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Result of the magnetic field measurements on β Aql using different sets of spectral lines

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Abstract. The magnetic field of β Aql has been studied using different sets of lines in spectra obtained on October 6, 2014. We identify two sets of lines that give different values of the magnetic field of 40.8 ± 1.9 G and 8.7 ± 2.0 G, respectively. We conclude that for the calculation of the magnetic field and its geometry on a convective star it is necessary to take into account the distribution of physical conditions over the stellar surface and to select homogeneous sets of spectral lines.

Key words: stars: late-type – stars: magnetic fields – stars: individual: β Aql

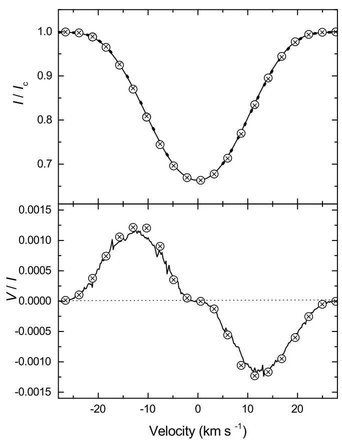
1. Introduction

The effect of physical condition irregularities on the surface of the Sun is well known in the solar physics: magnetic field measured using different spectral lines significantly differs (e.g. Rezaei et al., 2007; Stenflo et al., 2013; Lozitsky, 2015). We present the result of our study of the magnetic field on the convective subgiant β Aql (G8 IV–V) using two different sets of lines in circularly polarized spectra obtained on October 6, 2014.

2. Results

To test our method of magnetic field calculation a synthetic spectrum has been computed for a longitudinal field of about 60 G. Each contour was normalized to the selected wavelength λ, the Landé factor g and the central residual intensity R_0 independently. The circularly polarized σ-components were calculated using the dependence $r_{\mathrm{n,k}} = f(R_{\mathrm{k}}^{\mathrm{center}})$ (1), where $r_{\mathrm{n,k}}$ is the residual intensity in each n-th point of each k-th contour; $R_{\mathrm{k}}^{\mathrm{center}}$ is the residual intensity in the center of gravity or in the minimum intensity of the contour ($n = 1, 2, ..., N$ and $k = 1, 2, ..., K$). An example of Stokes V computed by our code is shown on the left bottom panel of Fig. 1.

Butkovskaya et al. (2017) have supposed that two components of the magnetic field are present on β Aql. The low amplitude one is due to the global



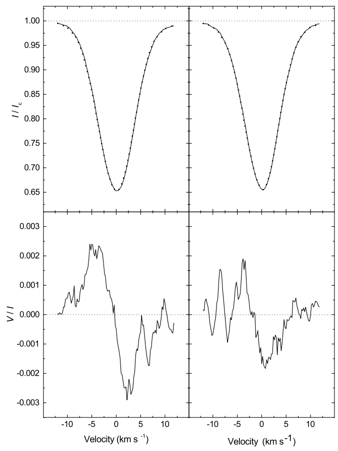


Figure 1. *Left*: Top panel: origin synthetic σ-components calculated for the longitudinal field of 60 G (open circles and crosses); σ-components calculated by Eq. (1) (solid and dotted lines). Bottom panel: Stokes V calculated using polarized synthetic contours of a single line with selected λ, g, R_0 (open circles and crosses); Stokes V calculated by Eq. (1) (solid line). *Right*: σ-components (top panels) and Stokes V (bottom panels) calculated by Eq. (1). All lines from the first set demonstrate a stronger field (left). Longitudinal magnetic field calculated using these lines is 40.8 ± 1.9 G. All lines from the second set give a weaker field (right) of 8.7 ± 2.0 G. Longitudinal magnetic field calculated using centers of gravity of all unblended lines is 23.6 ± 1.0 G.

large-scale magnetic field and the large-amplitude one originates from the small-scale magnetic activity. The right panels of Fig. 1 show that the magnetic field of β Aql significantly differs if measured using two different sets of spectral lines. This agrees with the solar magnetic field measurements. We conclude that for the calculation of the magnetic field and its geometry on a convective star it is necessary to take into account the distribution of physical conditions over the stellar surface and to select homogeneous sets of spectral lines.

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