LITHIUM AND REE SURFACE STRUCTURE OF TWO roAp STARS, HD 83368 AND HD 60435. PRELIMINARY RESULTS

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We determined the Li and REE surface distribution on two roAp stars by computing line profiles in the region near Li I line 6708 Å using high resolution spectra in different rotation phases.

INTRODUCTION

The quantitative analysis of two roAp stars atmospheres was completed by means of synthetic spectra using STARSP code (Tsymbal) and Kurucz's model atmospheres. Line lists with atomic data were those by Kurucz (CDROM 23) and VALD Computations of spots' parameters (size, location and elemental abundance) were performed with the ROTATE code of Tsymbal allowing to calculate the line profiles for a rotating star.

For HD 83368 the best agreement in the abundances computed from the Fe I and Fe II lines was achieved for the model $T_{\rm eff} = 7750$ K, $\log g = 4.0$. For HD 60435 the best agreement between the abundances computed from the Fe I, Fe II and Cr I, Cr II lines was reached for the model $T_{\rm eff} = 8250$ K, $\log g = 4.5$. Also for HD 60435 we used $v \sin i = 11$ km s^{-1} and for HD 83368 $v \sin i = 34$ km s^{-1}. Models with [M/H] = 0.0 were the best ones.

RARE EARTHS

Spectra of these roAp stars are rich in REE lines. Especially strong lines are the ones of Nd II, Pr II and Pr III lines. The most significant abundance variations are shown by La II, Ce II, Nd III, Sm II, Gd II and Er II lines in HD 83368, and by Nd II and Nd III lines in HD 60435.

As it was shown in [1], REE create ring-like structures surrounding the Li spots in HD 83368. In the same way we tried to determine the position of REE spots on HD 60435 using the lines of ionized rare earth elements near the Li line (Pr III, Sm II and Ce II) and Pr III 6160.22 Å and 6161.24 Å (spectral region 6120-6180 Å) for the phase 0.005. For insufficient phase coverage, our results can be considered as preliminary ones only.

The lithium spots parameters for HD 83368 [1] are following:

- spot 1: $l_1 = 173 \pm 6°, \varphi = 0 \pm 6°, R = 33 \pm 6°, \log(N_{\rm Li}/N_{\rm H}) = -8.4 \pm 0.2$.
- spot 2: $l_2 = 337 \pm 6°, \varphi = 0 \pm 6°, R = 35 \pm 6°, \log(N_{\rm Li}/N_{\rm H}) = -8.5 \pm 0.2$.

where l is the longitude, φ the latitude and R the radius of the spot ($R = 90°$ is corresponding to a whole hemisphere). The resulting lithium spots parameters for HD 60435 are following:

- spot 1: $l_1 = 205 \pm 10°, \varphi = 15 \pm 5°, R = 40 \pm 7°, \log(N_{\rm Li}/N_{\rm H}) = -9.3 \pm 0.2$.
- spot 2: $l_2 = 11 \pm 6°, \varphi = -15 \pm 5°, R = 44 \pm 3°, \log(N_{\rm Li}/N_{\rm H}) = -8.2 \pm 0.2$.

Table 1: REE spots data for HD 83368 and HD 60435

El, λ_{lab}, Å	HD 83368 λ_{obs}, Å	longitude, l_{sp}	Radius, R_{sp}	$\log N_{El}$, dex	HD 60435 λ_{obs}, Å	longitude, l_{sp}	latitude, φ_{sp}	Radius, R_{sp}	$\log N_{El}$ dex
	Phase = 0.689 ($248^{\circ}\!.04$)				Phase = 0.743 ($267^{\circ}\!.48$)				
Ce II	6705.5	$305 \pm 10^\circ$	$30 \pm 10^\circ$	-8.5 ± 0.3	6706.1	$230 \pm 10^\circ$	$15 \pm 10^\circ$	$15 \pm 10^\circ$	-8.7 ± 0.3
6706.051	6706.1	$240 \pm 10^\circ$	$10 \pm 10^\circ$	-8.1 ± 0.3	6706.2	$180 \pm 10^\circ$	$15 \pm 10^\circ$	$40 \pm 10^\circ$	-8.3 ± 0.3
Ce II	6707.6	$305 \pm 10^\circ$	$26 \pm 10^\circ$	-8.5 ± 0.3	6708.2	$230 \pm 10^\circ$	$15 \pm 10^\circ$	$15 \pm 10^\circ$	-8.7 ± 0.3
6708.099	6708.0	$250 \pm 10^\circ$	$15 \pm 10^\circ$	-8.2 ± 0.3	6708.3	$180 \pm 10^\circ$	$15 \pm 10^\circ$	$40 \pm 10^\circ$	-8.3 ± 0.3
Pr III	6706.1	$305 \pm 10^\circ$	$15 \pm 10^\circ$	-8.8 ± 0.3	6706.9	$170 \pm 10^\circ$	$15 \pm 10^\circ$	$40 \pm 10^\circ$	-8.3 ± 0.3
6706.705	6706.8	$240 \pm 10^\circ$	$30 \pm 10^\circ$	-8.5 ± 0.3	6706.8	$270 \pm 10^\circ$	$10 \pm 10^\circ$	$40 \pm 10^\circ$	-9.1 ± 0.3
	6707.3	$195 \pm 10^\circ$	$15 \pm 10^\circ$	-8.0 ± 0.3	6706.5	$330 \pm 10^\circ$	$-5 \pm 10^\circ$	$40 \pm 10^\circ$	-8.3 ± 0.3
Sm II	6707.6	$235 \pm 10^\circ$	$20 \pm 10^\circ$	-8.2 ± 0.3	6707.6	$190 \pm 10^\circ$	$10 \pm 10^\circ$	$40 \pm 10^\circ$	-7.3 ± 0.3
6707.473	6708.0	$207 \pm 10^\circ$	$20 \pm 10^\circ$	-7.8 ± 0.3	6707.5	$265 \pm 10^\circ$	$10 \pm 10^\circ$	$40 \pm 10^\circ$	-7.5 ± 0.3
	Phase = 0.320 ($115^{\circ}\!.2$)				Phase = 0.005 ($1^{\circ}\!.8$)				
Pr III	6160.0	$145 \pm 10^\circ$	$25 \pm 10^\circ$	-8.0 ± 0.3	6160.2	$310 \pm 10^\circ$	$0 \pm 10^\circ$	$30 \pm 10^\circ$	-8.3 ± 0.3
6160.243	6160.2	$120 \pm 10^\circ$	$15 \pm 10^\circ$	-8.0 ± 0.3	6160.3	$55 \pm 10^\circ$	$0 \pm 10^\circ$	$30 \pm 10^\circ$	-8.3 ± 0.3
	6160.8	$65 \pm 10^\circ$	$20 \pm 10^\circ$	-8.3 ± 0.3					
	6160.9	$45 \pm 10^\circ$	$20 \pm 10^\circ$	-8.3 ± 0.3					
Pr III	6160.9	$145 \pm 10^\circ$	$25 \pm 10^\circ$	-8.0 ± 0.3	6161.2	$310 \pm 10^\circ$	$0 \pm 10^\circ$	$30 \pm 10^\circ$	-8.3 ± 0.3
6161.224	6161.1	$120 \pm 10^\circ$	$15 \pm 10^\circ$	-8.0 ± 0.3	6161.3	$55 \pm 10^\circ$	$0 \pm 10^\circ$	$30 \pm 10^\circ$	-8.3 ± 0.3
	6161.7	$65 \pm 10^\circ$	$20 \pm 10^\circ$	-8.3 ± 0.3					
	6161.8	$45 \pm 10^\circ$	$20 \pm 10^\circ$	-8.3 ± 0.3					

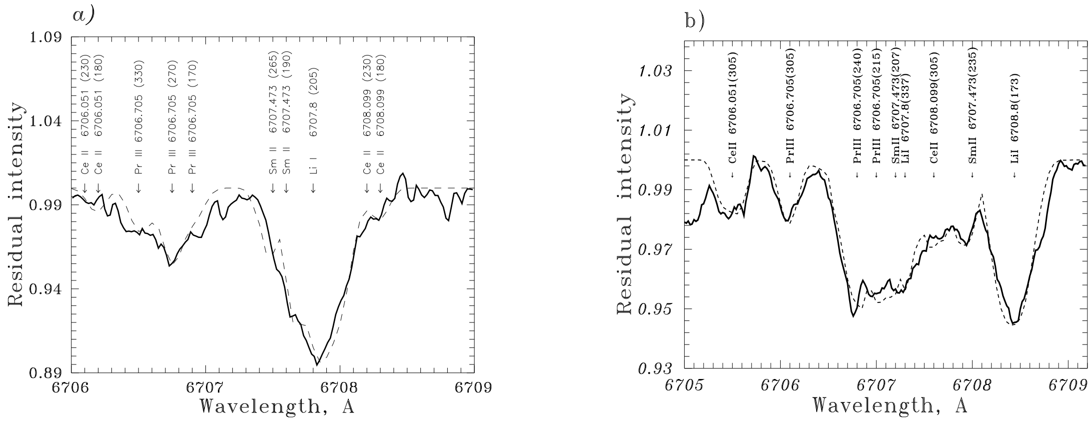

Figure 1: The calculated and observed spectrum a) for HD 60435, phase 0.743, and b) for the HD 83368, phase 0.689

Our results of location for some REE from their lines in the Li I 6708 Å region and from the Pr III lines 6160 Å and 6161 Å are given in Table 1. The calculated and observed spectra for selected phase of each star are shown in Fig. 1.

CONCLUSION

In HD 83368 the behaviour of the Li line profile and magnetic field shows that lithium spots approximately coincide with magnetic poles. Some of the other elements (mainly REE) may form the ring-like features surrounding the lithium spots. A similar structure is revealed for HD 60435.

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