

# RAPID VARIATIONS IN THE SPECTRA OF *o* And, $\gamma$ Cas, AND $\chi$ Oph

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## *o* And

*o* And is a shell star which has lost its shell characteristics several times since 1897. It exhibits short time scale light variations with a period of about one day. Its binary nature is doubtful according to Olsen (1972). We have detected rapid spectroscopic variations in October 1973 when *o* And had no envelope, that is, when it appeared as a 'normal' B star. Spectrograms of  $7.2 \text{ \AA mm}^{-1}$  dispersion were obtained at the Haute Provence Observatory with exposure times ranging from 12 min to 52 min.

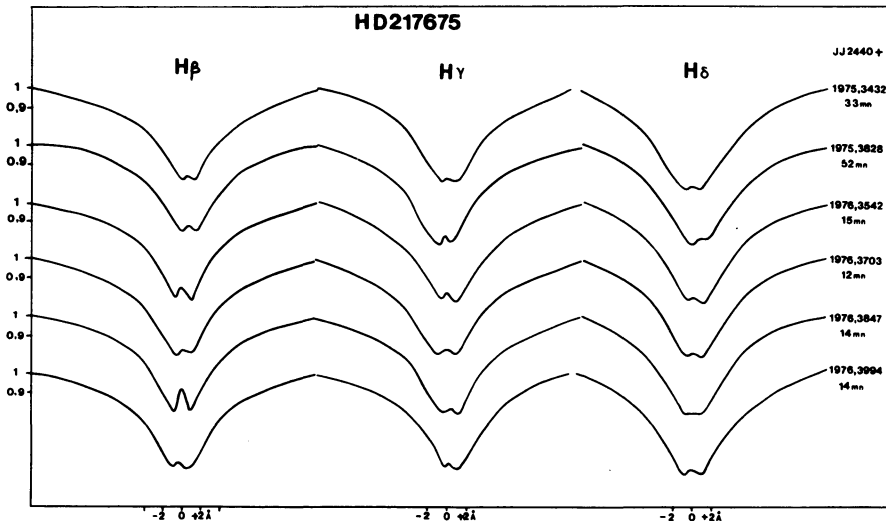


Fig. 1.  $H\beta$ ,  $H\gamma$  and  $H\delta$  line profiles for *o* And.

The variations in the hydrogen lines can be seen even by visual inspection of the plates. We notice in Figure 1 that:

- (1) The variations of the profiles are irregular and occur in about 15 minutes.
- (2) The variations of  $H\beta$ ,  $H\gamma$ , and  $H\delta$  show some correlation for the first four spectra but this correlation does not persist for the last two spectra.
- (3) The observed line variations cannot account for the smallest light variations detected previously in the B band.
- (4) On lower dispersion spectra *o* And would have been considered as a 'normal' B star.

These observations show that even when  $\sigma$  And has lost its shell characteristics, it does not behave as a normal B-type star: short time scale variations occur in the lines. In consequence rapid activity does not depend on the size of the envelope.

### $\gamma$ Cas

We have obtained a series of spectra of  $7.2 \text{ \AA mm}^{-1}$  dispersion during five consecutive nights in October 1973, with exposure times ranging from 4 to 11 minutes. Our

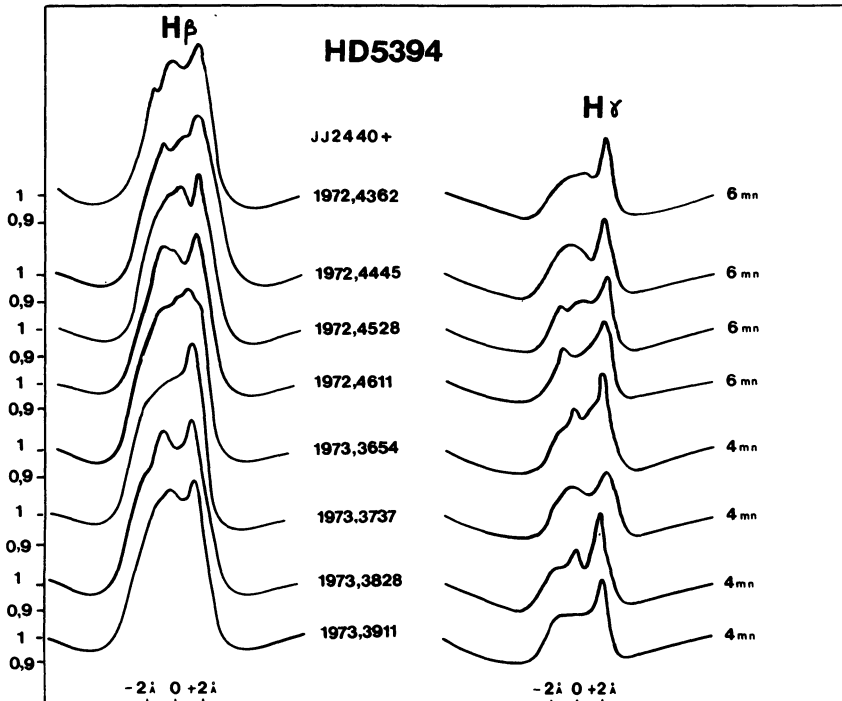


Fig. 2.  $H\beta$  and  $H\gamma$  line profiles for  $\gamma$  Cas.

aim was to detect an eventual correlation between the variations of  $H\beta$  and  $H\gamma$ . We notice in Figure 2 that:

- (1) The variations are very similar to those reported by Hutchings in 1969.
- (2) The variability affects essentially the emission peaks. Consequently fluctuations of the  $V/R$  ratio occur.
- (3) No correlation could be detected between the variation of  $H\beta$  and  $H\gamma$ .

### $\chi$ Oph

The intensity of the emission lines and the  $V/R$  ratio of  $\chi$  Oph show long term variations. Low dispersion spectra obtained since 1959 show that the most notice-

able changes concern the metallic emission lines, which disappear completely in about five years. According to its low value of  $v \sin i$   $\chi$  Oph is considered as a pole-on star. This fact is particularly interesting since in this case rapid variations cannot be the consequence of rotation. We have obtained a series of spectrograms with a dispersion of  $12.2 \text{ \AA mm}^{-1}$  during four consecutive nights in July 1972, with exposure times ranging from 16 to 25 minutes. The hydrogen emission lines, which are usually double, show a complex structure with three components. This structure was observed in a few cases for  $H\gamma$  by McLaughlin (1932).

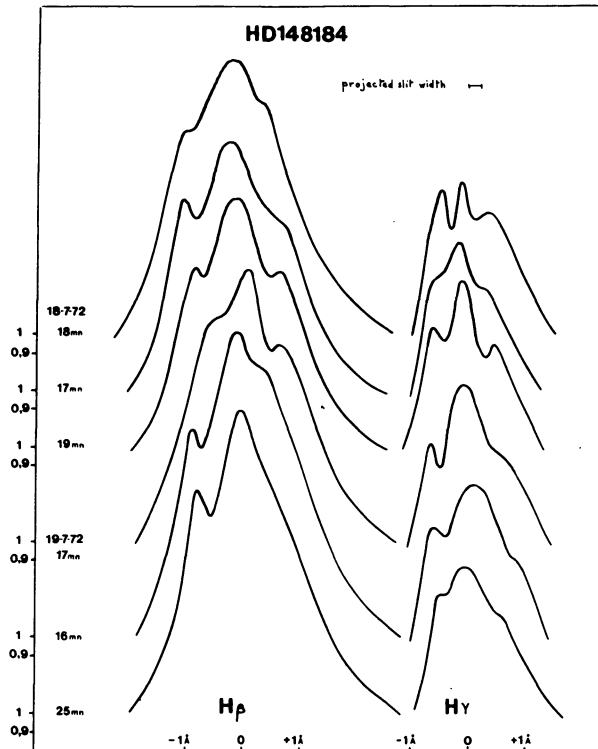


Fig. 3.  $H\beta$  and  $H\gamma$  line profiles for  $\chi$  Oph.

We notice in Figure 3 that the triple structure of  $H\beta$  and  $H\gamma$  varies irregularly, being more or less pronounced. This variability could explain the fact that very few observations of the three components have been reported until this time.

In summary, the observations of  $\sigma$  And,  $\gamma$  Cas and  $\chi$  Oph show that rapid spectroscopic variations occur as well in a Be star which has lost its envelope, like  $\sigma$  And, as in a pole-on star like  $\chi$  Oph and as in a rapid rotator like  $\gamma$  Cas. It is thus tempting to conclude that rapid spectroscopic variations (1) do not depend on the size of the envelope (2) are not a consequence of the star's rotation.

## References

- Hutchings, J. B.: 1969 in L. Detre (ed.), *Non-Periodic Phenomena in Variable Stars*, Academic Press, Budapest, p. 191.
- McLaughlin, D. B.: 1932, *Publ. Obs. Mich.* **4**, 175.
- Olsen, E. H.: 1972, *Astron. Astrophys.* **20**, 167.

## DISCUSSION

*Swings:* In addition to the three classes of Be stars in which rapid variations are observed simultaneously in several Balmer lines, I wish to add peculiar Be stars. For example, let me mention the B2 IVep star HD 45677: variations in the complex profile of H $\gamma$  and H $\delta$  were observed first from night to night, then in the course of one night, with a time scale of the order of less than one hour: one of the components in absorption at  $V = -90 \text{ km s}^{-1}$  completely disappears. The observations, which were obtained at the Haute Provence Observatory and at the European Southern Observatory, are described and illustrated in a paper published in *Astronomy and Astrophysics* (**26**, 443, 1973).