A SEARCH FOR RAPID VARIABILITY IN THE SPECTRUM OF ALPHA ANDROMEDAE BY MEANS OF PHOTOGRAPHIC SPECTROSCOPY

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ABSTRACT. Seventy-two coudé spectrograms of 0.85 nm mm^{-1} dispersion were obtained to search for rapid variability in the spectrum of the CP3 star Alpha Andromedae. Results of measurements of radial velocities by means of comparator and microdensitometric tracings are discussed.

INTRODUCTION

The CP3 star Alpha And was mentioned as a spectrum variable on a scale shorter than its rotational period by Rakos and Kamperman (1977) and Rakos (1981). In our paper (Zverko et al., 1987) we intimated And to be rapidly variable in two periods, of 41 and 52 mins. In the work mentioned we used 0.27 nm mm^{-1} spectra and the amplitude of the variability was 10 km s^{-1}. Having come at this surprising result we decided to repeat observations. Owing to the amplitude derived we assumed a 0.85 nm mm^{-1} dispersion should be sufficient to disclose the variability. Thus we arranged an observational run at the 2-m telescope of Ondřejov observatory in October 1989 when And occured at nearly the same orbital phase as during the previous run in 1985.

OBSERVATIONS AND REDUCTION OF SPECTROGRAMS

On October 17/18, 1989 in a run of 8 hours' of duration we obtained in all 72 spectrograms at dispersion of 0.85 nm mm^{-1} in coudé spectrograph of the 2-m telescope on Kodak IIaO emulsion. Usually 5 to 8 mins (center to center) spaced exposures lasted 4.5 min. We evaluated the spectrograms in two independent ways: (i) measuring radial velocities on a TV-Abbe Laser-interferometer comparator and, (ii) digitizing the spectra and looking for deviatios from the averaged profile. Due to its high projected rotational velocity, 52 km s^{-1} (Uesugi and Fukuda, 1970) only H , H , H_8, Ca II 393.3 nm (k-line) and Mg II 448.1 nm could have been measured.

(i) measuring on the comparator

The TV-Abbe comparator enables to display a line profile together with the picture of a section of the spectrogram on a TV screen. The advantage of this TV imaging relative to the classic oscilloscopic instruments is that one can easy eliminate spoiling line profiles due to photographic or other plate defects. Neverlethess, some deformations of line profiles, mainly those of Ca II and Mg II lines can be seen on all spectrograms, without apparent deffects of plates. These "profile changes" are obviously the case of variable RV values discussed below.

a) Ca II - K line

RV-s from the calcium K-line are shown in Fig. 1. Certain similarity with Fig. 1b of our above cited paper is evident. However, period analyses of present measurements result in values quite different from the old ones. FT and PDM methods give identical results indicating most significant frequencies at 11 and 56 $c \cdot d^{-1}$. The error bars in the Fig. 1 represent errors estimated from polynomial fits of a dispersion curve in individual spectrograms. These errors are less than about 2 km s^{-1} and the amplitude of the variations well exceeds this internal accuracy. The mean value: $RV = -(10 \pm 0.6)$ km s^{-1}. Twenty-eight (54%) of 52 values fall outside the 3-sigma interval from the mean. In whatever way present result does not confirm the previous periods this share suggests a difference from random distribution.

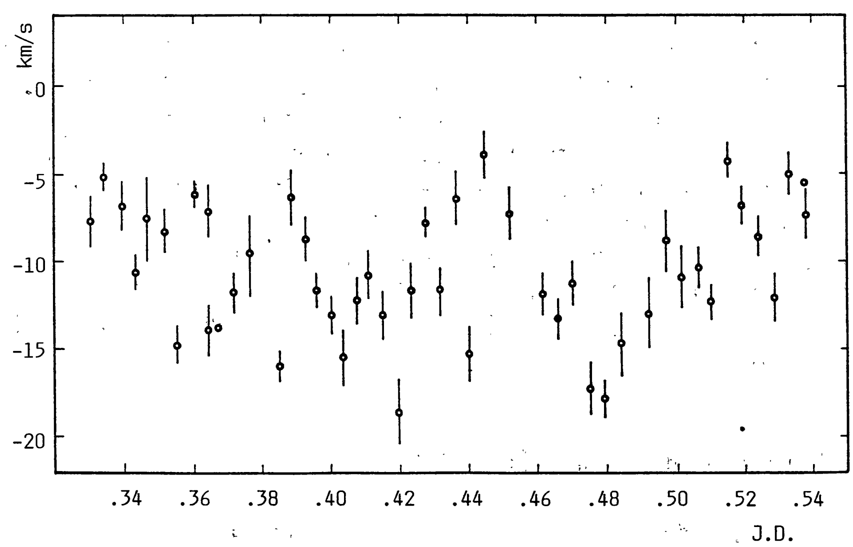


Fig. 1

b)Hydrogen lines

Result for H_γ, H_δ and H_8 is shown on Fig. 2. The mean value radial velocity is: $RV(H) = -(9.0 \pm 0.4)$ km s^{-1}. No variability similar to the RV(K) curve can be seen, but certain depression between 0.48 and 0.5 of JD on RV(H), resembling to that one on RV(K), occurs. The cross-correlation coefficient between RV(K) and RV(H) is -0.02, however after shifting RV(H) relative to RV(K) by about 18 mins (depression on RV(H) occurs later on) the coefficient increased to 0.4. Again, 30 (58%) of 52 values exceed the 3-sigma interval.

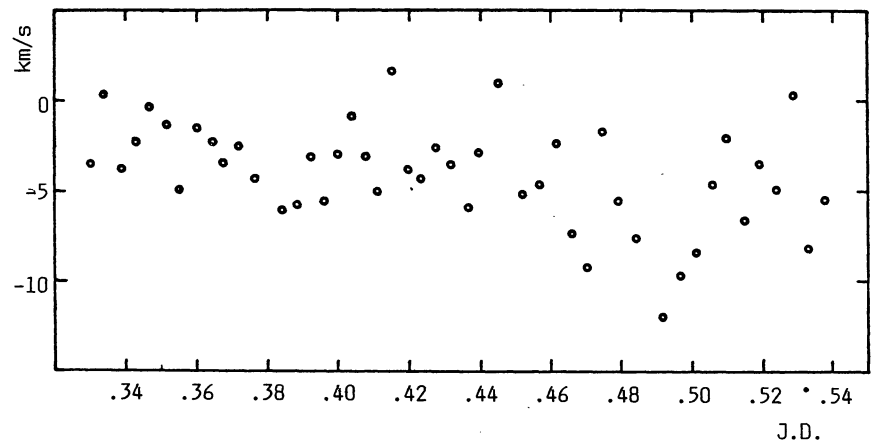
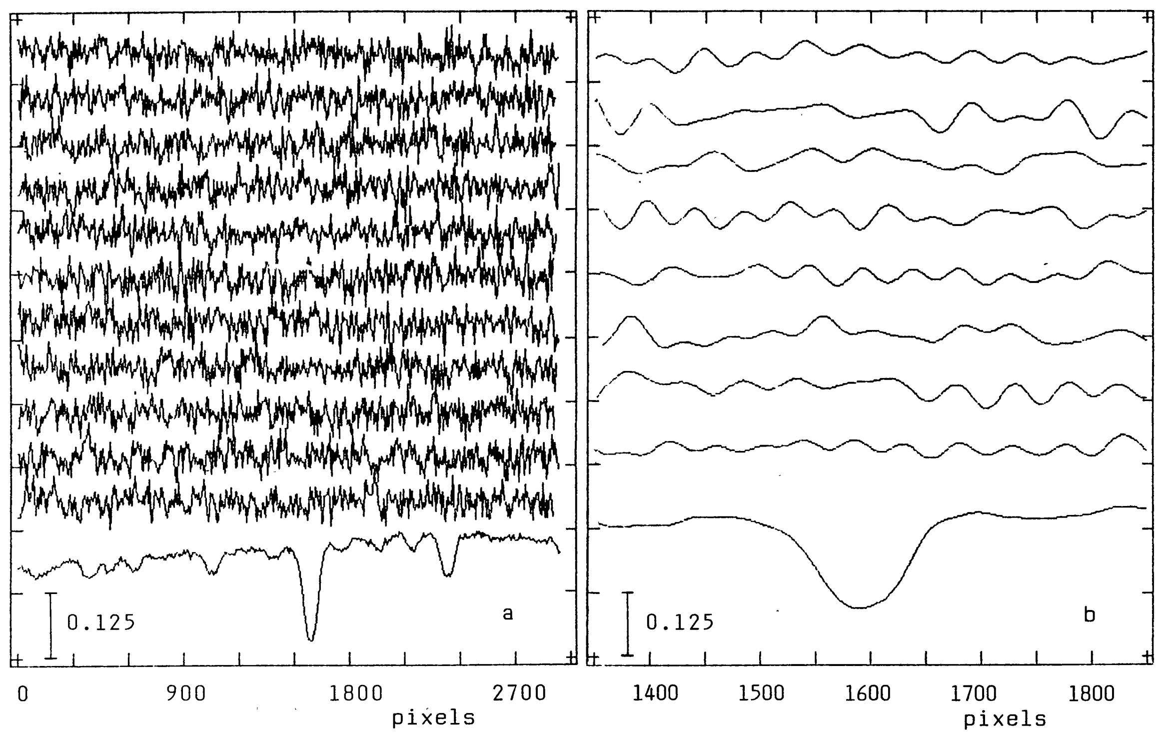


Fig. 2

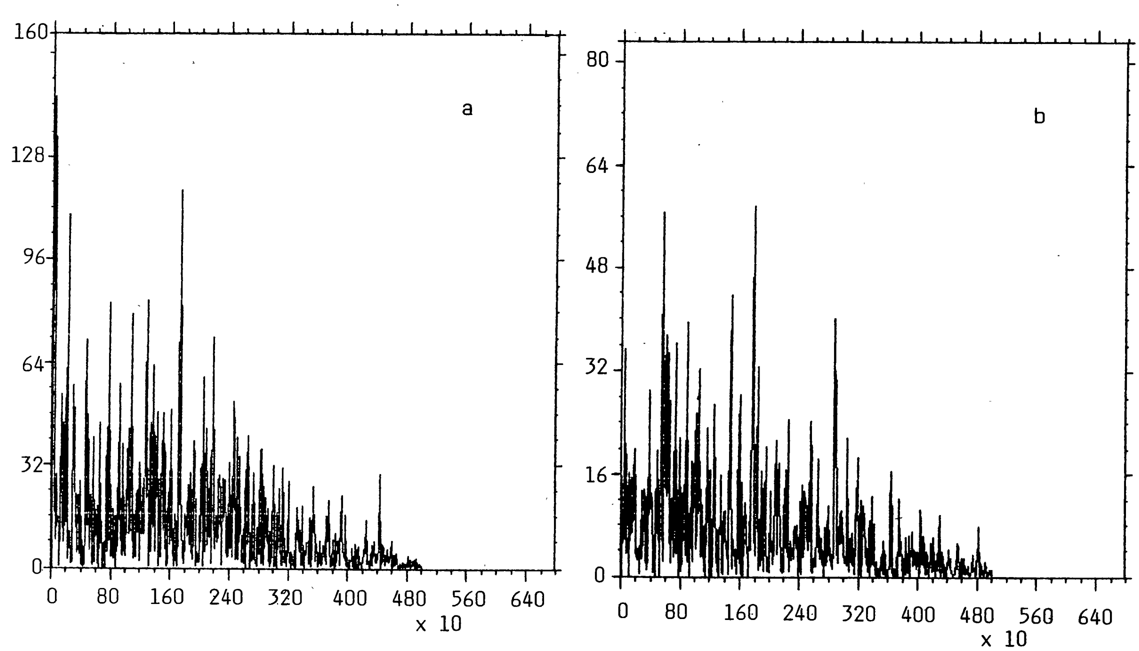
(ii) digitizing the spectra

We chose two sections of length about 3.8 nm each at Ca II and Mg II lines to digitize. The rate was 735 pixels nm^{-1}. The individual tracins were cross-correlated and co-added to form one averaged intensity tracing with a substantially less noise and a short-term variability, if there is any, smeared. Forty-four tracings were co-added and the resulting record was then subtracted from every individual one to see differences between subsequent spectrograms (Fig. 3a). No differences between the features within the spectral lines and the continuum are apparent. The photographic noise in individual spectrograms reaches to about 4% and to assure ourself whether the noise does not mask fine pattern within the lines, we filtered out the hig-frequency photographic noise by means of Fourier technique. To estimate the pure noise we recorded a part of the calibration stripe over the section of the spectrum at Ca II line. We chose the one of ten stripes which has its photographic density similar to that of continuum in the vicinity of the Ca II - K line. Applying FFT we received the power spectrum shown on Fig. 4a. The most prominent peak occurs at the value of 170, corresponding to the frequency 0.0415 $pixel^{-1}$ an the size of grain of 0.039 mm. There are some less prominent peaks towards lower frequencies and so we filtered out the high-frequency noise from the value of 101 which corresponds to the "noise wavelength" of 40 pixels. The zoomed vicinity of the Ca II - K line after filtering displays Fig. 3b. After the procedure, again no difference is apparent between the line and continuum parts of the spectra. For a comparison, the power spectrum of the noise obtained as the difference (Sp. No. 4883 - co-added) is shown on Fig. 4b. In this power spectrum the most prominent peak is at the value 180, similarly as on Fig. 4a. There is another prominent peak towards lower frequencies in Fig.4b at the value 55, corresponding to 74 pixels (0.1 nm in the spectrum). This might indicate certain additional pattern relative to pure emulsion, but another promi-



0.125
a
0.125
b
0
900
1800
2700
pixels
1400
1500
1600
1700
1800
pixels

Fig. 3



160
128
96
64
32
0
a
0
80
160
240
320
400
480
560
640
x 10
80
64
48
32
16
0
b
0
80
160
240
320
400
480
560
640
x 10

Fig. 4

nent peak at the value 20 (204 pixels, 0.28 nm wide) can be seen in the power spectrum of the pure emulsion suggesting that a noise features can be created of the size exceeding the line widths in the spectrum. Because the "0.05 nm" feature are apparent on filtered records (Fig. 5) which represents the same "variability" of profiles seen on TV-screen when measured on the comparator and resembles the same pattern as noted in our previous paper, we undertook another search by means of fitting the Gauss curve to the profiles of Ca II and Mg II lines. Because we have one-channel recording instrument the records without comparison lines could only have been done. The co-added and filtered records of Ca II and Mg II as the "comparison" lines were used. Then each filtered record was fitted by a Gauss curve by means of optimatization method, the Ca II and Mg II lines separately. Shifts of the central wavelength and a variable halfwidths of the gaussian were expected as the result of affecting the line profile by the "0.05 nm" feature. Fig. 6 displays the central wavelengths as derived in this procedure. The maximum amplitude amounts to about 10 pixels, corresponding to 10 km s^{-1}, comparable with the TV-Abbe measurements. But if such variations should be due to oscillations we are searching for, the correlation between Ca II and Mg II data would have to be high. However, the correlation coefficient equals to 0.09.

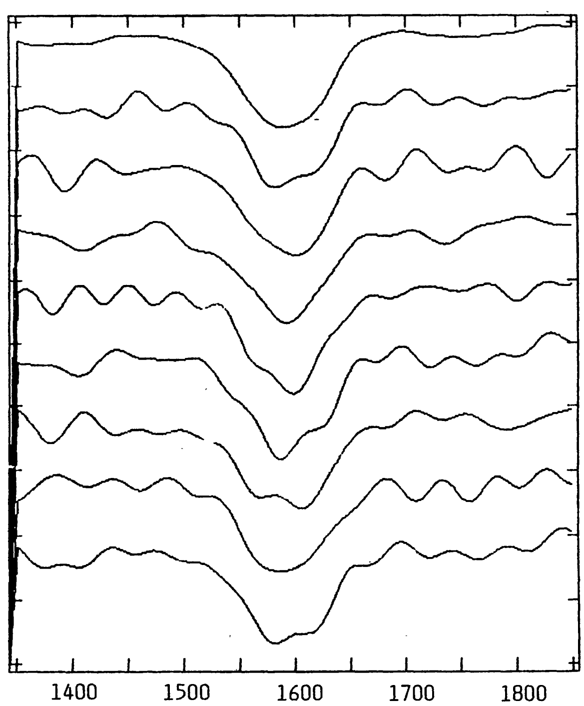


Fig. 5

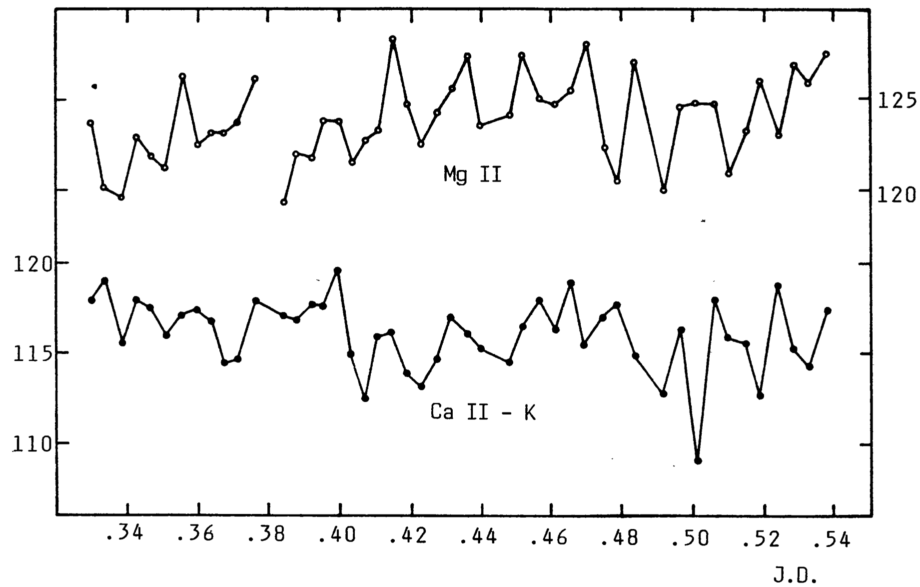


Fig. 6

CONCLUSIONS

The radial velocity measurements using a comparator resulted in some kind of variability for the Ca II - K line. Period analyses do not confirm our previous result, namely that two close frequencies superpose to create the 3 - hours' variability. The power spectrum indicates the value of 11 d^{-1} which is obviously due to the wave in the second half of the curve on Fig. 1. Anyway, only one line displays this result and so statistical significance of it is not too high. Digitized records of sections of the spectra showed a photographic noise of semiamplitude up to 4% in intensity but of size comparable with line widths. Thus, mainly for unclear frequency pattern of RV measurements on Abbe comparator, any statement on periodic variability is uncertain. In spite of this, we cannot avoid the impression that our results might reflect some variability in the spectrum of α And even when we did not succeed to describe it quantitatively.

One positive result is worth of mention, namely the asymmetry of the co-added profile of the Ca II - K line. This asymmetry is apparent on Fig. 5 and set off on Fig. 7. After substracting the side-reversed profile from the direct one we came at residual absorption at violet wing amounting 0.0011 nm in equivalent width. The absorption is centered to some 62 km s^{-1} from the central wavelength of the Ca II - K line. Thus we were able to confirm the existence of the stellar wind earlier mentioned by Rakos et al. (1981).

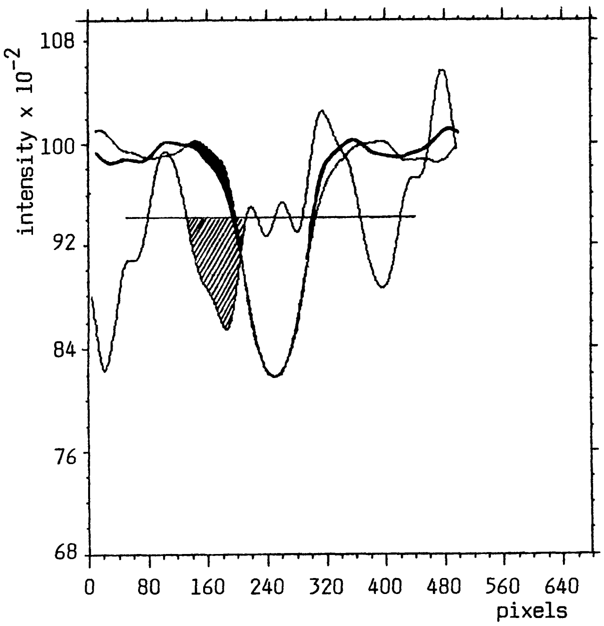


Fig. 7

The line profile of Ca II - K line. The dashed area between the direct and the side-reversed profiles in the violet wing visualises the residual absorption due to stellar wind from α And. Fine line is a result of substraction of the direct-(side-reversed) profiles in an enlarged scale.

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