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β CORONAE BOREALIS: LITHIUM AND CERIUM CONTRIBUTION TO THE BLEND AT 6708 Å

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We analyze the Li I 6708 Å spectral region of the chemically peculiar Ap star β CrB using high resolution, high signal-to-noise spectra obtained at different rotation phases. Our study shows that the Ce II line at 6708.099 Å is a main contributor to the spectral feature at 6708 Å. This fact explains the observed red shift of the Li I doublet of about 0.2 Å found by Hack et al. (1997). We derive the values of lithium and cerium abundances for different rotation phases and show that β CrB has "cosmic" Li abundance.

β CrB (HD 137909), one of the brightest and best studied Ap stars, was the first chemically peculiar star found to have the resonance Li I 6708 Å line in its spectrum (Faraggiana & Hack 1963). A detailed study of the spectrum of β CrB in the lithium region was carried out by Hack et al. (1997). They noted that the observed Li I blend at 6708 Å is redshifted by about 0.2 Å with respect to the computed one and showed that it cannot be well fitted by the Li doublet even by assuming an improbably high ^{6}Li/^{7}Li isotopic ratio.

High resolution and high signal-to-noise spectra of β CrB were obtained for different rotational and orbital phases with the VLT UV-Visual Echelle Spectrograph UVES at UT2 at ESO ($R = 110,000$), Paranal, Chile, and with the Nasmyth spectrometer ($R = 60,000$) at the BTA 6-m telescope of the Special Astrophysical Observatory, Russia.

β CrB is a binary star with variable radial velocity and a non-homogeneous distribution of chemical elements on its surface. Rotation and orbital phases were calculated using ephemerides of Leroy (1995) and Oetken & Orwet (1984), correspondingly. The atmospheric parameters of β CrB recently determined by Ryabchikova et al. (2004) ($T_{\rm eff} = 8000$ K, $\log g = 4.3$, [Fe/H] $= +0.7$) were adopted in our analysis. The scaled solar abundance model was interpolated from Kurucz models.

We selected a sample of unblended Ce II lines and lines of other chemical elements and determined radial velocities for each phase. The measurements of the equivalent widths of unblended Ce II lines and calculated cerium abundances for different rotation phases result in $\log \varepsilon(\mathrm{Ce}) = 4.35 - 4.55$ (where $\log \varepsilon(\mathrm{H}) = 12.00$).

To analyze the spectra of β CrB in the Li I region, we calculated synthetic spectra using the last version of the MOOG code. The line list described in Drake et al. (2005) was used. The lithium abundance of β CrB determined for different rotation phases is $\log \varepsilon(\mathrm{Li}) = 3.1 - 3.3$. In this way, we obtain for β CrB a "cosmic" lithium abundance. The main contribution to the Li blend in the spectrum of β CrB is due to the Ce II line at 6708.099 Å. This explains the red shift of the Li I doublet.

A recent analysis of the contribution of rare-earth elements to the Li I 6708 Å line in the spectrum of the roAp star HD 3980 (Drake et al. 2005) showed that Li is by far the main contributor to this spectral feature. The cerium abundance in the atmosphere of HD 3980 was determined to be about 1.0 dex lower than that of β CrB.

The behavior of the Li I 6708 Å line in the spectra of chemically peculiar A-type stars continues to be puzzling. Ap stars with identical physical parameters show a wide spread in lithium abundance.

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