1977, showing a redward emission with a shell absorption on Hα and Hβ.

This star has been intensively followed during our campaign with a total of 15 plates. The different profiles exhibited in Figures 6*a,b* display important night-to-night changes. During the first observational period, the red peak is strong and sharp, while two blueward emission peaks seem to vary in a random way. At JD 2′445, 610.753, these two peaks have a maximum intensity. During the second period, the redward bright peak is wider, showing a plateau that even splits into several emission components (shown as Nos. 5, 6, 7). One of the blueward faint emission peaks has disappeared and

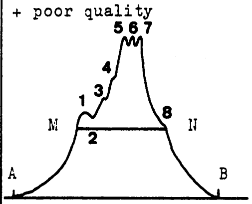
TABLE 6*b*

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 184279 (V1294 Aql), SECOND PERIOD

HD 184279 V 1294 Aql Second Period

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V5 I5	V6 I6	V7 I7	V8 I8	V7 - V1	V/R	MN (km/s)
EA 238	9/10 oct	45617.646	12.25	14.9	-203.4 1.73	-152.6	-107.9 1.85	-68.5 1.95	-16.8 2.30	19.4 2.40	79.4 2.40	225.7 1.60	282.8	0.72	388
EA 240	9/10 oct	45617.734	15.52	13.2	-187.6 1.88	-140.3	-97.0 2.08	-58.9 2.25	-10.7 2.63	15.1 2.66	66.6 2.72	167.4 1.73	254.2	0.69	381
EA 247	10/11 oct	45618.618	15.96	11.3	-189.6 1.94	-156.9	-105.8 2.09	-65.4 2.20		7.6 2.85	79.5 2.76	167.1 1.94	269.1	0.70	372
EA 249	10/11 oct	45618.710	16.18	-12.4	-186.9 2.01	-152.7		-75.4 2.22		5.8 2.88	82.8 2.75		269.7	0.73	377
EA 259+	11/12 oct	45619.623	13.68	7.8	-201.3 1.79		-98.9 2.02			6.1 2.85	71.9 2.71		273.2	0.66	-
EA 271	12/13 oct	45620.635	15.42	-0.6	-185.3 1.94	-151.8			-3.7 2.71		71.9 2.66	169.9 1.88	257.2	0.73	388
EA 272	12/13 oct	45620.704	14.36	-3.7	-183.5 1.87	-147.6			-14.1 2.61		67.4 2.67	194.4 1.77	250.9	0.70	365
EA 285	13/14 oct	45621.643	17.18	-11.7	-190.1 2.10	-149.5			-19.8 2.82	14.4 2.77	61.9 2.83		252.0	0.74	372

\+ poor quality



Time exposure = 90 mn	dI1 = 0.37	dV5 = 16.1 km/s	dV8 = 58.6 km/s
MN = see column 16	dV2 = 16.6 km/s	dI5 = 0.52	dI8 = 0.34
AB = 1362 km/s	dV3 = 10.9 km/s	dV6 = 13.6 km/s	d(V7 - V1) = 31.9 km/s
d(W(Å)) = 4.93 Å	dI3 = 0.24	dI6 = 0.48	d(V/R) = 0.08
dV_G = 27.3 km/s	dV4 = 16.5 km/s	dV7 = 20.9 km/s	d(MN) = 23 km/s
dV1 = 19.9 km/s	dI4 = 0.30	dI7 = 0.43	

been replaced by two small inflexions (Nos. 3 and 4). The equivalent width varies strongly from night-to-night and sometimes during the same night. During the first period, W changed from −19.7 A to −13.52 A (≈ 29%). During the second period it changed from −17.18 A to −12.25 A (≈ 29%) also. The total change represents a 36% variation within 10 days. The radial velocity centre of gravity of the emission line changes continually from +15.4 km s^{-1} to −8.0 km s^{-1}, in 3 days. *VG* increases up to +14.9 km s^{-1} and diminishes again to −11.7 km s^{-1}. The other observed features behave in a very similar way. Changes in the blueward emission components vary from 21% to 10% between the two observational periods. The redward peak (No. 5 and Nos. 5, 6, 7) changes from 81.4 km s^{-1} to 65.6 km s^{-1}, and from 82.8 km s^{-1} to 61.9 km s^{-1} respectively. The large difference between the FWHM during the first period (144 km s^{-1} diff.) is due to the large evolution of emission features 1 and 3. During the second period of observation, this FWHM changed only by 23 km s^{-1} as can be seen from our Table 6*b*. Our observations allow us to realize the possibilities of the spectroscopic studies of the Hα line to study the short-term (of the order of a few hours) periodic phenomena present in several active Be stars.

6) *HD 193237: BS 7763, P Cyg (Figure and Table 7).*

This star is the prototype of the 'P Cygni' star variables, characterized by a hydrogen and helium spectrum with strong emission lines, indicating a significant mass-loss rate (Underhill 1979). This early supergiant has been intensively observed in the past, and its spectrum has shown strong changes. Andrillat and Fehrenbach (1982)

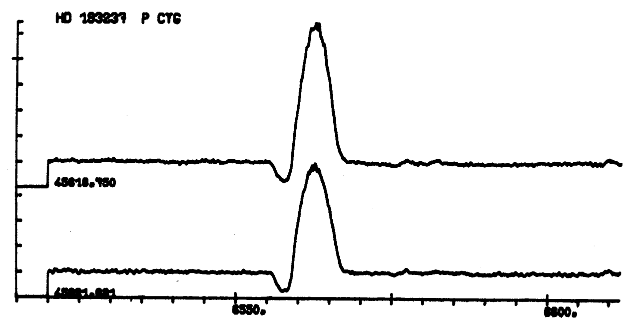


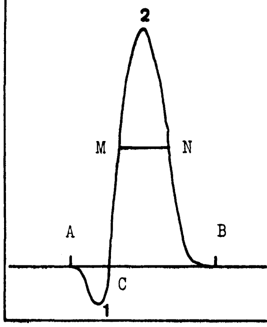
Fig. 7. Hα line profiles for HD 193237 (P Cyg).

TABLE 7

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 193237 (P Cyg)

HD 193237 P Cyg

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V2 - V1	MN (km/s)	CB (km/s)	AB (km/s)
EA 250	10/11 oct	45618.750	24.90	15.4	-228.9 0.28	-4.2 6.36	224.7	228	434	617
EA 286	13/14 oct	45621.681	19.66	19.2	-231.5 0.30	-4.1 5.21	227.4	242	480	662



Time exposure = 10 mn dV_G = 3.8 km/s d(V2 - V1) = 2.7 km/s
MN = see column 9 dV1 = 2.6 km/s d(MN) = 14. km/s
CB = see column 10 dI1 = 0.02 d(CB) = 46 km/s
AB = see column 11 dV2 = 0.1 km/s d(AB) = 45 km/s
d(W(Å)) = 5.24 Å dI2 = 1.15

give a Hα profile (April 3, 1980) which shows a ratio larger than 50 between the equivalent width of the redward emission component to the blue absorption component.

Our two Hα profiles displayed in Figure 7 are identical, and the bright emission line seems to be superposed on a very faint emission detected as a weak emission wing. The intensity of the emission line seems to be smaller than it was in 1980. Equivalent width changed from −24.90 A to −19.66 A in three days (≈ 21%). The absorption feature varies by 2.6 km s^{-1} while the emission peak changes by 0.1 km s^{-1} only in these 3 days.

7) *HD 200120: BS 8047, 59 Cyg (Figure and Table 8).*

This star has presented several shell episodes reported by Doazan, Briot, and Bourdonneau (1975), Hubert-Delplace; and Hubert (1981), and Barker (1982). The Hα profiles vary strongly at long-term intervals and may present one or two emission peaks, with important *V/R* changes (Barker 1982). Chalabaev and Maillard (1983) give an Hα profile (June 6, 1982) with *V/R* > 1. Barker (1983) gives 17 Hα profiles (April to November 1980) with important *V/R* changes and 17 other Hα profiles (August 23 and 24, 1980) clearly showing short-scale changes. Tarasov and Scherbakov (1983) find Hα line profile variations over three consecutive nights (August 16, 17 and 18, 1981) with a reversal of *V/R*.

Observed and reported in the Atlas, this star's spectrum shows large changes in the emission lines and a temporary strong shell of hydrogen, helium and metals. From 1953 to 1969, the Hα line is bright and strong. Emission is maximum in 1956 and 1961. At the end of 1971 and through 1974, the emission lines have increased their intensity reaching a prominent maximum from December 1973 to June 1974. In November and December 1974, a strong shell was present with 'P Cygni' profiles

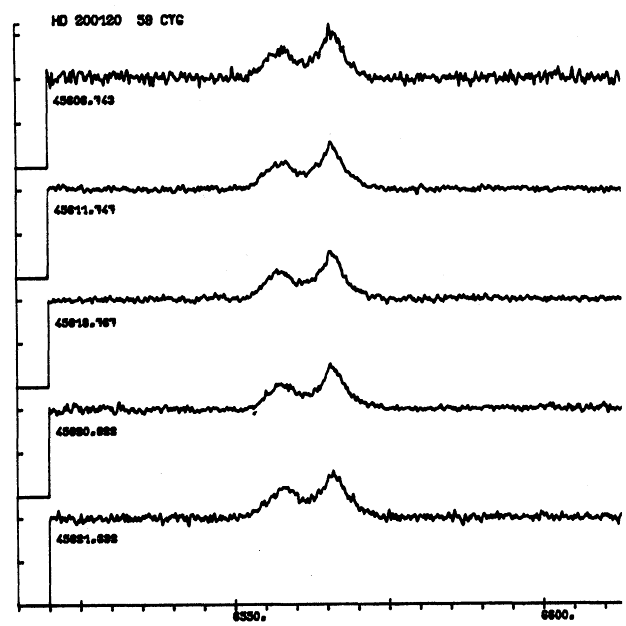


Fig. 8. Hα line profiles for HD 200120 (59 Cyg).

TABLE 8

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 200120 (59 Cyg).

HD 200120 59 Cyg

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R	MN (km/s)
EA 212+	28/29 sep	45606.743	4.64	-15.7	-209.3 1.33	-41.6 1.14	127.6 1.56	336.9	0.85	480
EA 230	3/4 oct	45611.747	4.73	-14.8	-195.4 1.32	-44.9 1.17	134.7 1.53	330.1	0.86	518
EA 251	10/11 oct	45618.767	4.84	-13.7	-249.3 1.33	-123.2 1.17	127.9 1.55	377.2	0.86	530
EA 276	12/13 oct	45620.822	4.19	6.7	-243.5 1.28	-84.9 1.15	124.8 1.49	368.3	0.86	525
EA 287	13/14 oct	45621.692	5.07	-14.8	-220.1 1.35	-103.1 1.19	142.3 1.51	362.4	0.89	534

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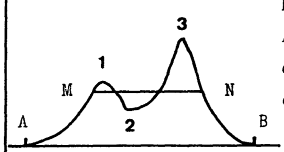


Time exposure = 3 mn
MN = see column 11
AB = 1046 km/s
d(W(Å)) = 0.88 Å
dV_G = 22.4 km/s

dV1 = 53.9 km/s
dI1 = 0.07
dV2 = 81.6 km/s
dI2 = 0.05
dV3 = 17.5 km/s

dI3 = 0.07
d(V3 - V1) = 47.1 km/s
d(V/R) = 0.04
d(MN) = 54 km/s

in lower terms of the Balmer series. The shell episode decreased in intensity, during 1975 and by 1976 no emission lines were seen on the spectrum: Hα was not distinguished from the continuum. From the 15 plates of the Meudon-Group plate collection (1961 to 1982), it is possible to follow the structure of the Hα profile. On January 1975, it showed two wide emission peaks with $V/R = 1$. Lacy (1977) observed the Hα line on August 19, 1975. This was a moderate emission line with an almost flat maximum (equivalent width = −8.91 A). Slettebak and Reynolds (1978) reported W = −0.44 A in 1976 and W = −0.27 A in 1977 on a weak double emission line, showing $V/R = 1$. Fontaine *et al.* (1982) observed this line on August 19, 1976. Hα was a very weak, double peaked emission line with a W = −0.36 A. The same structure was observed in 1977. On 1979, the Hα line showed considerable changes on the redward component, being stronger than the blue and having a small absorption on the red wing. Andrillat (1983) observed Hα on June 19, 1981 as a strong emission line with a large central absorption $V/R = 2$. The violet maximum is at 8.2 A from the red component of the line. The value of W is −5.5 A. During 1982, the ratio $V/R > 1$. The blue component was strong and narrow, while the redward one was wide and faint. On some occasions, He I λλ5875.6 A and 6678.1 A appear with two faint, wide emission components.

The five Hα profiles do not display very important changes during our observations, although W varies from −4.19 A to −5.07 A (≈ 17%) in 1 day. The radial velocity of the centre of gravity changes from −15.7 km s^{-1} to +6.7 km s^{-1} in 14 days. The radial velocity of the blueward component varies from −195.4 km s^{-1} to −249.3 km s^{-1} (≈ 22%) in 7 days while the redward peak (more intense), varies from 124.8 km s^{-1} to 142.3 km s^{-1} (≈ 12%) in 1 day. The broad minimum (No. 2) shows also important changes in radial velocity varying from −41.6 km s^{-1} to −123.2 km s^{-1} (≈ 66%). The FWHM reflects these changes varying from 480 km s^{-1} to 534 km s^{-1} (≈ 10%) in 15 days.

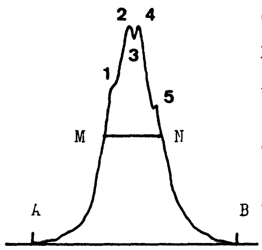
8) *HD 202904: BS 8146, UPS Cyg (Figure and Table 9).*

This star was classified as an extreme pole-on Be star by Schild (1973), showing a steady emission in the first terms of the Balmer series. Peters (1979) gave an Hα profile date October 21, 1974. Observed from 1953 to 1976 and reported in the Atlas, this star shows a very strong and wide Hα line from 1953 to 1967. From 1969 to 1972, the emission line intensity decreases and at the end of 1973, the emission strengthens again but remains weaker than it was in 1965. Lacy (1977) gave an Hα line profile and found W = −26.6 A. On June 26, 1975.

TABLE 9

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 202904 (υ Cyg).

HD 202904 Upsilon Cyg											
Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V5 I5	V4 - V2	V/R
EA 248	10/11 oct	45618.662	19.05	0.4	-69.6 3.36	-23.3 4.18	-4.1 3.94	23.0 4.18	100.4 3.00	46.3	1.00
EA 274	12/13 oct	45620.794	12.37	-0.8	-70.3 2.52	-29.9 2.92	2.5 3.06	38.8 2.88	89.5 2.32	68.7	1.01



Time exposure = 12 mn
MN = 264 km/s
AB = 982 km/s
d(W(Å)) = 6.68 Å
dV_G = 1.2 km/s
dV1 = 0.7 km/s

dI1 = 0.84
dV2 = 6.6 km/s
dI2 = 1.26
dV3 = 6.6 km/s
dI3 = 0.88
dV4 = 15.8 km/s

dI4 = 1.3
dV5 = 10.9 km/s
dI5 = 0.68
d(V4 - V2) = 22.4 km/s
d(V/R) = 0.01

Slettebak and Reynolds (1978) reported a value of W = −29.17 A in November 1976 and W = −31.72 A in June 1977. Andrillat (1983) observed this star on June 19, 1981; the profile shows a strong and roughly symmetric profile with a small inflexion on both sides of the line and a flat plateau at the top. The Meudon-Group plate collection comprises eight plates taken in the red, all showing a steady Hα line, symmetrical and bright from 1961 to 1982.

Our observations of the Hα line show the small inflexions on both sides of the emission line. Its top displays two reversed profiles. We observe a strong decrease of the equivalent width from W = −19.05 A to −12.37 A (≈ 35%) in two days, displayed also in the two inflexions observed that show a change d(V 5 −V1) = 31 km s^{-1}.

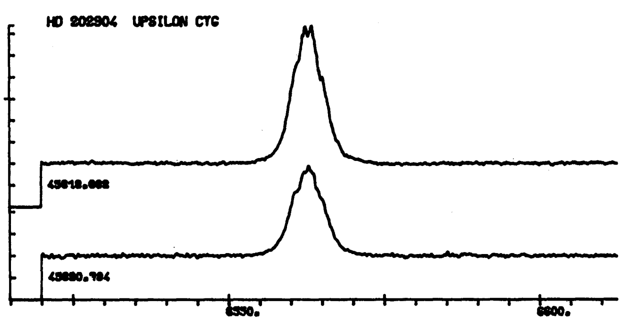


Fig. 9. Hα line profiles for HD 202904 (υ Cyg).

9) *HD 217050: BS 8731, EW Lac (Figure and Table 10).*

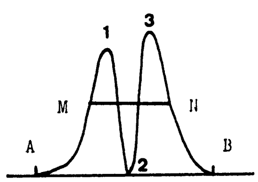
This star, presenting a permanent emission spectrum with central absorption on the Balmer lines, has been intensively followed by several authors: The observations from 1958 to 1976 are reported in the Atlas. Hα was a very strong emission line and the sharp core present in Hβ was not detectable in Hα, probably due to the relatively low dispersion used for these observations. In 1976, a weakening of the emission lines is observed, associated with a weakening of the shell structure. Kogure (1975) studied the shell spectrum from 1966 to 1972. Voikhanskaya (1976) observed a decrease of 50% of the Hα equivalent width during August 1974. The double peaked structure showed a small central absorption with $V/R = 1$. Gray and Marlborough (1974) gave an Hα line tracing with $V/R > 1$. Hirata and Kogure (1979) observed small inflexions along the emission profile with $V/R = 1$ on October 1974 and November 1978. Poeckert's (1980) observations showed $V/R < 1$. Slettebak and Reynolds (1978) obtained three Hα line profiles in December 1975, November 1976 and June 1977 with $V/R < 1$ each time and a continous decrease of the value of W (−44.75 A, −39.94 A, −32.84 A, i.e., a decrease of 38%). Fontaine *et al.* (1982) observed this star on September 12, 1976 and obtained $V/R < 1$ and W = −35.00 A. Kogure and Suzuki (1984) showed three tracings from 1978, 1979 and 1980, with $V/R = 1, > 1$ and $= 1$ respectively. Andrillat and Fehrenbach (1982) recorded an Hα

TABLE 10

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 217050 (EW Lac)

HD 217050 EW Lac

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R	MN (km/s)
EA 205	27/28 sep	45605.810	24.01	-18.8	-99.0 3.41	-17.7 0.68	76.3 3.96	175.3	0.86	381
EA 211	28/29 sep	45606.720	20.05	-2.7	-109.1 3.23	-17.7 0.57	79.0 3.80	188.1	0.85	375
EA 218	1/2 oct	45609.849	16.43	-20.1	-115.1 2.80	-19.8 0.65	76.9 3.24	192.0	0.86	377
EA 231	3/4 oct	45611.770	33.85	-15.0	-118.5 5.10	-17.7 0.62	80.3 6.24	198.8	0.82	345
EA 252	10/11 oct	45618.797	33.45	-23.7	-104.4 4.56	-19.8 0.72	82.3 5.69	186.7	0.80	372
EA 265	11/12 oct	45619.799	18.17	-29.5	-109.8 2.98	-19.8 0.71	76.3 3.23	186.1	0.92	397
EA 277	12/13 oct	45620.841	20.86	-18.8	-111.8 3.34	-19.8 0.75	78.3 3.91	190.1	0.85	363
EA 289	13/14 oct	45621.759	23.34	-24.2	-109.8 3.30	-19.8 0.75	76.3 3.75	186.1	0.88	386
EA 296	14/15 oct	45622.694	18.30	-12.9	-105.7 2.87	-19.8 0.67	73.6 3.44	179.3	0.83	372
EA 299	14/15 oct	45622.857	19.83	-20.6	-111.8 3.15	-19.8 0.65	74.9 3.65	186.7	0.86	379



Time exposure = 20 mn
MN = see column 11
AB = 1357 km/s
d(W(Å)) = 17.42 Å
dV_G = 26.8 km/s

dV1 = 19.5 km/s
dI1 = 2.3
dV2 = 2.1 km/s
dI2 = 0.18
dV3 = 8.7 km/s

dI3 = 3.01
d(V3 - V1) = 23.5 km/s
d(V/R) = 0.12
d(MN) = 52 km/s

line on December 25, 1980, showing $V/R > 1$ and an important shell-absorption core. The Meudon-Group plate collection has a set of 16 spectra showing bright-double peaked Hα emission line with a central reversal. Nevertheless, it is difficult to know from a visual inspection the precise value of the ratio V/R.

Our Hα line tracings displayed in Figure 10, are described in the following: The equivalent width shows large changes in a daily basis, going from −16.43 A to −33.85 A within two days. This large difference is reflected in the intensity of both the violet and red peaks of this emission line. The V peak has dI 1 = 2.3 and the R peak has dI 3 = 3.01, while the central absorption shows only dI 2 = 0.18. As is the case for other stars of our sample, the blueward peak has a large variation in radial velocity (dV 1 = 19.5 km s^{-1}) than the redward one (dV 3 = 8.7 km s^{-1}). The V/R ratio varies slightly around 0.85. The FWHM changes by 52 km s^{-1} in about 8 days.

10) *HD 218674: KY And (Figure and Table 11).*

This star was discovered as a Be star in 1958 by Herman and Duval (1962) who observed a double-peaked emission line in Hα, with a separation of 7 A. From the Atlas, this star was observed from 1958 to 1976, and emission in Hα did not change significantly. The Hα line profile displayed in Figure 11 is double peaked, with $VR/ = 1$ showing an asymmetric absorption core.

11) *HD 224559: BS 9070, LQ And (Figure and Table 12).*

This star shows rapid radial velocity and V/R ratio

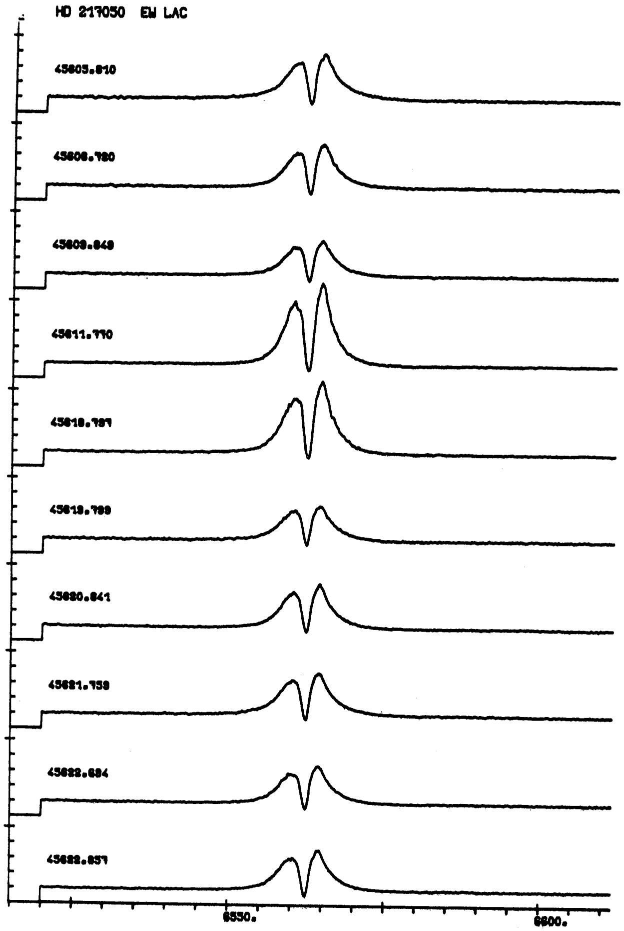


Fig. 10. Hα line profiles for HD 217050 (EW Lac).

variations at Hβ, as shown by Fraquelli (1979). It has recently been reported as having a photometric period of about 0.31 day (Percy 1983; Harmanec 1984; Alvarez *et al.* 1986) and also rapid spectroscopic variability with evidence of a double periodicity (Baade *et al.* 1984).

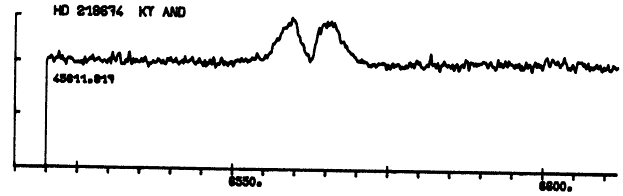


Fig. 11. Hα line profiles for HD 218674 (KY And).

The Atlas shows that this star was observed from 1953 to 1976 and presented a bright Hα emission line, showing a slow variation with a gradual decrease starting in 1969. Andrillat (1983) observed this star on October 24, 1981. The Hα line profile presented a strong emission with a weak central absorption. The ratio $V/R = 1$.

During our campaign, we obtained nine spectra showing Hα as a bright emission with two peaks of almost equal intensity $V/R > 1.03$. The equivalent width variations are small (≈ 14%) ranging from −15.20 A to −17.70 A in 14 days. Recent results of the analysis of the radial velocity features of Hα seems to confirm the photometric period of 0.31 days (Sareyan *et al.* 1986). As opposed to other emission stars studied in our sample, the longward peak varies more (dV 3 = 21 km s^{-1}) than the shortward one (dV 1 = 11.6 km s^{-1}).

b) *Late-type Be Stars*

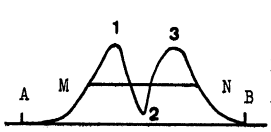
1) *HD 23862: BS 1180, Pleione (Figure and Table 13).*

This star underwent a famous shell episode between 1938 and 1951 as reported for example by Merrill (1952*b*) and began a new one in 1972 that has been studied by Hirata and Kogure (1976, 1977, 1978); Gulliver (1977); Higurashi and Hirata (1978), and Ballereau (1980) among others. Hirata and Kogure (1976) gave five Hα profiles, all showing $V/R = 1$ and strong variations of emission strength between 1969 to 1974. From the Atlas, we find

TABLE 11

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 218674 (KY And)

HD 218674 KY And									
Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R
EA 232	3/4 oct	45611.817	3.59	-33.1	-144.1 1.41	-15.6 1.03	107.8 1.37	251.9	1.03



Time exposure = 90 mn
MN = 491 km/s
AB = 936 km/s

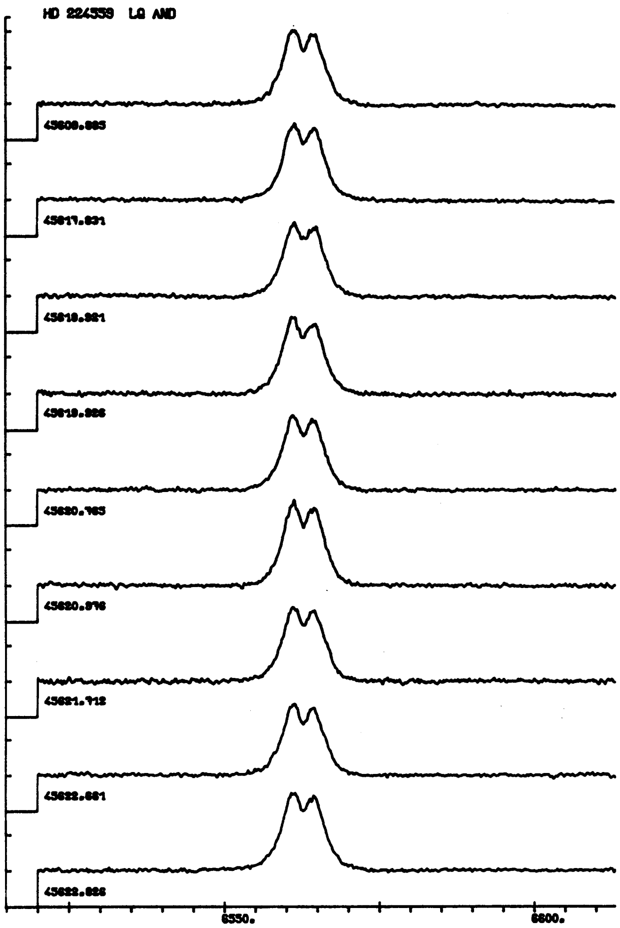


Fig. 12. Hα line profiles for HD 224559 (LQ And).

that this star exhibits a change in emission and the onset of a strong shell in 1972. From 1953 to 1957, Hα is a strong and wide bright emission line. In 1972, Hα is not distinguishable from the continuum, and there appears a hydrogen and metallic shell. From 1973 to 1976, Hα is again in emission. Slettebak and Reynolds (1978) recorded Hα line profiles of this star in December 1975, November 1976 and January 1977 and measured the following equivalent widths: −9.20 A, −9.43 A, and −8.64 A. Fontaine *et al.* (1982) observed this star on August 17, 1976 with W = −9.52 A. Andrillat and Fehrenbach (1982) on February 12, 1981 report $V/R = 1$. The Meudon-Group plate collection has a set of five spectra in the red: November 30, 1979, November 19, 1980, November 14, 1981 and November 16, 1981, showing $V/R > 1$ and the blueward emission component appearing wider than the red one. On March 6, 1983, the ratio $V/R < 1$.

Our single measurement of Hα line presented in our Figure 13 shows $V/R > 1$ with a deep sharp central reversal.

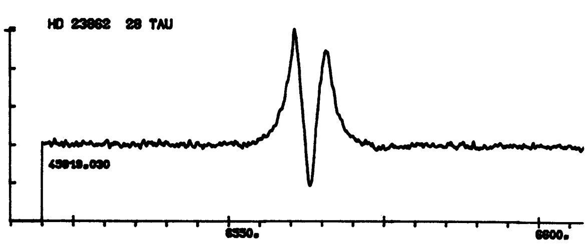


Fig. 13. Hα line profiles for HD 23862 (28 Tau).

2) *HD 174638: BS 7106, β Lyr (Figure and Table 14).*

This bright Be star is a close binary system of period 12.9 days, whose secondary component has not yet been observed by spectroscopic means. A complete review is given by Sahade (1980). Several authors gave some Hα line profiles at different phases: Batten and Shade (1973; the profile being interpreted as a superposition of a broad and a narrow emission profile originating from the unobserved secondary star and the whole system); Kriz and Zdarsky (1974: displaying 14 profiles as function of the phase, all of these showing strong changes but always with $V/R < 1$); Flora and Hack (1975: giving 20 very precise Hα tracings, all having two emission peaks with $V/R < 1$ with the exception of phase 0.5 where the upper part of the line is roughly linear and inclined upwards with wavelength); Sanyal (1982: 3 profiles dated May 3, 8 and 10, 1975). Lacy (1977) found an equivalent width of −12.3 A for Hα on June 27, 1975. Fontaine *et al.* (1982) gave an Hα line profile with $V/R < 1$ and W = −15.69 A. On August 20, 1976. Andrillat and Fehrenbach (1982) recorded an Hα line profile on March 3, 1980 with $V/R < 1$ and W = −17.2 A.

The Meudon-Group plate collection (from 1971 to 1984) has a set of seven spectra on red sensitive plates, each showing an Hα line with two emission peaks having $V/R < 1$.

On our two observations carried out on September 28, 1983, within a 45 minute difference, we see a well developed double peak with $V/R = 0.92$ and a very well marked minimum, close to a faint shortward emission component (No. 2 in Table 14). The equivalent width

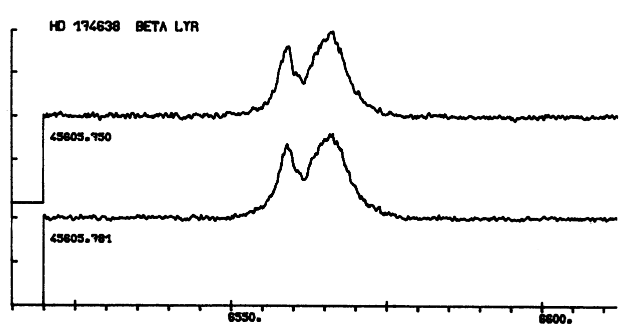


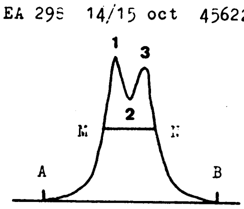
Fig. 14. Hα line profiles for HD 174638 (β Lyr).

TABLE 12

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 224559 (LQ And)

HD 224559 LQ And

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R
EA 219	1/2 oct	45609.885	15.90	-12.0	-75.1 3.05	-1.2 2.51	67.9 2.92	143.0	1.04
EA 241	9/10 oct	45617.831	16.31	-5.0	-73.4 3.09	-4.0 2.60	74.8 3.00	148.2	1.03
EA 254	10/11 oct	45618.921	15.20	-3.1	-71.8 3.02	-9.3 2.63	83.2 2.90	155.0	1.04
EA 267	11/12 oct	45619.926	15.68	-10.2	-79.6 3.08	-6.9 2.53	79.4 2.88	159.0	1.07
EA 273	12/13 oct	45620.765	15.61	-11.2	-83.4 3.07	-1.4 2.55	62.2 2.94	145.6	1.04
EA 281	12/13 oct	45620.976	17.15	-5.8	-74.2 3.31	-1.9 2.66	79.7 3.13	153.9	1.06
EA 288	13/14 oct	45621.712	16.22	-12.3	-80.2 3.06	-2.1 2.58	68.1 2.96	148.3	1.03
EA 293	14/15 oct	45622.661	15.43	-16.9	-72.7 3.01	-5.6 2.49	67.1 2.90	139.8	1.04
EA 298	14/15 oct	45622.826	17.70	-20.4	-73.2 3.15	-5.3 2.68	76.6 3.07	149.8	1.03



Time exposure = 60 mn
MN = 334 km/s
AB = 1007 km/s
d(W(Å)) = 2.5 Å
dV_G = 17.3 km/s
dV1 = 11.6 km/s
dI1 = 0.3
dV2 = 8.1 km/s
dI2 = 0.19
dV3 = 21.0 km/s
dI3 = 0.25
d(V3 - V1) = 19.2 km/s
d(V/R) = 0.04

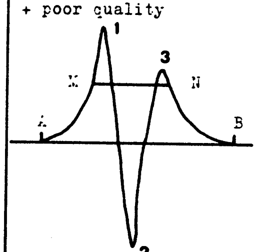
TABLE 13

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 23862 (28 Tau)

HD 183656 V 923 Aql

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R	MN (km/s)
EA 225	2/3 oct	45610.698	2.59	-47.7	-151.8 1.62	-9.7 0.48	131.1 1.46	282.9	1.11	443
EA 229	3/4 oct	45611.710	2.39	-44.4	-154.8 1.60	-9.6 0.49	133.9 1.50	288.7	1.07	420
EA 260+	11/12 oct	45619.678	1.97	-29.3	-157.1 1.65	1.2 0.40	133.1 1.40	290.2	1.18	400

+ poor quality



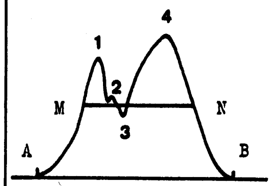
Time exposure = 60 mn
MN = see column 11
AB = 967 km/s
d(W(Å)) = 0.62 Å
dV_G = 18.4 km/s
dV1 = 5.3 km/s
dI1 = 0.05
dV2 = 10.9 km/s
dI2 = 0.09
dV3 = 2.8 km/s
dI3 = 0.10
d(V3 - V1) = 7.3 km/s
d(V/R) = 0.11
d(MN) = 43 km/s

TABLE 14

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 174638 (β Lyr)

HD 174638 Beta Lyr

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V4 I4	V4 - V1	V/R
EA 203	27/28 sep	45605.750	9.71	36.4	-172.3 1.79	-122.2 1.49	-57.0 1.39	147.8 1.97	320.1	0.91
EA 204	27/28 sep	45605.781	10.37	42.2	-176.3 1.83	-132.3 1.53	-51.9 1.44	145.2 1.96	321.5	0.93



Time exposure = 3 mn; MN = 518 km/s; AB = 1382 km/s; d(W(Å)) = 0.66 Å; dV_G = 5.8 km/s

dV1 = 4.0 km/s; dI1 = 0.04; dV2 = 10.1 km/s; dI2 = 0.04; dV3 = 5.1 km/s

dI3 = 0.05; dV4 = 2.6 km/s; dI4 = 0.01; d(V4 - V1) = 1.4 km/s; d(V/R) = 0.02

varies from −9.71 A to −10.37 A (≈ 6%) and V G goes from 36.4 km s^{-1} to 42.2 km s^{-1} (≈ 14%). Other features in our sample, near the limit of detection, vary very little.

3) *HD 183656: BS 7415, V923 Aql (Figure and Table 15).*

This late-type emission star was spectroscopically studied by Bidelman (1950), Merrill (1952*d*); Ringuelet and Sahade (1981), and Ringuelet *et al.* (1984). Fontaine *et al.* (1982) gave three Hα line profiles with $V/R < 1$ and a relatively strong central reversal. The values of W are −1.27 A, −4.02 A, and −2.21 A. On August 16, 17 and 19, 1976. These observed values are much smaller than those calculated by Briot (1971), W = −12.5 A). As can be seen in the Atlas, this star was observed from 1953 to 1972, showing a permanent strong Hα line with a strong shell of hydrogen and metals.

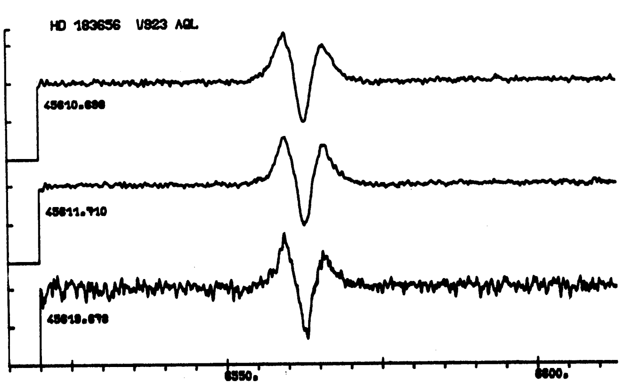


Fig. 15. Hα line profiles for HD 183656 (V923 Aql).

Our three Hα profiles, given in Figure 15, show small changes. The equivalent width runs from −2.59 A to −19.7 A (≈ 24%) in nine nights. V G changes from −47.7 km s^{-1} to −29.3 km s^{-1} (≈ 39%) also in the same period of time. The shortward peak varies more than the longward one although by very small amounts. The centre of gravity moves continuously longward as also the radial velocity, of the well below the continuum absorption feature.

4) *HD 218393: KX And (Figure and Table 16).*

This Be-shell star is a binary system which undergoes very complex changes in the Balmer line profiles. Its spectroscopic variations were studied by Merrill (1949); Halliday and Heard (1950); Doazan and Peton (1970), and Hubert (1971). The observations covering the period between 1954 and 1976 are reported in the Atlas. The 37 day period is well detected on the metallic shell lines. There are also strength variations easily detected from day to day observations and even during the same night. The Hα line is bright, very strong and wide. There are important changes in the rest of the Balmer lines, showing a P Cygni profile at different epochs. Its classification in the MK system is very difficult, due to the presence of a strong permanent shell and a cooler companion according to Goraya *et al.* (1984).

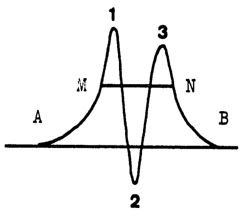
Our set of six Hα line profiles display very important changes mainly in the line shape, from day-to-day to several days time scale. The principal changes given in Table 16 are the following: the equivalent width varies from −13.23 A to −10.30 A. (≈ 22%) in eight days. The radial velocity of the centre of gravity moves continously shortward from + 41.9 km s^{-1} to −5.0 km s^{-1} (dV

TABLE 15

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 183656 (V923 Aql)

HD 23862 28 Tau

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R
EA 258	10/11 oct	45619.030	7.31	-9.1	-100.3 2.47	11.8 0.49	131.4 2.24	231.7	1.10



Time exposure = 20mn

MN = 347 km/s

AB = 1028 km/s

G = 46.9 km s^{-1} within the sixteen days of observations. A similar behaviour is also present for the absorption feature where dV 2 is only 7.6 km s^{-1} (≈ 11% variation) and dI 2 is 0.95 (≈ 46% change). The shortward peak (No. 1) increases continuously from 1.52 to 2.25 (≈ 32%) in 14 days, while dV 1 = 22.2 km s^{-1} (17% variation). The longward peak (No. 3) varies irregularly showing a total change in intensity dI 3 = 1.06 (≈ 29%) and dV 3 = 13.4 km s^{-1} (≈ 44%). The ratio V/R shows drastic changes with an exceptional variation of 0.32 (≈ 14%) in

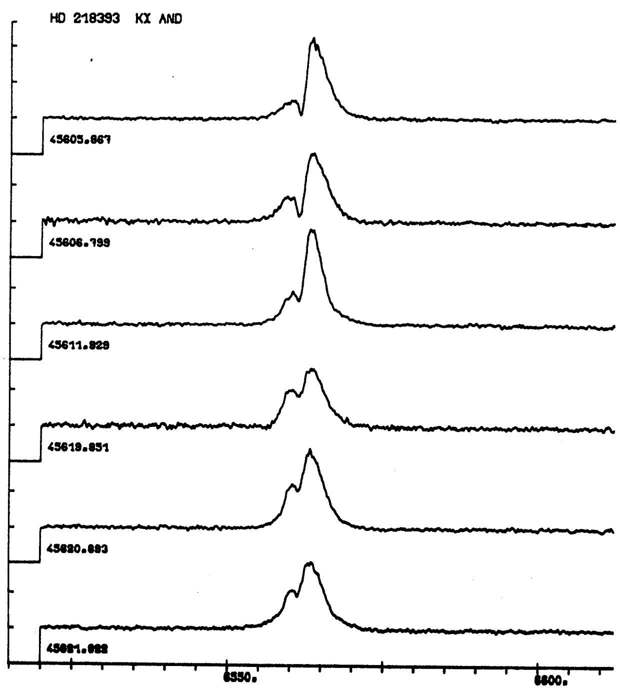


Fig. 16. Hα line profiles for HD 218393 (KX And).

14 days. Similarly the FWHM varies continuously with a change of 157 A (≈ 50%) in eight days.

c) *β CMa type Stars*

1) *HD 21803: BS 1072, KP Per (Figure and Table 17).*

This star has been identified as a β CMa variable by Lynds (1959) who found a photometric period of 0.200 day. Struve and Zebergs (1959) found a varying spectroscopic period (0.198 to 0.210 day) with correlated variations of the line width.

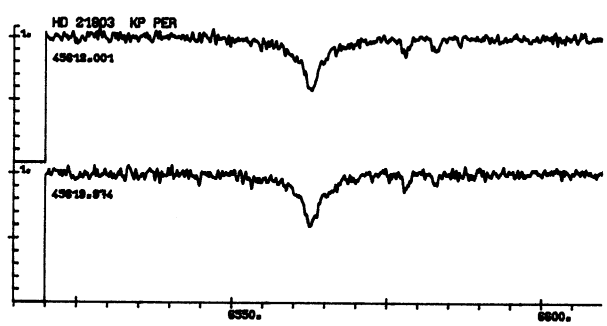


Fig. 17. Hα line profiles for HD 21803 (KP Per).

The two Hα line profiles in absorption given in Figure 17 are similar, and Table 17 shows a decrease of the equivalent width by ≈ 9% in seven days. V G changes by 6.7 km s^{-1} (≈ 23%); V 1 changes from –1.1 km s^{-1} to –5.5 km s^{-1} in 7 days and FWHM goes from 155 km s^{-1} to 144 km s^{-1}.

2) *HD 216916: BS 8725, 16 Lac (Figure and Table 18).*

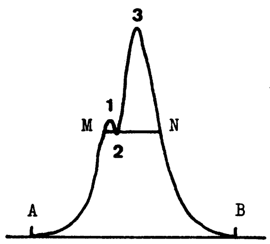
This β CMa star is a binary system of period 12.096

TABLE 16

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 218393 (KX And)

HD 218393 KX And

Plate number	Date 1983	Julian Day 2400000+	-W(Å)	V_G (km/s)	V1 I1	V2 I2	V3 I3	V3 - V1	V/R	MN (km/s)
EA 206	27/28 sep	45605.867	10.65	41.9	-113.2	-62.6	27.7	140.9	0.46	160
					1.52	1.11	3.28			
EA 213	28/29 sep	45606.799	11.06	17.9	-129.0	-63.8	30.6	159.6	0.58	176
					1.69	1.19	2.91			
EA 234	3/4 oct	45611.929	13.23	26.6	-110.3	-68.4	25.9	136.2	0.53	158
					1.96	1.69	3.70			
EA 266	11/12 oct	45619.851	10.30	15.0	-119.5	-65.7	24.2	143.7	0.78	315
					2.05	1.85	2.64			
EA 278	12/13 oct	45620.893	12.99	9.5	-110.3	-69.6	17.2	127.5	0.70	272
					2.25	2.06	3.23			
EA 290	13/14 oct	45621.822	12.55	-5.0	-106.8	-70.2	18.9	125.7	0.73	286
					2.10	1.92	2.89			



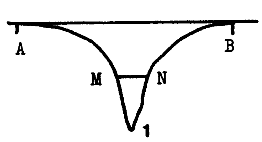
Time exposure = 120 mn
MN = see column 11
AB = 971 km/s
d(W(Å)) = 2.93 Å
dV_G = 46.9 km/s
dV1 = 22.2 km/s
dI1 = 0.73
dV2 = 7.6 km/s
dI2 = 0.95
dV3 = 13.4 km/s
dI3 = 1.06
d(V3 - V1) = 33.9 km/s
d(V/R) = 0.32
d(MN) = 157 km/s

TABLE 17

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 21803 (KP Per)

HD 21803 KP Per

Plate number	Date 1983	Julian Day 2400000+	W(Å)	V_G (km/s)	V1 I1	MN (km/s)
EA 236	3/4 oct	45612.001	2.51	-23.0	-1.1	155
					0.59	
EA 268	11/12 oct	45619.974	2.29	-29.7	-5.5	144
					0.60	

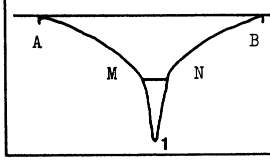


Time exposure = 60 mn
MN = see column 7
AB = 982 km/s
d(W(Å)) = 0.22 Å
dV_G = 6.7 km/s
dV1 = 4.4 km/s
dI1 = 0.01
d(MN) = 11 km/s

TABLE 18

EQUIVALENT WIDTHS, RADIAL VELOCITIES AND INTENSITIES MEASURED ON Hα LINE PROFILES OF HD 216916 (16 Lac)

HD 216916 16 Lac					
Plate number	Date 1983	Julian Day 2400000+	W(Å)	V_G (km/s)	V1 I1
EA 220	1/2 oct	45609.922	3.30	-2.1	0.4 0.52



Time exposure = 30 mn
MN = 98 km/s
AB = 1279 km/s

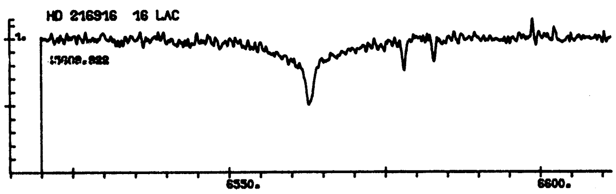


Fig. 18. Hα line profiles for HD 216916 (16 Lac).

days whose primary component pulsates with a period of 0.169166 day according to Fitch (1969). In addition to these radial velocity variations, there are also different photometric periods studied by several authors (Miczaika 1952; Walker 1952; Jarzebowski 1979). The Hα absorption line profile given in Figure 18 shows a thin absorption core superposed to a wide photospheric absorption component.

IV. SUMMARY AND CONCLUSIONS

From our sample of 15 Be and shell stars studied, a double emission peak is clearly seen on 8 early-type and 4 late-type stars; 2 of them are classified as 'pole-on' stars with single and narrow emission line profiles; the other is 'P Cygni' with its characteristic line profile.

We summarize in Table 19 the maximum relative change observed in some of the parameters. We define this relative change as follows:

$$\frac{dx}{\overline{x}} (\%) = |(X_{mx} - X_{mn})/0.5\,(X_{mx} + X_{mn})| \times 100\ (\%)$$

In this table, the blueward and the redward peaks are represented by 1 and 3 respectively and the central absorption is symbolized by 2. Also shown in this table is the time interval where the change has been observed. The table is arranged as follows:

Columns 2 to 11 have the *maximum relative change* of the equivalent width (W), the FWHM, the intensities of the emission and absorption features (I i), the *V/R* ratio, the radial velocity of the emission features (V i), the change between the red and blue peaks (V3 –V1). In column 12, we give the ratio between the blue and the red radial velocity variations. In column 13 the quantity 'dV G' from Tables 2 to 18 and finally in column 14 the 13-color photometric variability as given by Alvarez and Schuster (1981); Schuster and Alvarez (1983), and Schuster and Guichard (1984) where 'V^{++}' means a very variable star with photometric changes larger than 0.15 mag., 'V' a variable star and 'PV' a possible variable star.

As can be seen from column 12, most of these stars show that radial velocity variations are more important on the shortward emission peak, the ratio being variable between 1.5 and 3.1. Hutchings and Walker (1976), have observed this same fact on the Hβ line of X Per. The stars HD 45910 and HD 224559 show the opposite effect. Our sample of variable stars, show that the equivalent width and the intensity of the emission features (columns 2 and 4 to 6) have changes larger than 14 to 20% for most of them. Since the precision from photometric calibrations of these parameters is of the order of 10%, we can be sure of the variability of these quantities. 5 stars (HD 37202, HD 184279, HD 217050, HD 183656 and HD 218393), exhibit ($dW/\overline{W}$) larger than 25% and 3 more stars (HD 24534, HD 200120 and HD 224559) have (dW/W) comprised between 14 and 20%, at the limit of detection. Only HD 45910 shows a relative change smaller than 10%. For the relative intensities ($dI\ 1/\overline{I\ 1}$) and ($dI\ 3/\overline{I\ 3}$), HD 217050 and HD 218393 have obvious intensity variations, while 5 other stars are within the limits of detection.

TABLE 19

MAXIMUM RELATIVE VARIATIONS OF THE EQUIVALENT WIDTH, THE INTENSITIES OF THE EMISSION AND ABSORPTION FEATURES, THE V/R RATIO, THE RADIAL VELOCITY OF THE EMISSION FEATURES, THE CHANGE BETWEEN THE RED AND BLUE PEAKS AND THE FWHM[c]

Star	W (%) (Δt)	FWHM (%) (Δt)	I_1 (%) (Δt)	I_2 (%) (Δt)	I_3 (%) (Δt)	V/R (%) (Δt)	V_1 (%) (Δt)	V_2 (%) (Δt)	V_3 (%) (Δt)	(V_3-V_1) % (Δt)	dV_1/dV_3	dV_G (km/s)	Photometric Variability
HD 24534 X Per	19.9 (8d)	- -	11.1 (5d)	11.2 (5d)	16.8 (8d)	8.09 (8d)	27.8 (12d)	45.8 (5d)	30.8 (4d)	19.7 (9d)	2.95	6.6	V++
HD 37202 ζ Tau	33.2 (6d)	- -	18.5 (4d)	11.8 (6d)	16.2 (4d)	6.0 (0.14h)	17.5 (15d)	188.6[a] (14d)	6.8 (9d)	8.7 (9d)	1.95	30.7	V
HD 45910 AX Mon	8.3 (2d)	8.2 (4d)	3.9 (2d)	6.6 (4d)	14.2 (4d)	11.1 (4d)	0.7 (4d)	7.4 (2d)	12.0 (4d)	3.4 (2d)	0.09[b]	10.3	PV
HD 184279 (I) V 1294 Aql	34.6 (3d)	39.8 (4d)	15.8 (2.6h)	- -	12.6 (2.6h)	8.7 (1d)	20.6 (3d)	17.8 (4d)	21.5 (2d)	17.4 (3d)	2.50	23.4	V++
HD 184279 (II) V 1294 Aql	33.5 (4d)	6.1 (1.6h)	19.3 (4d)	- -	16.4 (4d)	11.4 (2d)	10.3 (3d)	11.2 (1d)	28.9 (3d)	12.0 (3d)	0.95[b]	27.3	V++
HD 200120 57 Cyg	19.0 (1d)	10.7 (15d)	5.3 (1d)	4.3 (15d)	4.6 (14d)	4.6 (15d)	24.2 (9d)	99.0 (12d)	13.1 (1d)	2.0 (7d)	3.08	22.4	V++
HD 217050 EW Lac	69.3 (2d)	14.0 (8d)	58.2 (2d)	27.3 (14d)	63.6 (8d)	14.0 (1d)	17.9 (6d)	11.2 (2d)	11.2 (4d)	12.6 (6d)	2.24	26.8	V++
HD 224559 LQ And	15.2 (4d)	- -	9.5 (2d)	7.4 (4.0h)	8.3 (1d)	3.8 (2d)	15.0 (2d)	154.3[a] (9d)	28.9 (2d)	12.9 (3d)	0.56[b]	17.3	PV
HD 183656 V 923 Aql	27.2 (9d)	10.2 (9d)	3.1 (8d)	20.2 (8d)	6.9 (8d)	9.8 (8d)	3.4 (9d)	256.5[a] (9d)	2.1 (1d)	2.6 (9d)	1.89	18.4	-
HD 218393 KX And	24.9 (8d)	66.4 (8d)	38.7 (15d)	59.9 (15d)	33.4 (8d)	51.6 (14d)	18.8 (15d)	11.5 (16d)	56.1 (14d)	23.8 (15d)	1.66	46.9	V++

$$X\,(\%) \equiv \mathrm{abs}\left[\frac{X_{MX} - X_{MN}}{\frac{1}{2}(X_{MX} + X_{MN})}\right] \times 100\ (\%)$$

a HD 37202 V_2 changed from +17.1 km/s to +0.5 km/s in 14 days of observations.
HD 224559 V_2 changed from - 1.2 km/s to -9.3 km/s in 9 days of observations.
HD 183656 V_2 changed from - 9.7 km/s to +1.2 km/s in 9 days of observations.

b HD 45910, HD 184279 (II period) and HD 224559 showed the longward feature more variable than the shortward peak as opposed to the other objects studied in this work.

c Also in this table is the ratio between the blue and red radial velocity variation, the change of the centre of gravity radial velocity, and the 13-color photometric variability criteria.

Since the precision obtained from FWHM is about 8 to 10 km s^{-1} and 2.2 km s^{-1} for the radial velocity variations (dV i), we can see from columns 7 to 11 of Table 19 and from Tables 2 to 18, that only for HD 45910 and HD 183656 it is difficult to detect their variable behaviour. Several of the stars may show short term and hopefully periodic variability, but in order to fully comprehend the physical mechanisms responsible for its behaviour, simultaneous photometric and spectroscopic observations are necessary.

From Tables 2 to 18, we can see that only HD 217050, HD 183656 and HD 218393 have *V*/*R* variations larger than 0.10, showing important unrelated intensity variations between blue and red emission features. All Be stars of our sample have important radial velocity variations of centre of gravity: the most pronounced are HD 37202 and HD 218393, two spectroscopic binary Be stars.

Figure 19 displays FWHM versus v sin i for 13 Be and shell stars of our sample. These stars follow approximately a linear relation as has been established by Slettebak (1976) for the Hβ line, Slettebak and Reynolds (1978); Dachs *et al.* (1981), and Dachs *et al.* (1986) for the Hα line. Two stars are well off the mean linear relationship: HD 174638 (γ Lyr) and HD 45910 (AX Mon), but these stars are known as binary systems.

Figure 20 displays the averaged total half-width of the Hα line (AB/2) versus v sin i for 13 Be and shell stars of our sample. There is no clear relationship in this figure. Doazan (1970) has found no correlation between the total width of the emission line and v sin i as shown also in our sample.

In conclusion, we can confirm that for our sample of Be stars, large variations are observed over a time scale of about 10 to 20 days on Hα line profiles. The present ATLAS of the Hα line adds useful information to that obtained and accumulated by several authors. Also, it points out several important problems that must be studied in a cooperative way using different techniques and not only by isolated investigations. Finally, we think that our observations can be useful to study the models of emitting shells surrounding Be stars, whose constant movements are reflected in spectroscopic changes. In the

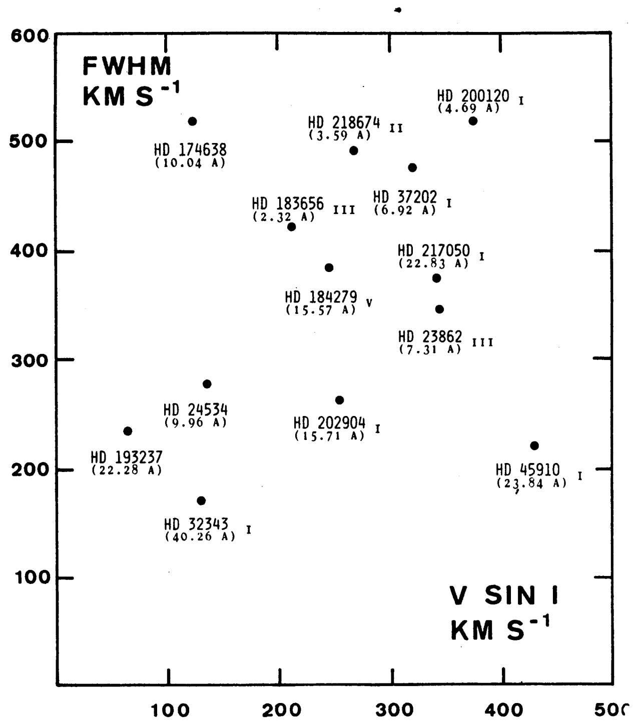


Fig. 19. Full width at half maximum for 13 stars of our sample, versus 'v sin i'. Averaged equivalent width for the whole spectra and Jaschek *et al.* group (1980), are given near the HD number.

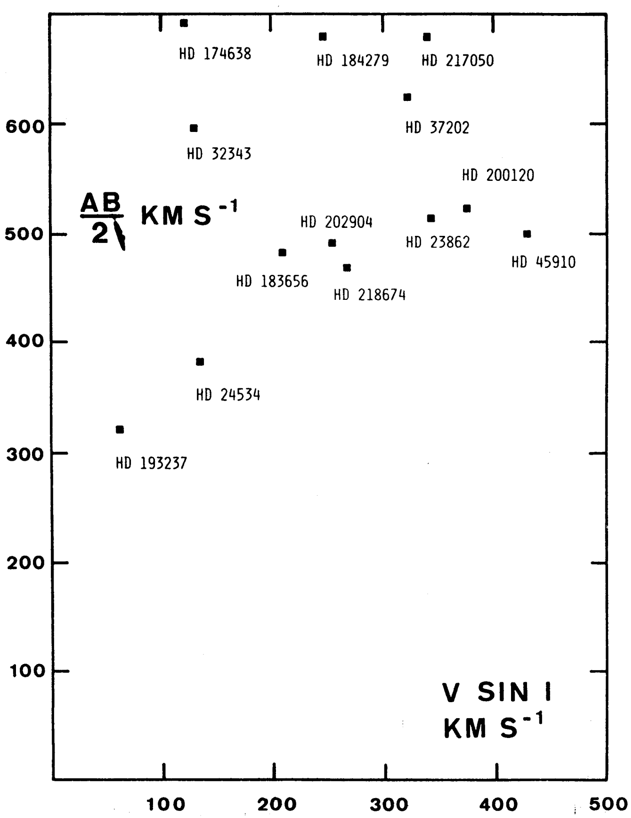


Fig. 20. Averaged half-width of emission for 13 stars of our sample versus 'v sin i'.

future, the Meudon Observatory Group and Institute of Astronomy of México staff working on Be and shell stars will continue their cooperative project to study these interesting objects both photometrically and spectroscopically.

This work has been supported by Centre National de la Recherche Scientifique (CNRS), Direction des Relations et de la Cooperation International (France) and Consejo Nacional de Ciencia y Tecnología (CONACYT), Dirección Adjunta de Relaciones Internacionales (México) under the program CONACYT-CNRS 140106G202-160 on the study of the variability of B and Be stars. Bibliographic search has been performed by using computed data set SIMBAD (Set of Identification, Measurements and Bibliography for Astronomical Data) from the Centre de Donnees Stellaires of Strasbourg, France. We want to thank the staff of the Observatorio Astronómico Nacional, where the observations where gathered and the staff of the Computing Center of the Centro de Investigación Científica y Educación Superior de Ensenada (CICESE), for its continuous support.

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