RAPID LINE PROFILE VARIABILITY OF Hα IN TWO A0E HERBIG STARS OF THE P CYG-SUBGROUP AND A MODEL FOR THEIR CIRCUMSTELLAR ENVELOPE

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Abstract. The present report gives the results on the Hα line profile investigation of two the most well-known A0e Herbig stars of the so-called P Cyg -subgroup: AB Aur and HD 163296 . 35 high-resolution CCD spectra ($R \sim 50\,000$) of HD 163296 (ESO, CAT+CES, July 1991 and 1992) and 43 CCD spectra ($R \sim 30\,000$) of AB Aur (Crimean Observatory, 2.6-meter telescope, January 1993) were obtained. A striking profile variability is discovered in both objects on the timescale from one our to a few days. The most dominant part of rapid variations ($\tau \sim$ hours) is the monotonous flux drift of different profile components. Positional shift of sharp spectral bumps, found in HD 163296 is probably connected with local inhomogeneities moving in the envelope. Shape variability of the absorption P Cyg -component of the Hα -line in AB Aur is suspected to be periodic with $P = 35$ or 70 hours. A model for a circumstellar envelope is proposed to explain the observed variability in this type of objects. It supposes the existence of an active non-stable region near the star, formed by equatorially concentrated stellar wind and an outer cool shell.

All Hα line profiles of HD 163296 correspond to the Beals's III P Cyg type with a main emission peak and a blueshifted secondary one divided by absorption (Fig. 1, left). Additional absorption components, corresponding to greater negative velocities appeared on some dates. The main P Cyg -absorption remained constant both in strength and position during the entire observing run in 1991 and was slightly variable in 1992.

All these variations can be qualitatively explained in the frame of the model of non-stable equatorially concentrated stellar wind with addition of a cool outer shell, where $r > 10\,R_*$ (Fig. 1, right).

Now AB Aur is not so active, as earlier or in comparison with HD 163296 in 1991–1992. The main type of variability of the II P Cyg -type Hα profile is the change of the P Cyg -absorption in shape (Fig. 2, the upper panel). Periodicity of these variations can be suspected with $P = 70$ or 35 hours.

Residual spectra with respect to the nightly mean Hα spectrum show obvious signs of a rapid line profile variability ($\tau \sim$ hours) in both HD 163296 and AB Aur. One can see standing waves on the residuals, reflecting the monotonous change of different profile components during a night (see Fig. 3–4).

Extremely sharp strong features can be easily identified in the red region of the profile in HD 163296 (Fig. 3, left). The theoretical traces of moving point inhomogeneities were constructed for different rotation phases and for a number of parameters, describing the kinematics of the stellar wind.

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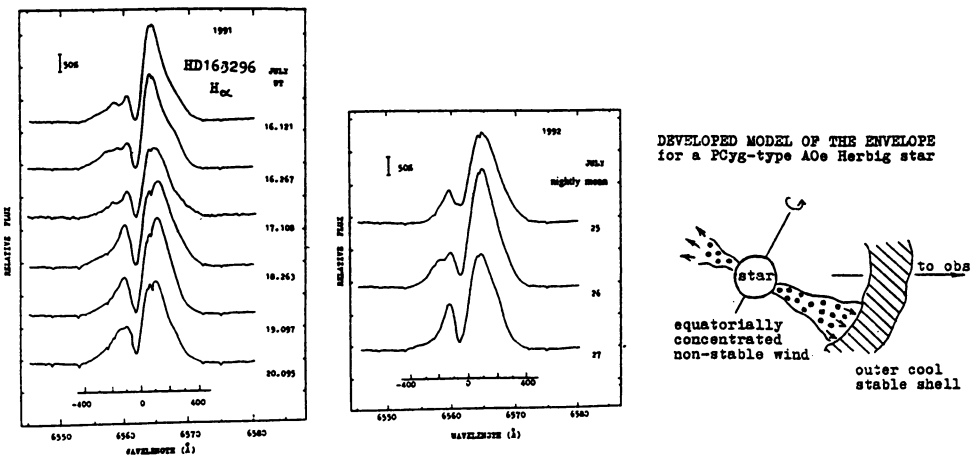

Fig. 1. Night-to-night variations of the Hα-line profile in HD 163296 and the qualitative envelope model.

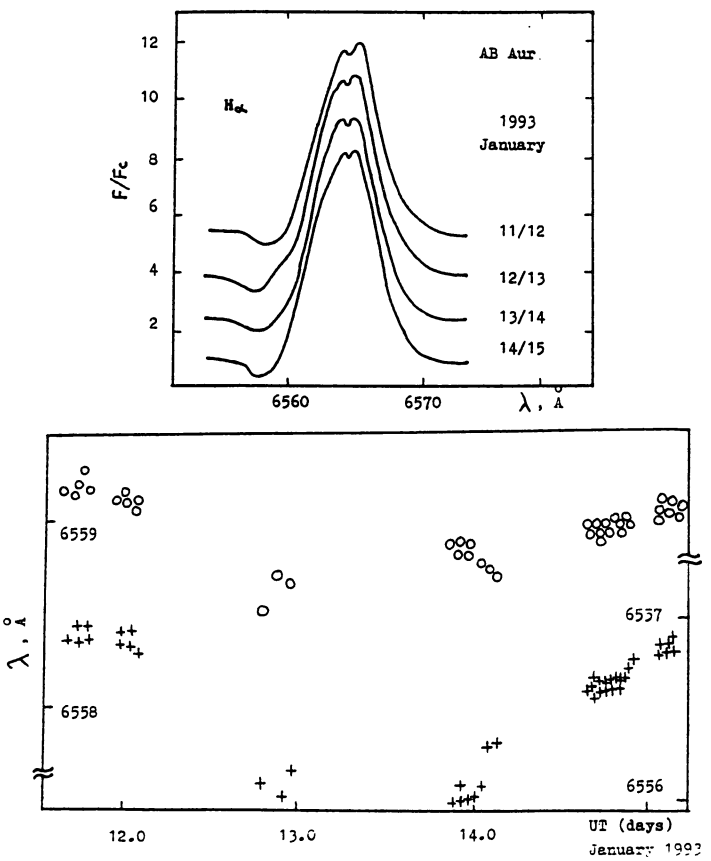

Fig. 2. Nightly mean Hα-profiles of AB Aur, observed in January, 1993 (the upper panel). Variations of the blue (+) and red (○) edges of the P Cyg-absorption on the 0.7 F_C-level (the lower panel).

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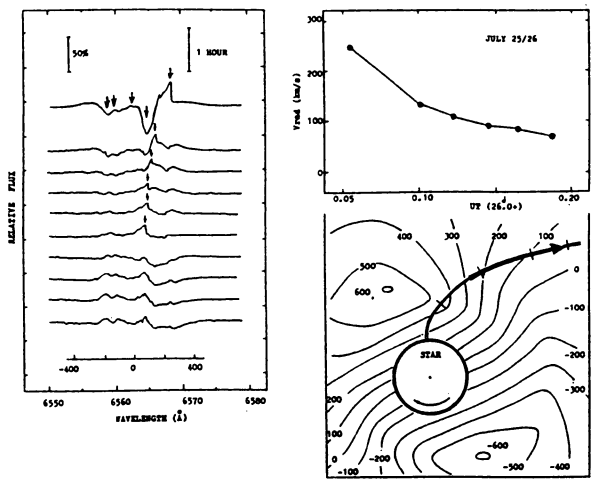

Fig. 3. Left: Residuals from the nightly mean profiles of HD 163296, observed on July, 25 1992. The offset of the residuals from the respective uppermost one is propotional to the time elapsed (time increases downwards). The radial velocity scale is given in km/s. Vertical bars provide the scales for flux (in the units of continuum F_C) and time. Remarkable moving and standing features are shown by arrows (at the top and at the bottom, respectively).
Right: Observed velocity changes of the moving bump (top) and theoretical trace of a point inhomogeneity, which is in the best agreement with observations (bottom). The trace (thick arrow) and surfaces of equal radial velocities are plotted in the non-moving star rest frame. Velocities are in km/s. The 1.5 h intervals are marked on the trace. Calculations were performed for the following kinematic parameters sample: $R_m = 2\,R_*$, $R_a = 3\,R_*$. The observer is at the bottom.

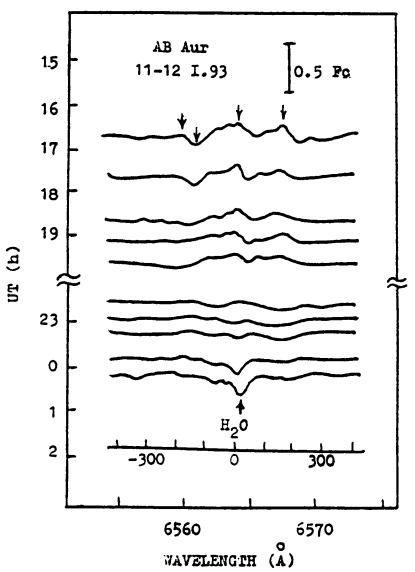

Fig. 4. The same as Fig. 3 (left) except for AB Aur (January, 11/12 1993).

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