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Optical and near-IR observations of variable stars with *AURELIE*⋆

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Abstract. We report high and intermediate resolution spectroscopic observations of many emission line stars mainly observed with *Aurélie* at the 1.52 m OHP telescope in December 1990 and January 1995, with special attention to the Hα and 1 μm regions. The near–IR observations of the Be star γ Cas disclosed the presence of a very strong fluorescence Fe II 1.00 μm emission, with intensity and profile similar to that of Pδ. Both have varied between 1990 and 1995. The Fe II 1.00 μm line is also weakly present in emission in β Ori, and in the 1990 and 1995 spectra of the VV Cep star KQ Pup. The high resolution 1995 observations of the yellow hypergiant HR 8752 disclosed a broad [N II] emission, and Hα with multiple components. The slow approaching of the KQ Pup system to periastron is marked by the large strengthening of the Hα emission between 1984 and 1995. Strong variation in Hα intensity was also found in the yellow symbiotic star AG Dra observed in quiescence and during its recent active phase. The red symbiotic star CH Cyg was especially interesting for the large profile variation of the Balmer lines on a daily time scale in January 1995. We detected expansion velocities of up to 2000 km s^{-1}. In December 1990 the yellow spectrum of CH Cyg displayed a broad He I 587 nm absorption, which turned to strong emission in 1995. We also report observations of π Aqr, R Aqr, EZ CMa, β CMi, and HD 200775.

Key words: line: profiles — binaries: symbiotic — stars: emission-line, Be

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⋆ Based on observations collected at the Observatoire de Haute Provence, and at the European Southern Observatory, La Silla, Chile.

1. Introduction

The high resolution spectroscopy is a fundamental tool for the study of the structure, geometry and velocity fields of the external atmospheric envelopes of stellar systems. In the framework of many observing programmes we have collected high resolution spectra of many emission line objects belonging to different stellar categories, and some results have beeen published on particular stars and projects (e.g. Rossi et al. 1988; Rossi et al. 1991; Altamore et al. 1992; Muratorio et al. 1992; Viotti et al. 1992, 1994), but the quantity of information that can be extracted from a single spectrum is often much wider than that used for a given project. For this reason we reanalysed from a different point of view some old spectra of ours, to which new ones have been added.

In this paper we present the results of the study of the profiles of particular lines of some emission line stars, which can be considered as interesting members of different stellar categories: EZ CMa (WN5), γ Cas (B0IVe), HD 200775 (Herbig Be), HR 8752 (G0Ia$^+$), AG Dra and CH Cyg (symbiotic stars), KQ Pup (VV Cep–type variable), and R Aqr (Mira–type symbiotic star).

The observations were collected in December 1990 and January 1995 within a project of a high resolution study of peculiar, emission line stars developed with the *Aurélie* spectrograph of the 1.52 m telescope of the Observatoire de Haute Provence (OHP), with special attention to the Balmer and He I lines, and to the 1 μm region which includes the peculiar Fe II 1.00 μm line. The 1990 observations of AG Dra, CH Cyg and R Aqr were also made within the RIASS campaign of coordinated ROSAT and IUE observations of symbiotic stars (Viotti et al. 1994).

As for comparison we collected the spectra of a few additional objects: π Aqr (B1Vpe), β CMi (B8Ve), β Ori (B8Ia), γ UMa (A0V), α Boo (K2IIIp), α Tau (K5III),

ζ Aur (K4Ib-II), VV Cep (M2Ia), α Ori (M2Iab), and μ Cep (M2Ia), some of which are shown in this paper. For long term monitored stars we compare the *Aurélie* observations with previous high resolution spectrograms obtained at ESO CAT–CES.

All the reduced spectrograms and their list are available on request to CR or RV.

2. Observations and data analysis

The target stars were observed with the *Aurélie* spectrograph attached to the Coudé focus of the *OHP* 1.52 m telescope. The receiver was a Thomson TH 7852 *double barette* photocell. The description and performance of the instrument are given in Gillet et al. (1994). A variety of gratings were used in order to obtain high ($R = 5-6\ 10^4$), and intermediate resolution ($R = 5 - 21\ 10^3$) spectra.

In December 1990 we did not observe spectroscopic standard stars because of the unfavourable weather conditions, the spectra have been only corrected for the flat field and atmospheric extinction. In the January 1995 observations we used ζ^2 Cet and 109 Vir for the spectrophotometric calibration; for the derived stellar fluxes we estimate an accuracy of about $\pm 20\%$.

In the high resolution spectra we checked the wavelength calibration by measuring the position of the telluric lines. These were particularly useful to improve the precision in near–infrared region (NIR, 994 – 1014 nm), where the comparison spectrum has very few lines. A typical error $0.5 - 1$ km s^{-1}, was finally obtained for the high resolution, while for the intermediate resolution spectra the accuracy is $5 - 7$ km s^{-1}.

For the present work we paid attention only to hydrogen, helium, and to a few other lines which appeared to be of particular interest for displaying a peculiar variability. The tracings are shown in Figs. 1 to 3, where the wavelengths are normalized to the stellar HRV. The results of the measurements are reported in Table 1 where we give the spectral resolution ($\lambda/\Delta\lambda$), the equivalent width (in nm), the width (in km s^{-1}) and the heliocentric radial velocity (HRV, in km s^{-1}) of the emission and absorption features (e, a). The uncertainty in the equivalent widths, essentially due to the choice of the continuum level, is not larger than 5%. The HRV refer to the line emission peak (or absorption minimum), unless specified in the notes. The two exposures of February 1984 were obtained at the ESO CAT-CES.

3. The WN star EZ CMa

We have obtained a high resolution red spectrum of the WN5 star EZ CMa (HD 50896) in the framework of a campaign of multiwavelength monitoring of a number of hot massive stars in the optical and ultraviolet (MEGA, cf. St–Louis et al. 1995). The spectrum was collected at phase 0.557 of the 3.766 day periodicity of the star (Lamontagne et al. 1986). The strong 656 nm He II feature (Fig. 1) is more extended than the instrumental spectral range (about ± 1600 km s^{-1}), so that we could only give a lower limit of the equivalent width. The emission presents a flat maximum and, on the red side, an emission hump at 658.06 nm.

4. B emission stars

4.1. γ Cas

γ Cas (B0IVe) is the best known and most studied member of the Be star category. In December 1990 we obtained the first high resolution spectrum ever made in the range 994 – 1015 nm (Fig. 2). Three emissions are clearly present: Fe II λ999.757, P δ λ1004.938, and a broad shallow emission for which the only identification we found is N I 1011.34 nm. Other emission or absorption features, such as the photospheric Pδ and He I absorption lines can also be present, but are difficult to identify. As noted by Viotti et al. (1992) the high excitation Fe II line and Pδ display broad and strong emissions with similar strengths and profiles. The NIR spectrum of γ Cas was observed again in January 1995 with the same instrumental set up to look for spectral variability. In fact variations were detected in shape, intensity and radial velocity, as can be seen in the figure and in Table 1. In January 1995 we also observed the Hα region. This line was present as a very prominent emission with a profile very different from that of Pδ, with only one maximum and three emission humps (Fig. 1).

4.2. π Aqr

The red spectrum of the B1Ve star π Aqr obtained in December 1990 as a comparison star shows Hα very strong in emission, split into two peaks by a central absorption (Fig. 1). The He I 667.81 nm line has a more complex profile with a broad emission and a wide central absorption which is attributed to the rotationally broadened photospheric absorption line. We have fitted the profile with two Gaussians describing the broad emission component, and the photospheric absorption (see Fig. 3a).

4.3. HD 200775

The intermediate resolution blue spectrum of this classical Herbig Be star was taken in the framework of the Fe II Project. In the observed range the most remarkable feature is that of Hβ which shows the Stark–broadened absorption with a strong emission superimposed, which is split into two emission peaks ($V > R$) by a deep and narrow central absorption (Beals' *Type VI* P Cygni profile, Beals 1951) (Fig. 3). Many Si II, [Fe II] and Fe II emissions are also present in the spectrum; He I and Si III lines are all in absorption.

Table 1. Observing log and data for the main lines

star	date	range[1]	resolution	line	$W_{\rm eq}$[2]	width[3]	e/a	HRV	notes
EZ CMa	1995 Jan. 15.94	653−660	60000	He II 656	640::		e	+29	4
γ Cas	1990 Dec. 27	996−1014	50000	Fe II 999	14.4	580z	e	−127, +134	
				Pδ	20.3	450z	e	−78, +106	
				N I 1011	4.9:		e	−34	10
	1995 Jan. 13	996−1014	50000	Fe II 999	20.9	580z	e	−125, +103	
				Pδ	27.1	530z	e	−87, +89	
				N I 1011	3.2		e	0	10
	1995 Jan. 13	653−660	60000	Hα	326.8		e	+52	
							e	−95,−15,+123	5
π Aqr	1990 Dec. 27	653−673	21000	Hα	179.3	750z	e	−79, +154	
							a	+49:	
				He I 667	20	500h	e	+48	
					15	323h	a	+53	
HD 200775	1995 Jan. 15	445−491	10000	Hβ			e	−67, +125	
							a	+26	
β CMi	1990 Dec. 27	996−1014	50000	Pδ			a	+106	
β Ori	1984 Feb. 4	653−660	50000	Hα	3.0	77h	e	+110	6, ESO
					5.7	144h	a	+27	7
				C I 657.8	2.2		a	+61	
				C I 658.3	1.6		a	+61	
	1990 Dec. 28	996−1014	50000	Fe II 999	0.8	54h	e	+29	
				Pδ	24		a	+30	
HR 8752	1995 Jan. 13	653−660	60000	Hα			e	−219, −83	
							e	−16, +29	
							e	−137	5
							a	−181,−69,+8	
				[N II] 654.8	1.3:		e	−48:	4, 10
				[N II] 658.4	3.4	110z	e	−49	4, 10
AG Dra	1990 Dec. 27	653−673	21000	Hα			e	−260	5
					191.4	810z	e	−147	10
							e	−108	
				He I 667	6.0		e	−148	
	1995 Jan. 16	653−660	60000	Hα			e	−201	5
					1085.0	1600z	e	−152	10
							e	−115	
R Aqr	1990 Dec. 27	653−673	21000	Hα	4.0		e	+44	

4.4. β CMi

This B8Ve star (HD 58715) has been observed at high resolution in the NIR. The spectrum which is underexposed because of the bad weather conditions, shows a broad photospheric Pδ with a central reversal, which in turn is split into two by a central absorption. This last is redshifted with respect to the stellar radial velocity of +22 km s^{-1} given in the literature. In Fig. 2 the NIR spectrum of β CMi is compared with that of the A0V star γ UMa taken on the same night.

4.5. β Ori

The NIR spectrum of the B8 supergiant β Ori (B8Ia) is shown in Fig. 2. Besides the photospheric absorption lines the spectrum displays a narrow emission at 999.861 nm which is attributed to the high excitation Fe II 999.757 nm line. The width of this line suggests its formation near

Table 1. continued

star	date	range[1]	resolution	line	W_{eq}[2]	width[3]	e/a	HRV	notes
CH Cyg	1990 Dec. 28	585–594	50000	He I 587	1.0:		a	−10:	10
	1995 Jan. 14	570–657	5000	He I 587	47		e	−62	
				Na D			e	−10	6
							a	−90	7
				M star			a	−50	9
	1995 Jan. 14.2	570–657	5000	Hα			a	−900, −570	7
	1995 Jan. 16.2	653–660	60000	Hα	205.1		e	−94, −19	
							e	−204	5
							a	−860, −600	7
				[N II] 658	8.6		e	−82	
	1995 Jan. 14.8	445–491	10000	Hβ			e	−145,−98,−7	
							a	−70	
							e	−406	5
							a	−1100,−540	7
	1995 Jan. 15.8	445–491	10000	Hβ			e	−98, −10	
							a	−63	
							e	−206	5
							a	−600	7
	1995 Jan. 11.8	405–450	7000	Hγ			e	−126, −15	
							e	−290, −200	5
							a	−70	
							a	−520	7
	1995 Jan. 12.2	405–450	7000	Hγ			e	−120, −19	
							e	−290, −210	5
							a	−70,	
							a	−510	7
	1995 Jan. 15.2	405–450	7000	Hγ			e	−154, −16	
							e	−287	5
							a	−70,	
							a	−600	7
	1995 Jan. 11.8	405–450	7000	Hδ			e	−245,−126,−10	
							a	−70,	
							a	−510	7
	1995 Jan. 12.2	405–450	7000	Hδ			e	−15	
							e	−230, −127	5
							a	−480	7
	1995 Jan. 15.2	405–450	7000	Hδ			e	−150, −10	
							a	−70,	
							a	−740, −430	4, 7
KQ Pup	1984 Feb. 3	653–660	50000	Hα	25.4 [8]		e	−16, +59	ESO
							a	+14	
				M star			a	+39	9
	1990 Dec. 28	996–1014	50000	Fe II 999	0.68	15h	e	+25	10
				M star			a	+34	9
	1995 Jan. 16	996–1014	50000	Fe II 999	0.62	15h	e	+18	10
				M star			a	+23	9
		653–660	60000	Hα	107.8 [8]		e	−32, +48	
							a	+19	
				M star			a	+24	9

[1] Spectral range in nm.
[2] Equivalent width in 10^{-2} nm.
[3] h: FWHM of gaussian fit, z: FWZI, in km s^{-1}.
[4] Broad, flat−topped line.
[5] Hump in the line profile.
[6] Emission component of P Cygni profile.
[7] Absorption component of P Cygni profile.
[8] Integrated over the whole profile.
[9] Mean HRV of the M-star absorptions.
[10] line barycentre.

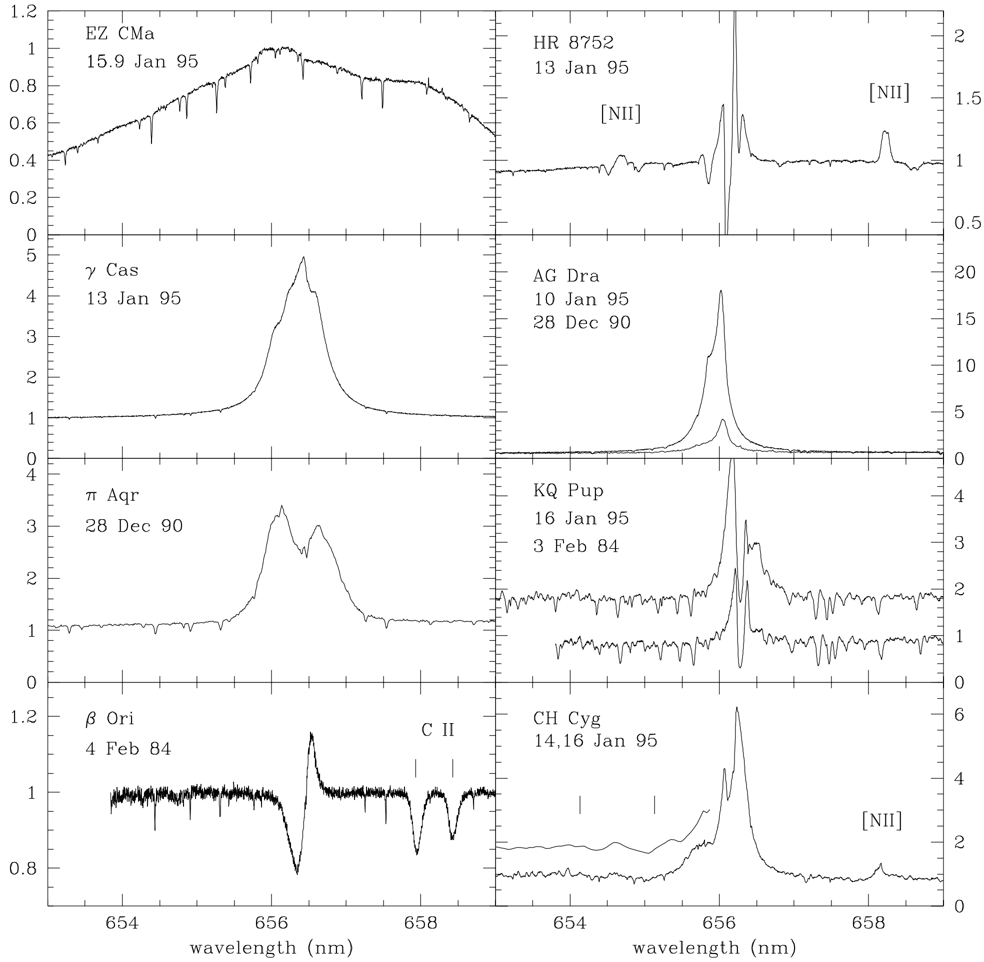

Fig. 1. High resolution observations of the Hα region. All the spectra but EZ CMa are normalised to the continuum. The narrowest absorptions are telluric lines. The spectrum of AG Dra is shown during quiescence (December 1990) and in outburst (January 1995). For CH Cyg the lower resolution observation is cut at the beginning of the emission due to saturation. The vertical bars mark a velocity shift of −500 and −1000 km s^{-1} with respect to H_α

the photosphere, probably by fluorescence excitation of the chromospheric Lyα. The radial velocity is close to the radial velocity of the photospheric Pδ line.

The Hα spectral region of this star was previously observed at ESO with CAT–CES (Fig. 1). At that time Hα displayed a P Cygni profile that we fitted with two–Gaussian components. Note that the radial velocity of the absorption component is in agrement with the above value of 1990 Pδ absorption. The two absorptions of C I (2) appear asymmetric, with the red wings more extended than the blue ones.

5. The superluminous star HR 8752

The red high resolution spectrum of HR 8752 was taken on request of the late Professor Jan Smolinski. HR 8752 (HD 217476, G0Ia$^+$) is the most luminous star of intermediate spectral type in our Galaxy. The star is known for several peculiarities, such as the intense radio emission, and the presence of the red [N II] emission lines, and of Hα emission with complex and variable profile (e.g. Smolinski et al. 1994; Sheffer & Lambert 1992). The spectrum plotted in Fig. 1 shows two broad flat–topped emissions of the red [N II] doublet. The edges of the 654.8 nm line are blended with photospheric absorptions making the measurements uncertain. The $W_{\rm eq}$ of the 658.4 nm is larger than expected from the extrapolation of the long term behaviour during 1976 − 1992 found by Sheffer & Lambert (1992).

The profile of Hα is similar to that of October 1992 (Smolinski et al. 1994, "type A" profile according to their designation), with four emission maxima separated by three narrow absorptions.

6. Symbiotic stars

6.1. *AG Dra*

AG Dra (BD +67° 922) is a yellow symbiotic star which during the last 16 years underwent many different phases of activity, characterized by a luminosity increase of $1-2^{\rm m}$ in the visual, and by dramatic spectroscopic variation.

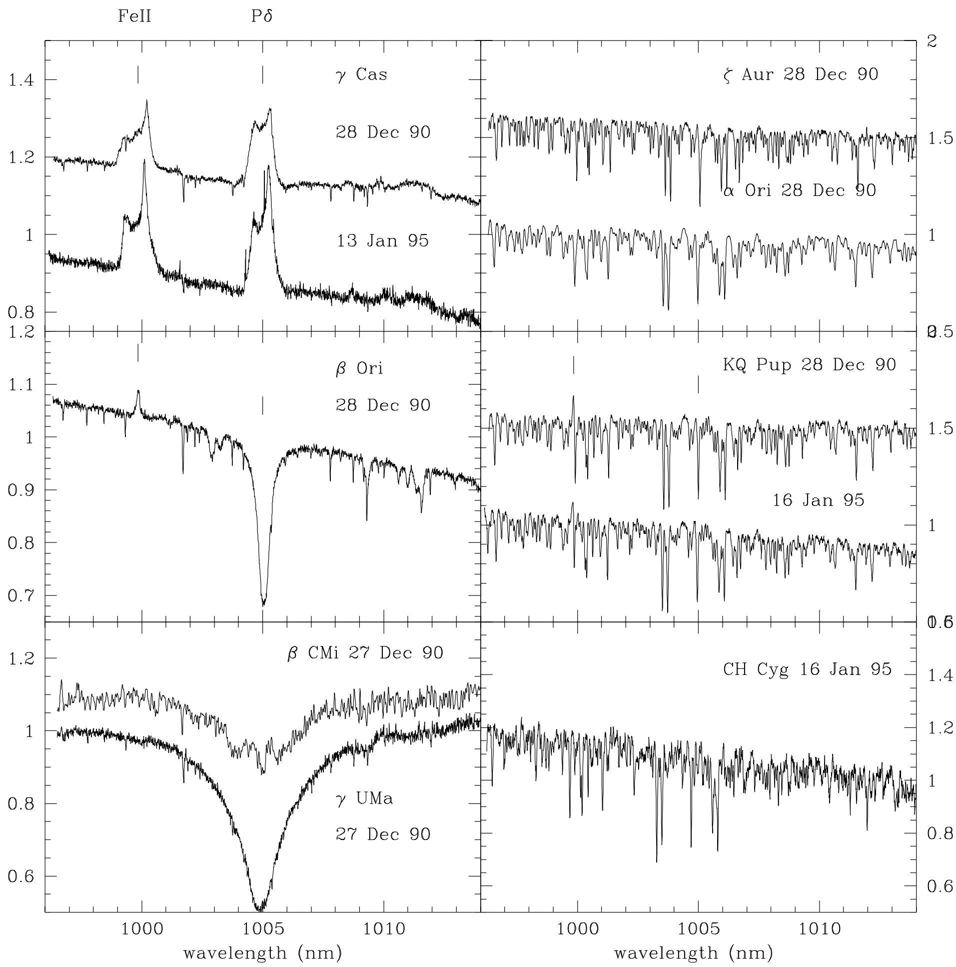

Fig. 2. *Aurélie* high resolution observations of the near infrared spectrum of different stars. The narrowest absorptions in γ Cas and β Ori are telluric lines. The laboratory wavelengths of Fe II 1.00 μm and Pδ is marked. The files are corrected for flat field and atmospheric extinction. γ UMa and β CMi are normalised to the continuum. In the different panels a vertical offset has been applied to the upper spectrogram

The December 1990 observation was made in the framework of the campaign of coordinated IUE and ROSAT observations of symbiotic stars, when the star was in quiescence ($V = 10.0$, Mattei 1996). The ROSAT PSPC observations indicate that AG Dra was in a high X–ray state, while the ultraviolet UV spectrum was at minimum (Viotti et al. 1994; Greiner et al. 1997). Our observation was made at spectroscopic phase 7.88 of the U-light curve according to Mikolajewska et al. (1995) ephemeris (Fig. 1). The only emissions present in the observed spectral region are Hα and the He I 667.8 line. The first appear asymmetric, with extended wings. The emission peak is red shifted, while the line barycentre at 0.1 $I_{\max}$, like also the He I 667.8 line, has the same velocity as the K–star absorptions.

Subsequently, we observed AG Dra with lower resolution at Loiano in May 1992. The star was still in quiescence, though slightly brighter than during the previous observing run ($V = 9.8$). Hα appeared stronger than in December 1990 with an indication of a double peak structure. In the NIR AG Dra displayed two emission lines of He II 1012.3 nm and of He I 1083.0 nm, and much weaker Pδ (Viotti et al. 1994).

In January 1995 AG Dra was observed during the recent outburst phase when it was declining ($V = 9.6$) after the first light maximum, and before the secondary light maximum of July 1995. The U–light curve phase was 10.56. We found Hα emission much stronger than the previous observation, but with the same shift as before with respect to the K spectrum. ROSAT observations indicate that at this epoch the star has nearly recovered its pre–outburst X–ray flux, after the remarkable flux decrease during the optical maximum (Greiner et al. 1997).

6.2. *R Aqr*

The yellow and red spectra of the symbiotic, Mira–type variable R Aqr (HD 222800) were obtained during the

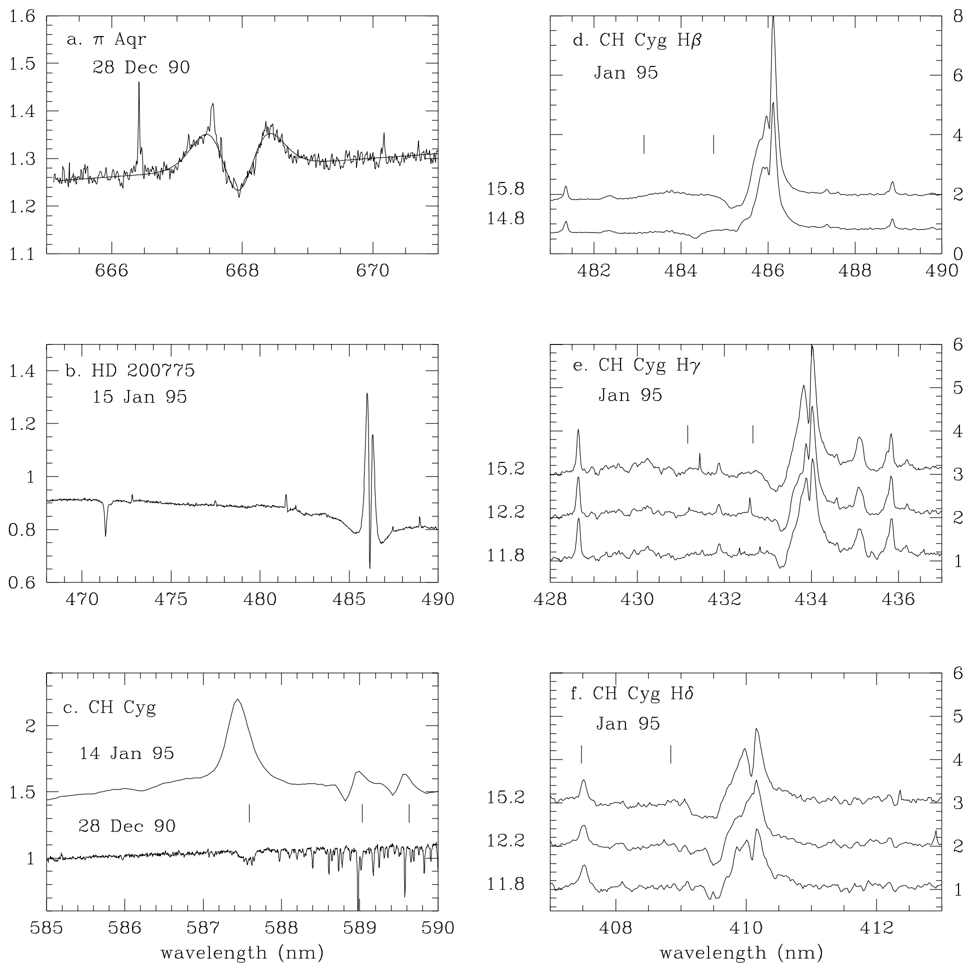

Fig. 3. a) the He I 667.8 nm line in π Aqr. The smooth line is the fit with a two–Gaussian (emission plus absorption) profile. **b)** The blue spectrum of HD 200775. The weak narrow emissions are all Fe^{+} lines. **c)** The He I 587.6nm region in CH Cyg. In the lower plot the high resolution spectrum is largely affected by the telluric lines. The laboratory wavelength of the He I and Na I lines is marked. **d-f)** Profile variation of Hβ, Hγ and Hδ in CH Cyg in January 1995. Note the large variation of the blue wings of Hβ down to ~ -2000 km s^{-1} from the line centre, while the other spectral lines did not show any change. The vertical bars mark a velocity shift of -1000 and -2000 km s^{-1} with respect to the Balmer lines

ROSAT–IUE campaign. The yellow region only shows a great deal of very narrow molecular absorptions of the M star, and a deep and broad Na I D–doublet (see Viotti et al. 1994). In the red spectrum Hα is present as a narrow emission whose intensity and radial velocity are strongly affected by the TiO band. The value of the equivalent width shown in Table 1, refers to the continuum level on the blue side. No other emissions are detectable in this spectrum.

6.3. CH Cyg

CH Cyg (HD 182917) is a late–type symbiotic star (M–type primary) especially known for the recent large photometric variation (from the sixth to the ninth magnitude, e.g. Skopal et al. 1996), and the radio jets. In 1990 ROSAT observations made within the above cited RIASS campaign indicated CH Cyg as a weak X–ray source (about 0.084 count s^{-1}, Viotti et al. 1994). In addition, the IUE ultraviolet spectrum taken on 1990 October 27, was rather faint, and the energy distribution fitted rather well that of the standard A0I star α Cyg, supporting the hypothesis of the presence of a warm photospheric–like (or shell–type) cocoon envelope.

The high resolution spectrum in the NaD region shown in Fig. 3, was obtained two months later, when the star had nearly the same visual luminosity ($V =\sim 8.4$, Tomov & Yudin 1992). It is noticeable the absence of the molecular absorption lines of the M–stellar component, which normally dominate this spectral region. The only detectable stellar feature is a broad absorption which we attribute to He I 587.56 nm whose profile is strongly contaminated by telluric lines. In May 1992 the He I 587.56 nm line was strong in emission and the M–type absorption spectrum was prominent (Viotti et al. 1994).

We observed again CH Cyg in January 1995 when the star was subject to large photometric variability especially in the Balmer continuum ($V = 8.3 - 8.9$, $U = 8.1 - 10.0$, Skopal et al. 1996). Skopal et al. noted variations in the Hα and Hβ profiles between spectrograms taken from many days to a few months apart. Deep changes of the profile of Hβ and He I λ447.1 were also observed by Iijima (1995) between 1995 February 28.1 and March 1.2. Our spectra show narrow emission lines of ionized metals overimposed to a strong M spectrum and reveal profile variations in the hydrogen and helium lines, on daily and shorter time scale. Figure 3 shows the Hβ, Hγ and Hδ regions. The Balmer lines have complex P Cygni profiles with prominent emissions split in two by a central minimum whose position remained stable with the same HRV for all the lines in all the exposures. The intensity and position of the red peak of the emission component showed minor variation. Major changes occurred on the blue side where the extended absorptions largely varied from one exposure to another. The Hα region is shown in Fig. 1. In the intermediate resolution spectrum, which ends at 657.5 nm, the emission peak resulted saturated, but the velocities of the absorption components are very close to those of the other Balmer lines. The same agreement has been found in the high resolution spectrum. In the same exposure, on the red side of Hα is present a small emission which we tentatively attribute to [N II] λ658.4.

In the yellow region, He I λ587.6 is strong in emission like in 1992, and the Na I resonance lines have a P Cygni profile (see Fig. 3). Profile variation similar to those of the hydrogen lines were also noted in the He I lines, but the quantitative measurement is difficult because of the blending with other lines. Contrary to the hydrogen and helium lines, the other emissions remained unchanged in all the exposures in intensity and position with a mean HRV of -70 km s^{-1}.

The NIR high resolution spectrum shows only a great deal of photospheric absorption lines of the M–star. In spite of the high S/N ratio and spectral resolution, no emission is detectable at the expected position of the main symbiotic features. Anyhow, it might be possible that these features are lost because they are too broad and shallow to be detected at our resolution (Fig. 2).

7. The VV Cep star KQ Pup

KQ Pup (HD 60414) is a well known long period spectroscopic binary of the VV Cephei type with a M1–2Iab primary and a B0V companion.

We observed the NIR of KQ Pup at high resolution in December 1990 and in January 1995, when the orbital phase Φ of the system was 0.69 and 0.84, respectively. Both spectra, reproduced in Fig. 2, present a rich M–type absorption spectrum and the fluorescence Fe II 1.00 μm line in emission. The photospheric lines are narrower than in the similar spectral type star α Ori suggesting a larger surface macroturbulence for the latter. The measurement of the Fe II emission is difficult because of the line crowding. In order to overcome this effect we used the spectrum of the K4–supergiant ζ Aur taken with the same instrumental setup, which appears similar in line depth and especially width to that of KQ Pup. After having scaled all the spectra to the same velocity and normalized them to the continuum, we subtracted ζ Aur to KQ Puppis.

The Fe II 1.00 μm dereddened line fluxes in the two epochs are of 8.0 and 7.5 10^{-12} erg cm^{-2} s^{-1}, respectively. These values are about three times larger with respect to the theoretical flux of 2.5 10^{-12} erg cm^{-2} s^{-1}, computed according to the Self–Absortion–Curve analysis of the Fe II lines in the 1979 UV spectrum of KQ Pup made by Muratorio et al. (1992). This difference should be accounted for by the anomalous strength of the high excitation Fe II emission lines as noted by Muratorio et al. (1992). It might also be at least partly due to the gradual increase of the line emission when the KQ Pup system is approaching the periastron (Cowley 1965).

The HRV of the M–component was in both epochs in good agreement with the velocity curve reproduced by Cowley (1965). On the other hand, the behaviour of the Fe II 1.00 μm line was similar to that observed in the Fe II emission lines during 1969–1983, i.e. radial velocity systematically more negative than that of the M–star, and smaller amplitude of the radial velocity curve (Rossi et al. 1992).

In 1995 we obtained a high resolution spectrum in the Hα region, which is plotted in Fig. 1 normalised to the continuum and compared with that one of the same resolution taken in 1984 with the ESO CAT–CES ($\Phi = 0.43$). While the M spectrum shows no change, the Hα profile largely varied between the two epochs with an increase of the emission intensity and a shift of the relative positions with respect to the M–spectrum. This last effect is probably due to the strong redshift of the absorption core. In the red wing of the emission a plateau extends to $+148$ km s^{-1} in 1984 and to $+132$ km s^{-1} in 1995; the difference in velocity is the same as for the M spectrum, confirming the hypothesis discussed by Rossi et al. (1992), that the plateau should be attributed to the stellar TiO γ(0,1) band absorption at 656.4 nm. In January 1995 we have also obtained intermediate resolution blue spectra which we compared with the Coudé spectrograms (with nearly the same resolution) described in the Atlas of Altamore et al. (1992). The Balmer lines are weaker than in December 1969 ($\Phi = 0.90$), very similar in shape and strength to those of March 1979 ($\Phi = 0.24$). and stronger than in February 1983 ($\Phi = 0.39$). Similar behaviour was displayed by the other emission lines. The picture arising from these observations, which span almost an entire cycle of the orbital motion, indicates that the emission spectrum of the KQ Pup system faded after the last periastron passage (1972), and now, as the next pariastron passage (1999) is approaching, it is brightening again.

8. Concluding remarks

The emission line stars are peculiar objects subject to photometric and spectroscopic variations. From the spectroscopic point of view this behaviour does not allow a rigorous classification of the line intensity and shape of a given object, on the basis of its belonging to a particular category. In spite of this, or rather because of this problem, any extensive description of the phenomenology of individual stars is important in helping the interpretation of the physical reasons of the observed behaviour, and for understanding the nature of the objects. This is particularly true for the still poorly investigated near–infrared region, which can now rather easily be observed with the currently used spectrographs and detectors with good resolution and S/N. As discussed here and in previous articles (e.g. Baratta et al. 1991; Altamore et al. 1992; Viotti et al. 1992; López et al. 1992) the region around 1 μm includes important transitions of hydrogen, neutral and ionized helium, and permitted and forbidden ionized iron which can be used for the diagnostics of the geometry and physical conditions in the circumstellar envelopes of mass losing stars and interactive binaries. Of particular interest is the Fe II 1.00 μm line arising from a level near the ionization limit, which might be populated by dielectronic recombination or by fluorescence. In many early–type emission line stars this line is in fact very intense, with a strength frequently comparable to that of the nearby Pδ (e.g. López et al. 1992). Also the similarity of the profiles of the two lines in many targets such as the classical Be star γ Cas studied here, suggests that the Fe II line should be formed in the same region, and can therefore be used to trace the stellar H II envelope, with the advantage of being optically thin and not affected by the photospheric absorption as in the case of the nearby hydrogen line.

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References

Altamore A., Rossi C., Viotti R., Baratta G.B., 1992, A&AS 92, 685
Baratta G.B., Damineli Neto A., Rossi C., Viotti R., 1991, A&A 251, 75
Beals C.S., 1951, Publ. Domin. Astrophys. Obs. IX, No. 1, p. 1
Cowley A.P., 1965, ApJ 142, 299
Gillet D., Burnage R., Kohler D., et al., 1994, A&AS 108, 181
Greiner J., Bickert K., Luthard R., et al., 1997, A&A 322, 576
Iijima T., 1995, IAU Circular 6146
Lamontagne R., Moffat A.F.J., Lamarre A., 1986, AJ 91, 925
López J.A., Damineli Neto A., de Freitas Pacheco J.A., 1992, A&A 261, 482
Mattei J.A., 1996 (private communication)
Mikolajewska J., Kenyon S.J., Mikolajewski M., et al., 1995, AJ 109, 1289
Muratorio G., Viotti R., Friedjung M., Baratta G.B., Rossi C., 1992, A&A 258, 423
Rossi C., Altamore A., Ferrari-Toniolo M., et al., 1988, A&A 206, 279
Rossi C., Viotti R., Muratorio G., 1991, La Lettre de l'OHP 6, 1
Rossi C., Altamore A., Baratta G.B., et al., 1992, A&A 256, 133
Sheffer Y., Lambert D.C., 1992, PASP 104, 1054
Skopal A., Bode E.F., Bryce M., et al., 1996, MNRAS 282, 327
Smoliński J., Climenhaga J.L., Huang Y., et al., 1994, Space Sci. Rev. 66, 231
St-Louis N., Dalton M.J., Marchenko S.V., et al., 1995, ApJ 452, L57
Tomov O.G., Yudin B.F., 1992, A&A 257, 615
Viotti R., Altamore A., Ferrari-Toniolo M., et al., 1986, A&A 159, 76
Viotti R., Altamore A., Rossi C., et al., 1992, ESO Conference Workshop Proceedings No. 40 High Resolution Spectroscopy with the VLT, Ulrich M.-H. (ed.), p. 183-186
Viotti R., Cardini D., Emanuele A., et al., 1994, Mem SAIt 65, 147