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Search for β Cephei Stars South of Declination −20°. I. Incidence of Light Variability among Early B Giants and Subgiants — Summer Objects

by

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ABSTRACT

A list has been compiled of all *Bright Star Catalogue* objects spectroscopically similar to β Cephei variables, and located south of declination −20°. Nearly one thousand differential *uvby* observations have been obtained of sixty-eight of these stars that fall within the right ascension range from about 4^h to 10^h15^m. Over 14 (but less than 24) stars turn out to be variable in *b* by more than $0\overset{m}{.}020$, while 21 have been found to be constant to within $0\overset{m}{.}010$ or better. The upper limit for the number of hitherto undiscovered β Cephei variables with the *b* amplitude exceeding $0\overset{m}{.}020$ could be estimated as equal to four. One star, HD 64722 = HR 3088 (B1.5 IV), shows β Cephei-type light variation in a very short period of $0\overset{d}{.}1160 \pm 0\overset{d}{.}0003$, with apparently stable *b* light amplitude equal to $0\overset{m}{.}027 \pm 0\overset{m}{.}002$.

In addition, out of a total of sixty-four non-β Cephei strip comparison stars, over 12 (but less than 21) prove to be variable in b by $0^{\rm m}.020$ or more, and 23 are constant. Of the former, at least two stars are periodic, viz., λ Columbae varies in a period equal to $0^{\rm d}.640 \pm 0^{\rm d}.002$, with the b amplitude of $0^{\rm m}.030 \pm 0^{\rm m}.003$, while for HD 74455 = HR 3462 the period is found to be $0^{\rm d}.563 \pm 0^{\rm d}.001$, and the b amplitude $- 0^{\rm m}.037 \pm 0^{\rm m}.002$. In both these cases the light variability is probably caused by proximity effects in a binary system.

1. Introduction

The main reason for studying β Cephei-type variables seems to come from the fact that the causes underlying their oscillations remain obscure, in spite of repeated efforts by the theoreticians to invent a suitable instability mechanism – *cf.* Dziembowski (1971), Davey (1973), Cox (1974), Aizenman *et al.* (1975). One of the possible lines of attack the observers can follow in an attempt to help solve the problem is to look for new β Cephei variables. As only two dozen β Cephei stars are presently known, adding even a few ones would significantly improve the statistics of this type of variability. Ultimately, increasing the number of β Cephei variables available for detailed study will provide a basis for investigating the extent and structure of the β Cephei instability strip in a more extensive manner than it is possible at present.

Since the pioneer work of Walker (1952), several programs aimed at discovering β Cephei stars have been carried out. Lynds (1959) examined for light variability thirty-six bright stars spectroscopically similar to β Cephei variables. Among the twenty-nine stars he found to vary by $0^{\rm m}.02$ or more, there were two β Cephei objects. (The rest comprised eclipsing binaries, ellipsoidal variables, shell stars with irregular light variations, stars having periodic light variations with periods slightly longer than those of β Cephei stars and shorter than would be expected for ellipsoidal variables, and, finally, objects which could not be classified because of irregularities, or because of insufficient data.) One of the β Cephei variables discovered by Lynds, V986 Ophiuchi, still lacks radial velocity confirmation, although its light variability has been investigated by several observers (*cf.* Jerzykiewicz 1975).

Another extensive photometric search was carried out by Hill (1967) among a sample of 153 early B stars, mostly members of the nearest associations and galactic clusters. This program yielded 24 new β Cephei variables, including 5 tentative ones. Unfortunately, for neither of Hill's candidates the existence of the β Cephei-type light variability has been confirmed by other workers. (The only exception, V986 Ophiuchi, which Hill included among his newly discovered β Cephei stars, was mentioned above.) In fact, several of these objects were subsequently shown to be either constant or to exhibit ellipsoidal light variations (Percy 1969, Deupree 1970, Jerzykiewicz 1974, Hill *et al.* 1976). Hill's conclusion that the limits of spectral type, luminosity class, period, and rotational velocity of the β Cephei variables should be *considerably* extended beyond their "classical" values should, therefore, be viewed with caution.

A program similar to that of Lynds (1959) has recently been completed by Jerzykiewicz (in preparation). The β Cephei-type light variability of HR 6684, discovered in the course of this program (Jerzykiewicz 1972), was promptly confirmed by McNamara and Bills (1973). The star's radial velocity variation was detected by Pike (1974).

All the above-mentioned search programs were confined to stars located north of declination −20°. South of this limit somewhat less effort was directed toward discovering β Cephei stars. Thus, Pagel (1956) examined seven variable radial velocity B stars for the presence of short periods characteristic of the β Cephei phenomenon, and obtained positive results in three cases. (Unlike all the other programs carried out so far, that of Pagel was primarily a spectroscopic one). More recently, several β Cephei variables were discovered by Shobbrook and his co-workers in the course of observing in detail the stars measured by the Narrabri Stellar Intensity Interferometer (Shobbrook *et al.* 1969, Shobbrook and Lomb 1972, Shobbrook 1972). Some scattered observations were also reported by van Hoof (1973, 1975a, 1975b). However, no systematic search of the Walker (1952) or Lynds (1959) type has ever been conducted on the southern sky.

In the present paper we give a short description of a program we have undertaken in order to fill in this gap, and, moreover, an account of the results obtained so far.

2. The Program

To begin with, we compiled a list of all stars south of declination −20°, which appear in the *Catalogue of Bright Stars* (Hoffleit 1964), and whose position in the spectral type-luminosity class plane is the same, or nearly the same, as that of the presently known β Cephei variables. The boundaries of the β Cephei region we adopted are shown in Fig. 1. Numbers of the β Cephei stars for each MK type are also indicated. The variables we took into account in deriving these numbers were those listed by Jones and Shobbrook (1974), with MK classification from Lesh (1968) for objects north of declination −20°, and from Hiltner *et al.* (1969) – south of this limit. We omitted UW Arietis on the grounds that this star has recently been shown by Jerzykiewicz (1974) to be constant in light.

The list of program stars, that we compiled according to the above mentioned criteria, is given in Table 1. All MK types in the fourth column are from Hiltner *et al.* (1969). In the last column the symbol "NO" indicates stars which we do not plan to observe in the present program, because

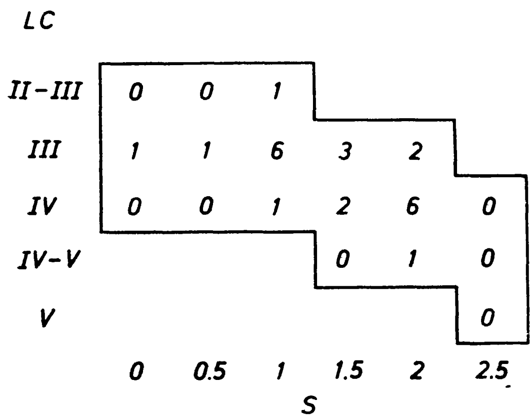

Fig. 1. The distribution of known β Cephei stars in the spectral type (early B subtypes) – luminosity class diagram. Numbers of β Cephei variables for each MK type are indicated. All stars listed in Table 1 fall within the delineated area of the diagram.

either they are already well-known variables, or because no suitable comparison stars could be found for them. (One object, the 17″ common motion pair HR 3142/3, was dropped, since it has been found at the telescope that the small separation between its components impeded accurate photometry.) In addition, the letter "C" denotes stars which we selected to be used as comparison stars for other program stars in the list. These we do not intend to observe with comparison stars of their own, unless they prove to be variable in light.

In this way, out of 131 program stars listed in Table 1, we decided to observe 105. Of the twenty-six stars we dropped, fourteen are well-known variables, while the eleven objects for which we could not find suitable comparison stars are all rather bright, so that they can easily be investigated spectroscopically for the presence of short-term radial velocity variations. The 17″ double, HR 3142/3, could probably be observed photoelectrically on nights of good seeing, provided that there would be no problems caused by imperfect telescope tracking.

3. Observations and Reduction

Up to date we obtained nearly one thousand photoelectric observations of sixty-eight program stars that fall within the right ascension range from about 4^h (HR 1258) to 10^h15^m (HR 4038). The observations were carried out at the European Southern Observatory, Cerro La Silla, Chile, by one of us (C. S.), on a total of thirty-two nights, in the period

Table 1

Master list of program stars

HD	HR	m_v	MK	Remarks
25631	1258	$6^m.4$	B2.5 V	
28873	1443	5.1	B2 IV-V	δ Cae
40494	2106	4.4	B2.5 IV	γ Col
42933	2212	var	B0.5 IV	δ Pic - EB type var - NO
44402	2282	3.0	B2.5 IV	ζ CMa - NO
44506	2288	5.5	B1.5 IIIn	
46189	2380	5.9	B2.5 V	
46328	2387	4.3	B1 III	ξ¹ CMa - β C type var - NO
46547	2397	5.7	B2 IV	
49131	2501	5.8	B2 III	
50012	2537	6.8	B2 IV	
50707	2571	4.8	B1 III	15 CMa - β C type var - NO
51283	2595	5.3	B2 III	
51823	2611	6.1	B2.5 V	C
52437	2628	6.5	B2 IV-V	C
54224	2688	6.4	B2 IV-V	C
54893	2702	4.8	B2 IV-V	
54912	2704	5.8	B2.5 IV	
55856	2733	6.3	B2 IV	
55958	2741	6.6	B2 IV	
55985	2743	6.3	B2 IV-V	C
56779	2770	5.0	B2 IV-V	
56876	2774	6.4	B2 IV-V	
57573	2799	6.6	B2.5 V	C
57593	2800	5.8	B2.5 V	C
58325	2824	6.6	B2 IV-V	
59026	2856	6.0	B2 IV-V	C
61641	2954	5.8	B2 IV-V	
61831	2961	4.8	B2.5 V	
61899	2964	5.8	B2.5 V	C
62747	3004	5.6	B1.5 III	
62758	3006	6.4	B2.5 V	
63271	3023	5.9	B2 IV-V	C
63578	3037	5.2	B1.5 IV	C
63922	3055	4.1	B0 III	
63949	3058	5.8	B1.5 IV	C
64287	3074	6.3	B2 IV-V	C
64365	3078	6.0	B2 IV	
64503	3084	4.5	B2.5 V	
64722	3088	5.7	B1.5 IV	C
65460	3114	5.4	B2.5 V	C
65551	3116	5.1	B2.5 IV	
66005/6	3142/3	5.8	B2 IV-V/B2 IV-V	17" double - NO
66546	3157	6.0	B2 IV-V	
67536	3186	6.3	B2.5 Vn	
68217	3204	5.2	B2 IV-V	
68243	3206	4.2	B1 IV	$42''.5$ double with γ Vel
68324	3213	5.4	B1 IVn	C
69081	3240	5.1	B1.5 IV	
69082	3241	6.1	B2 IV-V	C
69144	3244	5.3	B2.5 IV	C
69302	3250	6.0	B2 IV-V	
70556	3283	5.2	B2 IV-V	C
70839	3293	6.1	B1.5 III	
70930	3294	4.8	B1.5 III	
72108	3358	5.3	B2 IV	C
72127	3359	5.2	B2 IV	
72485	3375	6.5	B2.5 V	
72787	3388	6.5	B2.5 V	
74375	3457	4.3	B1.5 III	
74575	3468	3.7	B1.5 III	α Pyx - NO
74753	3476	5.2	B0 IIIn	
75821	3527	5.1	B0 III	
77002	3582	4.8	B2 IV-V	C
78548	3629	6.1	B2 IV-V	
79275	3658	5.8	B2 IV-V	
79351	3659	3.4	B2 IV-V	a Car
81188	3734	2.5	B2 IV-V	κ Vel - NO
83058	3819	5.0	B1.5 IV	
84567	3878	$6^m.4$	B0.5 IIIn	

Table 1 – concluded

HD	HR	m_V	MK	Remarks
84816	3886	$5^{m}.5$	B2.5 IV	
85871	3920	6.5	B1 IV	
86352	3933	6.4	B2 IV-V	
87152	3955	6.2	B2.5 V	
89104	4038	6.2	B2 IV-V	C
93163	4204	5.8	B2.5 V	
93845	4234	4.4	B2.3 IV	δ^2 Cha
99171	4403	6.1	B2 IV-V	
99264	4406	5.6	B2 IV-V	
100929	4472	5.8	B2.5 IV	
106490	4656	2.8	B2 IV	δ Cru - NO
106983	4679	4.0	B2.5 V	ζ Cru
108248	4730	1.6	B0.5 IV	α^1 Cru - NO
109668	4798	2.7	B2 IV-V	α Mus - NO
111123	4853	1.2	B0.5 III	β Cru - βC type var - NO
112092	4898	4.0	B2 IV-V	μ^1 Cru - 38" double with μ^2 Cru
116072	5034	6.2	B2.5 Vn	60" double with HR 5035
118716	5132	2.3	B1 III	ε Cen - βC type var - NO
119159	5151	6.3	B0.5 III	
120307	5190	3.4	B2 IV	ν Cen - C
121263	5231	2.5	B2.5 IV	ζ Cen - NO
121743	5248	3.8	B2 IV	φ Cen
121790	5249	3.9	B2 IV-V	υ^1 Cen - C
122451	5267	0.6	B1 III	β Cen - βC type var - NO
124471	5320	5.7	B1.5 III	
125238	5354	3.6	B2.5 IV	ι Lup
125721	5375	6.3	B1 III	
126341	5395	4.6	B2 IV	τ^1 Lup - βC type var - NO
127381	5425	4.4	B2 III	σ Lup
129056	5469	2.3	B1.5 III	α Lup - βC type var - NO
129557	5488	6.1	B2 III	
129954	5500	5.9	B2.5 V	
132058	5571	2.7	B2 III	β Lup - C
132200	5576	3.1	B2 IV	κ Cen
136298	5695	3.2	B1.5 IV	δ Lup - βC type var - NO
136504	5708	3.4	B2 IV-V	ε Lup
138690	5776	2.8	B2 IV	γ Lup - NO
139365	5812	3.6	B2.5 V	τ Lib
142114	5904	4.6	B2.5 Vn	2 Sco
142184	5907	5.4	B2.5 V	C
142669	5928	3.9	B2 IV-V	ρ Sco
143118	5948	3.4	B2.5 IV	η Lup
143275	5953	2.3	B0.5 IV	δ Sco - NO
144294	5987	4.2	B2.5 Vn	ϑ Lup - C
147165	6084	2.9	B1 III	σ Sco - βC type var - NO
147933	6112	5.2	B2 IV	ρ Oph A
148703	6143	4.2	B2 III	
149711	6174	6.1	B2.5 IV	
150745	6215	5.9	B2 IV-V	
151890	6247	var	B1.5 IV	μ^1 Sco - EB type var - NO
151985	6252	3.6	B2 IV	μ^2 Sco
156838	6440	5.9	B2 IV	
157056	6453	3.3	B2 IV	ϑ Oph - βC type var - NO
158408	6508	2.7	B2 IV	υ Sco - NO
158926	6527	1.6	B1.5 IV	λ Sco - βC type var - NO
160578	6580	2.4	B1.5 III	κ Sco - βC type var - NO
170235	6929	6.6	B2 IVp	
171034	6960	5.4	B2 IV-V	
172910	7029	4.9	B2.5 V	C
189103	7623	4.4	B2.5 IV	ϑ Sgr
193924	7790	$1^{m}.9$	B2.5 V	α Pav - NO

from 24 November to 30 December 1975. The equipment consisted of the simultaneous four-channel *uvby* spectrograph-photometer, attached to the Danish National 50 cm reflecting telescope. A detailed description of this equipment has recently been published by Grønbech *et al.* (1976).

The differential observations were taken according to the standard procedure of referring a program star to a pair of near-by comparison stars. One observation consisted of the following sequence:

C1C1sky(C1) PPPPsky(P) C2C2C2C2sky(C2) C1C1C1C1 PPPP
C2C2C2C2 C1C1,

where each symbol denotes a single integration, with C1 and C2 representing the comparison stars, and P — the program star. The sky background measurements were made close to the stars indicated in parentheses. A 10-second integration time was used in most cases, but this was shortened for the few very bright stars. About ten minutes were required, on the average, in order to complete one observation.

The comparison stars were chosen from the BS and HD catalogues. The well-known rules of proximity on the sky, as well as of similarity in spectral type and brightness were followed as closely as feasible. Known variables and emission line objects were avoided, of course. As mentioned in the previous chapter, a number of program stars were purposefully selected as comparison stars. In this way the number of non-β Cephei strip objects observed in our program was considerably reduced, which resulted in rather efficient use of telescope time.

In Table 2 the program and comparison stars are arranged in triplets, as they were actually observed. In each triplet the order is P, C1, and C2. The first five columns of Table 2 should be self-explanatory. The symbols used in the last column will be explained in chapter 5. The MK classification is from Hiltner *et al.* (1969), if available, and from various other sources — these latter types are enclosed in parentheses. If no MK classification could be found in the literature, the HD spectral type is given.

The differential observations were programmed in such a way, as to make most likely the discovery of light variations with time scale of about three to seven hours. That is, at least four observations of the same triplet were obtained during a night, and care was taken that these observations were spaced not closer than about one hour. After some twenty observations were secured, the stars were dropped, and another triplet was selected for observing. Therefore, all observations of the same triplet would be spread over a time span of several days. Of course, as many stars as possible were observed each clear night.

Table 2

Program and comparison stars. (In the last column our variability classification is given — see text for explanations.)

HD	R.A. 2000	Dec.	m_v	MK or S	Class	HD	R.A. 2000	Dec.	m_v	MK or S	Class
25631	$4^h\ 3^m.4$	$-20^\circ\ 8'$	$6^m.4$	B2.5 V	var	64365	$7^h 51^m.7$	$-42^\circ 53'$	$6^m.0$	B2 IV	var
26087	4 6.9	-21 59	6.6	(A3)	cst?*	64287	7 51.4	-43 5	6.3	B2 IV-V	var? *
25754	4 4.3	-19 27	7.4	(A0)	cst?*	65460	7 57.0	-43 30	5.4	B2.5 V	var? *
28873	4 30.8	-44 57	5.1	B2 IV-V	var?	64503	7 52.6	-38 52	4.5	B2.5 V	var **
28812	4 30.5	-43 13	6.9	(B9)	cst	63465	7 47.4	-38 31	5.1	B2.5 III	var **
28813	4 30.5	-43 25	7.2	(B9)	cst	64802	7 54.2	-35 53	5.5	B2 V	var **
40494	5 57.6	-35 17	4.4	B2.5 IV	var? *	65551	7 57.3	-44 6	5.1	B2.5 IV	var
39764	5 53.1	-33 48	4.9	B5 V	var	65211	7 55.8	-43 51	6.0	B6 V	cst?
41534	6 4.3	-32 10	5.6	B2 V	var? *	65460	7 57.0	-43 30	5.4	B2.5 V	cst?
44506	6 20.6	-34 9	5.5	B1.5 IIIn	var *	66546	8 1.4	-54 31	6.0	B2 IV-V	var? *
45871	6 28.6	-32 22	5.8	B4 Vnp	var	66441	8 0.8	-54 9	5.9	(B8)	var? *
44979	6 23.3	-35 0	6.6	(B9)	var *	64722	7 52.5	-54 22	5.7	B1.5 IV	var
46189	6 30.8	-27 46	5.9	B2.5 V	cst	67536	8 4.7	-62 50	6.3	B2.5 Vn	var
45382	6 25.7	-29 42	6.7	(A0)	var	66591	8 0.3	-63 34	4.8	B3 V	var? *
46813	6 34.2	-29 37	6.8	(A2)	cst	68423	8 8.4	-63 48	6.3	(B8)	var? *
46547	6 32.6	-32 1	5.7	B2 IV	cst	68217	8 9.6	-44 8	5.2	B2 IV-V	var **
45871	6 28.6	-32 22	5.8	B4 Vnp	var	66624	8 2.7	-41 19	5.6	(B9)	var **
46813	6 34.2	-29 37	6.8	(A2)	cst	68601	8 11.4	-42 59	4.7	(A3p)	var **
49131	6 45.5	-30 57	5.8	B2 III	var	68243	8 9.5	-47 21	4.2	B1 IV	var *
49028	6 45.0	-30 35	6.5	(B8 IV)	cst	68324	8 9.7	-47 57	5.4	B1 IVn	var *
49961	6 49.5	-32 33	6.8	(A2)	cst	69144	8 13.6	-46 59	5.3	B2.5 IV	var
50012	6 50.1	-27 20	6.8	B2 IV	cst? *	69081	8 14.0	-36 19	5.1	B1.5 IV	var
50379	6 51.8	-26 35	7.5	(B5)	var	69082	8 14.0	-36 20	6.1	B2 IV-V	var? *
51823	6 57.7	-27 32	6.1	B2.5 V	cst? *	70556	8 21.4	-36 29	5.2	B2 IV-V	var? *
51283	6 55.8	-22 57	5.3	B2 III	var? *	69302	8 14.4	-45 50	6.0	B2 IV-V	cst
51630	6 57.2	-22 12	6.6	(B8)	var? *	68895	8 12.5	-46 16	6.0	B5 V	cst
52437	7 0.3	-22 7	6.5	B2 IV-V	var	69144	8 13.6	-46 59	5.3	B2.5 IV	var
54893	7 8.8	-39 40	4.8	B2 IV-V	var?	70839	8 21.2	-57 58	6.1	B1.5 III	var?
54475	7 7.1	-40 53	5.9	(B9)	cst	70175	8 17.5	-58 41	6.8	(B9)	cst
55719	7 12.3	-40 30	5.3	(A3p)	cst	71634	8 25.5	-58 7	7.0	(B7 IV)	cst
54912	7 9.7	-25 14	5.8	B2.5 IV	var **	70930	8 22.6	-48 29	4.8	B1.5 III	var?
55522	7 12.2	-25 57	5.9	B2 V	var **	69144	8 13.6	-46 59	5.3	B2.5 IV	var
54224	7 7.0	-26 39	6.4	B2 IV-V	var **	72108	8 29.1	-47 56	5.3	B2 IV	cst
55856	7 13.8	-22 54	6.3	B2 IV	cst?	72127	8 29.4	-44 43	5.2	B2 IV	var? *
54669	7 8.8	-24 3	6.5	B2 V	var?	72014	8 28.9	-42 35	6.2	(B3 Vnnek)	var
57573	7 20.9	-22 51	6.6	B2.5 V	var	72067	8 29.1	-44 10	5.9	B2 V	var? *
55958	7 13.8	-31 5	6.6	B2 IV	var? *	72485	8 31.2	-47 52	6.5	B2.5 V	cst
56342	7 15.4	-30 42	5.3	B3 V	var? *	74273	8 41.4	-48 55	5.9	B1.5 V	cst
55985	7 14.0	-30 20	6.3	B2 IV-V	cst?	72108	8 29.1	-47 56	5.3	B2 IV	cst
56779	7 16.8	-36 36	5.0	B2 IV-V	var?	72787	8 33.3	-38 23	6.5	B2.5 V	var?
55718	7 12.4	-36 33	6.0	B3 V	cst?	72436	8 31.4	-39 4	6.3	B4 V	cst?
57150	7 18.3	-36 44	4.6	B2 V	cst?	72514	8 31.9	-39 4	7.2	(B9)	cst?
56876	7 17.8	-26 48	6.4	B2 IV-V	cst	74375	8 40.6	-59 45	4.3	B1.5 III	var?
55857	7 13.6	-27 21	6.1	B0.5 V	cst	73390	8 35.2	-58 14	5.2	B3 V/B3 V	cst
57593	7 20.9	-26 58	5.8	B2.5 V	var	76113	8 51.6	-57 38	5.6	(B8)	cst
58325	7 23.9	-30 13	6.6	B2 IV-V	cst	74753	8 43.7	-49 50	5.2	B0 IIIn	cst
58766	7 25.7	-31 44	6.3	B2 V	var?	74273	8 41.1	-48 55	5.9	B1.5 V	cst
59499	7 28.9	-31 51	6.5	B3 V	cst	74455	8 42.3	-48 6	5.5	B1.5 Vn	var
61641	7 38.7	-36 30	5.8	B2 IV-V	cst	75821	8 50.6	-46 31	5.1	B0 III	cst
61925	7 40.0	-37 35	6.0	B6 IV	cst	74455	8 42.3	-48 6	5.5	B1.5 Vn	var
59026	7 26.7	-34 8	6.0	B2 IV-V	cst	76566	8 55.3	-45 3	6.3	B3 IV	cst
61831	7 39.4	-38 19	4.8	B2.5 V	cst	78548	9 6.6	-55 48	6.1	B2 IV-V	var? *
61878	7 39.7	-38 9	5.7	B5 Vn	cst	78190	9 4.5	-56 21	6.9	(B9)	var? *
61899	7 39.8	-38 16	5.8	B2.5 V	cst	80094	9 15.3	-58 23	6.0	B7 IV	var
62747	7 44.6	-24 40	5.6	B1.5 III	var	79275	9 11.6	-46 35	5.8	B2 IV-V	cst
63028	7 45.9	-24 15	6.6	(B3 IV)	var *	78005	9 4.1	-47 27	6.6	(B3)	var?
63271	7 47.2	-22 31	5.9	B2 IV-V	var *	79621	9 13.6	-47 21	5.9	(B9)	cst
62758	7 42.2	-58 38	6.4	B2.5 V	cst	79351	9 11.0	-58 58	3.4	B2 IV-V	var
62612	7 41.8	-56 18	6.7	(B8)	cst	79447	9 11.3	-62 19	4.0	B3 III	var *
62714	7 42.3	-56 9	6.7	(B9)	var	77002	8 57.0	-59 14	4.8	B2 IV-V	var *
63922	7 49.2	-46 22	4.1	B0 III	cst	83058	9 34.2	-51 16	5.0	B1.5 IV	cst
635578	7 47.5	-46 37	5.2	B1.5 IV	cst	82419	9 30.1	-51 31	5.4	B8 V	cst
63949	$7^h 49^m.2$	$-46^\circ 51'$	$5^m.8$	B1.5 IV	cst	82984	$9^h 33^m.7$	$-49^\circ\ 1'$	$5^m.1$	B4 IV	cst?

Table 2 — concluded

HD	R.A. 2000 Dec.	m_v	MK or S	Class	HD	R.A. 2000 Dec.	m_v	MK or S	Class
84567	$9^h45^m.4$ $-30°13'$	$6^m.4$	B0.5 IIIn	var? *	86352	$9^h56^m.4$ $-51°21'$	$6^m.4$	B2 IV-V	cst
84824	9 47.1 −31 15	6.8	(A0)	var? *	85953	9 53.8 −51 8	5.9	B2 V	var
85860	9 54.1 −28 0	6.9	(B9)	var	86466	9 57.2 −52 39	6.1	B3 IV	cst
84816	9 46.5 −44 46	5.5	B2.5 IV	var?	87152	10 1.7 −53 22	6.2	B2.5 V	var?
85355	9 50.0 −45 44	5.1	B7 III	cst	86466	9 57.2 −52 39	6.1	B3 IV	cst
85980	9 54.3 −45 17	5.7	B3 V	cst	89104	$10^h15^m.3$ $-54°59'$	$6^m.2$	B2 IV-V	var?
85871	9 53.0 −55 22	6.5	B1 IV	var *					
84228	9 41.8 −55 12	6.0	B4 V	var *					
84809	$9^h45^m.7$ $-57°11'$	$6^m.5$	(B8)	var					

In addition to the differential measurements, several observations were obtained on each night of a bright standard star, in order to determine the atmospheric extinction by means of the Bouguer method. The extinction coefficients are being published separately (Sterken and Jerzykiewicz 1977).

The reductions of the differential measurements consisted in computing for each observation the three sets of *uvby* magnitude differences, viz., "P minus C1", "P minus C2", and "C2 minus C1", corrected for the atmospheric extinction. Heliocentric Julian dates corresponding to the middle of each observation were also obtained. All computations were performed with the ODRA 1204 digital computer of the Wrocław University.

Throughout the remainder of the present paper we shall use the *b* observations alone. Additional information which can be obtained from the simultaneous *u*, *v*, and *y* magnitude differences will be taken into account in one of the forthcoming papers of this series.

4. Average Mean Error of a Single Magnitude Difference

The standard deviation corresponding to a series of magnitude differences is composed of contributions coming from the light variability of the two stars involved, and of observational errors. Since our observations were obtained on photometric nights only, without changing the equipment, in a fraction of a single season, and by one person, the errors of observations taken not very far from the zenith can be assumed to be normally distributed. Unfortunately, a number of measurements were obtained through larger air masses than one would like. This was a consequence of the programmed spacing between successive observations of the same stars, coupled with the uneven distribution of program stars in right ascension, and also because observing time was a limiting factor.

The measurements taken through large air masses are expected to be much less accurate than those obtained close to the zenith, not only because of the air mass dependence of photometric errors, but also because the telescope tracking was rather poor at large hour angles. In order to eliminate these effects, we divided our data into two groups, viz., group I, containing all observations for which the air mass did not exceed 1.3, and group II — with all observations obtained through air masses larger than 1.3, but not exceeding 2.0. The few measurements for which the air mass was greater than 2.0 were rejected.

All standard deviations computed from group I data are listed in Table 3, in columns from second to fourth. The stars referred to above as P are identified by their HD numbers in the first column. The last column contains the number of group I observations for each triplet, and, in parentheses, of all observations.

Table 3

Standard deviations of *b* magnitudes differences

HD	"P-C1"	"P-C2"	"C2-C1"	N	HD	"P-C1"	"P-C2"	"C2-C1"	N
25631	$0^{m}.0082$	$0^{m}.0068$	$0^{m}.0036$	32 (41)	66546	$0^{m}.0051$	$0^{m}.0106$	$0^{m}.0103$	16 (21)
28873	0.0042	0.0042	0.0026	25 (35)	67536	0.0114	0.0108	0.0040	14 (20)
40494	0.0073	0.0058	0.0101	10 (31)	68217	0.0114	0.0095	0.0069	16 (20)
44506	0.0244	0.0080	0.0225	8 (28)	68243	0.0068	0.0090	0.0106	16 (20)
46189	0.0078	0.0029	0.0095	11 (26)	69081	0.0056	0.0077	0.0044	16 (22)
46547	0.0154	0.0019	0.0160	10 (23)	69302	0.0030	0.0096	0.0099	15 (19)
49131	0.0145	0.0170	0.0037	11 (22)	70839	0.0068	0.0039	0.0044	15 (21)
50012	0.0065	0.0043	0.0074	10 (20)	70930	0.0095	0.0045	0.0069	16 (20)
51283	0.0051	0.0048	0.0079	9 (21)	72127	0.0191	0.0047	0.0194	16 (20)
54893	0.0055	0.0043	0.0037	12 (25)	72485	0.0037	0.0035	0.0021	15 (20)
54912	0.0097	0.0131	0.0110	11 (24)	72787	0.0043	0.0047	0.0036	15 (22)
55856	0.0057	0.0065	0.0081	11 (23)	74375	0.0057	0.0054	0.0027	14 (20)
55958	0.0071	0.0048	0.0048	10 (20)	74753	0.0032	0.0121	0.0126	15 (20)
56779	0.0056	0.0054	0.0044	10 (22)	75821	0.0139	0.0025	0.0135	16 (20)
56876	0.0025	0.0477	0.0470	10 (22)	78548	0.0050	0.0118	0.0104	14 (20)
58325	0.0060	0.0034	0.0055	10 (18)	79275	0.0061	0.0029	0.0056	17 (20)
61641	0.0028	0.0022	0.0021	10 (20)	79351	0.0070	0.0103	0.0071	12 (19)
61831	0.0034	0.0034	0.0019	10 (20)	83058	0.0024	0.0037	0.0036	15 (19)
62747	0.0184	0.0170	0.0080	9 (21)	84567	0.0062	0.0224	0.0250	16 (20)
62758	0.0036	0.0117	0.0104	10 (21)	84816	0.0043	0.0031	0.0020	17 (21)
63922	0.0022	0.0028	0.0032	10 (20)	85871	0.0177	0.0316	0.0369	17 (21)
64365	0.0125	0.0092	0.0044	11 (20)	86352	0.0099	0.0031	0.0107	15 (20)
64503	0.0135	0.0077	0.0086	11 (20)	87152	$0^{m}.0055$	$0^{m}.0040$	$0^{m}.0054$	16 (20)
65551	$0^{m}.0079$	$0^{m}.0104$	$0^{m}.0037$	10 (21)					

The frequency histogram of these standard deviations is displayed in Fig. 2. The distribution shows a fast increase from nearly zero to a quite well defined maximum, followed by a much slower and rather irregular descent. This behaviour is reminiscent of the frequency diagrams of probable errors in the radial velocity programs, first studied by Petrie (1960). As in that case, the diagram seen in Fig. 2 can be regarded as combination of a normal frequency curve, with its mode located at the average mean error, and a flatter and somewhat irregular one, generated by the observ-

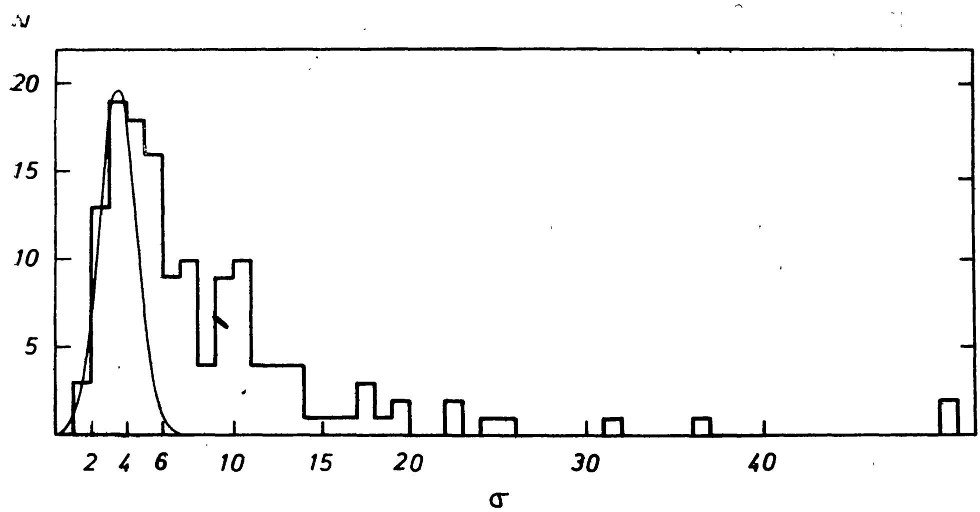

Fig. 2. Frequency histogram of standard deviations, σ, of the b magnitude differences (in units of $0^m\!.001$) obtained from observations taken through air masses smaller than 1.3 (*i.e.*, group I data). The Gaussian (thin solid line) was fitted to the frequencies left of the maximum.

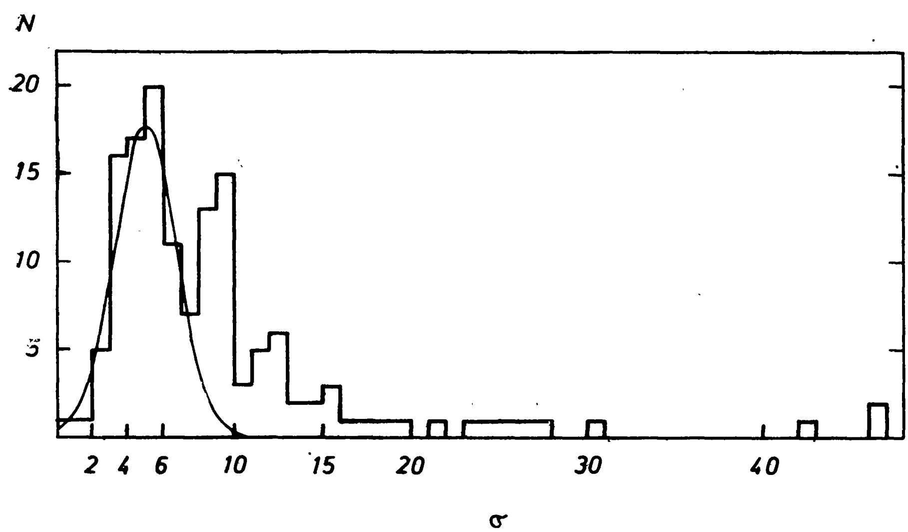

Fig. 3. The same as Fig. 2, but for group II data, *i.e.*, for observations obtained through air masses larger than 1.3, but not exceeding 2.0.

ed distribution of intrinsic variability. We assume that the portion of the frequency histogram to the left of maximum gives a reasonably good approximation of the observational error distribution. The solid line shown in Fig. 2 represents the resulting normal frequency curve. Numerically, its equation is of the form

$$N = 19.7\exp\left[-0.47\,(\sigma-3.5)^2\right], \tag{1}$$

where we used a convenient unit of $0^m\!.001$.

The frequency histogram of standard deviations corresponding to group II observations is shown in Fig 3. The error curve fitted to the frequencies left of maximum (solid line) has the following equation:

$$N = 17.7 \exp[-0.16(\sigma - 5.0)^2]. \tag{2}$$

Thus, the average mean error of a single magnitude difference is equal to $0\overset{m}{.}0035$ for group I observations, while for group II data it amounts to $0\overset{m}{.}0050$.

In investigations of errors of the radial velocity programs a point was made by Kirillova and Pavlovskaya (1963), and also by Jaschek and Gómez (1970), that the distribution of standard deviations is of the χ^2-type rather than Gaussian. While this is true, of course, the assumption of a normal frequency curve for the standard deviation distribution appears to be a good approximation in our case. This follows from the well-known limit property of the χ^2-type distributions, which we were justified to take advantage of, because we computed standard deviations from relatively large number of between ten and sixteen observations. In the radial velocity programs these numbers are much smaller, viz., three or four individual measurements per star. Even so, the results of Jaschek and Gómez (1970) were almost identical with those of Petrie (1960), who has used a Gaussian, instead of the more nearly correct χ^2 distribution. Of course, the assumption that the parent population of observational errors is normally distributed must be made in any case.

5. Results

5.1. Incidence of Light Variability

From the observed behaviour of magnitude differences we shall now derive information as to the distribution of variables among the program and comparison stars. If not stated otherwise, we use for this purpose group I observations only.

To begin with, we classify magnitude differences into three categories, viz., constant, doubtful, and variable, according to the size of the largest deviation from the mean. Thus, we consider as constant such series of magnitude differences, in which the deviations never exceeded $2\bar{\sigma}$, where $\bar{\sigma} = 0\overset{m}{.}0035$, is the average mean error of a single magnitude difference, as determined in the previous chapter. If in a series of magnitude differences there occured even one deviation equal to or greater than $3\bar{\sigma}$, we classify the magnitude differences as variable. The in-between cases we label as doubtful.

Having completed this, we could make an attempt to find out which stars can be regarded as constant in light, and which, on the other hand, should be considered variable. First, we identified as constant all stars which occur in magnitude differences classified "constant". Such stars we indicated with "cst" in the last column of Table 2. As it turned out, many of these stars were also included in the "doubtful" and "variable" magnitude differences. It was therefore possible to unambiguously identify the other stars as those causing the variation. Thus, stars which together with the ones already found constant yielded variable magnitude differences we indicated in the last column of Table 2 as "var". Furthermore, the series of magnitude differences classified "doubtful" were carefully examined, group II data being now included with proper weight, and stars apparently responsible for this classification we denoted as "cst?" or "var?", according to our estimate of the amount of the light variability likely to be present. Using these it was again possible to single out a number of variables, which we also indicated as "var" in the last column of Table 2. Moreover, in some cases light variability of a star was so pronouced that we could confidently label it as "var", although neither of the other two stars in the same triplet was unambiguously found "cst", "cst?", or "var?".

However, an unambiguous assessment of the degree of variability was not always possible. In a number of instances it could not be decided which, if any, of the stars involved was constant. In such cases we put an asterisk after the variability classification. That is, at least one of the stars in the same triplet so indicated is "cst?", "var?" or "var", whichever the case may be. Worse yet, in a few cases the only acceptable conclusion was that out of the three stars observed, at least two are variable. All these stars are denoted in the last column of Table 2 as "var**".

The above variability classification is, admittedly, somewhat schematic. It should, however, serve the purpose of selecting objects worth of further investigation, as most stars which varied in light by $0^{m}_{.}020$ or more will be found among those classified as "var", "var*", or "var**". On the other hand, it seems rather unlikely that a β Cephei variable with *b* amplitude exceeding $0^{m}_{.}010$ could have been missed altogether, *i. e.*, classified as "cst".

Quantitatively, the distribution of light variability is as follows. Out of the sixty-eight program stars observed, forty-eight could be unambiguously classified, viz., 21 as constant, 14 as doubtful cases (with 3 "cst?" and 11 "var?"), and 13 as variable. The results for the forty-two unambiguously classified non-β Cephei strip comparison stars (out of a total of sixty-four) are similar: 23 were found to be constant, 8 – doubtful

(6 "cst?" and 2 "var?"), and 11 — variable. As to sixteen series of magnitude differences, of which 11 were classified as doubtful (2 "cst?" and 9 "var?"), and 5 as variable, it was not possible to decide whether any of the stars involved is constant. Among these objects there were 17 program stars. In three cases all that could be concluded was that at least two stars in the same triple must be variable. These nine objects include four program stars.

The above results are summarized in Table 4, where we give the lower and upper limits of the number of stars for each division of our variability classification. The program stars and the non-β Cephei strip comparison stars are listed separately.

Table 4

Distribution of light variability
(The lower and upper limits of the number of stars for each division of our variability classification.)

Class	*Program stars* (68 *objects*)		*Comparison stars* (64 *objects*)	
	not less than	*not more than*	*not less than*	*not more than*
cst	21	38	23	38
cst?	4	21	7	23
var?	12	28	3	18
var	15	23	13	20

5.2. *The Individual Stars*

In this paragraph we shall first discuss the thirteen program stars that were unambiguously found to be variable in light. Next, we examine six program stars occuring in the magnitude differences classified as "var", but for which it was not possible to say if either of the stars involved was constant, *i. e.*, program stars denoted "var*" in the last column of Table 2. In addition, we shall deal with four program stars classified as "var**". Finally, we investigate variable non-β Cephei strip comparison stars. The remaining stars we observed will not be individually discussed in the present paper, because most information there is about the degree of their light variability can be easily obtained from the data presented in Tables 2 and 3.

Group I and II observations will be used in this section but with proper allowance for the inferior accuracy of the latter. However, all measurements taken through an air mass greater than 2.0 are rejected.

5.2.1. Variable Program Stars

HD 25631 = HR 1258 (B2.5 V). Comparison stars, HD 26087 (A3) and HD 25754 (A0), are probably constant. The range of night-to-night variation of HD 25631 amounts to $0\overset{m}{.}040$. On most nights the star did not vary by more than $0\overset{m}{.}005$, and only on one night the variation reached $0\overset{m}{.}013$, but on this night the comparison stars' magnitude differences showed a range of $0\overset{m}{.}015$. The period, if it exists, is probably longer than one day.

HD 49131 = HR 2501 (B2 III) is variable by about $0\overset{m}{.}12$. This result was obtained from group II observations, which explains why in Table 3 the standard deviations corresponding to HD 49131 are not so very large. The time scale of the variation appears to be of the order of days.

HD 52437 = HR 2628 (B2 IV-V). The light range is about $0\overset{m}{.}035$, and no periodicity shorter than one day seems to be present. In addition, at least one of the other two stars observed in the same triplet, HD 51283, = HR 2595 (B2 III) or HD 51630 = HR 2603 (B8), may be slightly variable.

HD 57573 = HR 2799 (B2.5 V). Although this star is certainly variable, the range reaching $0\overset{m}{.}035$, little can be said about character of the light variability present, because neither of the other two stars observed in the same triplet appears to be constant: HD 54669 = HR 2695 (B2 V) we classified as "var?", and HD 55856 = HR 2733 (B2 IV) – "cst?". It seems, however, that night-to-night variations predominate, so that the star is probably not a β Cephei variable.

HD 57593 = HR 2800 (B2.5 V) was nearly constant on most nights but on one night its brightness decreased by about $0\overset{m}{.}14$. The star may well be an eclipsing variable.

Comparison star observed with this star, HD 55857 = HR 2734 (B0.5 V), has been suspected by van Hoof (1973) to be a β Cephei variable with the V light amplitude equal to $0\overset{m}{.}02$. We find that HD 55857 is constant to within $0\overset{m}{.}010$.

HD 62747 = HR 3004 (B1.5 III). The light range is about $0\overset{m}{.}07$, and time scale of the variation appears to be longer than 10 hours. However, this conclusion is somewhat uncertain, because at least one of the comparison stars, HD 63028 (B3 IV) or HD 63271 = HR 3023 (B2 IV–V) is variable (*cf.* section 5.2.2.).

HD 64365 = HR 3078 (B2 IV). The $0\overset{m}{.}03$ light variation of this star seems to be somewhat erratic, but the possibility that HD 64365 is a β Cepehei variable cannot be rejected on the basis of observations obtained so far. Unfortunately, at least one of the comparison stars, HD 64287 = HR 3074 (B4 IV-V) or HD 65460 = HR 3114 (B2.5 V), appears to be slightly variable from night to night.

HD 64722 = HR 3088 (B1.5 IV). Although at least one of the other two stars observed in the same triplet, HD 66546 = HR 3157 (B2 IV-V) or HD 66441 = HR 3156 (B8), seems to be slightly variable from night to night, it can nevertheless be concluded that HD 64722 is a β Cephei variable. A search for period yielded the value of $0^d.1160 \pm 0^d.0003$ (estimated mean error). The light amplitude amounts to $0^m.027 \pm 0^m.002$ (estimated) and appears to be stable, but this will have to be verified, because our observations are spread over rather short time interval of only five days.

Observations of HD 64722 are shown in Fig. 4 as a function of phase of the $0^d.1160$ period. Zero phase corresponds to JD 2442742.

HD 65551 = HR 3116 (B2.5 IV) is variable on a time scale certainly longer than half a day. The light range appears to be slightly under $0^m.030$.

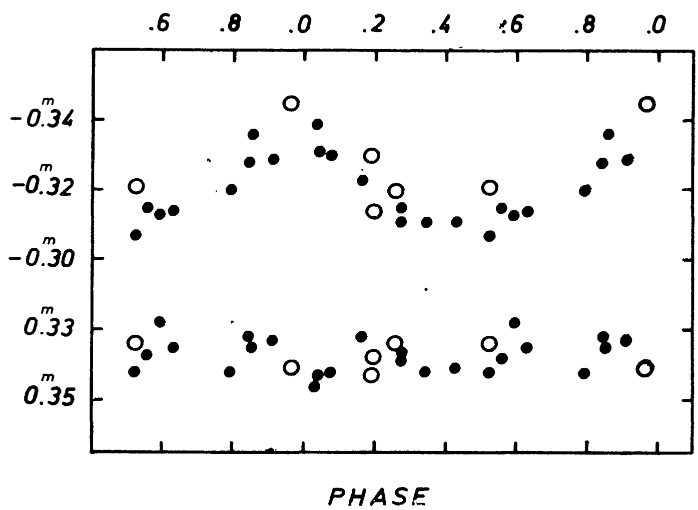

Fig. 4. The *b* magnitude observations of HD 64722 referred to the mean of HD 66546 and HD 66441 (top), plotted as a function of phase of the $0^d.1160$ period. Zero phase corresponds to JD 2442742. Magnitude differences HD 66546 *minus* HD 66441 are also shown (bottom). Open circles denote observations taken through an air mass greater than 1.3, but not exceeding 2.0 (group II data).

HD 67536 = HR 3186 (B2.5 Vn) shows a light range of about $0^m.040$. No period shorter than one day fits the data satisfactorily. The two best ones, $0^d.264$ and $0^d.359$, one cycle per sidereal day apart of each other, reduce the standard deviation to about $0^m.0080$. Although these quasi-periods seem much too long for a β Cephei variable with the low temperature and luminosity indicated by the MK type of B2.5 V, and may both be spurious, the star deserves further attention. In addition, at least one of the comparison stars, HD 66591 = *HR* 3159 (B3 V) or HD 68423 = HR 3217 (B8), seems to be slightly variable.

In Fig. 5 observations of HD 67536 are plotted as a function of heliocentric Julian date.

HD 69081 = *HR 3240* (B1.5 IV). On five nights (out of a total of six) the star varied by about $0\overset{\mathrm{m}}{.}010$, but on one night the range was almost $0\overset{\mathrm{m}}{.}030$. If, however, one observation obtained through rather large air mass of about 1.8 were rejected, the total variation would amount to only a little over $0\overset{\mathrm{m}}{.}020$. Moreover, one of the comparison stars, HD 69082 = HR 3241 (B2 IV–V) or HD 70556 = HR 3283 (B2 IV-V), appears to be slightly variable as well.

HD 69144 = *HR 3244* (B2.5 IV) is variable from night to night with a range of $0\overset{\mathrm{m}}{.}030$.

HD 79351 = *HR 3659* (B2 IV-V). Although at least one of the comparison stars, HD 79447 = HR 3663 (B3 III) or HD 77002 = HR 3582 (B2 IV-V), is variable (*cf.* section 5.2.2), it can nevertheless be concluded that HD 79351 shows a $0\overset{\mathrm{m}}{.}035$ night-to-night variation.

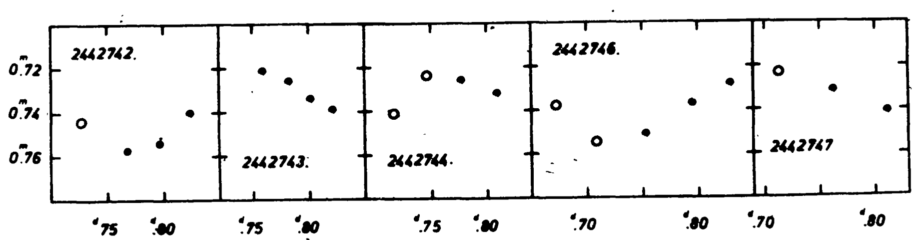

Fig. 5. The *b* magnitude observations of HD 67536 plotted as a function of heliocentric Julian date. The star's brightness is referred to the mean of comparison stars, HD 66591 and HD 68423. Open circles denote group II data.

5.2.2. *Program Stars Classified as "var*"*

HD 44506 = *HR 2288* (B1.5 IIIn) and HD 44979 (B9). The light range amounts to $0\overset{\mathrm{m}}{.}065$, and time scale of the variation is certainly longer than half a day.

HD 63271 = *HR 3023* (B2 IV-V) and HD 63028 (B3 IV). There is a $0\overset{\mathrm{m}}{.}030$ light variation present. The time scale appears to be longer than one day.

HD 68243 = *HR 3206* (B1 IV) and *HD 68324* = *HR 3213* (B1 IVn). Both these objects are program stars. It seems that HD 68324 is responsible for most of the $0\overset{\mathrm{m}}{.}025$ light range observed. The possibility that the star is a small amplitude β Cephei variable cannot be excluded.

HD 77002 = HR 3582 (B2 IV-V) and HD 79447 = HR 3663 (B3 III). A night-to-night variation can be seen with a range of $0^{m}.025$.

HD 85871 = HR 3920 (B1 IV) *minus* HD 84228 = HR 3868 (B4 V) magnitude differences are plotted as a function of heliocentric Julian date in Fig. 6. The range amounts to $0^{m}.055$, and the shortest period which

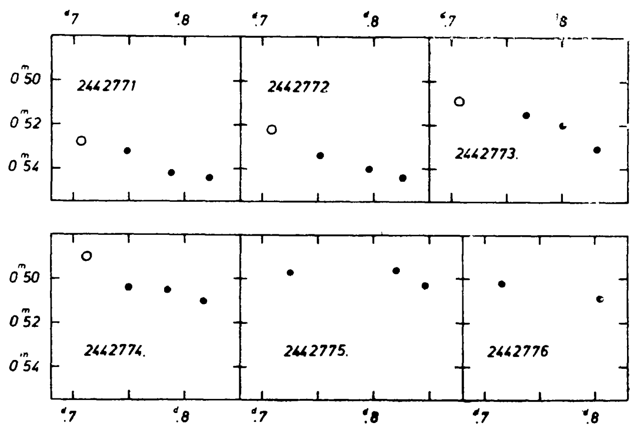

Fig. 6. The *b* magnitude differences HD 85871 *minus* HD 84228 plotted as a function of heliocentric Julian date. Open circles denote group II data.

seems to fit the data is equal to $0^{d}.530$. However, the observations are not well distributed in phase, and therefore it is possible that this value is spurious. Moreover, which of the two stars is the variable cannot be decided from the data obtained so far.

*5.2.3. "Var**" Program Stars*

HD 54912 = HR 2704 (B2.5 IV) and *HD 54224 = HR 2688* (B2 IV-V) were observed together with HD 55522 = 26 Canis Majoris (B2 V). First two objects are program stars. HD 54912 and HD 55522 are probably both variable by about $0^{m}.04$ each. On the other hand, HD 54224 may be constant to within $0^{m}.015$, but this is by no means certain. No periodicity shorter than about one day seems to be present in the data.

HD 55522 has been recently discovered by van Hoof (1975b) to be variable in V with an amplitude of $0^{m}.037$. From his eleven observations van Hoof determined a period of $2^{d}.68$, and concluded that the star might be a binary with an orbital period twice that long.

HD 64503 = HR 3084 (B2.5 V) was observed with HD 63465 = HR 3035 (B2.5 III) and HD 64802 = HR 3091 (B2 V). Of these three stars, at least two are variable with light ranges between $0^{m}.02$ and $0^{m}.03$. The observations indicate that if the variations were periodic, the periods would be longer than half a day.

Olsèn (1974) found HD 64503 to vary in y with an amplitude of $0\overset{m}{.}07$.

HD 68217 = HR 3204 (B2 IV-V). The comparison stars were *HD* 66624 = HR 3162 (B9) and HD 68601 = HR 3226 (A3p). At least two stars are variable from night to night by almost $0\overset{m}{.}03$. In addition, HD 66624 shows nightly light variations, but these appear to be smaller than $0\overset{m}{.}020$.

5.2.4. Variable non-β Cephei Strip Comparison Stars

HD 39764 = λ Columbae (B5 V) varies in a period equal to $0\overset{d}{.}640 \pm 0\overset{d}{.}002$, with an amplitude of $0\overset{m}{.}030 \pm 0\overset{m}{.}003$ (estimated mean errors). In Fig. 7 observations of this star are shown referred to HD 40494 = γ

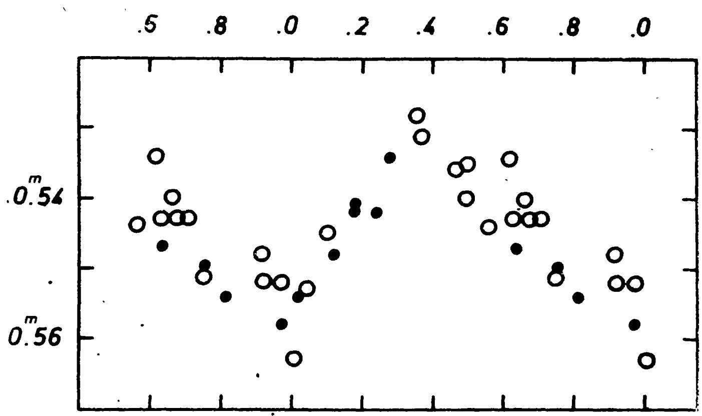

Fig. 7. The b magnitude observations of HD 39764 = λ Columbae *minus* HD 40494 = γ Columbae plotted as a function of phase of the $0\overset{d}{.}640$ period. Zero phase corresponds to JD 2442741. Open circles denote group II data.

Columbae (B2.5 IV), which seems to be less variable than HD 41534 = HR 2149 (B2 V), the third star observed in the same triplet.

The light variability of HD 39764 is probably due to proximity effects in a close binary system.

HD 45382 (A0) is variable from night to night with a range slightly over $0\overset{m}{.}020$.

HD 45871 = HR 2364 (B4 Vnp) shows a range of $0\overset{m}{.}055$. As can be seen from Fig. 8, where observations of HD 45871 are plotted against heliocentric Julian date, no obvious periodicity in the light variation is apparent. The star could well be a shell variable similar to EW Lacertae (*cf.* Lester 1975). Another possibility is that HD 45871 may be an ellipsoidal variable with periodic light curve, which, however, has its alternating minima of very unequal depth.

HD 50379 (B5) has a range of only $0^{m}_{.}025$. No periodicity shorter than 10 hours seems to be present.

HD 62714 (B9) is variable by about $0^{m}_{.}040$, on a time scale of half a day or longer.

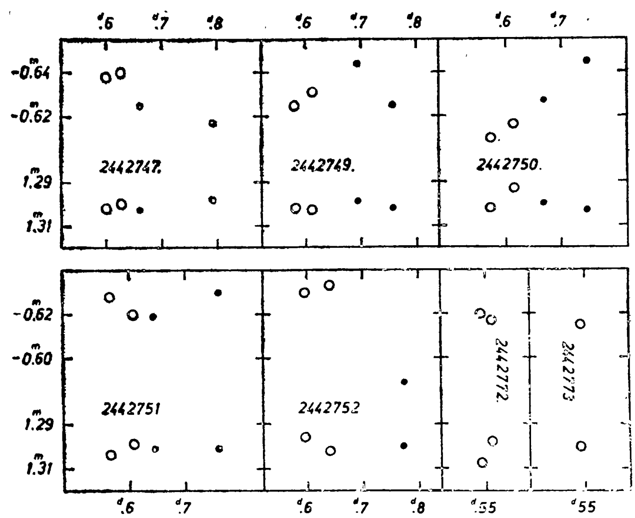

Fig. 8. The *b* observations of HD 45871 referred to the mean of HD 46547 and HD 46813 (top each panel), and magnitude differences HD 46813 *minus* HD 46547 (bottom each panel). Open circles denote group II data.

HD 72014 (B3 Vnnek). Although at least one of the other two stars in the same triplet, HD 72127 = HR 3359 (B2 IV) or HD 72067 = HR 3356 (B2 V), appears to be slightly variable, it is nevertheless clear that HD 72014 increased in brightness by about $0^{m}_{.}050$ during first three of the four successive nights on which it was observed. On the last of these nights the star was of about the same magnitude as on the third.

HD 74455 = HR 3462 (B1.5 Vn) was a comparison star in two triplets (*cf.* Table 2). While it turned out to be variable, the four remaining stars appear to be constant, so that all observations could be used in order to investigate the light variation. Observations taken with HD 75821 = HR 3527 (B0 III) and HD 76566 = HR 3562 (B3 IV) were referred to the mean of HD 74273 = HR 3453 (B1.5 V) and HD 74753 = HR 3476 (B0 IIIn). In this way forty data points were obtained, spanning a time interval of ten days. A period search yielded $0^{d}_{.}563 \pm 0^{d}_{.}001$ (estimated mean error) as the best value. The observations are plotted in Fig. 9 as a function of phase of this period. Zero phase corresponds to JD 2442758. The light curve is sinusoidal in shape, with amplitude amounting to $0^{m}_{.}037 \pm 0^{m}_{.}002$.

The star's light variation is probably caused by ellipticity effect in a binary system having orbital period twice the value mentioned above.

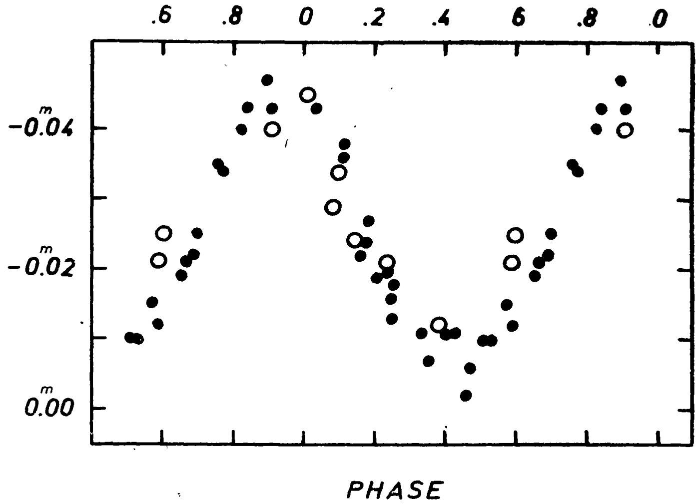

Fig. 9. The *b* observations of HD 74455 referred to the mean of HD 74273 and HD 74753 are shown plotted as a function of phase of the 0.d563 period. Zero phase corresponds to JD 2442758. Open circles denote group II data.

Variable radial velocity of HD 74455 has been reported by Buscombe (1962). His four plates show a range of 29 km/s.

HD 80094 = HR 3691 (B7 IV). One of the two stars observed together with this star, probably HD 78190 (B9), seems to be slightly variable. Nevertheless, it can be concluded that HD 80094 varied from night to night by about 0.m040.

HD 84809 = HR 3883 (B8) is variable with a range of almost 0.m100. The time scale of the variation is probably longer than one day.

HD 85860 (B9) shows a range of nearly 0.m080. The variation seems to be somewhat erratic. This can be seen from Fig. 10, where magnitude

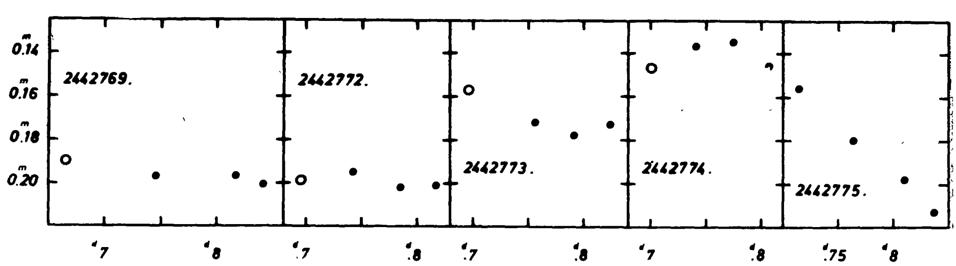

Fig. 10. The *b* magnitude differences HD 85860 *minus* HD 84824 as a function of heliocentric Julian date. Open circles denote group II data.

differences, HD 85860 *minus* HD 84824, are plotted as a function of heliocentric Julian date. HD 84824 (A0) may, however, be slightly variable itself, but probably less so than HD 84567 = HR 3878 (B0.5 IIIn), the program star observed with HD 85860. (These two stars were classified as "var?*" – *cf.* Table 2.)

HD 85953 = *HR 3924* (B2 V) is variable from night to night with a range of about $0^m_.030$.

6. Concluding Remarks

Photometric observations of Table 1 stars in the right ascension range from 10^h45^m to 20^h (winter objects) will be carried out in the near future. We postpone a discussion of the statistics of β Cephei variables until that date. Presently we wish to point out that so far we found only four stars with the *b* light range in excess of $0^m_.020$, which show indications of short periods characteristic of the β Cephei phenomenon. These stars are: HD 64365, HD 64722, HD 67536, and HD 68324. Moreover, for one of them, HD 64722, we derived a period of $0^d_.1160$, by far the shortest value known to occur among β Cephei variables. This result is somewhat puzzling, as the star's MK type of B1.5 IV places HD 64722 close to the middle of the β Cephei instability strip. If confirmed, it might cast some doubt as to the existence of a universal period-luminosity relation for this type of stellar variability.

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REFERENCES

Aizenman, M. L., Cox, J. P. and Lesh, J. R. . . . . 1975 *I. A. U. Colloquium No. 29*, in press.
Buscombe, W. . . . . 1962 *Mon. Not. R. astr. Soc.*, 124, 189.
Cox, J. P. . . . . 1974 *Rep. Prog. Phys.*, **37**, 563.
Davey, W. R. . . . . 1973 *Astrophys. J.*, **179**, 235.
Deupree, R. . . . . 1970 *Bull. am. astr. Soc.*, **2**, 308.
Dziembowski, W. . . . . 1971 *Acta astr.*, **21**, 289.
Grønbech, B., Olsen, E. H., and Stromgren, B. . . . . 1976 *Astr. Astrophys. Suppl.*, **26**, 155.
Hill, G. . . . . 1967 *Astrophys. J. Suppl.*, **14**, 263.
Hill, G., Drolet, B., and Odgers, G. J. . . . . 1976 *Astr. Astrophys.*, **51**, 1.
Hiltner, W. A., Garrison, R. F., and Schild, R. E. . . . . 1969 *Astrophys. J.*, **157**, 313.
Hoffleit, D. . . . . 1964 *Catalogue of Bright Stars* (Yale University Obs., New Haven, Conn.), 3rd edition.

Jaschek, C., and Gómez, A. E. .	1970	*Publ. astr. Soc. Pacific*, **82**, 809.
Jerzykiewicz, M.	1972	*Publ. astr. Soc. Pacific*, **84**, 718.
. . . .	1974	*ibid.*, **86**, 43.
. . . .	1975	*Acta astr.*, **25**, 81.
Jones, D. H. P., and Shobbrook, R. R.	1974	*Mon. Not. R. astr. Soc.*, **166**, 649.
Kirillova, T. S., and Pavlovskaya, E. D.	1963	*Astr. Zu.*, **40**, 131.
Lesh, J. R.	1968	*Astrophys. J. Suppl.*, **16**, 371.
Lester, D. F.	1975	*Publ. astr. Soc. Pacific*, **87**, 177.
Lynds, C. R.	1959	*Astrophys. J.*, **130**, 577.
McNamara, D. H., and Bills, B. G.	1973	*Publ. astr. Soc. Pacific*, **85**, 632.
Olsen, E. H.	1974	*Comm.* **27** *I. A. U. Inf. Bull. var. Stars*, No. 925.
Pagel, B. E. J.	1956	*Mon. Not. R. astr. Soc.*, **116**, 10.
Percy, J. R.	1969	*J. R. astr. Soc. Can.*, **63**, 233.
Petrie, R. M.	1960	*Ann. Astrophys.*, **23**, 744.
Pike, C. D.	1974	*Publ. astr. Soc. Pacific.*, **86**, 681.
Shobbrook, R. R.	1972	*Mon. Not. R. astr. Soc.*, **157**, 5P.
Shobbrook, R. R., Herbison-Evans, D., Johnston, I. D., and Lomb, N. R.	1969	*Mon. Not. R. astr. Soc.*, **145**, 131.
Shobbrook, R. R., and Lomb, N. R.	1972	*Mon. Not. R. astr. Soc.*, **156**, 181.
Sterken, C., and Jerzykiewicz, M. .	1977	*Astr. Astrophys. Suppl.*, in press.
van Hoof, A.	1973	*Comm.* **27** *I. A. U. Inf. Bull. var. Stars*, No. 807.
. . . .	1975a	*ibid.*, No. 969.
. . . .	1975b	*ibid.*, No. 992.
Walker, M. F.	1952	*Astr. J.*, **57**, 227.