

Magnetic chemically peculiar stars

I. Catalogue

I.I. Romanyuk

Special Astrophysical Observatory of the Russian AS, Nizhnij Arkhyz 369167, Russia

Abstract. On the basis of analysis of original publications and our own measurements a Catalogue of magnetic chemically peculiar (CP) upper main-sequence stars has been established. The sample includes 211 magnetic CP stars with magnetic fields ranging from hundreds of gauss to dozens of kilogauss, for 49 of them the surface magnetic field (B_s) has been measured from the Zeeman splitting.

1. Introduction

Magnetic fields of stars were discovered by Babcock in 1947. More than 50 years ago he found the Zeeman effect in the spectra of the Ap star 78 Vir. Many thousand magnetic measurements of different type stars made from young Herbig Ae/Be and T Tau stars to magnetic white dwarfs at the final stage of evolution have been made ever since.

The measurements show that magnetism is a wide-spread phenomenon among stars. As a rule, different types of bursts, explosions and other instabilities are connected with magnetic fields.

Unfortunately, magnetic field measurements are a very involved problem. For example, even the modern technique often fails to detect magnetic fields (even very strong) of complex topology.

From the late 40s to the middle 80s mainly photographic Zeeman spectra were analyzed, their low S/N ratio (20-30) did not permit fine analysis of line profiles, especially studying distribution of circular and linear polarization over the line profile.

That is why, the detection of complex structure magnetic fields (of the type of solar spots) was impossible.

Fortunately, chemically peculiar stars have ordered, mainly dipolar, very reliably measurable magnetic fields. The simple configuration of their magnetic fields leads to Zeeman shifts (very rarely to magnetic splitting) of lines as a whole, while in the case of complex non-dipolar magnetic field one needs to study the fine structure of line profiles. Results of Babcock's measurements are presented in his famous catalogue (Babcock, 1958).

Since the magnetic field value in CP stars is about a few kilogauss (which correspond to a Zeeman splitting of about 0.1-0.2 Å) only spectra of narrow-line stars can be measured for detection of magnetic fields.

The accuracy of measurements is highly dependent on the line width and therefore magnetic field measurements of fast-rotating CP stars (with $v \sin i > 40$ km/s) were impossible.

Photoelectric Balmer-line magnetometers were first used by Landstreet in 1970. He measured circular polarization in the wings of hydrogen lines. A Balmer magnetometer was effectively used in searching for magnetism of fast-rotating stars, hot helium-strong and helium-weak stars, magnetic white dwarfs, where photographic techniques would not be used because of the small number of broad lines in their spectra.

The results of magnetic measurements from 1958 to 1982 were collected by Didelon (1983).

Zeeman observations of CP stars provide direct evidence of magnetic fields, independently of any models. Various assumptions have certainly to be made when constructing magnetic field configuration models and field mapping.

New digital techniques: reticons and then CCD detectors permit study the line profiles with a high S/N ratio and a high spectral resolution. This made it possible to start studying magnetic field complex structure (for example, Robinson, 1980). Many new magnetic stars have been discovered, especially among cool stars.

The situation with magnetic field measurements of CP stars has also undergone essential changes: the use of CCD permits studying not only average parameters of lines (equivalent width, radial velocity, Zeeman shift), but, using the analysis of intensity and polarization profiles, also simultaneous mapping of chemical composition and magnetic field on the surface of CP stars and looking for connection between them. Separate attempts of doing this work were made earlier (for example, Khokhlova, 1983), but it is at the present time that the work has become extensive and coordinated.

A second important achievement in the study of CP stars is due to Hipparcos results. Recently the Hipparcos satellite has measured parallaxes of most of the magnetic CP stars. This permits reliable distances and, as a result, accurate absolute parameters and reliable spatial distribution of magnetic CP stars in our Galaxy to be found.

Magnetic field observations are still extremely rare: tens of thousands of stars against a few hundred magnetic stars are known to have measured radial velocities.

2. Catalogue

2.1. Fraction of CP stars

A General catalogue of Ap and Am stars, which contains almost 6700 stars, has been completed by Renson et al. (1991a), a database for 3195 Ap stars was described by Renson et al. (1991b).

The number of CP stars is essentially higher than the number of magnetic stars. More than 90% of known CP stars have never been observed with a Zeeman analyzer; most of them are faint CP stars and for their measurements one has to request time on the world's largest telescopes.

It can commonly be found in the literature that CP stars account for 10-15 % of main sequence stars of the same spectral class (e.g. see Khokhlova, 1983).

The Hipparcos team (Gomes et al., 1998) informed that among stars brighter than 7.5 mag one can find 2578 normal main-sequence stars and 467 different chemically peculiar stars in the spectral range B5-F5 in the Hipparcos catalogue. Thus we can calculate a fraction as $467/(2578 + 467) = 15.3\%$.

We have enough sufficient evidence to be certain that all chemically peculiar stars brighter than 7.5 mag have been properly classified because all bright stars have been analyzed using spectra obtained with a reasonably high spectral resolution. We can also conclude that the Hipparcos data have practically not changed the fraction of CP stars.

2.2. Catalogue of magnetic CP stars

The last published catalogue of magnetic measurements (Didelon, 1983) contains information for about 140 magnetic chemically peculiar stars. Mainly it consists of Babcock's catalogue (1958) of magnetic measurements and also photoelectric magnetic measurements of Landstreet and his co-authors.

However, during the last 15 years new data have been taken by observations with new digital devices and many new magnetic CP stars of the main sequence have been discovered.

Because Didelon's catalogue has become outdated, our purpose is to select from original papers all

possible information about magnetic measurements of CP stars, to make a new list of magnetic CP stars and to conduct a complex study of the stars from this list.

We have collected about 10000 magnetic measurements of different type main-sequence stars (published and our own). Taking into account unpublished results or ones available in the inaccessible publications, we estimate that 20000 magnetic measurements of about 300 CP and 200 normal stars have been made.

Most of them have been made by H. Babcock, G. Preston and his co-authors, J. Landstreet and his co-authors, G. Mathys with his co-authors and by the SAO group with the 6 m telescope of Russian Academy of Sciences.

Observations of most stars yield "zero-field" results: practically all normal stars (for example, Landstreet, 1982) and a large fraction of chemically peculiar stars do not show magnetic fields larger than the typical accuracy of measurements (100-300 G). For very bright narrow-line CP stars the accuracy is essentially better, since the standard error σ is about a few dozen gauss.

Publication of all measurements from our catalogue is too difficult because of the large body of collected data. Now we are making the first step only: we present a new sample of magnetic CP stars. We have included in our list only such stars, which have been found to be magnetic by the authors of the original publications.

On the basis of all collected data we have made a sample of 211 magnetic chemically peculiar stars with reliably measured magnetic fields. We present the star HD/BD number, information about the longitudinal field (B_l) extrema, surface magnetic field (B_s), number of measurements [n] and references in Table 1.

3. Conclusion

Thus we have found 211 magnetic CP stars. Surface magnetic field (B_s) estimates are available for only 49 of them. Magnetic field data for the rest of the stars (162) of our sample have been obtained from measuring the longitudinal components (B_l) alone.

For some stars the longitudinal magnetic field (B_l) magnitudes derived from data of different authors are dramatically different. Since the aim of this first paper from a series of papers to appear is to make available a list of magnetic CP stars (a detailed analysis of magnetic fields and other parameters of stars is expected to be made later on), we have decided to postpone the discussion of the differences and tabulate herein only the extreme B_l values.

A sufficiently large number (over 10) of measurements of B_l have been made for 79 magnetic CP stars,

Table 1: *Magnetic chemically peculiar stars*

HD/BD	B_e extrema (G)	[n] B_e	B_p (G)	[n] B_p	References
HD 965	-	-	4400	6	126
HD 2453	-1000/-300	6	3700	8	1,126,127
HD 3980	-1200/+1300	8	-	-	77, 83
HD 4778	-1100/+1400	22	-	-	1, 105
HD 5737	-400/+500	23	-	-	92,109,127
BD +40.175 A	-3400/-2020	5	18000	5	128, 131
BD +40.175 B	+780/+2660	5	-	-	131
HD 6532	-517	1	strong	-	127
HD 8441	-700/+400	14	-	-	1
HD 8855	-600/+270	2	-	-	99
HD 9996	-1700/+400	>30	4800	11	1,21,26,91,126
HD 10783	-100/+1800	23	-	-	1, 7, 42
HD 11187	-70/+1200	7	-	-	1
HD 11503	-900/+410	17	-	-	79
HD 12288	-3100/-200	20	7900	20	126, 133, 137
HD 12447	-510/+430	21	-	-	79
HD 12767	-230/+290	8	-	-	79
HD 14437	-2000/-800	26	7700	17	86, 99,126,130,133,137
HD 15089	-65/+350	4	-	-	79
HD 15144	-1100/-530	>35	-	-	1, 88
HD 18078	-	-	3800	5	126, 138
HD 18296	-1000/+1350	>20	-	-	1, 9,79,104
HD 19832	-350/+380	11	-	-	79
HD 19918	-848	1	-	-	127
HD 21590	-100/+1600	3	-	-	99
HD 21699	< 500	?	-	-	100
HD 22316	-2200/+600	>20	-	-	138, 142
HD 22470	-1100/+1200	11	-	-	92
HD 22920	+200/+400	5	-	-	92, 127
HD 24155	-440/+1660	6	-	-	114
HD 24712	+200/+1600	>30	2600	?	34,76,111,129
HD 25267	-345/-15	7	-	-	79
HD 25354	-350/-20	4	-	-	1
HD 25823	-100/+1200	20	-	-	1, 37
HD 27309	-1200/-200	5	-	-	79, 99
HD 28843	-500/+250	5	-	-	92
HD 29578	-	-	2700	9	126
HD 30466	+1800/+2200	>5	-	-	1, 99
HD 32633	-5700/+3500	>40	-	-	1, 5,79,97,111
HD 33904	-170/+325	5	-	-	1, 79
HD 34452	-300/+1000	20	-	-	79, 99, 114
HD 35298	-2800/+2900	5	-	-	85
HD 35456	-300/+1080	6	-	-	85
HD 35502	-2200/-100	6	-	-	85
HD 36313	-1500/-1100	6	-	-	85
HD 36429	-840/+160	5	-	-	85
HD 36485	-3700/-1900	7	-	-	101,127
HD 36526	-980/+3480	6	-	-	85
HD 36540	-400/+1000	4	-	-	85
HD 36629	-1300/+1100	?	-	-	90
HD 36668	-1590/+1320	6	-	-	85
HD 36916	-640/-615	2	-	-	82, 92
HD 37017	-2300/-300	>30	-	-	69,72,101

Table 1: *Magnetic chemically peculiar stars (continued)*

HD/BD	B_e extrema (G)	[n] B_e	B_p (G)	[n] B_s	References
HD 37058	-800/+1000?	> 8	-	-	92, 127
HD 37140	-1050/+400	6	-	-	85
HD 37210	-760/-400	4	-	-	85
HD 37479	-1600/+3500	14	-	-	101
HD 37642	-2980/+2700	6	-	-	85
HD 37776	-2000/+1000	>50	80000	>50	72,98,112,123,136
HD 40312	-240/+360	18	-	-	79
HD 42616	-440/-840	4	-	-	1
HD 47103	-4000/-3000	11	17500	7	119,128
HD 49333	-800/+800	8	-	-	92, 114
HD 49606	-770/-100	>10	-	-	89, 114
HD 49976	-2000/+2200	>20	-	-	1,25,51,52
HD 50169	+700/+2000	7	5000	13	1, 126
HD 51418	-200/+750	10	-	-	41
HD 54118	-1600/+1600	7	-	-	114
HD 55719	-1040/+2100	>10	6500	29	54,126,127
HD 58260	+2000/+2600	10	-	-	72, 101
HD 59435	-	-	3200	19	126, 132
HD 61468	?	-	7300	4	126
HD 62140	-2200/+3200	>20	-	-	25, 46
HD 63843	-	-	11500	1	128
HD 64486	-1300/+600	6	-	-	25, 114
HD 64740	-870/+530	18	-	-	72, 101
HD 65339	-5400/+4200	>100	12800	>30	1,2,14,30,47,35,40,60, 62,70,78,105,126,138
HD 66522	-80/+1030	4	-	-	101
HD 68351	-50/+210	3	-	-	1, 114
HD 70331	-2800	1	12400	31	126, 127
HD 71866	-2000/+2000	> 100	-	-	1, 22
HD 72968	-700/+500	>30	2800	?	1,18,25,50
HD 73340	-2300/-900	5	-	-	114
HD 74521	-200/+1400	15	-	-	1, 111, 114
HD 75445	-	-	3000	9	126
HD 78316	-640/+460	> 20	-	-	1,11
HD 79158	-1200/+900	> 25	-	-	92, 116
HD 81009	-100/+2500	> 50	8400	39	25, 126, 139
HD 83368	-800/+800	13	-	-	93, 111, 127
HD 86592	-	-	16000	2	128
HD 89822	-290/+340	5	-	-	1,24,43,79
HD 90044	-800/+700	6	-	-	114
HD 90569	-230/+400	16	-	-	1, 53
HD 92664	-1300/-100	18	-	-	82, 114
HD 93507	+1600/+2600	2	7200	28	126, 127
HD 94660	-3300/-2100	8	6200	17	114, 126, 127
HD 96446	-2100/-1100	20	-	-	72, 101, 111
HD 96707	-3900/+800	20	-	-	25, 124
HD 98088	-1200/+1000	>20	-	-	1, 39
HD 101065	-2200/-2300	3	-	-	55
HD 103192	-250/-100	5	-	-	114
HD 103498	-630/+250	5	-	-	99

Table 1: *Magnetic chemically peculiar stars (continued)*

HD/BD	B_e extrema (G)	[n] B_e	B_s (G)	[n] B_s	References
HD 108651	-200/+560	5	-	-	1, 25
HD 108662	-1150/+550	>30	-	-	1,11,
HD 108945	+20/+440	3	-	-	79
HD 109026	+140/+470	5	-	-	92
HD 110066	-55/+300	5	4100	4	1,126
HD 111133	-1500/-500	>20	-	-	1,32, 86, 99
HD 112185	-50/+150	>30	-	-	75, 87, 141
HD 112381	-3700/-3100	5	-	-	114
HD 112413	-1400/+1600	>100	-	-	1,15,16,17,57,60,65,70, 71,75,78,96,111,138
HD 115708	-1500/+900	13	-	-	1, 120
HD 116114	-1900	1	5900	18	126, 127
HD 116458	-2200/-1300	17	4600	15	90,126,127
HD 118022	-1800/-200	>20	-	-	1,8,71,79
HD 119027	-	-	3100	12	126
HD 119213	-500/+1200	>50	-	-	94, 95
HD 119419	-4200/+1800	31	-	-	102,111, 114, 127
HD 120198	-1300?/+200	9	-	-	79, 99
HD 122532	-900/+900	24	-	-	102, 111, 114
HD 124224	-437/+811	14	-	-	79
HD 125248	-2500/+2800	50	-	-	1,2,10,79, 111, 127
HD 125823	-440/+370	19	-	-	49, 92
HD 126515	-2000/+2000	50	12300	20	1,23,25,111,126,127
HD 128898	-400/0	7	-	-	79, 111,127
HD 130559	-1300/-200	7	-	-	1
HD 133029	+1300/+3300	50	-	-	1,33,58,64,79
HD 133652	-2100/+700	8	-	-	114
HD 133880	-4400/+1920	12	-	-	108
HD 134214	-600/-200	2	3100	26	126, 127
HD 134793	-530/+450	5	-	-	1
HD 135297	-1100	1	-	-	1
HD 137193	+230/+970	4	-	-	102
HD 137389	-	2	-	-	25, 114
HD 137509	-1200/+2200	17	strong	-	111, 114, 127
HD 137909	-900/+1000	>100	5500	32	1,6,19,22,36,56,59,60, 68,71,79, 96,110,111,138
HD 137949	+980/+1920	14	4600	13	1,25,126,127
HD 140160	-1840/+760	?	-	-	90
HD 140728	-400/+400	5	-	-	79, 86,99, 114
HD 142070	-	?	4900	22	126
HD 142301	-4100/+1600	?	-	-	74, 92
HD 142884	950	3	-	-	82
HD 142990	-2500/+600	14	-	-	92, 114
HD 143473	+4200/+5100	4	-	-	111, 114
HD 143699	-250/-50	4	-	-	92
HD 143807	-340/+80	6	-	-	1
HD 144334	-1400/+500	12	-	-	92
HD 144661	-400/+1100	5	-	-	92
HD 144897	+2000	1	9000	26	126, 127
HD 145501	-1480/-1190	4	-	-	92
HD 146001	-200/+1300	5	-	-	92
HD 147010	-4500/-2500	21	-	-	82, 86,99,102,111,127,138
HD 148112	-250/-90	9	-	-	79

Table 1: *Magnetic chemically peculiar stars (continued)*

HD/BD	B_e extrema (G)	[n] B_e	B_s (G)	[n] B_s	References
HD 148199	-900/+1450	13	-	-	102, 114
HD 148330	-600/+200	15	-	-	140
HD 148898	-170/+370	4	-	-	79
HD 149911	-2100/+450	6	-	-	25
HD 150562	-	-	4800	7	126
HD 151525	(-)	2	-	-	1
HD 151965	-3700/-550	8	-	-	114
HD 152107	+500/+2000	>50	-	-	1, 79, 80, 107
HD 153882	-1800/+3100	>40	-	-	1,28, 111, 127, 138
HD 318107	+1980	1	14300	32	126, 127
HD 164258	-400/+1100	5	-	-	99
HD 164429	-640	1	-	-	114
HD 165474	-100/+900	3	6500	23	1, 111, 126, 127
HD 166473	-2200/-2000	3	7700	23	126, 127
HD 168733	-1000/-400	17	-	-	48, 111, 127
HD 170000	-180/+640	?	-	-	79
HD 170397	-650/+870	10	-	-	79, 114
HD 170973	-400/+1000	4	-	-	111, 114
HD 171586	-740?	1	-	-	1
HD 173650	-500/+700	>20	-	-	1
HD 174933	-500/+1550	?	-	-	90
HD 175362	-5000/+7000	>30	28000	est	63,81, 92, 101, 111, 127
HD 176232	-315/+440	6	-	-	1, 127
HD 177517	-600/+200	3	-	-	79
HD 177765	-	-	3400	-	126
HD 179761	-590/+170	4	-	-	1
HD 183339	-1600/+1800	5	-	-	100
HD 184905	var(+/-)	26	-	-	1
HD 184927	-1200/+3000	27	-	-	100, 134
HD 187474	-1800/+1800	15	5000	28	126, 127
HD 188041	-200/+1500	25	3600	15	1, 13, 20,111, 126, 127
HD 190073	+120	2	-	-	1
HD 191742	-900/-200	3	-	-	1
HD 192678	+1000/+1800	>20	4700	34	86, 99, 121, 126
HD 192913	-670/+380	5	-	-	1
HD 196178	-1500/-700	9	-	-	79
HD 196502	-700/-200	>20	-	-	1, 4
HD 335238	-1300	1	8700	16	126, 127
HD 200177	-1900/+300	4	-	-	85, 99
HD 200311	-1800/+1800	>25	8600	28	126, 135
HD 201601	-1100/+600	>100	3800	>50	1,5,6,29,30,40,45,66, 73,79,126,127,138
HD 203006	-650	1	-	-	1
HD 205087	-200/+800	6	-	-	99, 114
HD 208095	-10000?	1	-	-	25
HD 208217	-	-	8000	31	126
HD 209515	-270/+560	4	-	-	79
HD 213918	> 1000	3	-	-	82
HD 215038	-3000	2	-	-	1
HD 215441	+10000/+20000	>50	34000	>50	3, 12,35,38,67,84,113
HD 216018	+1200/+1300	3	5600	18	126, 127
HD 216533	-1000/+100	3	-	-	1, 61
HD 217833	-5500/-2000?	17	-	-	100, 115

Table 1: *Magnetic chemically peculiar stars (continued)*

HD/BD	B_e extrema (G)	[n] B_e	B_s (G)	[n] B_s	References
HD 220825	-400/+200	4	-	-	1, 79
HD 221006	+410/+990	3	-	-	114
HD 221394	-1490/-1100	4	-	-	99
HD 221568	1000	2	-	-	138
HD 223640	(-)	?	-	-	1
HD 224801	+250/+2200	2	-	-	1

References to Table 1

- | | |
|---------------------------------|------------------------------------|
| 1 - Babcock, 1958 | 50 - Hensberge, De Loore, 1974 |
| 2 - Adam, 1965 | 51 - Pilachowski et al., 1974 |
| 3 - Babcock, 1960 | 52 - Maitzen, Albrecht, 1975 |
| 4 - Babcock, 1963 | 53 - Bonsack, 1976(a) |
| 5 - Preston, Stepien, 1968(a) | 54 - Bonsack, 1976 (b) |
| 6 - Preston, Sturch, 1967 | 55 - Wolff, Hagen, 1976 |
| 7 - Preston, Stepien, 1968(b) | 56 - Bona, Vaughan, 1976 |
| 8 - Preston, 1969 (a) | 57 - Borra, Landstreet, 1977 |
| 9 - Preston, 1969(b) | 58 - Bonsack, 1977(a) |
| 10 - Hockey, 1969 | 59 - Borra, Vaughan, 1977 |
| 11 - Preston et al., 1969 | 60 - Glagolevskij et al., 1977 |
| 12 - Preston, 1969(c) | 61 - Floquet, 1977 |
| 13 - Wolff, 1969(a) | 62 - Landstreet, Borra, 1977 |
| 14 - Preston, 1969(d) | 63 - Wolff, Wolff, 1976 |
| 15 - Cohen et al., 1969 | 64 - Bonsack, 1977(b) |
| 16 - Pyper, 1969 | 65 - Borra, Vaughan, 1978 |
| 17 - Kodaira, Unno, 1969 | 66 - Schoiz, 1978 |
| 18 - Steinitz, Pyper, 1969 | 67 - Borra, Landstreet, 1978 |
| 19 - Preston, 1969(e) | 68 - Freeman, 1978 |
| 20 - Wolff, 1969(b) | 69 - Landstreet, 1978 |
| 21 - Preston, Wolff, 1970 | 70 - Glagolevskij et al., 1978 |
| 22 - Wolff, Wolff, 1970 | 71 - Wolff, 1978 |
| 23 - Preston, 1970 | 72 - Borra, Landstreet, 1979 |
| 24 - Conti, 1970 | 73 - Scholz, 1979 |
| 25 - Heuvel van den, 1971 | 74 - Landstreet et al., 1979 |
| 26 - Preston, 1971 | 75 - Glagolevskij et al., 1979 |
| 27 - Ewans, Elste, 1971 | 76 - Bonsack, 1979 |
| 28 - Hockey, 1971 | 77 - Maitzen et al., 1980 |
| 29 - Steinitz, Pyper, 1971(a) | 78 - Romanyuk, 1980 |
| 30 - Schoiz, 1971 (a) | 79 - Borra, Landstreet, 1980 |
| 31 - Schoiz, 1971(b) | 80 - Wolff, Preston, 1978 |
| 32 - Wolff, Wolff, 1971 | 81 - Hensler, 1978 |
| 33 - Steinitz, Pyper, 1971 (b) | 82 - Brown et al., 1981 |
| 34 - Preston, 1972 | 83 - Wood, Albrecht, 1981 |
| 35 - Kemp, Wolstencroft, 1973 | 84 - Glagolevskij et al., 1981 |
| 36 - Borra, Dworetsky, 1973 | 85 - Borra, 1981 |
| 37 - Wolff, 1973 | 86 - Glagolevskij et al., 1982 (a) |
| 38 - Adelman, 1974 | 87 - Glagolevskij et al., 1982 (b) |
| 39 - Hensberge, 1974 | 88 - Bonsack, 1981 |
| 40 - Bonsack, Pilachowski, 1974 | 89 - Chunakova et al., 1981 |
| 41 - Jones et al., 1974 | 90 - Didelon, 1983 |
| 42 - Borra, 1974 | 91 - Schoiz, 1983 |
| 43 - Oetken, Orwert, 1973 | 92 - Borra et al., 1983 |
| 44 - Severny et al., 1974 | 93 - Thompson, 1983 |
| 45 - Schoiz, 1975 | 94 - Glagolevskij et al., 1984 |
| 46 - Bonsack et al., 1974 | 95 - Mikulasek et al., 1984 |
| 47 - Huchra, 1972 | 96 - Romanyuk, 1984 |
| 48 - Jones, Wolff, 1974 | 97 - Renson, 1984 |
| 49 - Wolff, Morrison, 1974 | 98 - Thompson and Landstreet, 1985 |

- 99 - Glagolevskij et al., 1985
 100 - Chunakova and Glagolevskij, 1985
 101 - Bohlender et al., 1987
 102 - Thompson et al., 1987
 103 - Romanyuk, 1986
 104 - Glagolevskij et al., 1987
 105 - Glagolevskij et al., 1988
 106 - Bohlender, 1989
 107 - Gerth, 1990
 108 - Landstreet, 1990
 109 - Shore et al., 1990
 110 - Romanyuk, 1991
 111 - Mathys, 1991
 112 - Kopylova and Romanyuk, 1992
 113 - Elkin, 1992
 114 - Bohlender et al., 1993
 115 - Elkin, 1994
 116 - Bohlender, 1994
 117 - Bychkov et al., 1992
 118 - Romanyuk et al., 1995
 119 - Elkin, Wade, 1996
 120 - Wade et al., 1996 (a)
 121 - Wade et al., 1996 (b)
 122 - Glagolevskij et al., 1995
 123 - Romanyuk et al., 1997
 124 - Bychkov et al., 1997(a)
 125 - Bychkov et al., 1997 (b)
 126 - Mathys et al., 1997
 127 - Mathys, Hubrig, 1997
 128 - Babel, North, 1997
 129 - Leroy, 1995
 130 - Romanyuk, Kudryavtsev, 1998
 131 - Elkin, 1999
 132 - Wade et al., 1999 (a)
 133 - Romanyuk et al., 2000
 134 - Wade et al., 1997 (a)
 135 - Wade et al., 1997 (b)
 136 - Romanyuk et al., 1999
 137 - Wade et al., 2000 (a)
 138 - unpublished
 139 - Wade et al., 2000 (b)
 140 - Ziznovsky, Romanyuk, 1990
 141 - Bohlender, Landstreet, 1990
 142 - Hill, Blake, 1996

21 of which are slow rotators with more than 10 surface magnetic field estimates. For these 21 stars reliable magnetic field models can be constructed.

The number of stars is certainly very small to comply with the requirements for observational data.

Acknowledgements. I would like to thank my colleagues from the Stellar Magnetism Laboratory of SAO RAS, V.G. Elkin and D.O. Kudryavtsev, for helpful discussions and the Russian Foundation for Basic Research for partial financial support.

References

- Adam M.G., 1965, *Observatory*, 85, No. 948, 204
 Adelman S.J., 1974, *Astrophys. J. Suppl. Ser.*, 27, 242.
 Babel J., North P., 1997, *Astron. Astrophys.*, 325, 195
 Babcock H.W., 1958, *Astrophys. J. Suppl. Ser.*, 30, 141
 Babcock H.W., 1960, *Astrophys. J.*, 132, No. 3, 521
 Babcock H.W., 1963, *Publ. Astr. Soc. Pacific*, 75, No. 422, 74
 Bohlender D., Brown D., Landstreet J., Thompson I., 1987, *Astrophys. J.*, 323, 325
 Bohlender D., 1989, *Astron. Astrophys.*, 220, 215
 Bohlender D.A., Landstreet J.D., 1990, *Astrophys. J.*, 358, L25
 Bohlender D.A., Landstreet J.D., Thompson I.B., 1993, *Astron. Astrophys.*, 269, 355
 Bohlender D.A., 1994, in: Balona A., Hendrichs H., Contt J. (eds.), *IAU Symp. No. 162, "Pulsation, rotation and mass-loss in early stars"*, 165
 Bonsack W., Pilachowski C, 1974, *Astrophys. J.*, 190, No. 2, 327
 Bonsack W., Pilachowski C, Wolff S.C., 1974, *Astrophys. J.*, 187, No. 2, 265
 Bonsack W.K., 1976 (a), *Publ. Astr. Soc. Pacific*, 88, No. 521, 19
 Bonsack W.K., 1976 (b), *Astrophys. J.*, 209, 160
 Bonsack W.K., 1977(a), *Astron. Astrophys.*, 59, No. 1-2, 195
 Bonsack W.K., 1977 (b), *Publ. Astr. Soc. Pacific*, 89, No. 531, 613
 Bonsack W.K., 1979, *Publ. Astr. Soc. Pacific*, 91, No. 543, 648
 Bonsack W.K., 1981, *Publ. Astr. Soc. Pacific*, 93, No. 556, 756
 Borra E.F., Dworetzky M.M., 1973, *Astrophys. J.*, 186, No. 1, 211
 Borra E.F., 1974, *Astrophys. J.*, 193, 699
 Borra E.F., Vaughan A.H., 1976, *Astrophys. J.*, 210, No. 3, L145
 Borra E.F., Landstreet J.D., 1977, *Astrophys. J.*, 212, No. 1, 141
 Borra E.F., Vaughan A.H., 1977, *Astrophys. J.*, 216, No. 2, 462
 Borra E.F., Vaughan A.H., 1978, *Astrophys. J.*, 220, No. 3, 924
 Borra E.F., Landstreet J.D., 1978, *Astrophys. J.*, 222, No. 1, 226
 Borra E.F., Landstreet J.D., 1979, *Astrophys. J.*, 228, No. 3, 809
 Borra E.F., Landstreet J.D., 1980, *Astrophys. J. Suppl. Ser.*, 42, No. 3, 421
 Borra E.F., 1981, *Astrophys. J.*, 249, No. 1, L39
 Borra E.F., Landstreet J.D., Thompson I.B., 1983, *Astrophys. J. Suppl. Ser.*, 53, No. 1, 151
 Brown D.N., Landstreet J.D., Thompson I.B., 1981, in: "Upper Main Sequence CP stars", 23rd Liege Coll., Liege, 1981, 195
 Bychkov V.D., Elkin V.G., Shtol V.G., 1992, in: "Stellar

- magnetism", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), S. Petersburg, Nauka, 211
- Bychkov V.D., Kostynchuk L.Yu., Shtol V.G., 1997, in: "Stellar magnetic fields", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), Moscow, 110
- Bychkov V.D., Gerth E., Kroll R., Shtol V.G., 1997, in: "Stellar magnetic fields", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), Moscow, 204
- Chunakova N.M., Bychkov V.D., Glagolevskij Yu.V., 1981, *Soobshch.SAO*, 3 1, 3
- Cohen J., Deutsh A., Greenstein J., 1969, *Astrophys. J.*, 156, No. 2, 629
- Conti P.S., 1970, *Astrophys. J.*, 160, No. 2, 309
- Didelon P., 1983, *Astron. Astrophys. Suppl. Ser.*, 53, No. 1, 119
- Elkin V.G., Glagolevskij Yu.V., Romanyuk I.I., 1987, *Astrofiz. Issled. (Izv. SAO)*, 25, 24
- Elkin V.G., 1992, in: "Stellar magnetism", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), S. Petersburg, Nauka, 67
- Elkin V.G., 1994, in: "Chemically Peculiar and Magnetic Stars", J. Zverko and J. Ziznovsky (eds.), *Tatranska Lomnica*, 35
- Elkin V.G., Wade G.A., 1996, in: "Stellar magnetic fields", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), Moscow, 106
- Elkin V.G., 1999, *Pis'ma Astron. Zh.*, 25, No. 12,
- Ewans J.C., Elste G., 1971, *Astron. Astrophys.*, 12, 428
- Floquet M., 1977, *Astron. Astrophys. Suppl. Ser.*, 30, No. 1, 27
- Freeman R.S., 1978, *Astrophys. J.*, 224, No. 3, 910
- Gerth E., 1990, *Astron. Nachr.*, 311, 41
- Glagolevskij Yu.V., Kozlova K.I., Kopylov I.M., Kumajgorodskaya R.N., Lebedev V.S., Romanyuk I.I., Chunakova N.M., Chountonov G.A., 1977, *Pis'ma Astron. Zh.*, 3, No. 11, 500
- Glagolevskij Yu.V., Najdenov I.D., Romanyuk I.I., Chunakova N.M., Chountonov G.A., 1978, *Soobshch. SAO*, 24, 61
- Glagolevskij Yu.V., Chountonov G.A., Najdenov I.D., Romanyuk I.I., Ryadchenko V.P., Borisenko A.N., Drabek S.V., 1979, *Soobshch. SAO*, 25, 5
- Glagolevskij Yu.V., Kozlova K.I., Kumajgorodskaja R.N., Lebedev V.S., Romanyuk I.I., Chunakova N.M., 1981, *Astrofiz. Issled. (Izv. SAO)*, 13, 3
- Glagolevskij Yu.V., Bychkov V.D., Iliev I. Kh., Romanyuk I.I., Chunakova N.M., 1982, *Pis'ma Astron. Zh.*, 8, No. 1, 26
- Glagolevskij Yu.V., Bychkov V.D., Iliev I. Kh., Najdenov I.D., Romanyuk I.I., Chountonov G.A., 1982, *Astrofiz. Issled. (Izv. SAO)*, 15, 13
- Glagolevskij Yu.V., Romanyuk I.I., Bychkov V.D., Lebedev V.S., 1984, *Astrofiz. Issled. (Izv. SAO)*, 18, 57
- Glagolevskij Yu.V., Bychkov V.D., Romanyuk I.I., Chunakova N.M., 1985, *Astrofiz. Issled. (Izv. SAO)*, 19, 16
- Glagolevskij Yu. V., Chunakova N.M., 1985, *Astrofiz. Issled. (Izv. SAO)*, 19, 37
- Glagolevskij Yu.V., Elkin V.G., Romanyuk I.I., Piskunov N.E., 1988, in: "Magnetic stars", Yu.V. Glagolevskij and I.M. Kopylov (eds.), Leningrad, Nauka, 32
- Glagolevskij Yu.V., Elkin V.G., Romanyuk I.I., Shtol V.G., 1995, *Pis'ma Astron. Zh.*, 21, No. 3, 190
- Gomes A.E., Luri X., Greiner S., Figueras F., North P., Royer F., Torra J., Mennessier M.O., 1998, *Astron. Astrophys.*, 336, 953
- Hensberge G., 1974, *Astron. Astrophys.*, 32, No. 4, 457
- Hensbere H., De Loore C, 1974, *Astron. Astrophys.*, 37, No. 2, 367
- Hensler G., 1978, *Mitt Astron. Ges.*, No. 43, 215
- Heuvel van den, 1971, *Astron. Astrophys.*, 11, No. 3, 461
- Hill G.M., Blake C.C., 1996, *Mon. Not. R. Astron. Soc.*, 278, 183
- Hockey S.M., 1969, *Mon. Not. R. Astron. Soc.*, 142, No. 4, 543
- Hockey M.S., 1971, *Mon. Not. R. Astron. Soc.*, 152, No. 1, 97
- Huchra J., 1972, *Astrophys. J.*, 174, No. 2, 435
- Jones T.J., Wolff S.C., Bonsack W., 1974, *Astrophys. J.*, 190, No. 3, 579
- Jones T., Wolff S.C., 1974, *Publ. Astr. Soc. Pacific*, 86, No. 509, 67
- Kemp J.C., Wolstencroft R.D., 1973, *Astrophys. J.*, 179, No. 1, 33
- Khokhlova V.L., 1983, in: "Itogi nauki i tekhniki", Moscow, VINITI, 283
- Kodaira K., Unno W., 1969, *Astrophys. J.*, 157, No. 2, 769
- Kopylova F.G., Romanyuk I.I., 1992, in: "Stellar magnetism", Yu.V. Glagolevskij and I.I. Romanyuk (eds.), S. Petersburg, Nauka, 54
- Landstreet J.D., Borra E.F., 1977, *Astrophys. J.*, 212, No. 1, 141
- Landstreet J.D., 1978, *Astrophys. J.*, 224, No. 1, L5
- Landstreet J.D., Borra E.F., Fontaine G., 1979, *Mon. Not. R. Astron. Soc.*, 188, 609
- Landstreet J.D., 1982, *Astrophys. J.*, 258, 639
- Landstreet J.D., 1990, *Astrophys. J.*, 352, L5
- Leroy J.L., 1995, *Astron. Astrophys. Suppl. Ser.*, 114, 79
- Maitzen H.M., Albrecht H., 1975, *Astron. Astrophys.*, 44, No. 2, 405
- Maitzen H.M., Weiss W.W., Wood J.H., 1980, *Astron. Astrophys.*, 81, No. 3, 323
- Mikulasek Z., Glagolevskij Yu.V., Romanyuk I.I., Shtol V.G., Bychkov V.D., 1984, in: "Magnetic stars", V.L. Khokhlova et al. (eds.), *Salaspils*, 13
- Mathys G., 1991, *Astron. Astrophys. Suppl. Ser.*, 89, 121
- Mathys G., Hubrig S., Landstreet J., Lanz T., Manfroid H., 1997, *Astron. Astrophys. Suppl. Ser.*, 123, 353
- Mathys G., Hubrig S., 1997, *Astron. Astrophys. Suppl. Ser.*, 124, 475
- Oetken L., Orwert R., 1973, *Astron. Nachr.*, 294, 261
- Pilachowski C.A., Bonsack W.K., Wolff S.C., 1974, *Astron. Astrophys.*, 37, No. 2, 275
- Preston G.W., Stepien K., 1968, *Astrophys. J.*, 151, No. 2, 577
- Preston G., Sturch K., 1967, in: "Magnetic and Related stars", Baltimore, Mono Book Corp., 111
- Preston G., Stepien K., 1968, *Astrophys. J.*, 154, No. 3, 971
- Preston G.W., 1969, *Astrophys. J.*, 158, 243
- Preston G.W., 1969, *Astrophys. J.*, 158, 251
- Preston G.W., Stepien K., Wolff S.C., 1969, *Astrophys. J.*, 156, No. 3, 653

- Preston G.W., 1969, *Astrophys. J.*, 156, No. 3, 967
 Preston G.W., 1969, *Astrophys. J.*, 157, No. 1, 247
 Preston G.W., 1969, *Astrophys. J.*, 158, 1081
 Preston G.W., Wolff S.C., 1970, *Astrophys. J.*, 160, No. 3, 1071
 Preston G.W., 1970, *Astrophys. J.*, 160, No. 3, 1059
 Preston G.W., 1971, *Astrophys. J.*, 164, No. 2, 309
 Preston G.W., 1972, *Astrophys. J.*, 175, No. 2, 465
 Pyper D., 1969, *Astrophys. J. Suppl. Ser.*, 18, 1
 Renson P., 1984, *Astron. Astrophys.*, 139, No. 1, 131
 Renson P., Farragiana R., Catalano F., 1991(a), *Astron. Astrophys. Suppl. Ser.*, 89, No. 3, 429
 Renson P., Kobi D., North P., 1991 (b), *Astron. Astrophys. Suppl. Ser.*, 89, No. 1, 61
 Robinson R.D., 1980, *Astrophys. J.*, 239, No. 3, 961
 Romanyuk I.I., 1980, *Astrofiz. Issled. (Izv. SAO)*, 12, 3
 Romanyuk I.I., 1984, *Pis'ma Astron. Zh.*, 10, 443
 Romanyuk I.I., 1986, *Astrofiz. Issled. (Izv. SAO)*, 22, 39
 Romanyuk I.I., Elkin V.G., Wade G.A., Landstreet J.D., 1995, in: "Stellar Surface Structure", Strassmeier K. et al. (eds.), IAU Symp. No. 176, Wien, 153
 Romanyuk I.I., Elkin V.G., Wade G.A., Landstreet J.D., 1997, in: "Stellar magnetic fields" eds.: Yu.V. Glagolevskij and I.I. Romanyuk, Moscow, 101
 Romanyuk I.I., Kudryavtsev D.O., 1998, *Contr. of Scam. Pleso obs.*, 25, 485
 Romanyuk I.I., Elkin V.G., Kudryavtsev D.O., Landstreet J.D., Wade G.A., 2000, this issue
 Romanyuk I.I., Elkin V.G., Kudryavtsev D.O., Landstreet J.D., Wade G.A., 1999, *Bull. Spec. Astrophys. Obs.*, 45, 93
 Scholz G., 1971, *Astron. Nachr.*, 292, No. 5-6, 279
 Scholz G., 1971, *Astron. Nachr.*, 292, No. 5-6, 281
 Scholz G., 1975, *Astron. Nachr.*, 296, No. 1, 31
 Scholz G., 1978, *Astron. Nachr.*, 299, No. 2,
 Scholz G., 1979, *Astron. Nachr.*, 300, No. 4, 213
 Scholz G., 1983, *Astrophys. Space Sci.*, 94, No. 1, 159
 Severyn A.B., Kuvshinov V.M., Nikulin N.S., 1974, *Izv. KrAO*, 50, 3
 Shore S., Brown D., Sonneborn G., Landstreet J., Bohlender D., 1990, *Astrophys. J.*, 348, 242
 Steinitz R., Pyper D., 1969, *Commiss. IAU 27, IBVS*, No. 413, 1
 Steinitz R., Pyper D., 1971, *Astron. Astrophys.*, 11, 489
 Steinitz R., Pyper D.M., 1971, *Astrophys. Space Sci.*, 11, 322
 Thompson L.B., 1983, *Mon. Not. R. Astron. Soc.*, 205, No. 2, 43
 Thompson L.B., Landstreet J.D., 1985, *Astrophys. J.*, 289, No. 1, L9
 Thompson L.B., Bohlender D., Landstreet J.D., 1987, *Astrophys. J. Suppl. Ser.*, 64, 210
 Wade G.A., Neagu E., Landstreet J.D., 1996 (a), *Astron. Astrophys.*, 307, 500
 Wade G.A., Elkin V.G., Landstreet J.D., Leroy J.L., Mathys G., Romanyuk I.I., 1996 (b), *Astron. Astrophys.*, 313, 209
 Wade G.A., Bohlender D.A., Brown D.N., Elkin V.G., Landstreet J.D., Romanyuk I.I., 1997 (a), *Astron. Astrophys.*, 320, 172
 Wade G.A., Elkin V.G., Landstreet J.D., Romanyuk I.I., 1997 (b), *Mon. Not. R. Astron. Soc.*, 297, 748
 Wade G.A., Mathys G., North P., 1999, *Astron. Astrophys.*, 347, 164
 Wade G.A., Kudryavtsev D.O., Romanyuk I.I., Landstreet J.D., Mathys G., 2000 (a) *Astron. Astrophys.*, (in press)
 Wade G.A., Elkin V.G. et al., 2000 (b) (in preparation)
 Wolff S.C., 1969, *Astrophys. J.*, 157, No. 1, 253
 Wolff S.C., 1969, 129-th *Amer. Astron. Meet.*, Honolulu, Hawaii
 Wolff S.C., Wolff R.J., 1970, *Astrophys. J.*, 160, No. 3., 1049
 Wolff S.C., Wolff R.J., 1971, *Publ. Astr. Soc. Pacific*, 83, No. 495, 610
 Wolff S.C., 1973, *Astrophys. J.*, 186, 951
 Wolff S.C., Morrison N.D., 1974, *Publ. Astr. Soc. Pacific*, 86, No. 514, 935
 Wolff S.C., Hagen W., 1976, *Publ. Astr. Soc. Pacific*, 88, No. 522,
 Wolff R. J., Wolff S. C., 1976, *Astrophys. J.*, 203, No. 1, 171
 Wolff S.C., 1978, *Publ. Astr. Soc. Pacific*, 90, No. 536, 412
 Wolff S.C., Preston G., 1978, *Publ. Astr. Soc. Pacific*, 90, No. 536, 406
 Wood J.H., Albrecht R., 1981, in: "Upper Main sequence CP stars", 23rd *Liege Coll.*, Liege, 1981, 199
 Ziznovsky J., Romanyuk I.I., 1990, *Bull. Astr. Inst. Czechosl.*, 41, 118