Magnetic field variability of HD 96707

V.D. Bychkov[1], L.Yu. Kostynchuk[2], V.G. Shtol'[1]

[1] Special Astrophysical Observatory of the Russian AS, Nizhnij Arkhyz 357147, Russia
[2] Odessa State University, Ukraine

Abstract. The magnetic behaviour of HD 96707 is studied which appeared to be harmonic with a period of 2.55 days and an amplitude up to 1000 Gs.

1 Introduction

Extensive study of magnetic behaviour and orientation of magnetic fields of Ap stars is now under way at the Special Astrophysical Observatory. In the frames of this project the Ap star HD 96707 has been investigated. The magnetic field of HD 96707 (HR 4330, GC 15332, BD+68 632) was first examined by Van Den Heuvel (1971) using the photographic technique. According to his measurements this star has a strong magnetic field, however the estimates available are insufficient for determination of the period of variability, the kind of the magnetic curve, etc.

2 Observation results

A set of apparatus and techniques has been developed at SAO for measuring magnetic fields of stars (Glagolevskij et al., 1978; Bychkov et al., 1988; Najdenov, 1989; Shtol', 1991; 1993). Two techniques have been chosen for magnetic measurements. The principal one — circular polarization measurements in the wings of hydrogen lines of the Balmer series H_β and H_γ with a mask of 9 Å on the 6 m telescope with the hydrogen-line magnetometer (Shtol', 1991; 1993). The method allows the longitudinal magnetic field to be estimated in pure state, without the influence of chemical composition inhomogeneities. The other method — use of Zeeman spectra taken with the spectrometer GECS placed at the coude focus of the 1 m telescope (Musaev, 1993). Spectra of HD 96707 are recorded with a standard CCD detector of 580 $\times$ 530 pixels and reduced with the aid of the package DECH20 (Galazutdinov, 1992). This method makes it possible to obtain many different information on the spectra, in particular, to refine such an important parameter as *vsin i*, etc.

In Table 1 are given the results of magnetic field measurements for HD 96707 obtained by Van Den Heuvel (1971) and our estimates. As is seen from the table, the accuracy of photographic estimates is not high, therefore it was decided not to use them in further analysis.

Table 1:

JD	B_e	σ
Photographic method (Heuvel, 1971)		
2440340.85	+ 87	1466
2440341.82	- 1980	1551
2440342.83	- 81	1173
2440344.80	- 3919	1691
2440371.75	- 2686	1027
2440372.74	+ 830	1503
1 m telescope with GECS+Analyzer		
2450116.503	+ 179	243
2450117.517	- 219	224
2450118.500	+ 880	241
2450119.458	- 199	322
2450185.321	+ 241	170
6 m telescope with H–magnetometer		
2450209.448	- 266	289
2450211.281	- 99	246
2450211.390	+ 63	254
2450211.495	- 444	211
2450211.495	- 444	211
2450212.259	+ 52	240
2450212.359	+ 245	226
2450233.432	+ 405	196
2450296.458	- 128	287
2450297.528	+ 278	248

Table 2:

JD	The half-intensity width in Å Mg II 4481
2450116.503	1.06
2450117.517	1.03
2450118.500	0.93
2450119.458	1.08
2450185.321	0.91

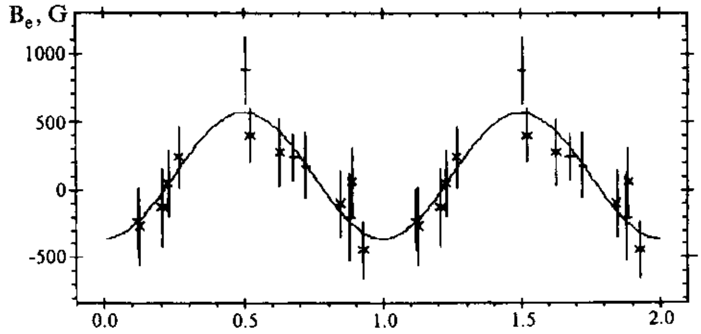

Figure 1:

From five Zeeman spectrograms the half-width of the Mg II 4481 line was measured (see Table 2). Using the well-known method (Sletteback et al., 1975) we have determined *vsin i* = 36 km/s.

Using our data an attempt is made to find the most likely period of magnetic variability from the minimum sum of the squares of deviations from the sinusoid inscribed by the least-squares method into a phase set of estimates convoluted consecutively with the tentative periods. The limits, in which the period of stars may lie, can be estimated from the known parameters of the star. The maximal period is possible if ***sini*** = 1, i.e. when the axis of rotation lies in the picture plane.
$V_e = 2\pi\ R/p = 50.61R/p$ — equatorial velocity;
$V_s = v_e \sin\ i = 36$ km/s — projection of equatorial velocity;
$P_{\max} = 50.61R/V_e = 5$ days — maximum possible period.

The minimum possible period can be found, from lg g, i.e. if V_e for a given star is higher than ~ 300 km/s, lg g will then be 3.5 - 3.7 but not 4.2 (Renson et al., 1991). Hence P_{min} = 50.61 R/V_e ~ 0.5 day. Thus, from the data available the most likely period, 2.55305 days, is found.

Having found the most likely period, determine parameters of magnetic variability. In Fig.l is displayed the phase magnetic curve drawn from all high accuracy magnetic field estimates. If to suppose that magnetic curve is sinusoidal, then

$$B_e(t) = B_0 + B_1 \sin(2\pi(t - T_0)/p),$$

where
B_0 = 110 ± 65 G — constant component of the magnetic field,
B_1 = 474 ± 90 G — half-amplitude of the magnetic field,
T_0 = 2450112.107 — initial epoch,
$p = 2.55305$ day — period.

The root-mean-square magnetic field estimate $< B_e >$ derived from 15 estimates by the procedure proposed by Borra et al. (1983) is $< B_e > = 342 \pm 243$ G.

Thus, HD 96707 is a magnetic variable star with a period of 2.55305 days and an amplitude of magnetic field variability about 1000 G.

References

Borra F.E., Landstreet J.D., Thompson I.: 1983, Astrophys. J. Suppl. Ser., 53, 151.

Bychkov V.D., Gazhur E.B., Glagolevskij Yu.V., El'kin V.G., Nazarenko A.F., Najdenov I.D., Romanyuk I.I., Chountonov G.A., Shtol' V.G.: 1988, in: Magnetic Stars, Eds.: Glagolevskij Yu.V., Romanyuk I.I., Leningrad, Nauka, 12.

Galazutdinov G.A.: 1992, SAO Report, No. 92.

Heuvel E.P.J.Van Den: 1971, Astron. Astrophys., 11, 461.

Renson P., Catalano F.A., Leone F.: 1991, Astron. Astrophys. Suppl. Ser., 89, 61.

Najdenov I.D., Drabek S.V., Bychkov V.D., Romanyuk I.I., Glagolevskij Yu.V., Gazhur Eh.B., Georgiev O.Yu.: 1989, Mitteilungen des Karl-Schwarzschild observatoriums Tautenburg, 125, 114.

Musaev F.A.: 1983, Pis'ma Astron. Zh., 19, 776.

Shtol' V.G.: 1991, Astrofiz. Issled. (Izv. SAO), 33, 176.

Sletteback A., Collins G.W., Boyce P.B., White N.M., Parkinson T.D.: 1975, Astrophys. J. Suppl. Ser., 29, 137.