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HDE 343872 and BD –03.987 — new magnetic CP stars

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Abstract. With the purpose of searching out magnetic stars, observations of CP stars having a strong depression at a wavelength of about 5200 Å have been carried out with the SAO RAS 6 m telescope. We have discovered two new magnetic stars, HDE 343872 and BD –03.987, with a high degree of reliability. The longitudinal component B_e of the magnetic field in the star HDE 343872 varies with a period of 8.724 days from –1 kG to +4 kG; three measurements of B_e for the object BD –03.987 yield a value of about $+(3 \div 4)$ kG. Another two CP stars, HD 29925 and BD +17.3622 are, apparently, magnetic, but the results need confirmation.

Key words: stars: chemically peculiar – stars: magnetic — stars: individual: HDE 343872 and BD-03.987

1. Introduction

In the course of more than half a century of observing, since 1947, about 200 magnetic chemically peculiar stars have been detected (Romanyuk, 2000). This number is insufficient to study their spatial distribution, search for relations with the magnetic field of the Galaxy and do other statistical work. The slow rate of revealing new magnetic stars is due first of all to the fact that a field can be found only by measuring Zeeman spectra obtained with high resolution at large telescopes the observational time of which rigidly regulated. It should be taken into account that practically all bright (brighter than 8^m) CP stars have already been investigated for the presence of magnetic fields. For this reason, one should look for new magnetic stars among fainter stars to obtain Zeeman spectra of which with a desired spectral resolution is especially difficult.

In connection with this, it is of current concern to search for and apply the criteria which could be used to accomplish a preliminary selection of stars — candidates for magnetic — by analysing comparatively readily accessible observations: photometry or low resolution spectroscopy data.

The broad and shallow depressions in continuous spectra detected by Glagolevskij (1966) and Kodaira (1969) turned out to be important distinguishing characteristic of these objects, which were consequently employed as criteria for selection of magnetic stars.

Cramer and Maeder (1980) have found a correlation between the so-called z parameter of the Geneva photometric system, which describes the depression at 5200 Å, and the strength of the surface magnetic field in CP stars of spectral classes B8–F0. The procedure of search for magnetic stars among CP stars with a large depression proved to be quite efficient: in particular, when working at the 6 m telescope (Glagolevskij et al., 1982; 1985), in approximately 30 % of the candidates we have selected, a magnetic field has been found.

It should be noted that a considerable part of the CP stars that we investigated in the 1980s with great depressions were fast rotators. The lines in their spectra were widened by rotation, which did not allow photographic Zeeman measurements to be made with a desired accuracy. It can therefore be suggested that the percentage of magnetic stars among the candidates — stars with strong depressions — is essentially higher than the found 30 %.

The introduction of CCD chips have enhanced considerably observational possibilities. This is why we have decided to go on searching for new magnetic stars among CP stars with strong depression at 5200 Å using the new technique.

2. Observations

The observations were made with camera 2 of the BTA MSS with a CCD of 1160 × 1040 (Chountonov and Glagolevskij, 1997) and circular polarization analysers (Naidenov and Chountonov, 1976; Chountonov, 1997). The procedure of the observations and their reduction is described in the papers by Romanyuk et al. (1998) and Kudryavtsev (2000).

We selected for observations 6 rather faint CP stars ($V = 8.5 \div 10$) with a strong depression at 5200 Å. These were HDE 343872, HD 29925,

HD 40711, BD –01.709, BD –03.987, BD +17.3622. No Zeeman observations of these stars had been made before. We based on the paper by Schneider (1986) for HDE 343872, the list of Bidelman (1985) for BD +17.3622 and the list of stellar groups of Egret and Jashchek (1981) for the rest of the stars.

During the period 1999–2001 we obtained 21 Zeeman spectra: 13 for the star HDE 343872 and 8 for the rest of the objects in the spectrum region 4450–4600 Å. The typical exposure time was 30–40 min., the S/N ratio was 50–100 with a spectral resolution R = 15000.

All the objects are cool CP stars, therefore a large enough number (20–50) of lines could be measured in each spectrum. The accuracy of measurements (σ = 200 – 400 G) was basically dependent on the quality (S/N ratio) of each obtained spectrum.

Note that magnetic investigations of such faint stars became possible after the introduction of CCD chips into Zeeman observations with the 6 m telescope and a grave updating of the Main stellar spectrograph (Panchuk, 2001).

3. Results of observations

3.1. HDE 343872

We have chosen the CP star HDE 343872 = BD +24.3675 ($V = 9.9^m$) for the study because a strong variable depression has been found in its continuous spectrum at 5200 Å, which varies with a period of about 7.5 days and an amplitude of 0.06^m, the largest among the previously measured CP stars (Schneider, 1986). The first Zeeman spectrum obtained by us showed a strong (over 3 kG) magnetic field B_e. Since the longitudinal magnetic field magnitude appeared to be more than the average of 1–2 kG, we decided to conduct a long enough cycle of observations to derive a B_e variability curve and determine the period of HDE 343872 rotation.

We will perform a detailed study of this star in a separate paper (being prepared to print), here we report only the results of magnetic field measurement (see Table 1). The columns of Table 1 present the following: the Julian date of the middle of exposure of each spectrum, the period phase, the longitudinal (B_e) field value, and the root-mean-square error of its measurement σ (in Gauss).

Based on these measurements, we have defined the period of magnetic variability of the star, P = 8.724 days. The period phases (Table 1) have been computed from the elements that we have determined:

JD = 2451768.000 + 8.724 E.

With the same period the curve of B_e variations is plotted in Fig. 1.

To chek independently the correctness of the period found, we have studied the variability of the depression at 5200 Å, in particular, a strongly variable detail at the wavelength 5152 Å. The observations were conducted at the 1 m telescope of SAO with the low-resolution spectrograph UAGS. The depth variation of this detail with the same period is shown in Fig. 2.

Table 1: *Magnetic field measurements for HDE 343872*

JD2451000+	phase	B_e	$\pm\sigma$
768.504	0.058	3590	300
770.391	0.274	2160	400
798.267	0.469	660	340
799.286	0.586	–760	220
800.432	0.718	–600	300
802.347	0.937	3860	250
804.315	0.162	2730	370
806.185	0.377	1980	350
807.185	0.492	1510	190
893.122	0.342	2210	350
952.640	0.165	3580	180
952.655	0.166	2880	300
953.622	0.277	2950	210

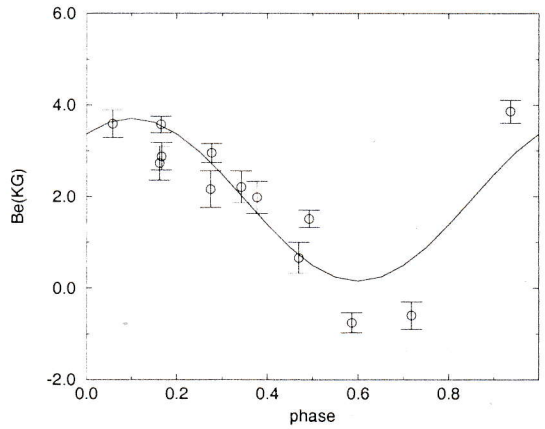

Figure 1: *Variability of longitudinal component of magnetic field B_e.*

Comparison of the curves of the magnetic field longitudinal component B_e and the depth of the detail R 5152 Å indicates that there is agreement between these values and that the period 8.724 days is, with a high degree of probability, the rotation period of HDE 343872. The disagreements with the depression variability period of 7.5 days, which is presented in the paper by Schneider (1986) can be explained by the fact that Schneider was observing this star only for 1 week, and the period that he determined from a single cycle of observations has therefore turned out to be inaccurate.

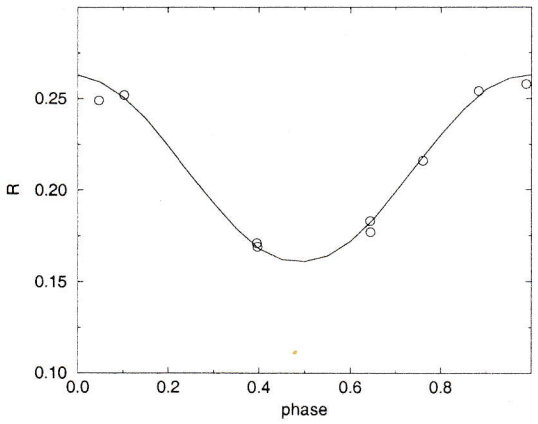

Figure 2: *Variability of depth of λ5152 Å detail in the HDE 343872 spectrum.*

Table 2: *Magnetic field measurements*

JD 2450000+	B_e	$\pm\sigma$
	BD-03.987	**V = 9.0**
1806.558	4040	230
1807.529	3770	310
1864.505	3590	290
	HD 29925	**V = 8.5**
1807.508	−1100	190
	HD 40711	**V = 8.4**
1807.550	−230	60
	BD-01.709	**V = 9.9**
1807.581	890	360
1864.534	30	440
	BD +17.3622	**V = 8.7**
1275.555	+1600	160
2069.450	+1510	200

3.2. Other CP stars

We have made magnetic field measurements in some other stars with strong depressions from the list of Egret and Jashchek (1981) and Bidelman (1985). Unfortunately, because of the faintness of the objects and the weather conditions, not always good, we failed to obtain a sufficient number of data. Eight Zeeman spectra proved to be fit for reduction. The results of their measurements are listed in Table 2.

It is seen from Table 2 that BD −03.987 possesses a strong magnetic field, however, the data are still inadequate to study the parameters of its variability. There are 2 alternatives which seem to be the most likely: either the star is seen magnetic pole-on, or the period of its rotation is very large.

The stars HD 29925 and BD +17.3622 are probably also magnetic, however, the results for each of them have been obtained from measuring one or two spectra, and therefore need to be confirmed. Because of the small number of observations, it is impossible to judge whether BD −01.709 and HD 40711 are magnetic stars.

4. Conclusions

On the basis of the data presented above, one can argue that the use of the Geneva photometry data proved to be advantageous: magnetic fields have been detected with a high degree of reliability in two stars, HDE 343872 and BD −03.987, out of 6 selected candidates — stars with large depressions. Two more stars, HD 29925 and BD +17.3622 are, probably, also magnetic, however additional observations are required to confirm the results.

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References

Bidelman W.P., 1985, Astron. J., **90**, 341
Cramer N., Maeder A., 1980, Astron. Astrophys., **88**, No. 1-2, 135
Chountonov G.A., 1997, in: Stellar magnetic fields, eds: Yu. V. Glagolevskij and I.I. Romanyuk, Moscow, 239
Chountonov G.A., Glagolevskij Yu.V., 1997, in: Stellar magnetic fields, eds: Yu. V. Glagolevskij and I.I. Romanyuk, Moscow, 225
Egret O., Jashchek H., 1981, Liege Coll., No.23, 495
Glagolevskij Yu.V., 1966, Ph.D. Thesis
Glagolevskij Yu.V., Bychkov V.D., Iliev I.Kh., Romanyuk I.I., Chunakova N.M., 1982, Pis'ma Astron. Zh., **8**, 26
Glagolevskij Yu.V., Bychkov V.D., Romanyuk I.I., Chunakova N.M., 1985, Astrofiz. Issled. (Izv. SAO), **19**, 37
Kodaira K., 1969, Astrophys.J., **157**, 59
Kudryavtsev D.O., 2000, in: Magnetic fields of CP and related stars, eds: Yu. V. Glagolevskij and I.I. Romanyuk, Moscow, 84
Naidenov I.D., Chountonov G.A., 1976, Soobshch. Spets. Astrofiz. Obs., **16**, 72
Panchuk V.E., 2001, Preprint SAO, No.154
Romanyuk I.I., Elkin V.G., Kudryavtsev D.O., Landstreet J.D., Wade G.A., 1998, Bull. Spec. Astrophys. Obs., 1998, **45**, 93
Romanyuk I.I., 2000, in: Magnetic fields of CP and related stars, eds: Yu. V. Glagolevskij and I.I. Romanyuk, Moscow, 18
Schneider H., 1986, IBVS, No.2870, Feb.25