MAGNETIC FIELD OF POLARIS

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ABSTRACT. 25 effective magnetic field (B_e) estimates of Polaris (α UMi) were obtained from July 1983 to December 2005 using 1m Zeiss and 6m BTA telescopes of SAO RAS, equipped by magnitometers. These data with added 7 ones from Borra et al. (1981), obtained in 1980 show that magnetizing force of Polaris vary from +162 to - 109 Gauss do not depend on the changes of pulsational amplitude, but Fourier analysis reveal variability of magnetic field with period of 3.97586 days, close well with its pulsational period of 3.96961 days.

Key words: Stars.

1. Introduction

α UMi named Polaris is perhaps an unique Cepheid with measured magnetic field during its pulsational period (Borra et al., 1981). Since Polaris is an unique Cepheid itself due to its unusial pulsational activity (Fernie et al., 1993, Usenko et al., 2005), revealed in the increase and decrease of light and radial velocity pulsational amlitude, it would be interesting to observe its magnetic field behavior. Since Polaris is a multiple system with visual and spectroscopic main-sequence companions, therefore its unusual pulsational activity could be connected with its effect. Therefore we attempted during last a quarter of a century to observe for possible changes of its magnetic field.

2. Observations

Observations of these objects have been realized using:

1. 6m telescope BTA SAO RAS (Russia), - equipped by the main stellar magnitometer with Fabri-Perot standard, used Cr I 4254.33 line (Bychkov et al., 1988), and hydrogen magnitometr, used H_β hydrogen lines as an indicator of magnetic field (Shtol', 1991, Shtol', 1993).
2. 1m Zeiss telescope SAO RAS (Russia), - equipped by the circular polarization analyzer ACP before CEGS spectrometer used from 477 to 890 spectral lines (Bychkov et al., 2006, Bychkov, 2008).

In the Table 1 we represent the B_e data of Borra et al. (1981) attached to radial velocities data, obtained by Arellano Ferro (1983). In the Table 2 are the original unpublished data, obtained during 1983 - 1987, using 6m telescope SAO RAS. And in the Table 3, - the last data, obtained during 2005, using 1m Zeiss telescope SAO RAS.

3. Results and Discussion

So, we have obtained 25 B_e values and that with 7 ones from Borra et al. (1981) add up to 32 measurements. These B_e values vary from +162 to -109 Gauss, respectively. As seen from the measurements' results, the effective magnetc field of Polaris do not depend on the changes of pulsational amplitude, nevertheless, we have observed long-periodical changes of the mean value during one year. To search any periodicity on the magnetic field's variability, we have used the Fourier analysis technique (PERIOD 98 program, Sperl, 1998). Unfortunately, we have very small set of observational data, nevertheless the highest amplitude peak corresponds to period of 3.97586 days that agrees well with the pulsational one of 3.96961 days! Hence, magnetic field variability of Polaris connected only with it pulsational period and do not depends from the increasing and decreasing of pulsational amplitude.

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Table 1: 1.2-m DAO (coude spectrograph) observations. The phase corresponds to the ephemeris of Brown & Bochonko (1994).

HJD 2440000+	B_e (Gauss)	σ (Gauss)	Phase*	RV ampl. (km s^{-1})	Remarks
4408.812	- 5.2	3.2	0.814	2.0±1	July 1980
4442.829	- 7.0	4.2	0.383		Circular polarization
4444.837	+ 15.5	3.4	0.889		of 230 lines
4470.984	- 2.5	3.2	0.475	2.0±1	August 1980
4471.744	- 3.5	4.8	0.667		ibid
4472.770	- 6.5	2.9	0.925		
4473.861	- 7.0	3.4	0.200		

Table 2: 6-m BTA, SAO RAS observations

HJD 2440000+	B_e (Gauss)	σ (Gauss)	Phase*	RV ampl. (km s^{-1})	Remarks
5545.390	+135	130	0.225	1.4±0.3	July-August 1983
5546.355	- 56	64	0.468		Magnitometer 4254.33 Ca I line
5547.367	- 72	66	0.722		RV Kamper et al. (1984)
5929.483	- 34	36	0.983	3.0±0.5	August 1984
5931.477	+104	70	0.486		RV Kamper (1996)
5932.519	- 48	76	0.748		
6633.337	- 29	36	0.295	1.5±0.5	July 1986
6634.395	- 10	40	0.561		Hydrogen magnitometer H_β line
6635.412	+ 67	47	0.818		RV Kamper (1996)
6777.228	0	27	0.543	1.5±0.5	December 1986
6780.283	- 55	26	0.313		Magnitometer 4254.33 Ca I line
6780.566	- 24	39	0.384		RV Kamper (1996)
7022.419	- 95	32	0.310	1.7±0.4	August 1987
7023.183	- 28	62	0.503		RV Dinshaw et al. (1989)

Table 3: 1-m Zeiss SAO RAS observations

HJD 2450000+	B_e (Gauss)	σ (Gauss)	Phase*	RV ampl. (km s^{-1})	Remarks
3628.530	+ 34	40	0.490	2.4±0.1	September 2005
3629.575	- 3	33	0.753		RV Usenko et al. (2008)
3632.584	+114	29	0.511		
3633.599	-109	52	0.767		
3636.598	+162	56	0.523		
3637.600	+ 14	29	0.775		
3638.499	- 88	97	0.002		
3665.606	- 9	24	0.831	2.4±0.1	October 2005
3666.615	- 38	28	0.084		
3667.603	+ 44	30	0.333		
3692.644	- 19	20	0.642	2.4±0.1	November 2005
3718.485	- 34	15	0.151		December 2005

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