SPECTRAL CLASSIFICATION OF 533 B8–A2 STARS AND* THE MEAN ABSOLUTE MAGNITUDE OF A0 V STARS

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ABSTRACT

Spectra of 533 B8–A2 stars with declinations between +10° and +40° and brighter than magnitude 6.5 were observed and classified according to the MK system. The MK spectral types were found to range from B3 to A8. Colors of 220 of these stars were observed photoelectrically. The mean parallax of A0 V stars of apparent magnitude 5.0 was derived from the motions of 99 non-peculiar main-sequence stars which were selected from the 533 stars. The absolute magnitude of A0 V stars was found to be +0.5.

I. OBSERVATIONAL PROCEDURE

a) *Spectral Types*

Spectra were obtained of all non-variable stars brighter than visual magnitude 6.50, with declination between +10° and +40°, and with *HD* spectral types in the range B8–A2. The observations were carried out by the author by means of the one-prism spectrograph attached to the 40-inch refractor of the Yerkes Observatory in the period from April, 1954, to March, 1955. The 6-inch camera, which gives a dispersion of 125 A/mm at Hγ, was used. The slit-width corresponded to about 4 A in the spectrum.

The spectra were classified on the revised system of the Yerkes *Spectral Atlas* (MK system) (Johnson and Morgan 1953). The revised types of these stars, 533 in number, lie in the interval B3–A8. Spectra of classes around A0 are most difficult to classify accurately. All lines, with the exception of the Balmer lines, are weak, and the broad-line stars show few spectral features that can be used for classification. The dispersion and resolving power used by the present investigation were about half the dispersion and resolving power that would be necessary for an accurate classification.

b) *Photometric Observations*

Photoelectric observations on the (U, B, V) system were made at the McDonald Observatory in March and April, 1955. The photoelectric photometer attached to the 13-inch reflector was used. Some stars were observed also with the 82-inch reflector with the help of Dr. Nancy G. Roman, whom the author wishes to thank cordially. The photoelectric observations were made for stars with right ascensions between 6^h30^m and 18^h30^m. Six of the primary standards (Johnson and Harris 1954), namely, β Cnc, η Hya, β Lib, α Ser, ε CrB, and τ Her were used to determine the extinction coefficients. In addition, ten additional standard stars of spectral type B or A were included in the observing program in such a way that at least one standard star could be observed every hour. These standard stars were chosen from the above-mentioned list of Johnson and Harris.

More than half the 220 stars were observed at least three times. The probable errors of the photometric observations are estimated to be about ±0.02 in $(B - V)$ and about ±0.03 in $(U - B)$ for a star observed on three nights.

In Table 1, columns 1 and 2 contain a running number and the *HR* number. Column 3 contains the spectral type on the MK system. An asterisk refers to a note at the end of the table. The visual magnitudes in column 4 were taken from the Yale *Catalogue*

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of Bright Stars (ed. of 1940). Columns 5 and 6 contain the results of the photoelectric observations; a colon after a number refers to a case of a poor internal agreement. Column 7 lists the number of photometric observations.

II. THE MEAN ABSOLUTE MAGNITUDE OF A0 V STARS

a) *The Observational Material*

The object of Section II is to obtain a calibration of the absolute magnitudes of late B and early A stars from their motions. The stars treated here were selected from Table 1 of the present paper. The selection of stars from this table was made by the following conditions:

1. Spectral types should be between B9 V and A3 V of the MK system. Giants, supergiants, and peculiar stars were rejected.
2. The observational probable error of the proper motion should be smaller than 10 per cent of the proper motion itself.
3. Stars belonging to the Ursa Major cluster (Delhaye 1948), the Pleiades (Hertzsprung 1947), the Hyades (van Bueren 1952), Praesepe (Klein-Wassink 1927), and the Coma Cluster (Trumpler 1938) were rejected.
4. The limits of the apparent magnitudes were as follows: for B8 and B9: $m < 5.0$; for B9.5, A0, and A1: $m < 6.0$; for A2 and A3: $m < 6.5$. The fourth condition implies that the stars were selected approximately inside a sphere 150 parsecs in radius.

Under these conditions, only 99 stars were selected from the 533 stars of Table 1. As they were selected on the basis of apparent magnitude, they may be somewhat brighter than average stars of the same spectral class per volume of space.

The proper motions were taken from the *General Catalogue* and were reduced to the system of N30 by the method described in the preface of the N30 catalogue (H.R. Morgan 1951). Further, they were subjected to the correction of the precessional constants, according to Morgan and Oort (1951), namely,

$$\text{Correction to } \mu_\alpha = \quad 0\overset{''}{.}31 \cos\delta - 0\overset{''}{.}300 \sin\alpha \sin\delta \,,$$

$$\text{Correction to } \mu_\delta = -0\overset{''}{.}37 \cos\alpha \,.$$

The corrections for differential galactic rotation in proper motion and radial velocity were not inserted because the stars are not very distant. Some stars were found in the N30 catalogue. In these cases the mean values of the proper motion of *GC* and N30 were adopted.

As the stars cover an appreciable range of distance from the sun, the proper motions were reduced to a standard distance. The standard distance was chosen to be that of an A0 V star with apparent magnitude 5.0. For other spectral types, the reduction factors to this standard were calculated by assuming, tentatively, the values of the absolute magnitudes given in Table 2. The standard distance defined above is merely a convenient unit, whose absolute value is to be determined by the present investigation.

Radial velocities were taken from the catalogue of R. E. Wilson (1953).

b) *The Solar Motion*

The stars were arranged in 24 groups for every 2 hours in right ascension and every 15° in declination. For each of the groups, mean values of α, δ, $\mu_{\alpha_1}\cos\delta$, μ_{δ_1}, and radial velocity ρ were computed. The position of the solar apex was obtained from the proper motions only, by solving the following equations for the unknowns X, Y, and Z by the method of least squares:

$$-X \sin\langle\alpha\rangle \qquad + Y\cos\langle\alpha\rangle \qquad\qquad = -\langle \mu_{\alpha_1}\cos\delta\rangle \,,$$

$$-X\cos\langle\alpha\rangle\sin\langle\delta\rangle - Y\sin\langle\alpha\rangle\sin\langle\delta\rangle + Z\cos\langle\delta\rangle = -\langle\mu_{\delta_1}\rangle \,,$$

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TABLE 1

CATALOGUE

No.	H.R.	Sp.	m_V	B-V	U-B	n
1	15	B8 p *	2.15			
2	26	B8 V	5.51			
3	44	A1 V	6.06			
4	49	A0 V	6.05			
5	53	A1 V	6.06			
6	63	A2 V	4.44			
7	68	A2 V	4.51			
8	71	A1 V	5.80			
9	78	B6 IV	5.82			
10	149	B8 p *	6.26			
11	246	A1 V	6.48			
12	254	A1 V	5.76			
13	262	A3 V	5.94			
14	269	A4 III	3.94			
15	277	A2 V	6.41			
16	291	B9 V	5.46			
17	310	B9.5 IV	5.55			
18	311	B9 V	5.82			
19	328	A3 V	5.63			
20	348	B7 III	5.75			
21	364	B8 III	5.85			
22	383	A3 V	4.67			
23	395	Am *	5.53			
24	422	B9 III	6.36			
25	432	A4 III	5.96			
26	438	B6 V	6.28			
27	446	B8 V	5.77			
28	455	B9 III	6.20			
29	490	B9 V	5.45			
30	522	B9.5 V	5.73			
31	545	B9 V	4.83			
32	546	A1 p *	4.75			
33	578	A6 V	6.14			
34	599	A2 III	5.44			
35	613	Am *	5.08			
36	615	B8 V	6.00			
37	620	A4 V	4.77			
38	628	B9.5 V	6.05			
39	634	Am *	6.20			
40	655	B9.5 V	5.26			
41	664	A0 V	4.07			
42	669	A1 V	5.69			
43	675	A2 V	5.28			
44	677	B8 IV	6.51			
45	746	B8 IV *	6.28			
46	760	B5 V	6.40			
47	769	A0 III	6.26			
48	773	A7 V	5.36			
49	782	A3 V	5.38			
50	793	A0 IV-V	5.72			
51	797	A2 V	6.27			
52	803	A3 V	6.37			
53	809	B9 V	5.80			
54	830	B9 V	5.87			
55	838	B8 V	3.68			

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
56	873	A0 p *	5.18			
57	879	A2 V	4.62			
58	887	A2 V	5.55			
	888		5.25			
59	894	B8 V(e)	5.92			
60	905	Am *	5.91			
61	927	B7 V	6.11			
	928		6.11			
62	944	B7 V	5.60			
63	945	A0 V	6.38			
64	948	B8 V	5.91			
65	954	B8 p *	5.65			
66	971	A1 III ?	5.53			
67	972	A0 IV	4.95			
68	976	Am *	6.42			
69	986	A3 V	5.97			
70	1019	B9.5 V	5.64			
71	1027	A0 V	5.92			
72	1036	A3 III	6.45			
73	1039	B9.5 V	6.20			
74	1041	A2 V	5.60			
75	1061	B9.5 V	5.12			
76	1078	A3 V *	5.80			
77	1086	A3 V	5.92			
78	1103	A4 III	6.42			
79	1118	A2 V	6.15			
80	1126	B8 V(e?)	5.50			
81	1133	A3 III	5.57			
82	1137	A0 V	6.03			
83	1144	B8 V	5.63			
84	1151	B8 V	5.85			
85	1152	B9.5 V	6.46			
86	1172	B8 V	5.51			
87	1177	A2 V	5.10			
88	1178	B8 III	3.80			
89	1180	B7 pec *	5.18			
90	1183	B8 V	6.11			
91	1185	B8 III	5.92			
92	1194	B9 II-III	6.16			
93	1221	B9.5 IV	5.98			
94	1229	A1 V	6.38			
95	1234	B9.5 V	6.33			
96	1237	B9.5 V	6.30			
97	1268	A0 p *	5.27			
98	1284	B9.5 V	6.02			
99	1297	B8 II-III	6.16			
100	1339	B9 V p ? *	5.39			
101	1341	A1 p *	5.32			
102	1369	B9.5 V	5.38			
103	1375	B9 V	5.92			
104	1376	Am *	5.68			
105	1377	B7 V	5.58			
106	1378	B3 V	6.16			
107	1389	A3 III	4.24			
108	1402	B7 III	5.84			
109	1419	B9.5 V	6.19			
110	1442	B9 Vn *	6.24			

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
111	1445	B6 p *	5.70			
112	1471	B8 V	5.73			
113	1478	Am *	5.15			
114	1484	B7 IV	5.37			
115	1490	A2 V	5.68			
116	1512	B5 III	6.17			
117	1519	Am	5.43			
118	1570	A0 V	4.74			
119	1576	B8 III	5.74			
120	1590	B9.5 V ?	5.65			
121	1592	A1 V	4.99			
122	1600	B6 V	5.98			
123	1632	A7 V	6.48			
124	1638	B9 p *	4.65			
125	1642	A7 III	6.46			
126	1706	A9 V	5.14			
127	1711	A2 IV	6.16			
128	1718	A0 III	5.50			
129	1732	B9 p *	5.39			
130	1750	B8 V	6.30			
131	1752	A2 V	5.72			
132	1768	B9 V	6.39			
133	1774	A2 V *	6.09			
134	1776	B9 III	5.93			
135	1791	B7 III	1.78			
136	1795	A1 p ? *	5.85			
137	1804	B9 Ib	5.72			
138	1809	A2 V p ? *	6.13			
139	1814	B9 V	5.51			
140	1819	A4 V	6.26			
141	1821 A+B	B9 V	6.64+5.86			
142	1832	A3 V	5.78			
143	1847p	B7 IV	6.02			
144	1847f	B8 V	6.52			
145	1850	Am *	6.50			
146	1854	A4 V	6.05			
147	1860	B6 V	6.09			
148	1883	B8 III	5.59			
149	1902	B8 III	5.70			
150	1914	comp. *	5.49			
151	1929	A2 V	6.32			
152	1938	B7 V	5.96			
153	1951	B7 III	6.49			
154	1985	B7 III p ? *	5.91			
155	1989	A3 V	5.67			
156	1997	B7 V	5.94			
157	2010	B9 V	4.92			
158	2025	A3 III	6.46			
159	2030	comp. *	6.00			
160	2033	B9 p *	5.57			
161	2034	B9.5 V	4.54			
162	2050	A2 V	6.46			
163	2066	A2 Ib	6.42			
164	2095	B9 p *	2.71			
165	2110	A0 V	6.01			

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
166	2111	A0 Iab	6.08			
167	2116	B8 V *	6.28			
168	2130	B8 III *	5.17			
169	2133	B9.5 V	5.96			
170	2139	B9 III p *	6.10			
171	2191	B9.5 V	5.86			
172	2193	B9.5 V	5.70			
173	2207	B8 V	6.21			
174	2223	B7 V	5.28			
175	2229	B9 II-III	5.36			
176	2250	B9.5 V	6.48			
177	2253	A2 V	5.98			
178	2258	B9.5 p *	6.17			
179	2272	A1 V	6.27			
180	2304	A0 V	6.02			
181	2330	A2 V	6.11			
182	2374	B6 V	6.46			
183	2375	A4 V	5.08			
184	2383	A2 V	6.38			
185	2398	B9.5 V	5.05	-.03	-.08	2
186	2417	A3 V	6.44	.10	.05	2
187	2420	B8 III	5.28	-.07	-.43	2
188	2421	A0 IV	1.93	.00	.03	std
189	2425	B9.5 p *	5.54	-.01	-.08	2
190	2438	B6 III	5.84	-.09	-.50	2
191	2449	A3 V	5.88	.06	.11	2
192	2457	A0 V	6.18	-.01:	-.07:	2
193	2466	A2 V	5.14	.06	.01	2
194	2471	A2 V	6.28	.06	.11	2
195	2499	A2 V	6.16	.07	.01	2
196	2519	B8 III	5.69	-.14	-.53	2
197	2529	A2 V	5.22	-.02	.01	2
198	2540	A3 III	3.64	.10	.13	std
199	2547	B9 p ? *	6.23	-.05	-.19	2
200	2589	B7 V	5.88			
201	2605	B8 III	6.29	-.14	-.44	2
202	2659	B9.5 V	5.91	-.03	-.08	3
203	2669	B9 V	6.23	-.10	-.26	3
204	2700	A4 V	5.60	.12	.14	2
205	2757	B9.5 V	5.98	-.03:	-.10	3
206	2763	A3 V	3.65	.11	.10	std
207	2780	A2 V	6.47	-.02	.07:	3
208	2810	A1 V	6.02	-.01	-.01	2
209	2820	A4 III	5.34	.10	.13	3
210	2836	A2 V *	6.22	.09	.06	3
211	2840	B6 IV	6.31	-.13	-.47	3
212	2857	A6 V	5.04	.11	.12	3
213	2858	B9 V	6.07	-.05	-.11	3
214	2872	A2 V	6.46	.07	.03	3
215	2886	A1 V	5.07	.05	.06	3
216	2890) 2891)	comp. *	2.85 1.99	.04	.00	3
217	2893	B9.5 V	6.21	-.01	-.06	3
218	2931	A2 V	6.04	.01	.04	3
219	2991	A0 V	6.28	.00	.00	3
220	3008	A1 V	5.30	.01	-.02	3

TABLE 1 (continued)

No.	H.R.	Sp.	m_v	B-V	U-B	n
221	3040	Am *	6.02	.15	.13	3
222	3067	A4 V	4.99	.12	.11	3
223	3083	A pec *	6.11	.28	-.02	2
224	3086	B9.5 V	5.36	-.04	-.06	3
225	3132	A1 V	6.20	.01	.03	3
226	3134	B9 V	5.91	-.02	-.02	3
227	3158	B9.5 V	6.06	-.05	-.12	3
228	3163	A0 IV	5.11	.00	-.01	3
229	3164 A+B	A0 V *	6.16	-.02	-.07	3
230	3198	A2 V	6.14	.02	.02	3
231	3201	B7 III	6.07	-.12	-.41	3
232	3215	B9 p *	5.59	-.07	-.13	3
233	3224	A3 III	6.44	.11	.12	3
234	3268	B9 V	5.87	-.03	-.12	3
235	3310	A4 III	6.32	.18	.09	3
	3311		6.30			
236	3333	A5 V	5.90	.19	.14	3
237	3348	B8 V	6.06	-.06	-.13	3
238	3372	A0 V	6.30	-.02	-.04	3
239	3377	A2 III	5.83	.04	.02	3
240	3406	A3 V	5.98	.09	.10	3
241	3429	A6 III *	6.32	.16	.19	2
242	3449	A1 V	4.73	.00	.03	2
243	3465	A0 p *	5.58	-.10	-.25	3
244	3481	A1 V	5.71	.11	.05	3
245	3504	A0 V	6.14	-.01	.00	3
246	3528	A3 III	6.02	.04	.11	3
247	3566	A1 V	6.46	-.01	.01	3
248	3587	A3 V	5.83	.00	.09	2
249	3595	B9 p *	5.45	-.05	-.12	4
250	3601	A0 V	6.34	.00	.05	4
251	3623	B8 III p *	5.14	-.10	-.45	3
252	3657	A2 V	6.09	.02	.06	4
253	3689	A3 V	6.29	.07	.11	3
254	3690	A2 V	3.82	.06	.05	3
255	3711	A0 V	6.49	-.02	.01	3
256	3792	A3 III ? *	6.35	.12	.10	4
257	3818	A1 V	6.21	.04	-.05	4
258	3861	A3 V *	5.73	.12	.06	4
259	3900	A5 V *	5.33	.23	.09	4
260	3937	B9.5 V	5.18	-.04	-.13	4
261	3975	A0 Ib	3.58	-.01	-.24	4
262	3982	B7 V	1.34	-.11	-.36	std
263	4024	A0 V	5.35	.01	.01	4
264	4041	B9.5 p *	6.46	-.03	-.11	4
265	4070	A1 V	6.10	.01	-.03	4
266	4101	B9 p *	5.87	-.06	-.10	3
267	4113	A4 III	5.87	.07	.14	4
268	4124	A0 IV *	5.83	.08	.07	4
269	4137	A2 V	5.58	.02	.04	4
270	4189	A5 V	5.55	.17	.09	3
271	4192	A2 V	5.05	.04	.05	4
272	4203	B9 V	5.37	-.05	-.12	4
273	4227	A2 V	5.27	.01	.05	3
274	4259	A1 V	4.51	.01	.02	5
	4260		6.30			
275	4300	A1 V *	4.42	.07	.05	5

TABLE 1 (continued)

No.	H.R.	Sp.	m_v	B-V	U-B	n
276	4309	A3 V	6.08	.16	.10	5
277	4322	A5 V	6.39	.17	.12	5
278	4332	A3 III	5.63	.06	.12	5
279	4359	A2 V	3.41	.02	.02	3
280	4378	A2 V	6.50	.07	.05	4
281	4380	A2 V	4.78	.09	.04	3
282	4422	A1 V	5.26	.00	.01	2
283	4454	A5 V *	6.46	.18	.10	4
284	4464	A4 III	6.45	.13	.10	4
285	4534	A3 V	2.23	.09	.07	std
286	4535	Am *	5.95	.26	.14	4
287	4564	A3 V	5.49	.10	.12	4
288	4632	A2 V	6.34	.06	.10	4
289	4633	A3 V	5.78	.12	.09	5
290	4650	Am *	5.81	.27	.09	4
291	4663	A2 V	5.08	.05	.03	4
292	4673	A4 V *	5.68	.16	.11	5
293	4705	A0 V	6.02	-.02	.00	5
294	4717	A3 V	5.10	.08	.11	5
295	4738	A4 V	5.04	.08	.14	5
296	4752	A0 p *	5.38	-.04	-.12	5
297	4756	A3 V	5.72	.07	.09	5
298	4780	A4 V	6.14	.10	.10	5
299	4789	A0 III	4.78	-.03	-.01	5
300	4816	A p *	6.32	.05	.01	5
301	4828	A1 V	4.95	.07	.04	4
302	4861	A0 V	6.43	.02	.00	4
303	4865	A2 V	5.64	.00	.06	4
304	4869	A2 V	5.83	.02	.05	4
305	4875	A4 V *	5.86	.15	.09	4
306	4886	A5 V	6.25	.16	.11	4
307	4904	A5 V	6.26	.19	.09	4
308	4914)		5.39			
	4915)	A0 p *	2.90	-.11	-.32	4
309	4943	B9 V	5.11	-.08	-.21	4
310	4948	A3 V	6.44	.03	.07	4
311	4967	B7 III	6.22	-.12	-.48	4
312	5057	A3 V	5.75	.06	.08	4
313	5144	A1 V	5.65	.00	.01	4
314	5214	A4 V	6.57	.11	.07	4
315	5220	A2 V	5.99	.04	.01	4
316	5255	A0 V	5.42	-.04	.02	4
317	5333	A8 V	6.40	.17	.09	4
318	5373	A2 V	5.98	.04	.06	4
319	5374	Am *	6.34	.15	.10	4
320	5422	B9.5 p *	5.96	-.03	-.09	4
321	5433	A7 IV-V	5.90	.22	.07	4
322	5475	B9 III p *	4.94	-.02	-.33	4
323	5476	Am *	5.81			
324	5477)	A2 III	4.83	.03	.05	4
	5478)		4.43			
325	5532	A3 III	5.66	.05	.08	4
326	5567	B9.5 V	5.77	-.06	-.08	4
327	5569	A3 V	6.11	.11	.07	4
328	5574	A1 V	6.24	-.02	.01	4
329	5633	A2 V	6.00	.06	.06	4
330	5665	A2 V	6.25	.06	.06	4

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
331	5676	A2 V	5.26	.02	.08	4
332	5702	Am *	6.14	.24	.09	4
333	5717	B9.5 V	6.20	-.03	-.05	4
334	5718	B9 V	5.36	-.06	-.21	4
335	5760	A5 V *	6.35	.19	.14	4
336	5770	B8 V	6.14	-.05	-.21	4
337	5793	A0 V	var.	-.04	-.03	4
338	5833	B6 V	6.00	-.12	-.47	4
339	5834	B7 V	5.07			
340	5842	A1 V	4.49	.01	.04	4
341	5843	A1 p	5.26	.02	.05	4
342	5849	A0 IV	3.93	.00	-.05	4
343	5858	A0 V	5.89	.00	-.03	4
344	5867	A2 IV	3.74	.07	.08	4
345	5870	A2 V	5.72	.09	.06	4
346	5931	B7 III	6.22	-.12	-.41	3
347	5971	A0 II-III p *	4.91	-.08	-.18	4
348	5972	A3 V	4.82	.05	.09	4
349	6013	A0 V	6.07	.00	-.07	3
350	6035	A0 V	5.90	.02	-.02	3
351	6074	A3 III	5.73	.04	.12	4
352	6110	A3 V	6.20	.06	.09	4
353	6117	B9 p *	4.53	.00	-.04	3
354	6169	A2 V	6.27	.05	.00	3
355	6176	B9 p *	6.29	-.11	-.18	3
356	6203	A2 V	5.98	.05	.03	3
357	6246	A1 V	5.95	.03	-.02	3
358	6268	B9.5 p *	6.41	-.05	-.07	3
359	6281	B8 IV	4.29	-.08	-.35	3
360	6324	B9.5 V	3.92	-.03	-.09	3
361	6326	A2 p *	6.16	.06:	.00	3
362	6332	A3 III	5.27	.02	.02	3
363	6341	A1 V	5.86	.00	-.04	3
364	6352	B9.5 V	6.13	-.01	-.09	3
365	6385	Am *	6.46	.09	.09	3
366	6410	A3 IV	3.16	.07	.06	3
367	6432	A1 V	5.90	.01	.02	3
368	6436	A2 V	4.80	.04	-.01	3
369	6455	A3 III	5.32	.03	.10	3
370	6457	A1 V	5.12	-.04	.02	3
371	6481	A3 III	5.69	.06	.10	3
372	6482	B9.5 IV	6.25	-.03	-.17	3
373	6484	A0 p *	5.47	-.03	-.04	3
374	6485	A0 IV	4.52			
375	6506	A1 p ? *	5.91	-.01	-.06	3
376	6521	A2 V	6.40	.06	.01	3
377	6532	A0 III	6.18	-.02	-.19	3
378	6533	B9.5 V	5.58	.00	-.05	3
379	6559	A7 III	5.82	.18	.15	3
380	6570	A7 V	5.76	.16	.09	3
381	6571	A2 V	5.67	.09	.04	3
382	6589	A2 V	6.26	.04	.01	3
383	6619	A0 Ib	6.25	-.01	-.20	3
384	6627	A0 V	5.58	.01	.00	3
385	6642	A0 IV	6.04	.02	-.09	3

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
386	6696	A2 V	6.50	.11	.08	3
387	6720	B7 IVn(e)	6.42	-.06	-.39	3
388	6741	B3 V	6.12	-.10	-.63	3
389	6744	A0 V	6.48	.01	-.01	3
390	6776	A2 V	6.46	.05	.07	3
391	6779	B9.5 III	var.	-.05	-.04	3
392	6784	A6 III *	6.30	.17	.21	3
393	6814	A2 III	5.85	.01	.11	3
394	6826	B8 V	5.88	-.08	-.23	3
395	6852	B9.5 III	5.99	.03	-.10	3
396	6876	A6 V	5.54	.22	.06	3
397	6883	A2 V	5.89	.04	.08	3
398	6903	A3 III *	5.04	.03	.08	3
399	6904	A2 V	6.20	.05	.02	3
400	6906	B9 V	6.45	-.03	-.27	3
401	6917	A2 V *	5.71	.04	.10	3
402	6955	A2 V	5.67	.04	.07	3
403	6968	B8 IV	5.37	-.10	-.34	3
404	6975	A3 V	6.44			
405	6976	A1 V	6.38			
406	6977	B9.5 IV	5.73			
407	6992	B8 V	6.36			
408	6997	B8 II p *	5.46			
409	7001	A0 V	0.14			
410	7030	B8 V	6.47			
411	7058	A0 p *	6.39			
412	7086	A2 V	5.82			
413	7098	B9.5 V	6.50			
414	7102	A3 V	5.16			
415	7109	B8 V	6.09			
416	7113	B9 II-III	5.33			
417	7147	B9.5 p *	6.41			
418	7171	B6 V	6.22			
419	7174	B6 V	5.75			
420	7178	B9 III	3.30			
421	7235	B9.5 V	3.02			
422	7248	B7 V	5.10			
423	7283	B8 p *	5.77			
424	7285	B8 V	6.44			
425	7286	A2 V	5.90			
426	7305	B5 III	6.26			
427	7307	B9 V	5.46			
428	7324	A3 V	6.48			
429	7332	A3 V	6.02			
430	7338	A0 III	6.19			
431	7346	B7 III	6.29			
432	7364	B8 V	6.47			
433	7369	A2 III ? *	6.03			
434	7374	B3 V	6.36			
435	7384	A1 V	6.36			
436	7390	A0 V	5.58			
437	7395	B8 p *	5.15			
438	7418	B7 V	5.36			
439	7419	B9.5 III	6.04			
440	7436	A3 V	6.48			

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
441	7437	B7 V	4.88			
442	7452	B9 III p ? *	6.12			
443	7457	B8 V	5.86			
444	7467	B3 III	6.38			
445	7481	A3 V	6.12			
446	7493	B8 III	6.26			
447	7502	A4 III	5.89			
448	7505	A1 V	6.06			
449	7511	B8 IV	6.12			
450	7512	B8 II-III	5.95			
451	7529	B9.5 III	6.50			
452	7543	B8 V	5.67			
453	7546	A3 V	4.95			
454	7556	B3 III	6.29			
455	7592	B9.5 III	4.50			
456	7601	A0 III	5.47			
457	7607	B5 V	6.36			
458	7610	A1 V	5.29			
459	7616	A3 III	6.47			
460	7622	B9 IV	5.38			
461	7640	B9 III	5.44			
462	7656	B5 IV	5.75			
463	7664	B8 II-III	5.47			
464	7699	B5 Ib	6.07			
465	7711	A3 III	5.46			
466	7719	B7 V(e)	5.91			
467	7723	Am *	6.48			
468	7724	A2 V	4.96			
469	7734	A0 III	6.41			
470	7736	A2 III ?	4.98			
471	7752	B9.5 V p *	6.14			
472	7769	A3 V	5.52			
473	7782	A1 III	6.47			
474	7784	A2 V	6.24			
475	7789	B7 IV(e)	5.41			
476	7826	A3 V	5.45			
477	7833	Am *	6.38			
478	7835	A1 Ib	5.94			
479	7836	A1 pec *	5.92			
480	7839	Am *	6.00			
481	7858	A2 V *	5.23			
482	7871	A3 V	4.69			
483	7874	A4 III	6.29			
484	7880	B9 V	5.52			
485	7883	A2 V *	5.43			
486	7885	B8 IV	6.24			
487	7891	B9.5 V	4.78			
488	7903	A0 III	5.94			
489	7906	B9 V	3.86			
490	7917	A3 V	6.09			
491	7922	B6 IV	6.44			
492	7981	A1 V	6.49			
493	8012	A4 V	5.54			
494	8143	B9 Ia	4.28			
495	8158	B7 IV	6.15			

TABLE 1 (continued)

No.	H.R.	Sp.	m_V	B-V	U-B	n
496	8169	A2 V	6.03			
497	8186	A2 V	6.45			
498	8194	A2 V *	6.22			
499	8217	A1 V *	5.38			
500	8231	B9 V	5.94			
501	8240	A2 p *	6.44			
502	8292	B5 IV	5.95			
503	8307	B9.5 V	5.62			
504	8338	B8 V	5.80			
505	8343	A0 V	5.00			
506	8348	B6 V p *	5.68			
507	8349	B8 III p ? *	6.19			
508	8358	A0 V *	5.76			
509	8373	A2 V	5.59			
510	8397	B5 V	6.36			
511	8404	B9 IV	5.75			
512	8419	A0 V	5.58			
513	8438	B6 V	5.66			
514	8459	A4 III	6.40			
515	8522	B8 III	4.88			
516	8574	B9 V	5.51			
517	8605	A2 V	6.40			
518	8624	A2 V	6.14			
519	8634	B8 V	3.61			
520	8641	A1 IV	4.85			
521	8706	B6 III	6.24			
522	8723	B7 III	5.63			
523	8781	B9.5 III	2.57			
524	8798 A+B	A3 V				
525	8873	B5 IV	6.14			
526	8887	B3 V	5.37			
527	8891	B9.5 IV	6.22			
528	8903	B9 III	5.46			
529	8915	A0 III	5.87			
530	8933	A0 p *	6.23			
531	8947	A2 III	5.50			
532	8960	A2 V	6.18			
533	8963	A1 V	5.42			

NOTES TO TABLE 1

As was mentioned in the text, it is difficult to make a very accurate classification by the present spectrograms of small resolving power (about 1000), and it is much more so to do detailed studies about the peculiar spectra. Some peculiar stars, especially manganese stars and weak-line stars might have been classified incorrectly in Table 1. In the following, peculiar features are described only when they are very significant; complete description is not intended. "4128" means a line or a group of lines near 4128 A; it could be the silicon lines 4128-31, chromium line 4129, europium line 4130, or a blend of some of these lines.

No references are given in the notes, but the peculiar lines in general are referred to the papers of Morgan (Ap.J., 77, 330, 1933), Deutsch (Ap.J., 105, 283, 1947) and Slettebak (Ap.J., 119, 146, 1954).

H.R.	
15	3944, 3984 and 4128 are strong; known to be a Mn-star.
149	3984 is strong, Balmer lines are narrow; probably a Mn-star.
395	A3 K-line, F5 metallic and F2 hydrogen spectrum.
546	similar to 78 Vir except that 4078 is not very strong.
613	A2 K-line, A8 metallic and A8 hydrogen spectrum.
634	A1 K-line, A6 metallic and A5 hydrogen spectrum.
746	perhaps similar to HR 149.
873	3955, 4078, 4200 and a group of lines near 4003-4017 are strong.
905	A2 K-line, F1 metallic and A8 hydrogen spectrum.
954	4200 is strong, K-line is weak; similar to HR 1732.
976	A2 K-line, F2 metallic and A8 hydrogen spectrum.
1078	metallic lines indicate A6.
1180	shell star Pleione.
1268	3955 and 4128 are strong, Balmer lines are narrow, K-line is very weak.
1339	4128 and other lines seem to be stronger than normal.
1341	3955, 4128 and 4200 are very strong; similar to HR 1732.
1376	A1 K-line, F5 IV metallic and F0 hydrogen spectrum.
1442	very diffuse lines. 4128 may be stronger than normal.
1445	similar to HR 149.
1478	A3 K-line, A9 metallic and A7 hydrogen spectrum.
1638	4128 is strong, K-line is very weak.
1732	3955, 3992, 4128, 4200 are very strong; prototype of the peculiar spectra of type (Si, 4200).
1774	metallic lines indicate A3.
1795	4128 is stronger than normal, Balmer lines are narrow.
1809	4171 is strong.
1850	A2 K-line, A7 metallic and hydrogen spectrum.
1914	A2 V plus G8 III ?
1985	probably similar to HR 149.
2030	B9 V plus K ?
2033	similar to 78 Vir.

NOTES TO TABLE 1 (continued)

H.R.	
2095	4128 is strong, K-line is weak.
2116	4128 and 4171 are strong.
2130	3930 and 4171 seem to be stronger than normal.
2139	4128 is strong, K-line is weak.
2258	4128 is strong.
2425	4128 and 4171 are strong, K-line is wide and shallow.
2547	4128 and some other lines are strong.
2836	metallic lines indicate A4.
2890-1	Am plus A3 III.
3040	A3 K-line, F0 metallic and A7 hydrogen spectrum.
3083	a weak-line star; metallic lines (including K-line) indicate A2 or A3, Balmer lines indicate F0.
3164 A+B	Balmer lines are broader than in a regular A0 V star.
3215	4128 is strong, Balmer lines are narrow, K-line is very shallow or absent. Probably similar to HR 1732.
3429	metallic lines indicate A8. The absolute magnitude effect might be spurious.
3465	similar to 78 Vir.
3595	4128 is slightly stronger than normal.
3623	4171 is strong; known to be a Mn-star.
3792	difficult to classify because the lines are very diffuse.
3861	K-line indicates A3, metallic lines indicate A5.
3900	metallic and hydrogen lines indicate A7.
4041	4128 and 4171 are strong.
4101	4171 and a group of lines near 4003-4017 are strong.
4124	K-line indicates A0, Balmer lines indicate A0 IV or A5 V. This star might be a weak-line star.
4300	metallic lines indicate A4.
4454	metallic lines indicate A8.
4535	A2 K-line, F3 metallic and A7 hydrogen spectrum.
4650	A3 K-line, F2 metallic and A7 hydrogen spectrum.
4673	metallic lines indicate A6.
4752	similar to 78 Vir.
4816	similar to 78 Vir. There is a broad, shallow K-line superposed over the sharp component. Similar appearance of K-line in 78 Vir was described in the Atlas and was illustrated by Deutsch (Ap.J., 105, 283, Figure 6, 1947).
4875	K-line indicates K4, other metallic lines are weak and diffuse, hydrogen lines indicate A7.
4915	4128 is strong; known to be a Si, Cr, Eu-star.
5374	A3 K-line, F0 metallic and A4 hydrogen spectrum.

NOTES TO TABLE 1 (continued)

H.R.	
5422	4128 and a group of lines near 4003-4017 are strong.
5475	3984 and 4128 are strong; known to be a Mn-star.
5476	A2 K-line, A7 metallic and hydrogen spectrum.
5702	A3 K-line, F0 metallic and A7 hydrogen spectrum.
5760	A5 K-line, A7 metallic and hydrogen spectrum. 4078 is strong.
5971	3984 is strong, known to be a Mn-star.
6117	4171 is very strong, K-line is very shallow and broad.
6176	similar to 78 Vir, lines of the 3955 group are visible.
6268	4128, 4171 are strong.
6326	similar to 78 Vir.
6385	A1 K-line, A5 metallic and A3 hydrogen spectrum.
6484	4128 is strong.
6506	3944 and 4137 seem to be strong.
6784	A6 K-line, F0 metallic and A8 hydrogen spectrum. 4078 is strong.
6903	metallic lines are weak.
6917	metallic lines indicate A4.
6997	3944 and 3984 are strong.
7058	similar to 78 Vir.
7147	similar to HR 1732.
7283	4128 is strong, Balmer lines are narrow.
7369	metallic lines indicate A3.
7395	4128 is very strong.
7452	4128 and 4171 are strong.
7723	A4 K-line, F4 metallic and F0 hydrogen spectrum.
7752	4026 (He I) is visible, K-line as strong as in an A1 star.
7833	A4 K-line, F0 metallic and A7 hydrogen spectrum.
7836	known to be a peculiar shell star.
7839	A2 K-line, A7 metallic and hydrogen spectrum.
7858	metallic lines indicate A3.
7883	metallic lines indicate A4.
8194	metallic lines indicate A3.
8217	metallic lines indicate A3.
8240	similar to 78 Vir.
8348	4128 is strong.
8349	3984 is strong.
8358	metallic lines indicate A3.
8933	similar to 78 Vir.

where the suffix 1 means the values of the proper motions reduced to the standard distance, and the symbol $\langle\ \rangle$ indicates a mean value for a group. The following results were obtained:

$$A = \tan^{-1}\frac{Y}{X} = 261\overset{\circ}{.}2 \pm 4\overset{\circ}{.}5 \text{ (p.e.)} ,$$

$$D = \tan^{-1}\frac{Z}{(X^2+Y^2)^{1/2}} = 29\overset{\circ}{.}5 \pm 3\overset{\circ}{.}8 \text{ (p.e.)} .$$

Next, by assuming these values of A and D, the following equations of condition were solved by the method of least squares:

$$V_0 \cos\lambda + K = \langle \rho \rangle ,$$

where V_0 and K denote the velocity of the solar motion and the K-term, respectively, and λ is the angular distance of the apex from the mean position ($\langle\alpha\rangle$, $\langle\delta\rangle$) of a group. The result was

$$V_0 = 19.1 \pm 1.1 \text{ km/sec}$$

and

$$K = 2.9 \pm 0.7 \text{ km/sec} .$$

These results may include systematic errors arising from the grouping of stars into large areas (Smart 1936). However, it is easily shown that errors of this source would not be larger than the probable errors presented above.

TABLE 2

ASSUMED DIFFERENCE IN ABSOLUTE MAGNITUDE WITH RESPECT TO A0 V

	SPECTRAL TYPE						
	B8 V	B9 V	B9.5 V	A0 V	A1 V	A2 V	A3 V
Assumed abs. mag..	−0.5	0.0	0.3	0.5	0.8	1.2	1.8
Difference in abs. mag. with respect to A0 V..........	−1.0	−0.5	−0.2	...	0.3	0.7	1.3

It is of interest to compare these results with the values obtained by other investigators. According to Vyssotsky and Williams (1947), the solar apex derived from the proper motions (*GC* system) of B7–A4 stars brighter than 7.0 is

$$A = 270\overset{\circ}{.}2 \pm 1\overset{\circ}{.}3 , \qquad D = 26\overset{\circ}{.}0 \pm 1\overset{\circ}{.}2 .$$

Campbell and Moore (1928) obtained $V_0 = 18.6$ and $K = 1.68$ km/sec from an analysis of radial velocities of 500 B8–A3 stars. McRae and Nevin (1948) obtained, from radial velocities of 457 B8–A3 stars of average photovisual magnitude 6.90, $V_0 = 18.37 \pm 1.11$ and $K = 1.38 \pm 0.71$ km/sec. Our values are in fair agreement with these previous values obtained from different material.

c) Mean Parallax from the Upsilon Components

The υ and the τ components of proper motions were calculated by the following formulas:

$$\upsilon = \mu_1 \cos(\theta - \theta_0) , \qquad \tau = \mu_1 \sin(\theta - \theta_0) ,$$

where θ and θ_0 denote the position angle of the proper motion and the position angle of the great circle directed from the star to the antapex of the solar motion, respectively. Here μ_1 again denotes a proper motion reduced to the standard distance.

From the υ components, the mean parallax, P_0, of these stars was obtained by using the following formula (Smart 1938):

$$P_0 = 4.738 \frac{\upsilon_0}{V_0}, \qquad \upsilon_0 = \frac{\Sigma \upsilon \sin \lambda}{\Sigma \sin^2 \lambda}.$$

The probable error of P_0 can be obtained from the average value of the residuals of the υ-components, namely,

$$\text{p.e. of } \upsilon_0 = 0.845 \frac{\langle |\upsilon - \upsilon_0 \sin \lambda| \rangle}{(\Sigma \sin^2 \lambda)^{1/2}}.$$

The numerical results were as follows:

$$\upsilon_0 = 0''.0444 \pm 0''.0029 , \qquad P_0 = 0''.0110 \pm 0''.0007 .$$

d) Mean Parallaxes from the Tau Components

We have, if the peculiar motions of the stars were uniformly distributed for all directions in space,

$$P_0 = \frac{4.738 \langle |\tau| \rangle}{\langle |\Delta \rho| \rangle},$$

where $\langle|\tau|\rangle$ and $\langle|\Delta\rho|\rangle$ denote the average absolute values of the τ-components and the residual radial velocities, respectively. However, the actual distribution of the velocity is ellipsoidal instead of spherical. Therefore, it is necessary to calculate a correction factor before a final result of the statistical parallax is derived. This correction factor was calculated from a simple geometric consideration. The numerical value of this factor is 1.075. Therefore, we have

$$P_0 = \frac{1.075 \times 4.738 \langle |\tau| \rangle}{\langle |\Delta \rho| \rangle}.$$

Still more corrections are necessary to correct for the observational errors of the proper motions and the radial velocities. The mean observational error of the proper motion was taken to be 0″.0025. Therefore,

$$\langle |\tau| \rangle = [(0.0275)^2 - (0.0025)^2]^{1/2} = 0''.0262/\text{year} .$$

The average observational error of the residual radial velocities was estimated to be 1.76 km/sec. This rather high value was caused by the inclusion of some radial velocities of low precision (grade c in Wilson's catalogue). We have

$$P_0 = \frac{1.075 \times 4.738 \times 0.0262}{9.47} = 0''.0141 .$$

This is the final value of the parallax derived from the τ-components. The probable error of P_0 can be estimated by means of the following formulas:

$$\left(\frac{\text{p.e. of } P_0}{P_0}\right)^2 = \left(\frac{\text{p.e. of } \langle |\tau| \rangle}{\langle |\tau| \rangle}\right)^2 + \left(\frac{\text{p.e. of } \langle |\Delta\rho| \rangle}{\langle |\Delta\rho| \rangle}\right)^2,$$

$$\frac{\text{p.e. of } \langle |\tau| \rangle}{\langle |\tau| \rangle} = \frac{\text{p.e. of } \langle |\Delta\rho| \rangle}{\langle |\Delta\rho| \rangle} = \frac{0.755}{(n-1)^{1/2}} = 0.076$$

(Brunt 1917). The numerical value is

$$\text{p.e. of } P_0 = \sqrt{2} \times 0.076 \times 0''.0141$$
$$= 0''.0015 .$$

III. CONCLUSION

Summarizing the results obtained in the preceding sections, we have

$$\text{From the } \upsilon \text{ components:} \quad P_0 = 0''.0110 \pm 0''.0007 ,$$
$$\text{From the } \tau \text{ components:} \quad P_0 = 0''.0141 \pm 0''.0015 .$$

As these two values are not close to each other, a simple arithmetic mean $P_0 = 0.0125$ has been adopted as our final result. This is equivalent to a distance modulus of 4.52 mag. Our standard distance has been the distance of an A0 V star of apparent magnitude 5.0 (see Sec. I). Therefore, the absolute magnitude of an A0 V star becomes

$$5.00 - 4.52 = 0.48 .$$

It is difficult to estimate the probable error of this value because the two values of P_0 derived by different methods are discordant, and there may be a systematic error in one or both of these two values of P_0. However, judging from the difference between these two values, the probable error of the absolute magnitude is of the order of $\pm 0^m.2$.

TABLE 3

MEAN PARALLAX FOR DIFFERENT SPECTRAL TYPES

Spectral Type	No.	Parallax from υ-Components	Parallax from τ-Components	Mean
B8 V, B9 V....	8+5	0''.0151±0''.0022	0''.0215±0''.0066	0''.0183
B9.5 V, A0 V, A1 V........	39	.0122± .0008	.0129± .0022	.0124
A2 V, A3 V...............	52	0.0083±0.0009	0.0152±0.0022	0.0118
Total..................	99+5	0 0107±0.0007	0.0149±0.0016	0.0128

Table 3 shows the values of P_0 calculated for different spectral subdivisions separately. As the number of stars included in the first group (B8 and B9) was only 8, the limit of the apparent magnitude was extended to 6.0. By this extension, 5 stars were added to the 99 selected stars. We see, from Table 3, that there is a slight tendency for the parallaxes of B stars to be larger (relative to the parallax of A0 V) than we assumed in the beginning. But a definite conclusion should not be drawn from this result only, because the number of stars included in the present study was not sufficient.

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