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PHOTOMETRY AND SPECTRAL CLASSIFICATION OF EARLY-TYPE STARS AWAY FROM THE GALACTIC PLANE

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SUMMARY

Magnitudes and colours on the *UBV* system and MK spectral classifications are reported for 138 southern early-type stars away from the galactic plane.

1. INTRODUCTION

The comparative rarity of early-type stars in regions of the sky away from the Milky Way allows a fairly complete survey to be made of those that are in the Henry Draper Catalogue. The observational programme reported here originated after the discovery of the helium star HD 168476 by Thackeray & Wesselink (1952). The galactic latitude of this star is $-18°$. Although not all the known helium stars are at such high latitudes (Hill 1969a), the possibility of finding interesting objects amongst the early-type stars increases with distance from the galactic plane.

This paper reports *UBV* photometry and spectral classification of southern early-type stars in the categories listed below, generally with $|b^{II}| \geqslant 15°$ and no previous MK classification or *UBV* photometry. Radial velocity measurements of some of these stars will be reported later.

(i) Relatively faint early B stars away from the galactic plane for which observations were started by Dr A. J. Wesselink and continued by the present writer. Some stars have latitudes as low as 7°.

(ii) Early B stars brighter than $m_v = 8{\cdot}5$ and with unknown radial velocity, as part of a programme initiated by Dr A. D. Thackeray to complete the radial velocity measurements of all southern early B stars to at least $7^{m}{\cdot}5$.

(iii) Faint HD early B stars not included in (i) were added in the hope of finding interesting stars.

(iv) A few bright horizontal branch candidates from the lists of Luyten (1957) and Haro & Luyten (1962).

(v) Early B stars observed for radial velocity by Neubauer (1943).

(vi) Some late B stars. Those found to be of earlier spectral type than given in the HD catalogue will be selected for further study.

2. PHOTOMETRY

Photoelectric observations were made by Dr Wesselink with the 74-inch (1·88 m) reflector of the Radcliffe Observatory in Pretoria during 1960–1963. Included in the material discussed here are 78 observations by him on 25 stars. All the other observations were made by the author with the 74-inch reflector on 24

nights between 1963 September and 1964 September, concurrently with a programme on Luyten faint blue stars (Hill & Hill 1966), and with the 40-inch (1·02 m) Elizabeth reflector of the Royal Observatory, Cape of Good Hope, on 12 nights during 1968 March and April.

The Radcliffe photometer has been described by Feast, Thackeray & Wesselink (1960) and by Wesselink (1962). Filters used were 1 mm Schott UG2 for U, 4 mm Schott GG13 + 1 mm Schott BG12 for B and 2 mm Omag 302 for V with an EMI 6256A quartz-window photomultiplier tube. The system used with the Cape 40-inch telescope is identical except that 1·3 mm of glass has been added to the ultraviolet filter to make a closer match to Johnson's U band based on the glass window 1P21 photomultiplier (Cousins 1967a). The Radcliffe photometer was used with a D.C. amplifier (Cousins & Wellgate 1961) and Brown recorder. The Cape photometer utilized a D.C. integrator with a digital voltmeter and strip printer along with differentiator and recorder to monitor the observations.

The Radcliffe observations in 1963 and 1964 were affected by atmospheric dust produced by a volcanic eruption in Indonesia (Hill 1964a). The visual extinction varied from $0^m.6$ in 1963 September to an average near $0^m.3$ in 1964. Variations in the colour coefficients were smaller. Where possible the extinction coefficients were determined independently from each night's observations, but mean values were used for a few nights, usually partly cloudy, where this procedure was not possible. The mean values from eighteen nights in 1964 were $0^m.29$ in V, $0^m.13$ in $B–V$ and $0^m.31$ in $U–B$ in the natural system of the Radcliffe photometer. Mean values of $0^m.20$, $0^m.15$ and $0^m.30$ for the extinction coefficients in V, $B–V$ and $U–B$ were used at the Cape. Zero points were based on the standards and variation with time taken into account following the usual practice at the Cape (Cousins 1966).

Stars in the Harvard E Regions (Cousins & Stoy 1962) were used as standards, with revised $U–B$ colours measured by Cousins (1967b). Additional standards, particularly at high southern declinations, were selected from stars measured at the Cape Observatory (Cousins & Stoy 1963; Cousins, Lake & Stoy 1966). The $U–B$ colours for these stars are based on preliminary values for the E regions, but the differences are small and no significant differences between the two groups of standards have been found in the zero point of the present work.

Colour equations have been based only on E Region stars. The final residuals for other standards show no dependence on either $B–V$ or $U–B$. The following colour equations, based on 159 observations, were used to convert the natural system of the Radcliffe photometer, *uby*, to the *UBV* system as defined at the Cape.

$$V = y - 0{\cdot}007(b-y) + \text{const.},$$

$$\begin{aligned} B-V &= 1{\cdot}06(b-y) - 0{\cdot}026 + \text{const.}, && B-V \leqslant 0{\cdot}4; \\ B-V &= (b-y) + \text{const.}, && B-V > 0{\cdot}4; \end{aligned}$$

$$\begin{aligned} U-B &= (u-b) + 0{\cdot}022 + \text{const.}, && U-B \leqslant -0{\cdot}43; \\ U-B &= 0{\cdot}89(u-b) - 0{\cdot}029 + \text{const.}, && -0{\cdot}43 < U-B \leqslant -0{\cdot}26; \\ U-B &= (u-b) + \text{const.}, && U-B > -0{\cdot}26. \end{aligned}$$

No significant changes were found during the period of the observations. At the Cape, colour equations for the 40-inch telescope had been measured just prior to the

start of observations on this programme. They were

$$V = y + 0{\cdot}03(b-y) + \text{const.}$$

$$B-V = 1{\cdot}04(b-y) + \text{const.}$$

$$U-B = (u-b) + \text{const.},$$

The hottest stars in the E Regions have $U-B$ near $-0^{m}{\cdot}8$, while the blue limit for the programme stars is $U-B = -1^{m}{\cdot}0$. An attempt was made to use the bluest stars in the Magellanic Cloud regions (Wesselink 1962) but this proved unsatisfactory owing to possible variability and the large zenith distances involved. Dr Wesselink has discussed the difficulties in his paper. Since there was no difference between the natural system of the 40-inch telescope and the standard system at the time the Cape observations were made, observations of the bluest stars at the Cape have been taken to be on the standard system in $U-B$ after the zero point has been removed. The relation between the Radcliffe and Cape $U-B$ colours for the bluest stars is discussed below.

All but one of the stars observed by Dr Wesselink were also observed by the author at least once. Although the apparatus was the same, differences in the method of reduction might lead to systematic errors. For the 20 stars with at least two observations by each observer, no significant differences were found except in $B-V$ where Dr Wesselink's results were adjusted by $-0^{m}{\cdot}01$. No colour dependence was found in the differences. In a comparison of 19 stars with at least 2 consistent observations at both Radcliffe and the Cape no evidence was found for any colour dependence of the differences in V and $B-V$. Mean differences were $+0^{m}{\cdot}007 \pm 0^{m}{\cdot}012$(s.d.) in V and $-0^{m}{\cdot}002 \pm 0^{m}{\cdot}007$(s.d.) in $B-V$ in the sense Cape–Radcliffe. For $U-B$, however, while the mean difference was $0^{m}{\cdot}000 \pm 0^{m}{\cdot}014$(s.d.), a difference amounting to at most $+0^{m}{\cdot}02$ was found for some stars with $U-B < -0^{m}{\cdot}8$, the blue limit to the E region standard stars discussed above. This is in the sense to be expected on account of the greater ultra-violet transmission of the Radcliffe photometer. Some differences amounting to a few hundredths of a magnitude occurred for stars near $U-B = -0^{m}{\cdot}5$, probably due to uncertainty in the colour equation in that region.

Omitting known and suspected variables the average number of observations per star was 4·4. The internal standard errors per observation with the 74-inch telescope are $0^{m}{\cdot}026$ in V, $0^{m}{\cdot}016$ in $B-V$ and $0^{m}{\cdot}022$ in $U-B$, no significant differences being found between the errors determined from observations by Hill or Wesselink. The internal errors for the 40-inch observations are $0^{m}{\cdot}017$, $0^{m}{\cdot}009$ and $0^{m}{\cdot}012$. The improvement by a factor of approximately $\sqrt{2}$ is probably due to the shorter observing period and clearer atmosphere for the Cape observations. Accordingly the Cape observations have been given twice the weight of the Radcliffe observations in determining the final means. The overall standard errors for an observation of unit weight are $0^{m}{\cdot}024$, $0^{m}{\cdot}015$ and $0^{m}{\cdot}019$.

Small corrections have been made to the final magnitudes and colours collected in Table III to bring them onto the *UBV* system as defined by Cousins (1967a) to be as near as possible to the Johnson system.

A number of these stars have been measured by other observers including some independent observations made at the Cape Observatory (i.e. not used as standards). Most of these are included in the compilation by Blanco *et al.* (1968). Comparisons

with Cape, Mount Stromlo (MSO) and Cerro Tololo (CTIO) observations are given in Table I. The Cape observations were first adjusted as described in the previous paragraph.

TABLE I

Comparison with other observatories

Obs.	Obs.—Hill						No. of Stars
	$\overline{\Delta V}$	s.d.	$\overline{\Delta(B-V)}$	s.d.	$\overline{\Delta(U-B)}$	s.d.	
Cape	−0·004	±0·012	−0·004	±0·019			7
MSO	+0·015	±0·020	+0·002	±0·024	−0·030	±0·028	6
CTIO	+0·007	±0·012	+0·012	±0·017	−0·007	±0·013	6

The agreement is satisfactory apart from the large difference in $U-B$ with Mount Stromlo. This is due to three stars observed by Przybylski & Kennedy (1965) which give differences of $0^m{\cdot}05$. The comparison with the Cerro Tololo observations by Gutiérrez-Moreno & Moreno (1968) is similar to their comparison with the Cape observations reported by Cousins & Stoy (1963).

3. SPECTRAL CLASSIFICATION

Plates for spectral classification were taken with the f/2 camera (86 Å mm^{-1} at Hγ) of the 2-prism Cassegrain spectrograph on the Radcliffe 74-inch reflector. Although some resolution is lost the spectra were taken with a wide slit (projected width 27 microns) in order to make them more directly comparable with the MK system which is based mainly on spectra at 120 Å mm^{-1} (Feast & Thackeray 1963). The linear width of the spectra was 0·5 mm. Emulsions were Eastman Kodak 103aO or IIaO (generally baked).

Classifications were made by comparing the spectrograms of the programme stars with spectra of MK standards taken under the same conditions which are held on file at the Radcliffe Observatory. Table II gives the spectral types of the standards available. Most of the stars in Table I were classified twice independently by the author and many were also classified by Dr A. D. Thackeray or Dr T. Lloyd Evans. A comparison of the classifications suggests that systematic errors are less than half a spectral sub-class or luminosity class, and that the standard deviation of a single classification is about one spectral sub-class or luminosity class. For many of the stars the classifications were checked by visual inspection of radial velocity plates taken with the f/3·7 camera (49 Å mm^{-1} at Hγ).

The spectral types determined in this programme are given in Table III. For 24 stars in Table III MK spectral types are given in the somewhat heterogeneous collection of the Jaschek Catalogue (Jaschek, Conde & de Sierra 1964) or elsewhere. For three of these stars there are no Radcliffe classifications, two (HD 135485 and HD 160641) are peculiar stars, while for HD 173994 the catalogue classification (B8 V) appears to be erroneous. A comparison of the spectral types in Table III with other determinations gives residuals in the sense Radcliffe–Other of +0·5 spectral sub-class with a standard deviation for one star of ±1·1, and +0·2 in luminosity class with standard deviation ±0·7. Although the accuracy of a classification will depend on the spectral type, due to the differing criteria used, and the differences would not be expected to follow a normal distribution, these figures,

TABLE II

Spectral types of standards

	Ia	Iab	Ib	II	III	IV	V
O9				×	×		×
O9·5			×	×			
B0	×				×		×
B0·5	×		×		×		×
B1					×		×
B1·5	×		×				
B2	×			×	×	×	×
B2·5							
B3	×			×	×		×
B4							
B5	×	×	×		×		×
B6					×		×
B7	×				×	×	×
B8	×			×	×		×
B9		×	×	×	×		
B9·5							×
A0	×		×				×

being similar to those obtained for the determination of a Radcliffe spectral type, give some idea of the confidence which may be placed in such classifications. A comparison between the observed spectral types for main sequence stars and those determined from the colours using the Q method (Johnson 1958) shows good agreement except for five stars (HD 97185, CPD -44°6953, HD 137595, HD 138503 and HD 143495) where the colours suggest earlier spectral types than observed. CPD -44°6953 is an emission line star and HD 138503 is variable.

4. DESCRIPTION OF TABLE III

The table contains the results of *UBV* photometry and MK spectral classification. The contents of the columns are as follows:

Column 1. HD number or, in the case of a few stars from the *Cape Zone Catalogue of Faint Stars* (Spencer Jones & Jackson 1939), the CPD number.

Columns 2, 3. Galactic coordinates calculated using the relations given by Torgård (1961).

Columns 4, 5, 6. Visual magnitude and colours on the *UBV* system. A colon (:) indicates that the standard deviation for the star lies between two and three times the overall standard deviation. Quantities in italics are quoted from the reference in column 10.

Column 7. Weight of the magnitude and colours calculated as number of Radcliffe observations plus twice the number of Cape observations.

Column 8. HD spectral type.

Column 9. MK spectral type determined at the Radcliffe Observatory. A spectral type in italics is quoted from the reference in column 11.

Columns 10, 11. Sources of photometry and spectral type respectively.

Columns 12, 13. Cross-references to other *UBV* and MK spectral type measures.

(1) Blanco *et al.* (1968),
(2) Jaschek *et al.* (1964),
(3) Gutiérrez-Moreno & Moreno (1968),

Table III

UBV photometry and MK spectral types

HD	l^{II} °	b^{II} °	V m	$B-V$ m	$U-B$ m	Wt	Spectral Type HD	Spectral Type MK	References Source Mag	Source Sp	Others Mag	Others Sp	Remark
3175	306·23	−53·95	9·28	−0·17	−0·61	3	B5	B5 III					
10747	298·87	−41·07	8·16	−0·14	−0·66	12	B3	B3 V					
18100	217·93	−62·74	8·46	−0·24	−0·97	2	B5						
21305	210·47	−54·22	10·35	−0·16	−0·72	5	A	B5 V					
21996	212·70	−53·06	9·40:	−0·14	−0·61	7	B5	B5 V					
22413	224·63	−53·88	*8·82*	*+0·31*	−0·05	7	A3	*F2 V–VI*	(4)	(8)	(1)		
22586	264·18	−50·36	8·03	−0·19	−0·91	4	B3	B2 III					
24757	265·88	−47·05	7·75	−0·13	−0·49	9	B5	B6 V					
33599	271·32	−35·91	8·88	−0·18	−0·71:	14	B5	B3 p					*
34525N	212·10	−25·62	10·55	+0·43	−0·05	4	B						**
34525S	212·10	−25·62	10·25	+0·40	−0·06	4	B						*
35575	204·17	−19·70	*6·41*	*−0·17*	*−0·73*		B3	B3 V	(6)		(1)	(2)	
35792	204·24	−19·31	*7·20*	*−0·14*	*−0·64*		B3	B5 V	(6)		(1)	(2)	
37622	215·05	−21·01	8·03:	−0·09	−0·71	10	B3	B3 Vn				(11)	*
40556	246·44	−26·88	8·57	−0·18	−0·71	9	B5	B3 Vn					
43071	243·54	−23·09	*6·87*	*−0·14*	*−0·72*		B3	B5: Vn	(7)			(2)	
46189	236·16	−16·46	*5·93*	*−0·16*	*−0·67*		B5	B5 V	(7)		(1)	(2)	
47851	240·82	−16·30	9·69	−0·19	−0·76	7	B3	B3 V					
52057	246·63	−14·41	6·31	+0·06	−0·26	9	Ao	Ao V			(1)	(1)	
53071	251·31	−15·56	7·90	−0·14	−0·71	13	B5	B2 V					
54967	270·25	−21·27	6·46	−0·13	−0·54	13	B5	B3 V					
57697	289·43	−25·35	9·70	0·00	−0·65	7	B5	B3 III					
58657	265·09	−17·06	7·22	−0·07	−0·21	4	B5	B9 V			(7)		
59446	259·42	−13·94	7·58	+0·08	−0·35	4	B3	B7 V					
60429	253·02	−9·86	8·35	−0·06	−0·72	4	B5	B3 III–IV					
61948	265·37	−14·69	8·51	−0·04	−0·58	5	B3	B3 V					
62193	258·90	−11·20	8·68	−0·10	−0·76	5	B3	B2 V					
62483	265·76	−14·45	8·24	−0·06	−0·81	5	B2	B2 III			(1)	(2)	
66738	233·19	9·67	8·06	−0·15	−0·67	6	B5	B3 III					
68444	235·48	10·42	9·19	−0·17	−0·80	6	B3						

73834	278·76	−13·47	8·10	−0·02	−0·71	6	B3	B3ne				*
78985	253·35	14·65	7·49	−0·13	−0·67	7	B5	B5 V				
81504	281·01	−17·99	7·40	+0·05	−0·13	4	B9	B9·5 V				
83093	289·12	−15·20	7·73	−0·03	−0·74	5	B3	B2 V				
84567	261·84	17·45	*6·45*	*−0·14*	*−0·94*		B2	B2 V	(5)	(1)	(2)	
84971	239·69	36·86	8·68	−0·17	−0·75	8	B5	B3 V		(1)	(11)	
85289	291·72	−16·37	9·63	+0·06	−0·47	6	B8					
86085	269·23	12·33	8·94	−0·09	−0·85	5	B3	B1 Vn				
86248	264·58	18·11	9·63	−0·19	−0·89	13	B3	B3 II				
86612	259·77	24·15	*6·20*	*−0·10*	*−0·68*		B5	B5 Ve	(5)			*
87782	268·76	16·52	8·17	−0·06	−0·38	6	B9	B5 III				
88493	267·72	19·56	9·41	−0·03	−0·10	6	B9	B9·5 V				
88597	271·04	15·51	8·96	−0·09	−0·39	6	B8	B6 V				
88799	295·28	−18·39	9·26	+0·02	−0·43	6	B8	B5 V				*
89075	264·84	24·57	8·54	−0·04	−0·17	6	B9	B9 V				
89341	295·79	−18·74	8·56	+0·10	−0·01	6	B9	A0 V				
89403	295·60	−18·44	7·70	−0·03	−0·62	4	B5	B2 V				
89480	294·47	−16·85	8·73	+0·25	−0·07	4	B9	B9 V				
89884	260·00	32·11	7·13	−0·12	−0·56	6	B5	B6 V		(1)		*
93971	277·55	19·90	9·73	+0·21	+0·23	6	B9	B9 III				
96901	292·16	−3·91	8·82	+0·20	−0·62	4	B3	B1 II				*
97185	286·67	10·02	7·49	−0·10	−0·72	6	B5	B4 V				
97895	279·07	28·87	8·77	−0·10	−0·56	6	B9	B5 III				
97991	262·33	51·74	7·41	−0·22	−0·91	6	B3	B1 V		(1)	(2)	
98763	276·96	36·21	7·35	−0·06	−0·35	6	B9	B7 IV				
99077	285·02	20·39	9·28	+0·37	+0·18	6	B9					
99171	286·33	17·38	*6·11*	*−0·19*	*−0·80*		B3	B2 III	(5)	(1)	(2)	
99508	285·10	21·77	7·89	+0·05	+0·07	6	B9	A0 V:				
102657	293·10	10·27	7·73	−0·03	−0·56	6	B5	B3 V				
106304	295·32	21·46	9·06	+0·01	0·00	8	B9	B9 V		(1)		
106337	294·62	25·71	7·85	−0·10	−0·50	8	B8	B6 V				
108230	296·75	30·25	9·34	−0·16	−0·81	6	B8	B5 II				
108769	297·92	28·16	9·05:	−0·15	−0·78	10	B3	B3 V				
CPD -51°5580	303·15	10·98	10·87	+0·50	0·00	8	B5	F6 III				
112192	303·67	20·57	6·82	−0·13	−0·67	12	B3	B5 Vn				

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TABLE III—*Continued*

HD	l^{II} °	b^{II} °	V m	$B-V$ m	$U-B$ m	Wt	Spectral Type HD	Spectral Type MK	References Source Mag	References Source Sp	References Others Mag	References Others Sp	Remark
112481	303·94	13·09	8·36	+0·04	−0·74	14	B2	B2 Ib					
113009	304·77	18·08	7·67	−0·08	−0·47	6	B9	B6 V			(1)		
114444	304·33	−12·50	10·32	−0·01	−0·79	15	B	B2 III					
114981	307·89	24·00	7·11	−0·06	−0·64	6	B8	B5 V					*
115067	308·15	25·20	8·06	−0·10	−0·47	6	B8	B8 V					
115987	309·13	22·52	7·48	−0·01	−0·06	6	B9	B8 V					
116538	308·23	10·69	7·92	−0·07	−0·90	5	B2	B2 IVn					
119069	312·05	16·12	8·43	−0·20	−0·98	7	B5	B1 III			(3)		
119103	312·65	18·76	7·15	−0·07	−0·18	6	B9	B8 III			(1)		
119338	314·04	23·49	8·93	−0·12	−0·51	6	B8	B5 V			(3)		
119644	312·77	16·49	8·10	−0·09	−0·52	7	B5	B4 III			(3)		
120086	329·61	57·48	7·89	−0·18	−0·79	11	B5	B3 III			(1)	(11)	
120958	315·89	22·25	7·6::	−0·11:	−0·77	19	B5	B3 Vne					*
121983	318·88	27·21	8·10	−0·10	−0·75	7	B5	B3 III			(3)		
122449	315·48	14·30	8·12	−0·08	−0·43	6	B8	B5 III			(3)		
123884	328·18	40·97	9·36	+0·06	−0·25	6	B2	Ao Ib?			(1)		
124448	317·65	14·19	9·99	−0·09	−0·80	16	B2	B3p					*
CoD -45°9031	317·64	14·22	10·52	+1·22	+1·1::	7							*
125924	338·14	48·28	9·68	−0·19	−0·85	8	B5	B2 IV					*
129929	327·02	20·21	8·09	−0·18	−0·87	10	B5	B3 V					
CPD -44°6953	323·36	13·01	10·14	+0·06	−0·54	4	B5	B6 Ve			(1)		*
CPD -42°6798	324·45	15·09	10·26	+0·05	−0·62	4	B	?B2 III–II					
130095	332·33	28·96	8·14	+0·08	+0·10	11	B8	Ao V			(1)		
132041	329·80	20·11	7·80	−0·07	−0·38	6	B8	B5 III					
134411	330·06	15·54	9·56	−0·18	−0·82	6	B8	B2 Vn					
134591	333·07	19·78	8·37	+0·06	−0·35	6	B8	B5 III					
135485	347·31	35·46	8·17	−0·08	−0·54	7	B3	B5 IIp				(2)	*
136445	339·11	24·20	*8·17*	*+0·52*	0·00	14	F8		(5)				*
137179	307·79	−22·01	8·75	−0·08	−0·69	7	B5	B2 III					
137595	336·73	18·87	7·49	+0·03	−0·74	13	B5	B3 Vn					

138503	343·35	24·87	9·1::	−0·03	−0·73	38	B5	B5 Vn				*
138600	343·40	24·72	7·62	+0·58	+0·11	62	F8					*
138790	343·63	24·55	8·04	+0·44	−0·02	8	F2					*
142883	350·90	24·08	5·86	+0·01	−0·48	12	B5	B3 V		(1, 3)	(2)	
143495	316·33	−15·15	9·48	+0·07	−0·36	12	B5	B8 V				
145537	343·29	11·99	10·41	+0·10	−0·79	4	B	Bo·5 V				
149671	321·70	−14·29	*5·90*	*−0·08*	*−0·41*		B5	B8: V:	(5)		(2)	*
153382	344·08	0·02	7·29	+0·14	−0·28	6	B8	B8 III				
156359	328·67	−14·52	9·67	−0·14	−0·98	4	Bo	O9 III				
158243	337·60	−10·63	8·15	0·00	−0·82	5	B3	B1 I(ab)				
160641	8·98	6·49	9·86:	+0·15	−0·85	9	B	*Op*		(12)		*
160993	345·60	−8·57	7·73	+0·02	−0·82	4	Bo	B1 I				
160995	343·27	−9·95	10·38	−0·05	−0·57	4	B5	B5 V				
161633	344·77	−9·78	9·86	+0·12	−0·95	4	B2	Bo V				
163007	345·61	−10·74	7·50	−0·04	−0·65	4	B3	B5 Ve				*
163522	349·57	−9·08	8·43	−0·01	−0·86	4	Bop	B1 Ip				*
164806	335·34	−17·37	6·83	−0·10	−0·53	7	B5	B5 III				
165938	333·06	−19·09	8·21	−0·09	−0·46	6	B5	B5 III				
168476	338·11	−18·71	9·30:	−0·01	−0·69	19	B	B5p				*
170385	351·10	−14·99	7·90	−0·14	−0·63	5	B3	B3 V				
171141	349·28	−16·51	8·38	−0·22	−0·96	7	B5	B1 III				
172094	353·49	−15·80	8·28	−0·15	−0·88	4	B5	B2 III				
172140	5·26	−10·60	9·96	−0·06	−0·90	5	B	Bo·5 III				
173994	348·45	−19·62	7·07	−0·15	−0·71	7	B5	B2 V			(2)	
177566	355·55	−20·42	10·20	−0·20	−1·00	9	B5	B1 III				
178370	5·46	−17·53	9·51	−0·12	−0·69	5	B5	B3 III				
179007	1·70	−19·48	10·00	−0·13	−0·68	7	B5	B3 III				
179202	14·26	−14·70	8·35	0·00	−0·44	5	B5	B5 V				
180183	340·88	−25·95	6·81	−0·17	−0·76	6	B5	B3 Vn			(2)	
183899	13·07	−20·13	9·80	−0·08	−0·79	5	B	B2 III				
187311	358·71	−28·17	10·25	−0·17	−0·67	4	B5	B3 V				
187536	12·52	−24·76	9·46	−0·08	−0·86	5	B	B2 III				
195455	20·27	−32·13	9·20	−0·18	−0·90	3	B5	Bo·5 III:				
203532	309·45	−31·74	*6·37*	*+0·13*	*−0·37*		B3	B5 V	(5)		(5)	
204076	13·90	−45·68	8·79	−0·15	−0·84	3	B5	B1 V				

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TABLE III—*Continued*

HD	l^{II} °	b^{II} °	V m	$B-V$ m	$U-B$ m	Wt	Spectral Type HD	Spectral Type MK	References Source Mag	References Source Sp	References Others Mag	References Others Sp	Remark
208213	17·88	−51·48	8·42	−0·13	−0·57	3	B5	?B3 Vn					
209522	23·56	−53·00	5·95	−0·15	−0·66	3	B5	B5 V			(1)	(2)	*
214080	44·80	−56·91	6·80	−0·14	−0·92:	3	B2	*B1 Ib*		(9)		(2)	
220023	30·88	−69·72	9·35	+0·03	+0·01	3	A0						
220172	68·10	−62·64	7·68	−0·21	−0·83	3	B3	B3 V				(2)	*
220787	67·78	−64·39	8·30	−0·18	−0·68	3	B8	B3 III			(13)	(13)	*
221166	31·76	−71·73	10·49:	+0·12	+0·12	3	A2						
224927	37·01	−78·82	8·96	+0·32	−0·11	3	A2	*A8 VI*		(10)	(1)	(1)	*

Notes to Table III

33599	LHα 5. Balmer lines very sharp and deep. He and other lines very weak and diffuse. No emission at Hβ. Probably a shell star.
34525N	SSC 150306 (*Smithsonian Star Catalogue*).
34525S	SSC 150307.
	Separation 28″, HD spectral type B due to overlapping spectra.
37622	Guetter (1968) gives B3 Ve.
73834	LHα 109.
86612	MWC 581.
88799	Double. Rst 2681, Sep 2″·6, Δm = 3·1.
89884	MWC 582.
96901	Double. I 872, Sep 2″·6, Δm = 1·5.
114981	LHα 775.
120958	LHα 829. Variable, range $0^{m}\cdot2$ in V.
124448	Helium Star. Photometry includes result published previously (Hill 1964b) and has been discussed in detail elsewhere (Hill 1969b).
CoD -45°9031	Close to HD 124448.
125924	Photometry includes result published previously (Hill 1968).
CPD -44°6953	LHα 924.
135485	Helium rich (Stewart 1956).
136445	Nearest standard to variable star HD 138503. $(U-B)_c$ previously measured.
138503	Variable, range $0^{m}\cdot2$ in V.
138600, 138790	Comparison stars for HD 138503.
149671	LHα 1143.
160641	Helium star. Photometry discussed in detail elsewhere (Hill 1969b).
163007	LHα 1350.
163522	O^{+} strong.
168476	Helium star. Note as for HD 124448.
209522	MWC 650.

(4) Cousins *et al.* (1966),
(5) Cousins & Stoy (1963),
(6) Sharpless (1952, 1954),
(7) Cape Observatory (provisional results, unpublished),
(8) Przybylski & Kennedy (1965),
(9) Morgan, Code & Whitford (1955),
(10) Buscombe (1959),
(11) Guetter (1968),
(12) Bidelman (1952),
(13) Greenstein & Eggen (1966).

Column 14. An asterisk indicates a note at the end of the table. In the notes an MWC number refers to the Mount Wilson Catalogue of Stars with Hα in emission by Merrill & Burwell (1943, 1949). An LHα number refers to the unpublished catalogue of southern Hα emission stars by Henize, a copy of which is held at Radcliffe Observatory. Details of the observational procedures have been given by Henize (1967). Information on double stars is from the *Index Catalogue of Visual Double Stars* (Jeffers, van den Bos & Greeby 1963).

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