Magnetic field and element surface distribution of the CP2 star α^2 CVn

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Abstract. We investigate the radial velocity and the magnetic field of the CP star α^2 CVn. The observed variation of the magnetic field is compared with that of our model. We search for a relation between the magnetic field and the distribution of the chemical elements. The period in the radial velocities is constant over a time interval of about 100 years.

Key words: stars: chemically peculiar - magnetic fields - radial velocities - abundances

1. Introduction

HD 112413 = α^2 CVn is a CP star whose variability in line intensities and radial velocities (RVs), was detected already 100 years ago. In the earlier 50-ies α^2 CVn was one of the first stars in which a magnetic field was discovered. Photographic observations of the longitudinal magnetic field $B_{\rm eff}$, e.g. by Babcock & Burd (1952), Oetken et al. (1970), gave a very anharmonic field curve whereas the photoelectric ones by Borra and Landstreet (1977) show a more harmonic shape.

Michaud (1970) and Glagolevskij (1994) showed that the distribution of the chemical elements on the stellar surface of magnetic stars has to be connected with the magnetic field. Therefore, we search for a relation between the concentration of the chemical elements and the structure of the magnetic field assuming a concrete magnetic field model.

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2. Observations

For the investigation we use spectroscopic observations obtained with the échelle spectrograph and Zeeman analyzer (TRAFICOS, Hildebrandt et al. 1997) attached to the 2 m telescope of the Karl-Schwarzschild-Observatory at Tautenburg. Table 1 summarizes the results of the observations. The data are mean values of about 15 metallic lines.

Table 1. RV and $B_{\rm eff}$ of α^2 CVn

HJD 2450000+	RV (km/s)	$B_{\rm eff}$ (gauss)	HJD 2450000+	RV (km/s)	$B_{\rm eff}$ (gauss)
494.658	-0.3 ± 0.6	$+940\pm220$	559.455	-1.3 ± 0.5	-530 ± 140
496.646	-3.3 ± 0.6	-720 ± 280	583.378	-1.6 ± 0.4	$+690\pm280$
528.513	-2.4 ± 0.8	$+1070\pm330$	585.347	-6.7 ± 0.9	-960 ± 220
556.427	-4.3 ± 1.0	-500 ± 180	586.391	-3.1 ± 0.6	-920 ± 180
558.420	-4.5 ± 0.9	-990 ± 220	588.364	-2.0 ± 0.6	$+1340\pm330$

3. Radial velocities

Radial velocities of α^2 CVn were accumulated over a period of nearly a century. For testing the validity of a unique ephemeris we investigate three sets of RVs. A frequency analysis gives no convincing evidence of a significant phase deviation between the different data sets. We find the same period of $5^{\rm d}\!.469$ given already by Farnsworth (1932), which is the period of rotation.

4. Magnetic model of α^2 CVn

For the modelling we fit a calculated $B_{\rm eff}$-curve to the observed one. The calculated curve results from the superposition of a dipole with a higher multipole including a fixed combination of the angles i and β; i is the inclination between the rotation axis and the line of sight and β is the angle between the rotation axis and the magnetic axis. From the stellar parameters we estimate $i = 135°$and we assume $\beta = 90°$. The magnetic sources are located at $R_* = 0.1$ from the centre; they produce at the stellar surface the magnetic field strengths of the dipole of +3.2 and −3.2 kG and of the quadrupole of −6.0, +6.0, −6.0, and +6.0 kG. In Fig. 1 the observed $B_{\rm eff}$-values (dots) and our model-curve (curve) are represented .

5. Magnetic structures and surface maps

We take the Fe, Cr, and Ti distribution from the maps derived by Pyper (1969) and Khokhlova & Pavlova (1984). These elements are mainly concentrated in

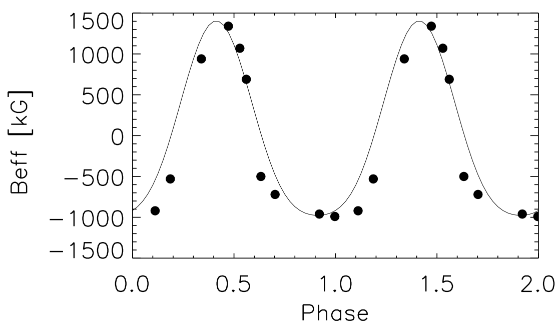

Figure 1. Variation of the longitudinal magnetic field. Measurements from Tautenburg (dots) and our model (curve)

the regions which coincide approximately with the longitudes of the negative quadrupoles. In other words, in our dipole-quadrupole model the positive and negative poles of the dipole are lying between the abundance spots, i.e., the elements are concentrated in a band around the zero magnetic field.

6. Discussion

Two findings seem to be important:
– the rotation period, which is constant for nearly one hundred years, suggests that the abundance patches have remained at a fixed position
– the Fe, Cr, Ti distributions show quite a unique relation to the magnetic field.

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