The UV Spectrum of \( \lambda \) Boo

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**Abstract.** By using stellar atmospheric models computed with the ATLAS9 and ATLAS12 codes, we compared computed ultraviolet fluxes with those observed for \( \lambda \) Boo with the low dispersion mode of IUE. We derive the chemical abundances of zinc and chromium from high-dispersion IUE data by spectrum synthesis.

1. Introduction

The \( \lambda \) Boo stars are A-type stars characterized by a deficiency of most elements with respect to solar values although carbon, nitrogen, and oxygen are approximately solar. Their abundance patterns reflect their evolutionary stage and not their hydrodynamic history as for the other CP stars. Theoretical models do not well reproduce their anomalous abundances (Charbonneau 1993). Venn and Lambert (1990) and Stürenburg (1993) performed detailed abundance analyses based on high resolution optical data and spectrum synthesis. In the ultraviolet, Baschek and Slettebak (1988) used IUE spectra and a differential analysis technique.

Using Kurucz’s (1995) ATLAS9 and ATLAS12 models, we determine the zinc and chromium abundances for \( \lambda \) Boo by comparing theoretical and archival IUE spectra in the intervals 202–203 nm and 205.3–207.0 nm. In the Interstellar Medium (ISM) zinc is not depleted (Roth and Blades 1995). Blending of Zn II resonance lines with chromium lines require that we also determine the chromium abundance. We used the IUE/RDAF package to work with the IUE data, particularly to normalize the high dispersion spectra.
2. Analysis

After the parameters for λ Boo were adopted from Venn and Lambert (1990), T_{\text{eff}} = 8650 \text{ K}, \log g = 4.0, [\text{M/H}] = -2.0, \text{ and } \xi = 2.0 \text{ km s}^{-1}, we calculated our first model atmosphere with ATLAS9. As high-resolution optical region observations show that carbon, nitrogen, and oxygen are not as underabundant as other elements, we generated a new ATLAS 9 model (number 2) with C, N, O abundances equal to [-0.37], [0.06], and [-0.45], respectively. A third model was generated using the ATLAS12 code, which takes into account the depth dependence of abundances and should in principle better represent the observed spectrum.

Figure 1 compares the model fluxes in \lambda 120–300 nm. Some effects of changing the C, N, and O abundances in Models 2 and 3 are seen in 130–150 nm, where the flux is depressed compared to Model 1. But, the fluxes derived from Models 2 and 3 are not significantly different from each other.

As the resolution of computed fluxes available on Kurucz CDROM13 is insufficient for comparison with IUE low dispersion spectra, we computed synthetic absolute fluxes with Models 2 and Model 3 using Kurucz’s CDROM18 with v \sin i = 110 \text{ km s}^{-1}, and an instrumental resolving power of R = 300.
Figure 2. Flux distribution of model 2 from 135 to 180 nm compared to IUE observations. Differences between observations and model 2 are mainly visible around 140 and around 160 nm.

Figure 3. Flux distribution of model 3 from 135 to 180 nm compared to IUE observations. Note that there are no obvious differences to the fluxes computed from model 2.
Figures 2 and 3 compare the observed and synthetic absolute fluxes for the Models 2 and 3, respectively. Since no noticeable differences were found in the fluxes predicted by Models 2 and 3, we used Model 2 for the abundance analysis and the same parameters as for the calculation of the fluxes except that here the wavelength ranges (Figure 4) are 205–207 nm and (Figure 5) 202–203 nm and the instrumental resolution is 10,500.

In Figures 4 and 5, we compare our theoretical spectra with the observations. After initially using the abundances of Venn and Lambert (1990), we modified those of Zn and Cr until we got a good match between the observed and theoretical profiles in the region of Zn II lines and found [-0.50] and [-1.00] for Zn and Cr, respectively. The Zn value does not contradict the mechanism of gas, but not dust, accretion proposed by Waters et al. (1992).

3. Conclusions

Model fluxes based on the ATLAS9 model mimic the behavior of the one based on ATLAS12 in the wavelength interval 135–180 nm. In general, both models reproduce the observed flux behavior except for the absence of H-satellite depressions around λ140 nm and λ160 nm. In addition, some discrepancies remain around λ145 nm between the observed and computed fluxes. The Zn abundance is lower than the solar value, but is similar to those for the ISM.
Figure 5. Synthetic spectrum for the wavelength region from 202 to 203 nm in comparison with observations.

References