

## VARIABILITY OF SOME Be STARS ON HIGH-RESOLUTION, HIGH S/N SPECTRA

A.M. Hubert, H. Hubert, B. Dagostinoz AND M. Floquet  
DASGAL et UA 337  
Observatoire de Paris, Section d'Astrophysique de Meudon  
F-92195, Meudon Cedex, France

**ABSTRACT.** Rapid variability in Be stars could be understood by non radial pulsations or by rotation of an inhomogeneous surface brightness distribution...

The structure and the variability of the H $\alpha$  and of the HeI  $\lambda$ 6678 lines have been investigated with an optical fiber spectrograph and a CCD camera. The signal to noise ratio, measured in the continuum, is between 300 and 500.

Weak changes in the H $\alpha$  emission line profile of  $\gamma$  Cas have been detected on time-scale of hours and days. This line has an asymmetric profile exhibiting only one blue-shifted maximum while the HeI  $\lambda$ 6678 has a double-peak emission, superimposed to the photospheric contribution, with a violet to red peak ratio  $V/R > 1$ .

The H $\alpha$  emission line of  $\phi$  Per exhibits a complex structure with significant changes in its core, from night to night and on a short time scale <1hr. The HeI  $\lambda$ 6678 presents a blue-shifted asymmetric emission (red-winged) superimposed to the photospheric contribution.

Furthermore the HeI photospheric line  $\lambda$ 6678 of the B6 star  $\circ$  And has presented notable variations in its profile during the 2 observational campaigns, which do not seem correlated to the photometric period of 1.57 day.

### 1. INTRODUCTION

Rapid variability in Be stars (several hours, 1 or 2 days) could be induced by non radial pulsations (g or r modes), rotational modulation of superficial inhomogeneities, or in the case of 1-2 day period, by contact binary systems. Short-time scale spectroscopic variability of some Be stars has been investigated with the 1.93 m telescope of the Haute Provence Observatory, equipped with the optical fiber spectrograph ISIS (Felenbok et al., 1986) and a CCD camera. High S/N (300 to 500) spectra have been obtained for 2 resolutions (0.18 and 0.70 Å). Flat-field spectra and wavelength calibration (thorium-argon) were made each night of observations. All data reductions have been performed with a VAX 8600 computer.

## 2. RESULTS

Our preliminary results concern  $\gamma$  Cas,  $\phi$  Per and  $\circ$  And. The 2 early Be stars  $\gamma$  Cas and  $\phi$  Per are well-known to exhibit variable mass loss, and  $\circ$  And is a B6III star which exhibits temporary emission and/or shell features (episodic mass loss phenomena).

### 2.1 $\gamma$ Cas

The H $\alpha$  emission line fluctuations of  $\gamma$  Cas have been searched on 21 spectra taken on 5 consecutive nights (1986, September 19–24), at the resolution 0.18 Å.

1 During several nights we have found very weak variations (over about 3 hours interval) at the center of the H $\alpha$  emission line (1% in relative flux  $F_{\lambda}/F_c$ ), at the limit of the detectability of a CCD camera. Such variations could be due to non radial pulsations.

2 Faint night-to-night variations (about 5% in relative flux  $F_{\lambda}/F_c$ ) have been only detected over the 3 last nights of observations. These results are in agreement with those of Chalabaev and Maillard (1983).

The HeI line  $\lambda 6678$  Å (resolution 0.70 Å) has presented, in September 1986, a double asymmetric V-R emission superimposed to the broad photospheric absorption. So at the epoch of observations the inner layers of the cool disk where this double emission line is formed, were not only dominated by the rotational velocity law, but also by an additional inwards motion.

### 2.2 $\phi$ Per

8 H $\alpha$  emission line profiles at the resolution 0.18 and 0.70 Å have been obtained in 1986, September 20–24. A complex structure (several peaks) with significant changes in its core has been noted, fig 1a and b.

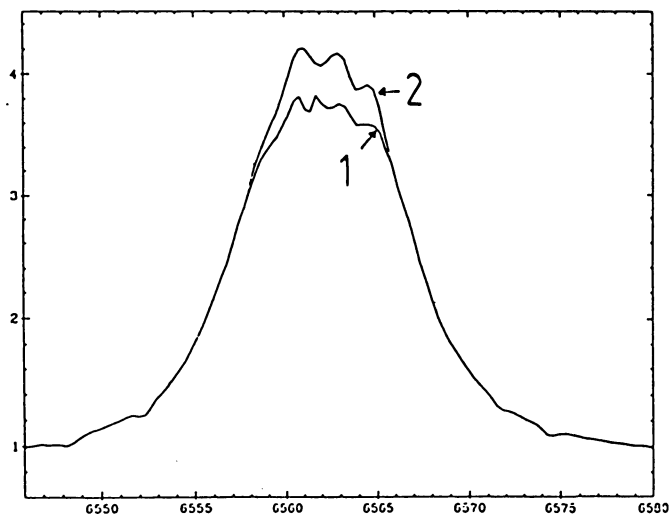
a) On September 22, a notable variation of the central depth and of the equivalent width (6%) has been seen on 2 consecutive spectra obtained at UT=3h 30mn and UT=4h 05mn, fig 1a. Stellar surface activity could explain such rapid fluctuations in intensity.

b) During 4 consecutive nights, a gradual enhancement of emission has been observed with an inversion of the most prominent peaks, fig 1b. Such variations could result from a temperature and density increase in the cool envelope by travelling shock waves induced by non monotonic winds.

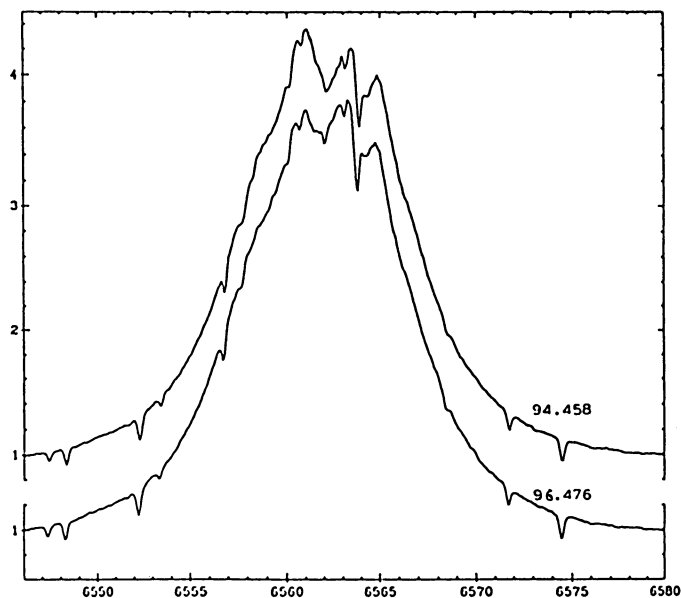
At the same epoch, the HeI  $\lambda 6678$  has exhibited an asymmetric rather narrow emission at the center of the broad photospheric line

a) some disturbance occurred in the wings during the night September 22, as rapid changes in H $\alpha$  was noted

b) the narrow emission component is formed in external layers of the cool envelope where the rotational velocity is low. As in  $\gamma$  Cas, HeI had a profile characteristic of infalling circumstellar layers.



**Fig.1a :** Variation of the H $\alpha$  line of  $\phi$  Per during the night of 1986, September 22 (JD2446695); 1: UT=3h 30m, 2: UT=4h 05m.



**Fig.1b :** H $\alpha$  line profiles of  $\phi$  Per. Julian dates are indicated on each profile (JD2446600 +). Resolution is  $R=0.18 \text{ \AA}$ .

### 2.3 $\circ$ And

Several photometric periods have been proposed for  $\circ$  And, the most probable value given by Harmanec (1984) is 1.57 day, but the light curve is variable in shape and amplitude.

We have analysed 33 spectra of the HeI photospheric line  $\lambda 6678 \text{ \AA}$  obtained in 1986, August 14–22, and September 19–23 fig 2 with a resolution  $0.70 \text{ \AA}$  and an exposure time 20mn.

- a) no variation over a time scale  $\leq 2$  hours has been detected
  - b) changes in line profile have been observed from night-to-night: temporary presence of asymmetry
  - c) asymmetry is more pronounced in August than in September
  - d) radial velocity of centroid is quite different in August and in September. It is a result in favour of duplicity of this star (P of several days or tens of days)
  - e) line profile variations do not follow the photometric period of 1.57d but would probably have a longer time scale.
- In conclusion no-short time scale periodicity has been found on the HeI line  $\lambda 6678$  of  $\circ$  And, but mid-term variability in favour of duplicity has been deduced from our spectra.

### Acknowledgements

We are indebted to Drs. P. Felenbok, D. Gillet and J. Guérin for their valuable help.

### 3. REFERENCES

- Chalabaev, A., Maillard, J.P.: 1983, *Astron. Astrophys.* **127**, 279  
 Felenbok, P., Guérin, J., Czarny, J.: 1986, *Colloque ESO/OHP sur les CCD*  
 Harmanec, P.: 1984, *IAU Inf. Bull. Var. Stars* N02506.

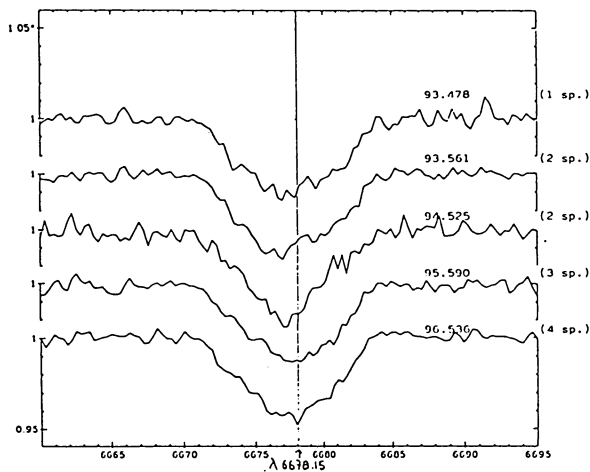


Fig.2 : Variability of the HeI line  $\lambda 6678.15 \text{ \AA}$  of  $\circ$  And. Number of average spectra and Julian day of observations (2446600 +) are indicated on each line profile. S/N is between 300 and 500.