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The magnetic field structure of the slowly rotating CP star HD 188041

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Abstract. The slowly rotating CP star HD 188041 is subjected to an analysis of its magnetic field structure by the modelling method of the *Magnetic Charge Distribution* (MCD), using the photographic measurements of Babcock. The first attempt to fit Babcock's observational results to a model of a central magnetic dipole gives two possible solutions for the angle between the magnetic and rotational axes $\beta_1 = 6°$ or $\beta_2 = 76.8°$ corresponding to inclination angles $i_1 = 80.5°$ and $i_2 = 14°$. With a decentralization of the dipole, the fitting of the phase curve of $B_{\rm eff}$ to the data by minimizing the sum of the quadratic deviations could be improved, while changing i and β only slightly.

Key words: stars: magnetic – stars: rotation – methods: analytical – stars: individual: HD 188041

With this paper we bring to an end a series of investigations on the magnetic field configuration of CP stars with long rotation periods ($P > 25$d), which have been published earlier by Glagolevskij and Gerth (2004; 2005; 2006).

Our method of modelling magnetic fields is founded on the postulate that **every vector field** – including the magnetic field – **must have a source**. With the coordinates of the monopoles (λ longitude, δ latitude), the magnetic moment M and the inclination angle i, we calculate the phase relations of the effective field strength $B_{\rm e}(\Phi)$ and the average surface field $B_{\rm s}(\Phi)$.

For the construction of a model field of the star HD 188041, at first we looked through all papers of Babcock (1954; 1958), Wolff (1969), Mathys (1991), Mathys and Hubrig (1997) and Mathys *et al.* (1997). The only series of measurements, containing a considerable quantity of $B_{\rm e}$ data, belongs to Babcock (1954). The measurements of $B_{\rm s}$ we took from Mathys and Lanz (1992) Mathys and Hubrig (1997) and Mathys *et al.* (1997). For convenience in comparing the phase curves of the calculated and the observed relations, we drew them in the form of smoothed mean values, which we obtained by the method of sliding averaging over 4 points. The values $B_{\rm e}$ and $B_{\rm s}$ are plotted in Fig. 1A and 1B by points. The ephemeris of the data is JD $2432323 + 226E$. [1]

The first approximation was carried out with the concept of a central dipole. The outcome was, that none of the two variants corresponds to the observed

[1] During the workshop Prof. Z. Mikulášek communicated an improved ephemeris, based on new observations: JD $2444871.65(0.44) + 223.^{\rm d}814(0.018) \times E$.

relation B_s according to the form of the phase curve. This means that the star does not possess a magnetic field of a central dipole.

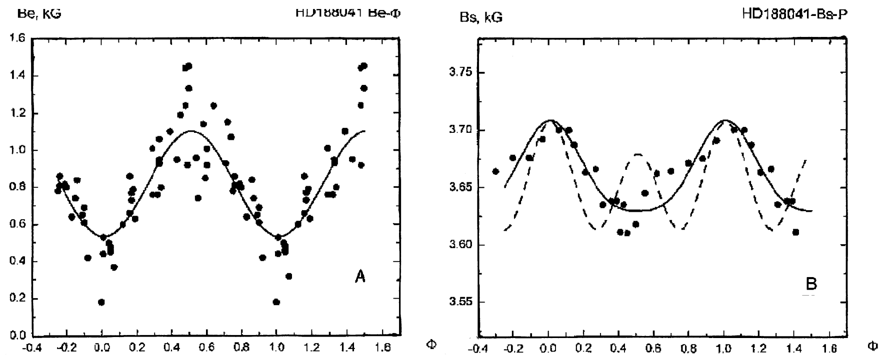

Figure 1. Phase arrangement of Babcock's measuring data of the star HD 188041. A – Left panel: $B_e(\Phi)$. B – Right panel: $B_s(\Phi)$. Ephemeris: JD 2432323 + 226E.

Then we tried to get coincidence for the relation $B_e(\Phi)$. Taking different parameters and applying the method of consecutive approximations, we obtained two solutions – one with a small and the other with a large angle β.
In Fig. 1 the first variant is marked by a solid line and the second one by a broken line. It can be easily seen, that the variant with a large angle β totally does not correspond to the observation according to the form of the phase curve. Only the variant with a small angle β is a good fit.

It turns out that the star HD 188041 possesses the structure of a magnetic dipole, but shifted from the center along an axis in direction to the negative monopole by a magnitude 0.07 of the star's radius.

The creation of CP stars is connected with their initial slow rotation – as shown already by Landstreet and Mathys (2000).

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