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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 of the distance angle of the magnetic and rotational axes $\beta_1 = 6^\circ$ or $\beta_2 = 76.8^\circ$ corresponding to the inclination angles $i_1 = 80.5^\circ$ and $i_2 = 14^\circ$. Admitting 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, but changing i and β only slightly.

Key words: Magnetic stars – slow rotation – modelling – star: HD 188041

By this paper[1] 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 imagination 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), and Mathys *et al.* (1991, 1997) for measurements of $B_{\rm e}$ and $B_{\rm s}$. 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 *et al.* (1992, 1997). For convenience of 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 $2432323 + 226E$. [2]

[1]Poster representation at CP#AP WORKSHOP, 10-14 September 2007, Observatory of the University Vienna, Austria. Original poster available by www.ewald-gerth.de/122pos.pdf.

[2]After a private communication given to E. Gerth during the conference by courtesy of Prof. Z. Mikulášek, the present (on the base of new observations improved) ephemeris of HD 188041 is $M_0 =$ JD 2444871.65 ± 0.44 with the period $P = 223\overset{\rm d}{.}814 \pm 0.018$ d.

The first approximation was carried out on a concept of a central dipole. The outcome was, that none of the two variants corresponds to the observed relation $B_{\rm s}$ according to the form of the phase curve. This means that the star does not possess a magnetic field of a central dipole.

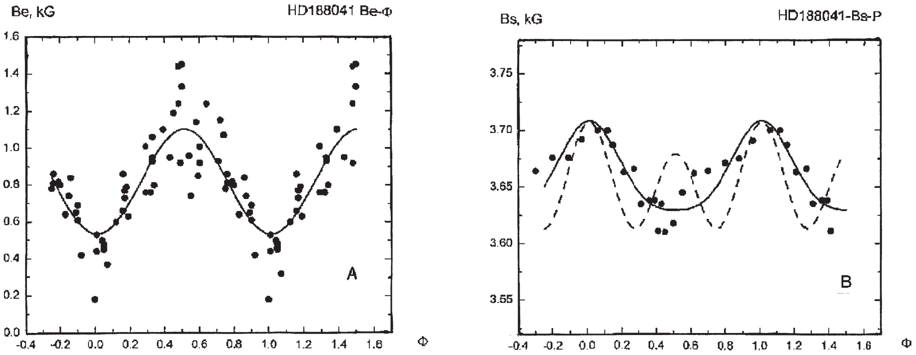

Figure 1. Phase arrangement of Babcock's measuring data of the star HD 188041. A – Left panel: $B_{\rm e}(\Phi)$. B – Right panel: $B_{\rm s}(\Phi)$. Ephemeris: JD 2432323 + 226E.

Then we tried to get coincidence for the relation $B_{\rm e}(\Phi)$. 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 is done by a broken line. It can be seen well, that the variant with a large angle β totally does not correspond to the observation according to the form of the phase curve. There fits only the variant with a small angle β.

It turns out that the star HD 188041 possesses the structure of a magnetic dipole, 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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