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Model atmospheres of magnetic CP stars: HD 137509

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Abstract. We present the results of modeling the atmosphere of one of the extreme magnetic CP star HD 137509, which has the mean surface magnetic field module of about 29 kG. Such a strong field, as well as clearly observed abundance peculiarities, make this star one of the most preferable target for testing our assumptions about the atmospheric structure of magnetic stars. The calculations presented are based on resent version of the LLmodels stellar model atmosphere code which accounts for full treatment of Zeeman splitting of spectral lines and polarized radiative transfer.

Key words: stars: chemically peculiar - stars: magnetic fields - stars: atmospheres

1. Introduction

HD 137509 is a B–type star with the strong surface magnetic field of about $< B_s >= 29\,\mathrm{kG}$ (Kochukhov, 2006). The atmospheric parameters were derived using theoretical fit of Hβ and Hγ line profiles: $T_{\rm eff} = 12\,750 \pm 500\,\mathrm{K}$ and $\log g = 3.8 \pm 0.1$ implementing ATLAS9 (Kurucz, 1993) model with metallicity [M/H] = +1.0. The preliminary abundances are: He < -3.5, Si $= -3.73$, Fe $= -3.19$, Cr $= -4.20$, Ti $= -4.54$, Ca $= -7.93$, Mg $= -5.71$. Here we focus on the application of LLmodels stellar model atmosphere code (Shulyak *et al.*, 2004) to investigate the atmospheric structure of this star (see Kochukhov *et al.*, 2005; Khan, Shulyak 2006 a, b, for computational details).

2. Results

The introduction of individual abundances and magnetic field in model calculations lead to noticeable changes in $T-P$ structure of models. In particular, the increase of $\log g$ value from 3.8 to 4.0 is required. We also note the important role of magnetic field in producing complex spectral features seen in observed energy distribution taken from ESO UVES (Bagnulo *et al.*, 2003). The comparison between observed and synthetic photometric colors is presented in Table 1.

Table 1. Photometric colors. Theoretical values were calculated for t12750g40 models with (mag) and without (non-mag) magnetic field included. Last column – their difference. Fifth column – colors calculated for scaled-solar abundance model

color index	observed	magnetic	non-magnetic	scaled solar	difference
$b-y$	−0.095	−0.057	−0.044	−0.026	−0.013
m_1	0.183	0.141	0.135	0.116	0.006
c_1	0.411	0.572	0.586	0.581	−0.014
Δa	0.070	0.054	0.031	0.014	0.022
X	0.762	0.937	0.957	0.942	−0.02
Y	0.076	0.088	0.045	0.032	0.043
Z	−0.067	−0.044	−0.029	−0.016	−0.015

The synthetic Δa values were calculated with respect to the theoretical normality line from Khan and Shulyak (2007). Note that both models with and without magnetic field were calculated with individual abundances.

3. Conclusions

- magnetic models should be used for stars with strong magnetic fields;
- the effect of magnetic field influences photometric colors is comparable with the effects of individual abundances pattern;
- magnetic models allowed us to obtain better agreement between observed and theoretical colors;

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