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ASTRONOMY AND ASTROPHYSICS

Lithium on the surface of cool magnetic CP stars*

I. Summary of spectroscopic observations with three telescopes

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Abstract. We present new results of observations of the 6708 Å line in twelve CP stars made with three telescopes: the ESO CAT telescope, the Crimean Observatory (CrAO) 2.6-m telescope, and the Nordic Optical Telescope (NOT). Unique profile and wavelength variations of the line at 6708 Å were discovered in two stars, HD 60435 and HD 83368. We present arguments in favour of the identification of this feature with the resonant Li I line. According to the incidence and variability of this line, spectra of twelve stars were divided in four groups: Group 1 – the line is remarkably variable in intensity and wavelength; this group includes the stars HD 83386 and HD 60435; Group 2 – the line is variable to a lesser extent; includes β CrB and HD 188041; Group 3 – the line is not variable; includes 33 Lib, HD 134214, HD 166473 and γ Equ; Group 4 – the line is not present; includes HD 42659, HD 80316, HD 118022 and HD 128898. The behaviour in Groups 1–3 can be explained by the existence of Li rich spots on the star's surface using the oblique rotator model with different inclination and magnetic obliquity for each star. For HD 83368 we have found a tight correlation between the visibility of the spots and the orientation of the dipole pulsation mode.

Key words: stars: chemically peculiar – stars: variables: general – stars: magnetic fields – stars: oscillations – line: identification – line: profiles

1. Introduction

The problem of lithium in cool magnetic CP stars is still poorly studied and estimations of the Li abundance in these stars are scarce. There is some evidence of variability of the Li I 6708 Å line, but this variability has not been studied systematically. Even the identification of the 6708 Å line with the Li I resonance doublet is still in doubt.

This problem is important in the broader context of the lithium abundances in various types of stars, as well as for a deeper understanding of the magnetic star phenomenon itself. The reason for this is that the Li abundance is very sensitive to the evolutionary status of the stars and their properties, such as the character and intensity of mixing processes.

The history of this problem may be illustrated by the example of β CrB, one of most studied Ap stars. The first attempt to detect the Li I 6708 Å line in the spectrum of β CrB was made by Faraggiana & Hack (1963) and its variability was first suspected by Wallerstein & Hack (1964). Then Merchant (1965) found that this line is redshifted relative to the expected Li I line in the spectra of β CrB and some other Ap stars. Later these problems, as well as the problem of the identification of the 6708 Å line was considered by Polosukhina (1973, 1974). In these works it was supposed that lithium-rich spots are present on the surfaces of these stars. Gerbaldi & Faraggiana (1991) estimated the lithium abundance to be log N(Li) = 4.0 [on the scale of log N(H) = 12.00] for β CrB, but the agreement between the observed and theoretical profiles of the 6708 Å line was rather poor.

Long-term observations of β CrB in the 6708 Å region were carried out at the Crimean Astrophysical Observatory (CrAO) by Polosukhina & Lyubimkov (1995) in 1993–1995. The most recent results of these observations are given by Hack et al. (1997). The first studies of the 6708 Å line in a large sample of CP stars were carried out by Faraggiana et al. (1986, 1996) and Gerbaldi et al. (1995). These surveys have shown that some CP stars are Li poor, while others with very similar characteristics may be Li rich. These programs provided only few observations of each star, so the variability of the 6708 Å line was not examined.

This wide range of the lithium abundance in CP stars is not surprising, since their nature is rather complicated. They have

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* Based on observations collected at the European Southern Observatory, La Silla, Chile, the Nordic Optical Telescope, La Palma, Spainand the Shajn Telescope, Crimean Astrophysical Observatory, Ukraine

many individual peculiarities: widely varying overabundances, especially of rare earths (hereafter RE) such as Eu, Gd, Ce, Pr, Nd; strong, global magnetic fields; non-radial rapid oscillations (roAp stars); non-uniform distribution of various elements over their surfaces, with complex structure. This complexity greatly hampers the determination of the Li abundance. For instance, many RE lines are still not identified. This makes the identification of the 6708 Å line uncertain - it may be the Li I line that we think it is, it may be an unidentified RE line, or it may be a blend of both. During a meeting in Tatranská Lomnica in the Slovak Republic in 1996, this situation prompted us to initiate the project "Lithium in CP stars" with the following goals:

- to obtain spectra of cool CP stars in the 6708 Å region in order to determine the lithium abundance using spectrum synthesis;
- to carry out numeric computations of theoretical line profiles with treatment of the magnetic splitting in order to estimate the influence of magnetic fields on the spectra of CP stars in the 6708 Å region;
- to try to detect other lines of lithium, such as the 6103 Å and 8126 Å lines for some CP stars with a strong 6708 Å line, in order to confirm its identification with the Li I resonance line;
- to build a database of spectral observations of CP stars in the 6708 Å region in order to allow a statistical analysis of these data. Such an analysis may reveal the dependence of the Li abundance on physical parameters of the stars, such as $T_{\rm eff}$, log g, surface magnetic field, RE abundances, *etc.*;
- to study the rotational variability of the Li blend at 6708 Å for some CP stars, in order to investigate the inhomogeneous surface distribution of lithium.

The program stars, listed in Table 1, were selected from known cool Ap-stars.

This summarises the first results of the observations obtained for this project. We present observations of 12 of the stars selected and characterise the behaviour of the 6708 Å line. Based on overall variability of the RE lines we present arguments in favour of the identification of the feature as the Li I resonance doublet, and we discuss the incidence of lithium with respect to other properties of CP stars.

2. Observations

The majority of the observations presented here were made by PN with the European Southern Observatory (ESO) Coudé Auxiliary Telescope (CAT).

The Coudé Echelle Spectrograph was used with resolving power R= 100000 and the S/N ratio for an individual spectrogram better than 100 per pixel at the 1 σ level. The detector was the ESO CCD 34 with 2048 pixels along the dispersion. A Thorium-Argon lamp was used for the wavelength calibrations with an accuracy better than 0.3 km s^{-1}. The wavelength range observed was 6675–6735 Å. The spectra were reduced by PN during the observing run, using the old IHAP system of ESO with interactive procedures running on HP computers.

Table 1. The list of program stars

HD	Name or HR	Telscp.	N	Sp	$P_{\rm rot}$ [d]	$P_{\rm puls}$ [min]
6532		NOT	2	A3SrCr	1.944973	6.9
9289				A3SrEu		10.5
12932				A5SrEu		11.6
15144	710	NOT	3	A5SrEu	2.9978	
19918				A5SrEuCr		14.5
24712	1217	NOT	3	A9SrEuCr	12.4610	6.2
42659		ESO	5	A3SrCrEu		9.7
60435		ESO	7	A3SrEu	7.6793	11.4–23.5
80316		ESO	5	A3SrEu		7.4
83368	3831	ESO	8	A8SrCrEu	2.851976	11.6
84041				A5SrEu		15.0
86181				F0Sr		6.2
101065		ESO	3	F3		12.1
118022	78 Vir	ESO	6	A2CrEuSr	3.722	
119027				A3SrEu		8.7
128898	α Cir	ESO	6	A9SrEu	4.4790	6.8
134214		ESO	6	F2SrEuCr		5.65
137909	β CrB			A9SrEuCr	18.4868	
137949	33 Lib	ESO	6	F0SrEuCr	7.2	8.3
		CrAO	26			
143654		ESO	1	A0EuCrSr	8.5244	
150562				A5EuSi		10.8
161459				A2EuSrCr		12.0
166473		ESO	7	A5SrEu		8.8
176232				A6Sr	6.5	11.6
185256				F0		10.2
188041	7575	CrAO	11	A6SrEuCr	224.	
		NOT	2			
190290				A0EuSr		7.3
193756				A9SrCrEu		13.0
196470				A2SrEu		10.8
201601	γ Equ	NOT	2	A9SrEu	¿70 yr	12.4
203932				A5SrEu		5.94
206088	γ Cap	NOT	4	F0p		
217522				A5SrEuCr		13.7
218495				A2EuSr		7.4

The observations made at the CrAO were a part of a long-term program, some results of which were published in Hack et al. (1997) and North et al. (1998). The Coudé spectrograph of the Shajn 2.6-m telescope was used; it is equipped with a CCD camera with a red-sensitive detector with a 600x400 pixel array. The linear dispersion is 2.5 Å/mm in the region of 6708 Å and R= 65000. A typical S/N ratio is better than 100. The wavelength range was 6690–9730 Å. The spectra were reduced by DS using the package of S. Sergeev.

The observations with the Nordic Optical Telescope (NOT) on La Palma, Spain, were carried out with the SOFIN echelle spectrograph (Tuominen 1992) and two CCD cameras, yielding R= 80000 and 160000 in the 5500–8500 Å range and S/N ratios of 90–300 per pixel.

A detailed description of the observations and the discussion of the line identification problems may be found in Hack et al. (1997), North et al. (1998), and Zverko et al. (1998).

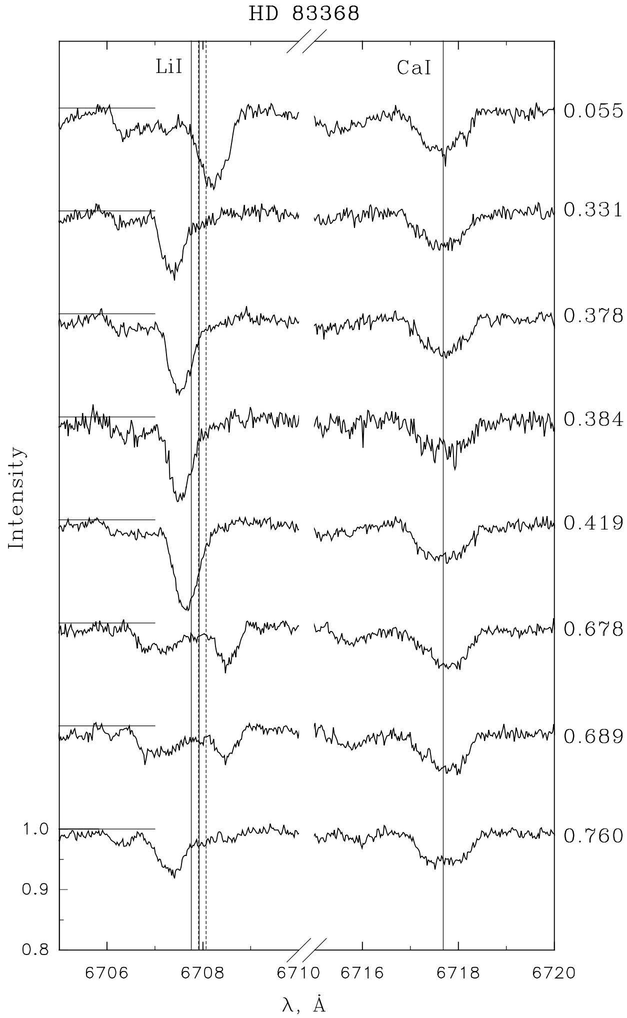

Fig. 1. The spectral region of Li I for HD 83368 in relative intensity scale. The Ca I line is shown as a RV reference. The vertical lines indicate the rest wavelength of ^{7}Li (full lines), ^{6}Li (dotted) and Ca. The Doppler shifts of the Li I line at different rotation phases are evident. The position of the continuum for each spectrum is shown at left, the rotational phases are designated at right.

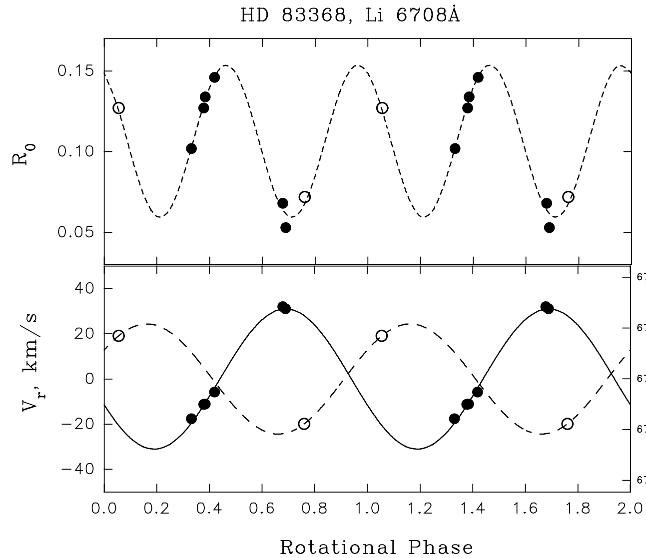

Fig. 2. The variation of the central depth, R_0, (top) and of the radial velocities, V_r of the Li I lines (bottom). The full and open circles represent the two separate spots.

3. Results and discussion

After a preliminary analysis of the spectra we divided the stars into four groups with different 6708 Å line appearances:

Group 1 – These stars have prominent 6708 Å line which exhibits strong variability of equivalent width (hereafter EW) and wavelength (RV). We consider this variability to be due to the star's rotation, caused by the concentration of lithium in compact spots which coincide, or nearly coincide with the magnetic poles. This group includes HD 83386 (Figs. 1 and 2) and HD 60435 (Figs. 4 and 5);

Group 2 – These stars have a variable 6708 Å line but the amplitude is smaller than those in Group 1 and the appearance of the variability is more complex. The nature of this variability is not so clear (Fig. 6). This group includes β CrB and HD 188041;

Group 3 – These stars have a strong 6708 Å line, but no detectable variability of the line (Figs. 7 and 8). This group includes 33 Lib, HD 134214, HD 166473 and γ Equ;

Group 4 – The 6708 Å line is not detectable at all for these stars. This group includes HD 42659, HD 80316, HD 118022 and HD 128898.

In order to express quantitatively the spectrum variability of the stars, we computed a "spectrum variability" or a "dispersogram" as described in Sect. 3.3.

3.1. Group 1

The general pattern of the variability for the stars of Group 1 can be interpreted in terms of the motion of two Li rich spots across the visible disk due to rotation of the star.

HD 83368 has spots which are not concentric about its magnetic poles. This is not uncommon in Ap stars. Mean light observations from 1975 to 1987 and pulsation observations from 1981 to 1995 give the same rotation period independently; they agree to 1 σ. Together they give $P_{\rm rot} = 2.851976 \pm 0.000003$ d (Kurtz 1982, 1990, 1991, Kurtz et al. 1991, 1992, 1997). But they are not in phase! Least squares fits give the following times of maxima:

$$\begin{aligned} \mathrm{t_0(puls)} &= \mathrm{HJD}\ 244\ 4576.150 \pm 0.004\ , \\ \mathrm{t_0(mean)} &= \mathrm{HJD}\ 244\ 4576.327 \pm 0.006\ , \\ \mathrm{t_0(mag)} &= \mathrm{HJD}\ 244\ 4576.210 \pm 0.054\ . \end{aligned}$$

These differ by:

$\mathrm{t_0(puls)} - \mathrm{t_0(mean)} = -0.177 \pm 0.007$ days
$= -0.062 \pm 0.002$ rotation periods,
$\mathrm{t_0(puls)} - \mathrm{t_0(mag)} = -0.060 \pm 0.054$ days
$= -0.021 \pm 0.019$ rotation periods,

$\mathrm{t_0(mean)} - \mathrm{t_0(mag)} = 0.117 \pm 0.054$ days
$= +0.041 \pm 0.019$ rotation periods,

which shows that the spots which produce the mean light variations lag behind the pulsation pole by 0.062 ± 0.002 rotation periods. The data are consistent with the pulsation pole and magnetic pole coinciding, as can be seen in Fig. 3.

Recently, Baldry et al. (1998) showed that the pulsational radial velocity in HR 83368 varies as a function of rotation phase. From their data we find

$$\mathrm{t_0(puls\ RV)} = \mathrm{HJD}\ 244\ 4576.336 \pm 0.040\ ,$$

which gives

$\mathrm{t_0(puls)} - \mathrm{t_0(puls\ RV)} = -0.186 \pm 0.040$ days
$= -0.065 \pm 0.014$ rotation periods,
$\mathrm{t_0(mean)} - \mathrm{t_0(puls\ RV)} = -0.009 \pm 0.040$ days
$= -0.003 \pm 0.014$ rotation periods,

indicating that the radial velocity pulsation maximum lags behind the pulsational light maximum in longitude by the same amount the mean light variations do. Therefore the radial velocity variations are concentric with the spots.

HD 83368 has a basically dipolar magnetic field with the inclination angle i close to 90° and magnetic obliquity, $\beta \geq 40°$. The inclination is tightly constrained to be near 90 ° by estimates of the radius and precise knowledge of the rotation period coupled with a measurement of the projected rotation velocity to be $v \sin i = 32.6 \pm 2.6\,\mathrm{km\,s^{-1}}$ (Mathys 1991); the magnetic obliquity is less tightly constrained by the amplitude modulation of the pulsational light variations and the magnetic field strength. See Kurtz (1999) for a detailed discussion of these and other properties of HD 83368.

With the inclination near 90° this means that both magnetic poles, both pulsational poles, and both Li spots are seen from the same aspect angle. As shown in Figs. 1 and 2, the profile of the Li 6708 Å line shows strong variation with the rotation of the star (also see North et al. 1998). We fitted a sinusoid to the $\mathrm{R_0}$ and RV measurements. As can be seen from Fig. 2 this fit is very good. The times of maximum we calculate to be

$\mathrm{t_0}(\lambda_c) = \mathrm{HJD}\ 244\ 4576.410 \pm 0.019$,
$\mathrm{t_0(R_0)} = \mathrm{HJD}\ 244\ 4576.367 \pm 0.011$,

which gives

$\mathrm{t_0}(\lambda_c) - \mathrm{t_0(mean)} = +0.083 \pm 0.020$ days
$= +0.029 \pm 0.007$ rotation periods, $\mathrm{t_0(R_0)} - \mathrm{t_0(mean)} = +0.040 \pm 0.013$ days $= +0.014 \pm 0.005$ rotation periods,

indicating that the Li spots are close to, and possibly are concentric with, the spots which produce the mean light variations. This lags behind the magnetic pole, as we have shown above. Both Li spots seem to be almost identical. Fig. 3 shows the synchronous behaviour of the variations in the Li 6708 Å line, magnetic field strength and pulsation amplitude and phase. The largest difference in the central depth and the λ centre of the Li 6708 Å line are observed when the regions of the magnetic poles are visible at the centre of the stellar disk and when they are at the limb. In this case we observe a very strong difference in the amplitude of oscillations - the oscillations intensify and the amplitude increases - when the magnetic pole moves to centre of star's disk.

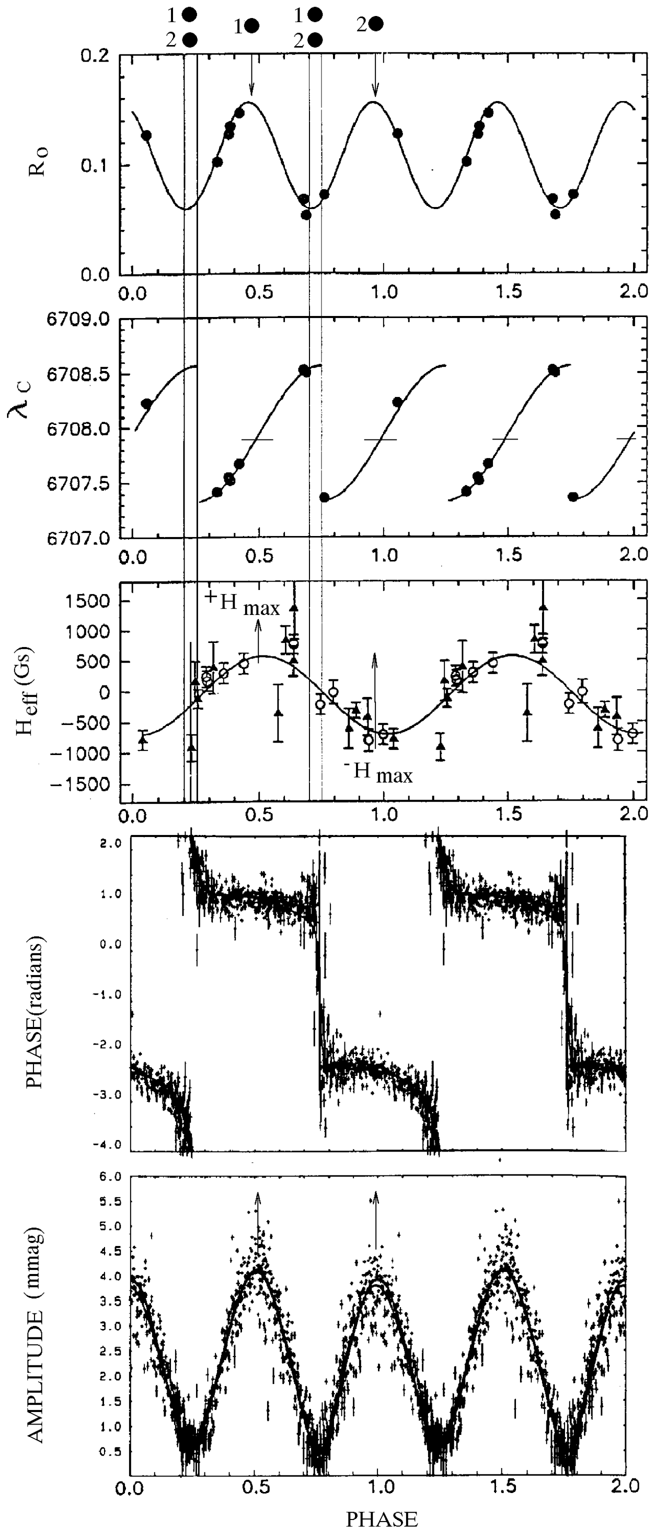

Fig. 3. The variations in the spectra of HD 83368 in the Li line region from top to bottom: the central depth, central wavelength, magnetic field intensity, pulsation phase and amplitude.

In this case the oscillation phase is nearly constant. The appearance of the second Li spot (second pole region) on the limb of the star simultaneously with the first Li spot coincides with the

Table 2. Equivalent widths and central wavelengths of the 6708 Å line in HD 60435

HJD	Phase	W	lambda
2450150.608	0.741	0.054	6707.813
2450151.647	0.877	0.091	6707.753
2450152.558	0.995	0.134	6707.792
2450153.560	0.126	0.131	6707.853
2450154.701	0.274	0.065	6707.910
2450155.642	0.397	0.053	6707.755
2450156.583	0.519	0.072	6707.801

phase "jump" in the oscillations. This jump indicates the appearance of the region on the opposite hemisphere (with some different physical conditions). Both spots are observed on the limb of the star for a very short time together, and during this time we observe splitting of the Li 6708 Å line; there are two weak components of the line, the pulsation amplitude goes to zero, the pulsation phase jumps by 180° and the polarity of the magnetic field $H_{\rm eff}$ reverses (the crossover phase).

HD 60435 was analysed by Zverko et al. (1998) using the spectra listed in Table 1. The RV, as well as EW, of the Li I line vary remarkably during the rotational period of the star. Table 2 gives EW and central λ with rotation phases for HD 60435.

The comparison of the EW variations of the 6708 Å line with the mean light curves (Kurtz et al. 1990) shows that the U and B light minima correspond to maxima of the 6708 Å line. The variations of EW and RV (see Fig. 5) suggest that there are two spots on the surface seen from very different aspects. While one spot is seen from a favourable aspect when crossing the meridian near to the line-of-sight, the other spot crosses the meridian near the apparent limb of the star. This accounts for the double waves in EW seen in Fig. 5, as well as in Kurtz et al's (1990) Fig. 2. Because of the inclination, obliquity and positions of the Li spots, they are never seen simultaneously, so there is no splitting of the Li line seen in this case.

The observations of the oscillations in HD 60435 (Matthews et al. 1987) show variations in the amplitude, but no "jumps" in the pulsation phase.

Finally, we can say that the differences between HD 83368 and HD 60435 may be attributed to differences in the geometry of the oblique rotator – the angles i and β. Unfortunately, the EW and RV measurements versus the rotation phase are not sufficient for drawing a definite conclusion in the case of HD 60435, because the observations cover only small parts of the two radial velocity curves: we have four points for one spot and only three for the other spot.

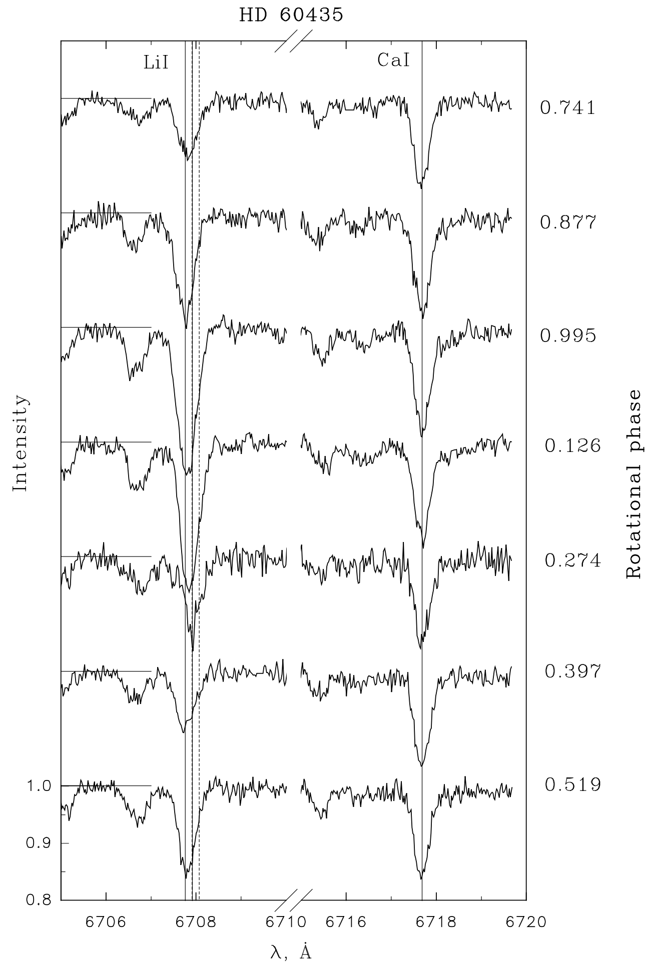

Fig. 4. The spectrum of HD 60435.

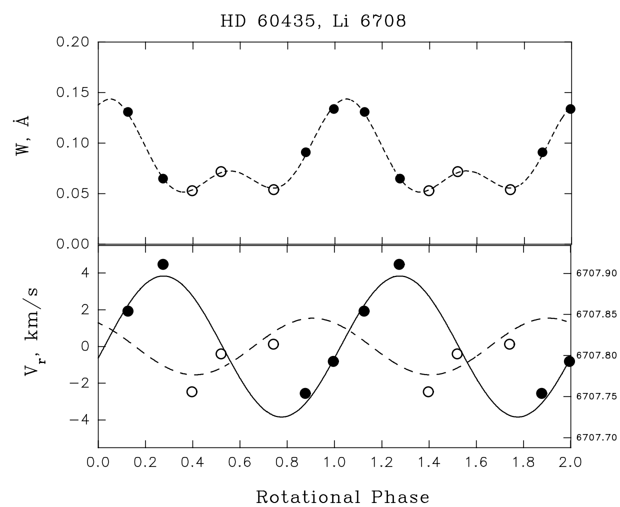

Fig. 5. The variations of EW and RV in HD 60435.

3.2. Group 2

The stars of Group 2 show a variable Li I line which is, however, smaller in amplitude and more complicated in appearance. Although the sample of two stars in each of these groups is statistically insignificant, it is noteworthy that β CrB and HD 188041 have remarkably longer rotational periods, 18.5 and 224 d respectively, than HD 60435 and HD 83368, 7.7 and 2.8 d resp. Fig. 6 displays the spectrum of HD 188041.

Table 3 gives EW and central λ for the stars of Groups 2 and 3.

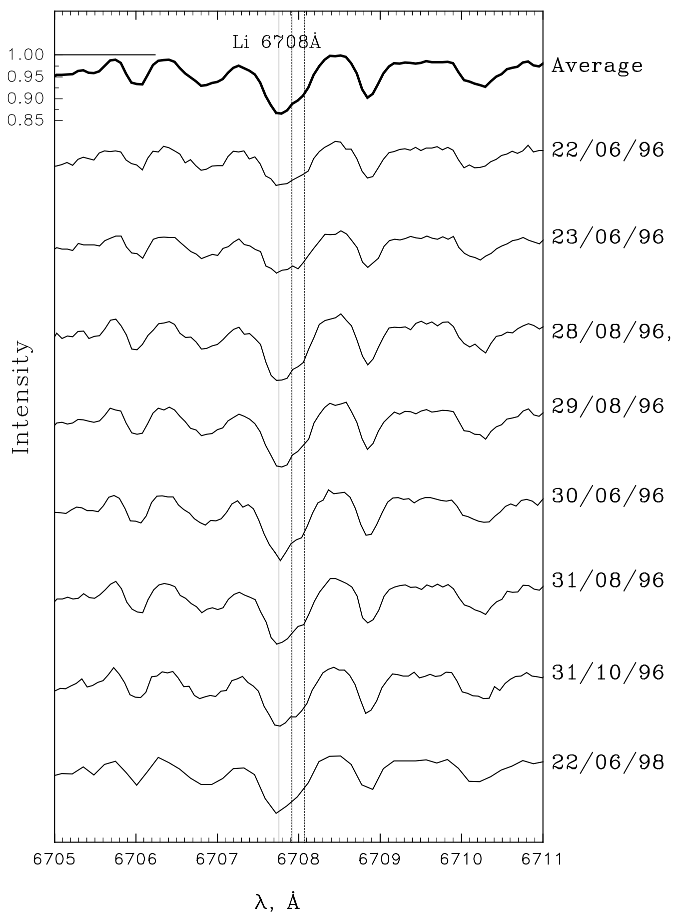

Fig. 6. The spectrum of HD 188041.

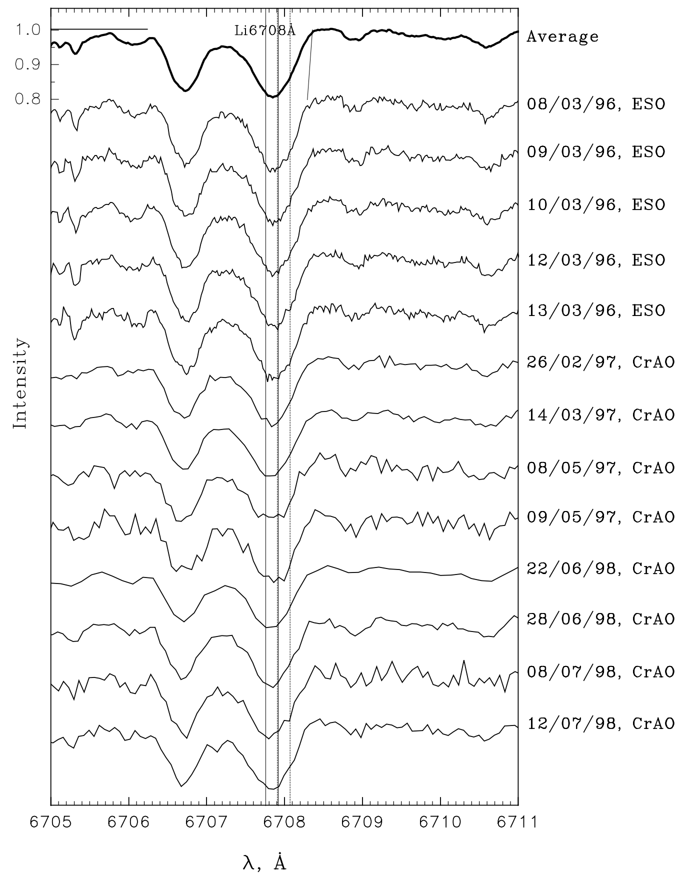

Fig. 7. The spectrum of 33 Lib.

Table 3. The 6708 Å line parameters

Object	W(A)	±	lambda	±	Group
HD 188041	0.082		6707.817		2
β CrB	0.057		6707.885		2
HD 134214	0.099	0.001	6707.839	0.001	3
HD 166473	0.125	0.002	6707.787	0.004	3
33 Lib	0.090	0.002	6707.824	0.003	3

3.3. *Group 3*

The stars of the Group 3 have a strong 6708 Å line, but on our spectrograms the line is not variable. The parameters of the line are included in Table 3.

For 33 Lib (Fig. 7), some authors (see Kurtz, 1991) show that this star is not remarkably variable in light and magnetic field. The magnetic field ($H_{\rm eff}$ = 1.8 kG,$H_{\rm s}$ = 4.7 kG, Mathys & Hubrig 1998) does not change its polarity. We observed this star with two telescopes, the ESO CAT and the Shajn CrAO telescope, with a different resulting S/N ratio, spectral resolution and epochs (March 1996 with ESO CAT, July 1998 with CrAO). Fig. 7 shows these observations. A stable position of the 6708 Å line is evident. Kurtz (1991) found this star to be pulsating, but the amplitude of the pulsations is very small (0.001–0.002 mag.) The data for the other stars of this group are very poor, but the behaviour of 6708 Å line seems to be similar (Fig. 8). For HD 134214 and HD 166473 we can only state the absence of short-term variations, since they were observed in one eight-day run only.

3.4. *"Spectrum variability" or "Dispersogram"*

While the variability of the 6708 Å line in the spectra of stars of Groups 1 and 2 is striking, that of other lines in the region this is not so remarkable. This feature is the most variable off all lines present in the observed wavelength interval, when it varies at all. In order to make the variability more evident, we computed the "spectrum Variability" as a quantity

$$|\delta| = \frac{1}{\bar{I}_\lambda}\left(\frac{\Sigma(I_\lambda - < I_\lambda >)^2}{N}\right)^{\frac{1}{2}} .$$

The plot of this function against wavelength we call a "dispersogram". These dispersograms are shown in Figs. 9, 10, 11, 12, 13, 14 and 15. They demonstrate: a) evidence of different spectral variability of the stars HD 83368 and HD 60435, b) more complicated (intermediate) cases for β CrB and HD 188041,

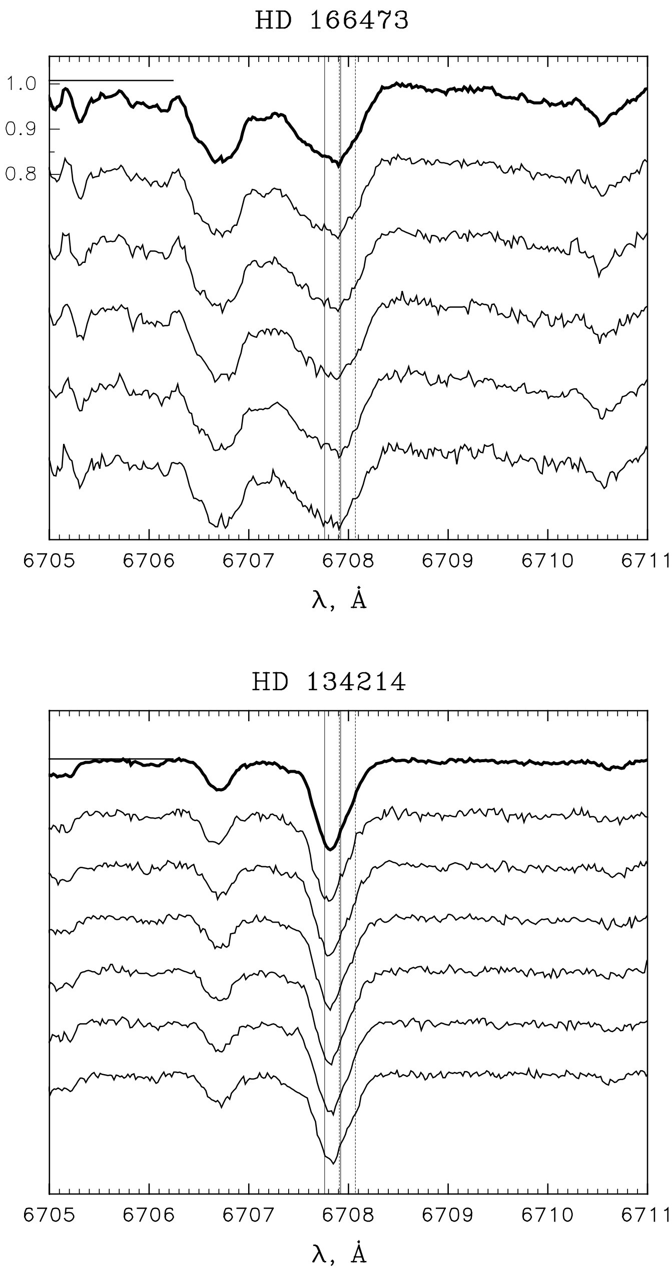

Fig. 8. The spectrum of HD 166473 (top) and HD 134214 (bottom), respectively.

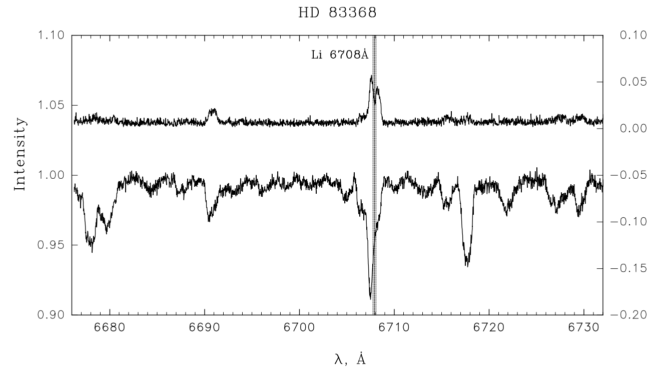

Fig. 9. The dispersogram for HD 83368. The average (bottom) and dispersion spectrum (top), computed as described in the text. The strong variability of Li I line is evident. Also Nd II 6690 Å shows noticeable variability but in a less degree than Li I.

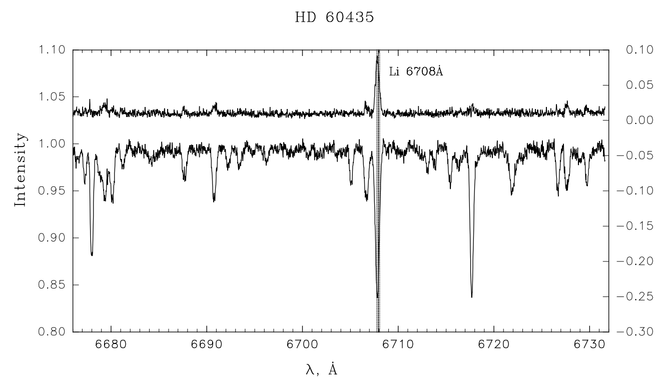

Fig. 10. The dispersogram for HD 60435. The strong variability of the Li I line is evident, while several other RE lines show a slight degree of variability.

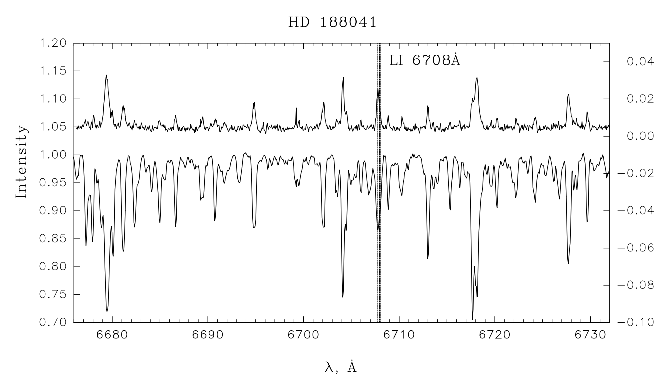

Fig. 11. The dispersogram for HD 188041.

c) non-variability of the spectra of 33 Lib, HD 134214 and HD 166473.

Besides the quantification of the profile variability, these dispersograms offer a way to a solution of the problem of the identification of the 6708 Å line. Indeed, if the 6708 Å line was a non-identified RE line, one should expect the same variability pattern as in other RE lines. The variability of the RE lines in CP2 stars is well known: they strengthen when the magnetic poles cross the meridian (Hatzes 1991a,b). The variability of the 6708 Å line in the Group 1 reaches ∼10%, thus exceeding significantly the maximum level of the variability, ∼2%, shown by the RE lines. This applies to both stars of this group. The size of this variability makes the element responsible for 6708 Å line strongly different from RE (Nd III, Pr III, Nd II, Pr II, Gd II, Ce II...) lines. It implies that the element is more concentrated in spots than are the REs. This fact may be considered as an argument in favour of the identification of the 6708 Å line with the resonant Li I line as the most important contributor to the absorption.

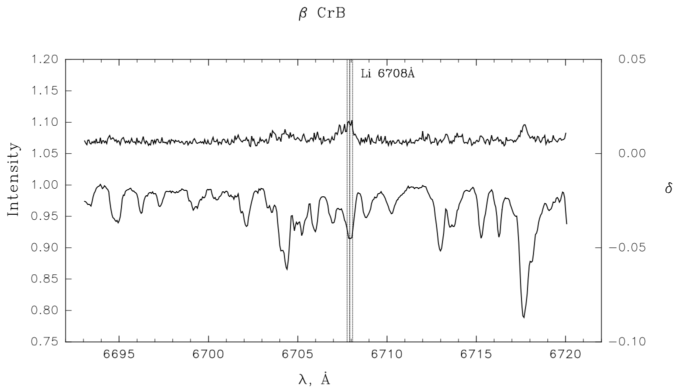

Fig. 12. The dispersogram for Beta CrB. Li I shows strong variability.

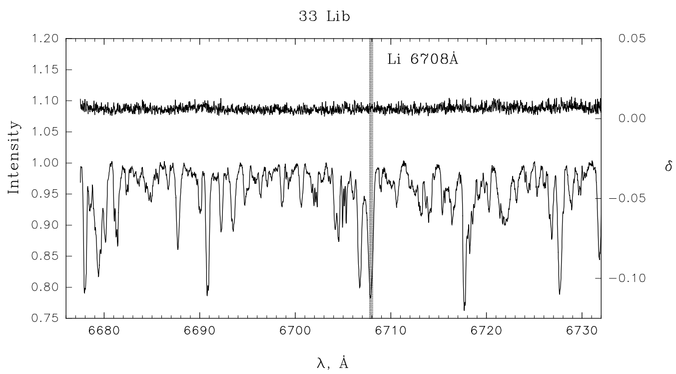

Fig. 13. The dispersogram for 33 Lib. It is evident that no lines show measurable variability.

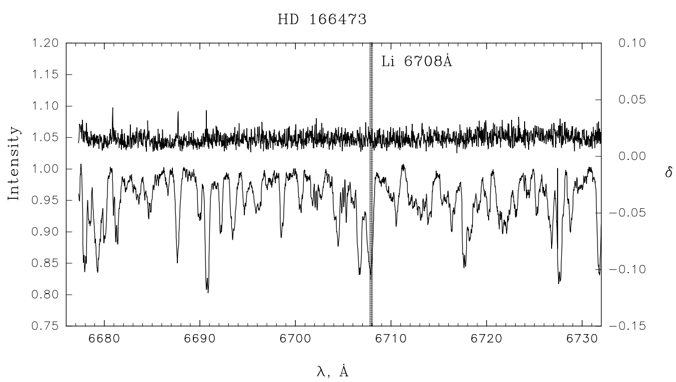

Fig. 14. The dispersogram for HD 166473: no clear evidence of line variability.

4. Conclusions

In this paper we have presented some results of observations made with three telescopes for the project "Lithium in CP stars":

The 6708 Å line was identified in spectra of eight of twelve observed program stars. We created "dispersograms" that proved to be indirect evidence of the identification of the line with the resonance doublet of Li I. The appearance of the line on the spectrograms permits us to distinguish four groups on the basis of the line's behaviour:

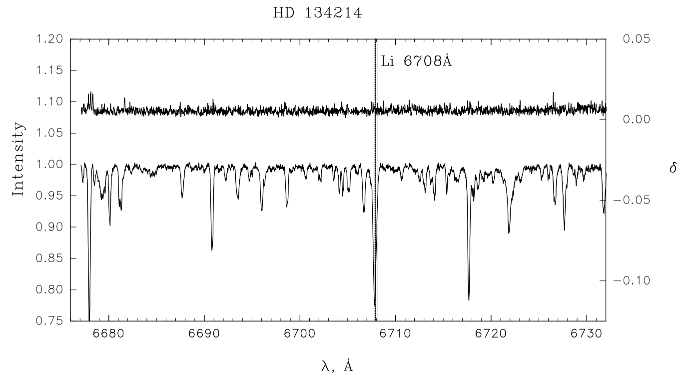

Fig. 15. The dispersogram for HD 134214: no clear evidence of line variability.

Group 1 – The line shows great variability of EW and RV with rotation phase. This behaviour can be explained by the presence of two Li spots on the star's surface.

Group 2 – The line is variable, but the observations are too sparse to make a conclusion about the nature of the variability.

Group 3 – The 6708 Å line is strong and non-variable. (Data for 33 Lib obtained with two different telescopes agree perfectly.)

Group 4 – The line was not detected.

We explained the behaviour of the 6708 Å line using the model of the "spotted" oblique rotator, with different parameters for each star. In HD 83368 the lithium spots are situated at the poles of the magnetic dipole. The angles i and β for different stars determine the visibility of the magnetic poles and spots and, consequently, the behaviour of the line. In the case of constancy of the line, the observer sees practically the same part of the surface of the star independently of the rotation phase. This means either that the star is seen nearly pole-on, or that the spots are near the rotation poles.

The behaviour of the Li I line is consistent with the variability of the pulsation amplitude and phase reversal with rotation in HD 83368.

The discovery of Li I spots in HD 83368 and HD 60435 is the first indication of spottiness in the lithium distribution in some cool magnetic CP stars. A good correlation between the positions of the spots, magnetic field, brightness and oscillation phenomena indicates possible connections between the magnetic field configuration and the local structure of the atmosphere and the local distribution of the chemical anomalies such as Li I. However, the present state of our knowledge does not allow us to make any more detailed conclusions about the structure and physical conditions in the atmosphere within or outside the magnetic spots. Model atmospheres which take into account the magnetic field, radiative and convective energy transport, opacity due to overabundances, *etc.*, are needed. Also, the occurrence of lithium on the surface needs to be studied. A theoretical possibility has been suggested by Babel (1993): ambipolar diffusion of hydrogen may result in a significant overabundance of Li I in the vicinity of magnetic poles of CP2 stars.

The investigation of the physical conditions in Li spots should be the next step in the study of the cool magnetic CP stars' anomalies. Lithium might be the "key" element to improve our understanding of the atmospheric structure and other anomalies in these stars.

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