Peculiar Versus Normal Phenomena in A-Type and Related Stars
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STATISTICS OF CP STARS IN A MAGNITUDE-LIMITED SAMPLE: THE BRIGHT STAR CATALOGUE

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ABSTRACT In the past several authors investigated the incidence of CP stars among field stars of the upper main sequence, e.g. Jaschek&Jascheck (1967), Wolff (1968), Abt (1979) , or in open clusters e.g. Young&Martin (1973), Hartoog (1976), North&Cramer (1981). But the published values seem not to be very precise or universal because of the use of incomplete data bases like Osawa's list (1965) or the old version of the *Bright Star Catalogue* or the concentration on selected samples e.g. open clusters. Only Smith (1973) gave realistic values in the case of CP1 stars.
In the meantime two decades passed and many new observations were obtained. In 1982 a new version of the *Bright Star Catalogue* with better spectral classifications was issued and a supplement to the BS catalogue was published (1983). Furthermore, Renson and co-workers presented 1991 their *General Catalogue of Am and Ap Stars* (in the following abbreviated to GCAAS). Now the moment has come to establish new and hopefully more precise values of the incidence of CP stars using the new version of the *Bright Star Catalogue* and its supplement as the data base.

INTRODUCTION

The *Bright Star Catalogue* (Hoffleit&Jaschek, 1982; in the following abbreviated to BSC) contains 9110 stars. Because of historical reasons (e.g. the use of photo-visual magnitudes) the catalogue is only complete up to $V=6\overset{m}{.}0$ while a substantial number of fainter stars is missing. The lack of fainter objects was partial overcome by the publication of *A Supplement to the Bright Star Catalogue* (Hoffleit et al., 1983) which contains 2554 additional stars between $V=6\overset{m}{.}0$ and $7\overset{m}{.}1$. In both catalogues 3414 and 870, respectively, stars can be found in the spectral region B6–F2 yielding 4284 stars in total. This sample was investigated for the incidence of CP stars.

As a first step all stars were divided in spectral classes ranging from B6 to F2 and available peculiarity types were noted. Excluding all peculiar objects other than CP (supergiants, emission-line, shell, δ Sct, and δ Del stars) 3889 stars of luminosity classes III–V remain. Giants were included because a substantial number of CP stars in the BSC are classified as III.

The MK types given in the BSC are definitely not very precise. In many cases an error in the classification of approximately ± 2 subclasses seems to be normal, in same cases up to $\pm$one MK class. In several cases the classification of different CP types are mixed up, also CP with δ Sct, δ Del stars or supergiants,

respectively. Nevertheless, in most cases the MK classification from the BS catalogue was taken. Only in cases where the BSC gives only 'Ap' or 'Am' the classification of the GCAAS was accepted (70 stars).

To overcome incorrect peculiarity classifications as close as possible all stars were checked by means of the GCAAS. In the cases of doubtful classification the peculiarity type of GCAAS was taken. It turned out that many of the fainter stars appear as peculiar only in the GCAAS. Stars were denoted as uncertain CP if the peculiarity type only appears in the BSC or it was marked in GCAAS as uncertain. Stars only in the GCAAS and without peculiarity type were taken as doubtful CP stars.

DISTRIBUTION OF V

The completeness of the sample is very importent to estimate precise frequencies. So, only stars up to $V=6^m.0$ were taken because the BSC is complete at more than 99% here. These stars are relatively close to the sun and no substantial reddening is exspected and, therefore, no derredening procedures were applied.

Nervertheless, the completeness of the sample was checked estimating the distribution of V for the different CP classes and comparing it with those of normal stars in the same spectral range. Assuming that CP stars have a similar distribution as normal stars the samples seem to be more or less complete. Only in the cases of cooler CP2 and CP4 the deviation is somewhat larger. But this might be a consequence of the small numbers (47 and 15, respectively).

In the case of the whole sample it is obvious that the sample is not complete. This is certainly due to the incompleteness of spectroscopic surveys with higher resolution. Therefore, in the following I will concentrate more on the stars up to $V=6^m.0$, but the results for whole sample will be mentioned, too.

DISTRIBUTION OF CP STARS

Figure 1 presents the distribution of the different CP classes relative to the MK type for stars up to $V = 6^m.0$. The CP1 stars show a maximum around A5, the hot CP2 at A0, the cooler at A6, and the CP3 at B8. The number of CP4 stars is too small to make a statement. The entire distribution shows an increasing up to A6 with an marginal peak around B9 and a drop-off towards the late types.

The whole sample shows a very similar behaviour but somewhat a more smooth distribution. Only in the case of the cooler CP2 stars the maximum is shifted to A1.

The values for a single MK class have to be taken with caution: the classifications have in many cases certainly an error of at least $\pm$1-2 subclasses on the avergage which, of course, influences the estimation of the frequencies. But the values averaged over the samples will not be affected by these uncertainties.

In the case of the whole samples it is obvious that the values depend on the limits of the sample: including fainter stars decreases the frequencies.

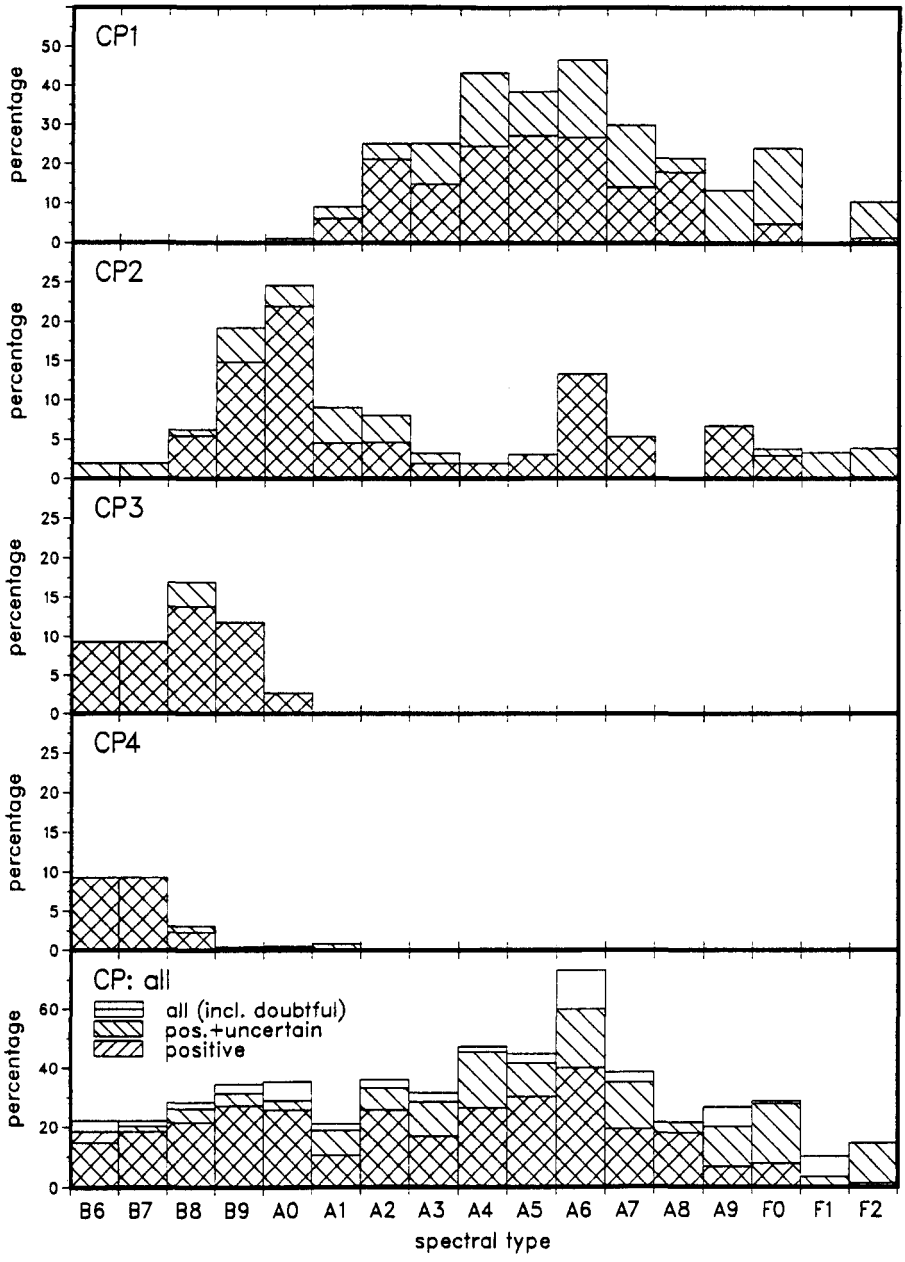

Fig. 1. Distribution of the different CP classes.

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DISTRIBUTION OF *B-V*

It is known that CP stars show abnormal colors relative to their MK class. In order to check this the mean values for different MK classes were estimated. Figure 3 presents the distribution of *B-V*. While the CP3 and CP4 stars show a more or less larger blue deviation from the relation for the normal stars, the one of the CP2 stars is only marginal and gets normal for later typs (the strong deviation in some cases at later types is due to low numbers: one or two). The early CP1 stars appear redder as normal ones and become normal for the later types. But the single values should not be taken too serious. As mentioned before the MK classification influences the single values strongly]

TABLE I Numbers and frequencies of CP stars

	B6 – A0			
	$V < 6^m.0$		$V < 7^m.1$	
class	#	%	#	%
CP2 hot	101	16.7	231	14.2
CP3	58	9.6	107	6.6
CP4	15	2.5	27	1.7
Σ	174	28.8	365	22.4
normal	431	71.2	1263	77.6
total	605		1628	

	A1 – F2				A1 – F0			
	$V < 6^m.0$		$V < 7^m.1$		$V < 6^m.0$		$V < 7^m.1$	
class	#	%	#	%	#	%	#	%
CP2 cool	47	5.3	109	5.0	43	5.5	103	5.4
CP1	219	24.6	431	20.0	211	27.9	417	21.8
Σ	266	29.9	540	25.0	254	32.5	520	27.2
normal	624	70.1	1620	75.0	528	67.5	1389	72.8
total	890		2160		782		1909	

	B6 – F2				B6 – F0			
	$V < 6^m.0$		$V < 7^m.1$		$V < 6^m.0$		$V < 7^m.1$	
class	#	%	#	%	#	%	#	%
CP all	440	28.3	905	23.3	427	29.4	885	24.3
doubtful	51	3.3	101	2.6	49	3.4	98	2.7
normal	1065	68.4	2883	74.1	974	67.2	2652	73.0
total	1556		3889		1450		3636	

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CONCLUSIONS

- The averaged frequency of CP stars in the spectral range B6-F2 and up to $V=6^m.0$ is 31.6% and up to $V=7^m.1$ is 25.9%. Reducing the range to B6-F0 yields 32.8% and 27.0%, respectively.
- These values should be taken as lower limits because of missing spectroscopic data with higher resolution for fainter stars.
- λ Boo stars are not included in this investigation. If one would do so the frquency of normal stars would be reduced by about 3-5%.

REMARKS

- Many stars show ambiguous classifications. These should be re-observed with higher resolution to obtain more precise classifications.
- The missing stars in the magitude intervall $6^m.0 < V < 7^m.0$ should be collected from the literature together with MK types, magnitudes and colors in order to complete the BSC up to $V=7^m.0$.
- Complete samples of stars fainter than $V=7^m.0$ in different galactic areas should be observed spectroscopically and photometrically in order to improve the statistic and to investigate the galactic distribution of CP stars.

REFERENCES

Abt,H.A. 1979, *Ap. J.*, **230**,485
Hartoog,M.R. 1976, *Ap. J.*, **205**,807
Hoffleit,D., Jaschek,C., 1982, *Bright Star Catalogue*, Yale Uni.Obs., New Haven
Hoffleit,D., Saladyga,M. Wlasuk,P., 1983, *A Supplement to the Bright Star Catalogue*, Yale Uni.Obs., New Haven
Jaschek,C., Jaschek,M. 1967, in *The Magnetic and Related Stars*, ed. by R.C.Cameron, Mono Book Corp. Baltimore, p.287
North,P., Cramer,N. 1981, in *Les Etoiles de Composition Chimique Anormale du Debut de la Sequence Principale*, 23^{rd} Liége Astrophys. Coll., p.55
Osawa,K. 1965: *Ann. Tokyo Astron. Obs. Ser. II*, **9**,121
Renson,P., Gerbaldi,M., Catalano,F.A. (**GCAAS**), 1991, *Astr. Ap. Suppl.*, **89**,429
Smith, M.A. 1973, *Ap. J. Suppl.*, **25**,277
Wolff,S.C. 1968, *Pub. A.S.P.*, **80**,281
Young,A., Martin,A.E. 1973, *Ap. J.*, **181**,805