CATALOGUE AND BIBLIOGRAPHY OF STARS OF CLASSES B AND A WHOSE SPECTRA HAVE BRIGHT HYDROGEN LINES[1]

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ABSTRACT

The main *catalogue*, Table I, lists 410 stars of classes O, B, and A whose spectra have bright hydrogen lines, while Table II gives six anomalous objects whose spectra have bright lines of hydrogen and helium, but whose absorption spectra include titanium oxide bands. The exact meaning of the word "bright" as applied to lines having complex structure is discussed in the introduction. Notes to Table I record considerable unpublished data, besides calling attention to the chief features of a few of the more interesting peculiar spectra.

The *bibliography* includes 365 references to observational material concerning the objects in Tables I and II. The items referring to each star are indicated in a key list.

Discussion.—The numbers of stars discovered at various observatories are in Table IV. Tables V and VI show the distribution in type and magnitude. The largest numbers are in subdivision B3 and magnitude 8. Stars of the P Cygni type are listed in Table VII. Tables VIII, IX, X, and XI compare the numbers of Be stars in various intervals of type and magnitude with the total numbers of H.D. stars in the same intervals. Stars of class B2 have a stronger tendency toward emission than those of either earlier or later subdivisions. The proportion of bright-line stars decreases very rapidly from B3 to A0. The galactic distribution of Be stars is shown by Figs. 2*a*, 2*b*, and 3. The divergence from the galactic plane characteristic of the local system is less strongly marked than for non-emission B stars, probably because the emission stars are somewhat brighter intrinsically. Table XIII lists 12 areas rich in Be stars, among which star groups of two types may be recognized. An extremely interesting region is that of the double cluster in Perseus. The distribution of faint Cepheids is similar to that of faint Be stars.

INTRODUCTION

About 1910 a card catalogue of B-type stars whose spectra were known to have bright hydrogen lines was formed by one of us as a basis for further spectroscopic observations of these objects.[2] Harvard lists of peculiar spectra and W. W. Campbell's visual observations of the $H\alpha$ line[3] were the chief sources. Cards have since been added as announcements of additional stars of this kind appeared, and it is believed that the list has been kept nearly complete. No general catalogue has appeared since the 1912 Harvard list of "Stars Having Bright Hydrogen Lines,"[4] which has 93 entries. The number

[1] *Contributions from the Mount Wilson Observatory, Carnegie Institution of Washington*, No. 471.

[2] *Lick Observatory Bulletins*, **7**, 162, 1913.

[3] *Astrophysical Journal*, **2**, 177, 1895.

[4] *Harvard Annals*, **56**, 182, 1912.

of Be stars now known exceeds 400, and descriptions of their spectra are widely scattered through astronomical publications. Several astronomers have therefore recently recommended the printing of the present catalogue. In its preparation we have had the advantage of referring to a somewhat similar unpublished catalogue compiled several years ago at the University of Michigan by the late Dr. R. H. Curtiss, who had offered its use for this purpose. It later became available through the kindness of Dr. W. C. Rufus and of Mr. W. J. Williams, who made a typewritten copy for our use. Other astronomers who have co-operated by supplying unpublished data concerning Be stars include V. M. Slipher, Lowell Observatory; W. E. Harper, J. A. Pearce, and C. S. Beals, Dominion Astrophysical Observatory; Dean B. McLaughlin, Observatory of the University of Michigan; Otto Struve, Yerkes Observatory; Frank C. Jordan, Allegheny Observatory; G. Shajn, Simeis Observatory; and several of our colleagues of the Mount Wilson Observatory. To all these gentlemen we express our cordial appreciation.

The main catalogue, Table I, includes all known stars of classes B and A whose spectra have bright hydrogen lines. It omits Wolf-Rayet stars and all other bright-line stars of class O, except five of classes O6–O9 whose bright lines resemble those characteristic of class Be. The stars omitted are those in the Harvard classes Oa, Ob, Oc, Od, Oe, and those additional stars with narrow emission lines at λλ 4634, 4640, and 4686, for which the Victoria observers have recently used the symbol "f."[5] The spectra of the omitted objects seem sufficiently different from those of typical Be stars, e.g., γ Cassiopeiae, to make it inadvisable to include them with Be stars in statistical studies.[6]

In Table II are six anomalous objects whose absorption spectra include titanium oxide bands together with lines having a partial resemblance to those of class K, but which are related to early type

[5] *Publications of the Dominion Astrophysical Observatory*, **5**, 110, 1930.

[6] Most spectra of classes Od and Oe (or O5–O9 with narrow emission at λλ 4634, 4640, and 4686) have dark hydrogen lines. A few may have one or more bright hydrogen lines of low intensity, but the structure of these lines probably differs from that regularly found in Be spectra. The star H.D. 108, included in Table I, offers an exception in that the bright hydrogen lines are well marked and not greatly different from those observed in certain Be stars.

spectra through the presence of bright lines of hydrogen and helium. These stars are not included in the statistical studies in the latter part of this contribution.

In dealing with lines having complex structure, such as those frequently present in Be spectra, the exact meaning to be attached to the word "bright" may require consideration. The condition that the intensity-curve of the line rise above that of the adjacent continuous spectrum is of course sufficient, but it is not necessary. In

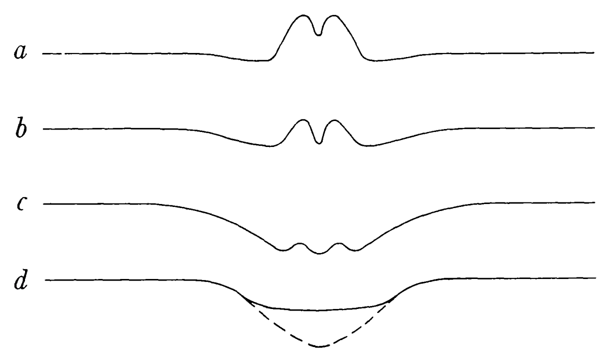

FIG. 1.—Illustrative intensity-curves of complex lines

the sequence of forms illustrated in Figure 1 it clearly seems appropriate to include *c* as well as *a* and *b* among the bright lines. Not to do so would terminate the sequence in an arbitrary and physically unjustifiable manner. When, however, no maxima are seen, and the central portion of the curve merely lies above the hypothetical extension of the wings, as in *d*, we consider it inadvisable to call the line bright.[7] A practical criterion seems to be that definite maxima (not caused by the superposition of lines of other elements) shall be seen.[8] The physical significance of this criterion is established by the fact that if a certain member of the Balmer series has a curve similar

[7] If it is thought that the appearance arises from incipient emission, two tests may be applied: (1) the line may be observed in such a way as to accentuate indistinct maxima (by using greater purity or higher dispersion or a more contrasty emulsion) or (2) the Balmer lines of longer wave-length may be photographed; this is the most decisive test, applicable to all lines except $H\alpha$.

[8] The same criterion might be useful for the bright components of the H and K lines in late-type spectra (Adams and Joy, *Publications of the Astronomical Society of the Pacific*, 43, 407, 1931).

to *c*, the members at longer wave-length have curves like *b* or *a*. In the spectra of many stars listed in Table I the structure of $H\gamma$ is qualitatively like *c*, and in a smaller number $H\beta$ is similar. We think, however, that in every instance the emission at the $H\alpha$ line rises above the level of the continuous spectrum. If a spectrum should be found in which $H\alpha$ is similar to *c* but with all the other hydrogen lines wholly dark, we should still be inclined to include it in the Be group.

DESCRIPTION OF TABLES I AND II

Col.	Heading	
1	MWC	Mount Wilson Catalogue current number.
2	H.D.	The number of the star in the *Henry Draper Catalogue* (*Harvard Annals*, **91–99**). Numbers larger than 225,300 are from the *Henry Draper Extension* (*ibid.*, **100**).
3	Desig.	The name by which the star is commonly known or the *Durchmusterung* number (given in the same system as that employed in the *Henry Draper Catalogue*). For a few faint stars lacking *Durchmusterung* numbers, MW refers to the *Mount Wilson discovery lists of Be stars* (*Mt. Wilson Contr.*, Nos. 294 and 456; *Astrophysical Journal*, **61**, 389, 1925, and **76**, 156, 1932).
4, 5	R.A. / Dec.	Right ascension and declination for 1900.
6, 7	*l*, *b*	Galactic longitude and latitude. The usual position for the north galactic pole, R.A. $=12^{h}40^{m}$, Dec. $=+28°$ (1900), has been assumed.
8	Mag.	Most of the values are *visual* magnitudes determined by the Harvard observers. The B.D., the C.D., or the C.P.D. magnitudes are given for most stars not in the H.D., but for stars in the double cluster in Perseus the magnitudes by Trumpler (*Publications of the Astronomical Society of the Pacific*, **38**, 350, 1926) or by van Maanen (*Mt. Wilson Contr.*, No. 205) have been substituted. For a few faint stars the values (in italics) are photographic magnitudes determined by Mr. M. L. Humason at Mount Wilson.
9	Type	The symbols have their usual meaning. In general the classifications made from slit spectrograms at Mount Wilson (*Contr.* Nos. 262, 294, 456) or at Victoria (*Publications of the Dominion Astrophysical Observatory*, **5**, No. 2) have been used. Most of these agree closely with the Harvard determinations, especially for the brighter stars. In many in-

stances Mount Wilson spectrograms have been re-examined to check the classification and especially to determine whether the symbols "n" or "s" should be included. The spectra of many, possibly all, of the stars in Tables I and II are variable to a greater or less extent. In certain stars the variation appears to affect only the bright lines; in others, the variations are more extensive, and in a few instances are so general that the classification would depend on the date of observation. It has not seemed feasible to indicate these changes in the catalogue. A few special instances are remarked upon in the notes to Table I, but for detailed information the original papers should be consulted.

TABLE I

STARS OF CLASSES B AND A WHOSE SPECTRA HAVE BRIGHT HYDROGEN LINES

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.	Type
1...	108	*2363*	0^h $0^m.9$	+63° 7′	86°	+ 1°	7.4	O6ep
2...	144	2107	0 1.2	+63 37	86	+ 2	5.5	B9neα
3...	....	*2829*	0 1.6	+60 4	85	− 2	9.5	B0ne
4...	698	28	0 6.3	+57 39	85	− 4	7.1	B8seα
5...	....	39	0 14.8	+61 54	87	0	8.9	B(0)e
6...	2789	35	0 26.3	+66 36	89	+ 5	8.2	B2ne
7...	2905	κ Cas	0 27.3	+62 23	89	0	4.2	B0seα
8...	4180	*o* Cas	0 39.2	+47 44	90	−14	4.7	B4neβ
9...	5394	γ Cas	0 50.7	+60 11	91	− 2	2.2	B0ne
10...	6343	129	0 59.4	+65 26	92	+ 3	7.1	B5eβ
11...	....	180	1 5.9	+60 47	93	− 1	9.4	B(3)e
12...	7636	*240*	1 11.2	+57 6	94	− 5	7.6	B2ne
13...	9105	259	1 24.6	+62 51	95	+ 1	7.5	B5s(e)
14...	....	*271*	1 27.9	+63 7	95	+ 2	8.2	B(8)eβ
15...	....	285	1 32.2	+62 57	96	+ 2	8.6	B(8)e
16...	10516	φ Per	1 37.4	+50 11	99	−11	4.2	B0ne
17...	....	MW 101	1 40.8	+60 12	97	− 1	*12.2*	Pec.
18...	....	358	1 42.7	+60 33	98	− 1	9.0	B(3)ne
19...	232552	398	1 45.9	+54 50	99	− 6	7.6	B(2)ne
20...	11554	425	1 48.4	+57 24	99	− 3	9.2	B(3)e
21...	11606	331	1 48.8	+58 47	99	− 2	7.0	B3ne
22...	....	261	1 50.1	+63 33	98	+ 3	9.1	Bne
23...	12302	*356*	1 55.6	+59 12	100	− 1	8.2	B3e
24...	236935	*469*	1 57.2	+58 0	100	− 2	9.1	B4ne
25...	12856	429	2 0.9	+56 38	101	− 3	8.4	B(2)ne
26...	12882	295	2 1.1	+64 33	99	+ 4	7.5	B(2)ne
27...	13051	432	2 2.6	+56 31	101	− 4	8.0	B(0)ne
28...	....	515	2 5.7	+57 13	101	− 3	9.3	B(3)e
29...	13661	*486*	2 8.1	+54 4	103	− 6	8.6	B(3)ne
30...	....	MW 112	2 9.0	+56 32	102	− 3	*11.4*	Be
31...	13854	471	2 9.9	+56 36	102	− 3	6.4	B1seα
32...	14134	522	2 12.1	+56 40	102	− 3	6.7	B3seα
33...	....	534	2 12.4	+56 37	102	− 3	*10.1*	Bne
34...	....	559	2 14.2	+56 51	103	− 3	*10.7*	Be
35...	....	Comp *o* Cet	2 14.3	− 3 26	137	−57	10 v	Bep
36...	....	563	2 14.7	+56 40	103	− 3	*9.6*	B3e
37...	14422	565	2 14.7	+56 56	103	− 3	9.4	Bne
38...	....	566	2 14.8	+56 42	103	− 3	*10.1*	B3e
39...	....	Anon	2 15.0	+56 43	103	− 3	*10.6*	B4e
40...	....	573	2 15.0	+56 38	103	− 3	*9.9*	B3e
41...	....	582	2 15.3	+56 50	103	− 3	*10.2*	B(3)e
42...	....	458	2 16.2	+58 31	102	− 1	9.4	B(3)ne
43...	....	MW 117	2 16.2	+57 4	103	− 3	*10.6*	Be
44...	14605	*605*	2 16.5	+56 8	103	− 3	9.7	B(2)ne
45...	14818	*612*	2 18.2	+56 10	103	− 3	6.2	B1seα
46...	....	624	2 19.6	+56 39	103	− 3	9.3	B(2)eα
47...	15238	488	2 22.2	+60 13	102	+ 1	8.4	B8eα
48...	15450	642	2 24.2	+56 27	104	− 3	8.7	B0ne
49...	15472	182	2 24.4	+70 30	99	+10	8.0	B4ne
50...	....	MW 122	2 24.6	+60 56	103	+ 1	*11.0*	Be

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	l	b	Mag.	Type
51...	....	510	$2^{h}26^{m}3$	+60 33	103	+ 1	9.0	B(9)eα
52...	....	MW 124	2 27.5	+59 0	103	0	*11.2*	Be
53...	....	*516*	2 28.4	+60 10	103	+ 1	9.5	Be
54...	....	492	2 29.3	+58 56	104	0	9.5	Be
55...	....	607	2 32.8	+57 21	105	− 1	9.5	Be
56...	....	MW 128	2 35.0	+60 50	104	+ 2	*11.6*	Bep
57...	....	487	2 42.3	+61 41	104	+ 3	9.4	B(0)ne
58...	....	727	2 44.1	+56 32	107	− 1	9.5	B(5)e
59...	....	606	2 51.5	+60 12	106	+ 2	9.1	Be
60...	237060	*554*	2 56.7	+59 2	107	+ 2	8.8	B(5)neα
61...	19243	*525*	3 0.7	+62 0	106	+ 4	6.5	B2e
62...	237091	612	3 7.3	+59 32	108	+ 3	8.8	Be
63...	20017	870	3 7.9	+48 19	114	− 7	7.9	Bne
64...	20134	625	3 9.1	+59 41	108	+ 3	7.5	B2e
65...	20336	H.R. 985	3 11.2	+65 17	105	+ 8	4.8	B3e
66...	237134	647	3 17.0	+59 54	109	+ 4	8.8	Bne
67...	21212	*587*	3 20.3	+62 9	108	+ 6	8.7	B2e
68...	21650	696	3 24.6	+41 25	120	−11	7.2	B5ne
69...	22192	ψ Per	3 29.4	+47 51	117	− 5	4.3	B5ne
70...	22298	698	3 30.3	+54 50	113	+ 1	8.4	B2ne
71...	....	623	3 31.9	+61 31	109	+ 6	8.7	B2ne
72...	23302	Electra	3 39.0	+23 48	134	−23	3.8	B5neα
73...	23480	Merope	3 40.4	+23 39	134	−22	4.2	B5ne
74...	23630	Alcyone	3 41.5	+23 48	135	−22	3.0	B5ne
75...	23862	Pleione	3 43.3	+23 51	135	−22	5.2	B8n(e)
76...	23982	458	3 44.3	+63 11	109	+ 8	8.1	B3e
77...	24479	628	3 48.6	+62 47	110	+ 8	4.9	B9neα
78...	24534	X Per	3 49.1	+30 45	131	−16	6 v	B0ne
79...	24560	816	3 49.3	+44 38	122	− 5	7.8	B(3)ne
80...	25348	*752*	3 56.6	+53 3	117	+ 2	8.2	B(1)ne
81...	25940	c Per	4 1.4	+47 27	121	− 2	4.0	B3ne
82...	26420	830	4 5.7	+41 52	126	− 6	7.6	B3neα
83...	26906	904	4 10.1	+45 58	124	− 2	8.6	B(3)ne
84...	....	MW 143	4 11.6	+55 46	117	+ 5	*11.5*	Bep
85...	232971	778	4 23.7	+53 36	120	+ 5	9.0	B(5)ne
86...	28497	893	4 24.5	−13 17	176	−36	5.5	B3ne
87...	237299	831	4 33.0	+57 43	117	+ 9	8.8	B(3)e
88...	29866	1032	4 37.3	+40 36	131	− 2	6.1	B4ne
89...	30076	56 Eri	4 39.3	− 8 41	173	−31	5.9	B5ne
90...	....	MW 146	4 40.0	+46 3	127	+ 2	*10.0*	Be
91...	....	974	4 43.2	+41 30	131	− 1	9.2	B0ne
92...	30614	9 (α) Cam	4 44.1	+66 10	111	+15	4.4	O9seα
93...	31293	AB Aur	4 49.4	+30 24	140	− 7	7.5v	A0ep
94...	....	1031	4 54.2	+41 7	132	+ 1	9.0	B(3)ne
95...	32256	(N.G.C. 1763)	4 56.6	−66 34	244	−36	......	Pec.
96...	32343	11 Cam	4 57.4	+58 50	118	+12	5.3	B3e
97...	32763	343	5 0.3	−70 20	248	−35	*9.6*	Pec.
98...	32991	105 Tau	5 2.0	+21 34	149	−10	6.0	B3ne
99...	33152	1021	5 3.2	+36 53	137	0	7.8	B2e
100...	33232	1196	5 3.7	+40 53	134	+ 2	8.1	B(3)e
101...	33461	1106	5 5.3	+41 6	134	+ 2	8.0	B(1)e
102...	33540	....	5 5.8	−71 3	249	−34	*12.3*	Beq
103...	33604	1213	5 6.3	+40 5	135	+ 2	7.3	B3se

TABLE I—*Continued*

MWC*	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.	Type
104...	33988	12 Aur	5 9.0	+46 19	130	+ 6	6.9	B5ne
105...	34664	In N.G.C. 1871	5 14.0	−67 34	245	−34	*11.4*	Beq
106...	....	Anon	5 14.4	−69 28	247	−34	*11.4*	Beq
107...	34921	1160	5 15.8	+37 35	138	+ 2	7.4	Bone
108...	35343	S Dor	5 18.9	−69 21	246	−33	9 v	Beq
109...	35345	1095	5 19.0	+35 33	140	+ 1	8.4	B2e
110...	35439	25 Ori	5 19.6	+ 1 45	169	−17	4.7	B3ne
111...	36576	120 Tau	5 27.6	+18 29	155	− 6	5.5	B3ne
112...	....	Anon	5 28.5	−69 4	246	−32	*13.0*	Beq
113...	....	(383)	5 29.0	−69 13	246	−32	*12.2*	Beq
114...	37115	1330	5 31.0	− 5 41	177	−18	8.2	B5ne
115...	37202	ζ Tau	5 31.7	+21 5	153	− 4	3.0	B3e
116...	37330	1138	5 32.7	+ 0 55	171	−14	7.2	B8ne
117...	37490	ω Ori	5 33.9	+ 4 4	168	−13	4.5	B3e
118...	37657	*1376*	5 35.1	+43 0	135	+ 8	7.0	B3ne
119...	37795	α Col	5 36.0	−34 8	206	−28	2.8	B8ne
120...	37806	1344	5 36.1	− 2 46	175	−15	8.6	Aoe
121...	37836	401	5 36.2	−69 44	247	−32	*10.5*	Beq
122...	37967	1015	5 37.2	+23 10	152	− 2	6.1	B3ne
123...	37974	420	5 37.2	−69 26	246	−32	*11.3*	Beq
124...	38010	941	5 37.5	+25 24	150	− 1	6.9	B3ne
125...	38191	958	5 38.9	+21 25	154	− 3	9.5	Bne
126...	38489	478	5 41.0	−69 26	246	−31	*12.0*	Beq
127...	39340	985	5 46.9	+26 25	151	+ 2	8.1	B3ne
128...	248753	1019	5 47.3	+25 43	151	+ 1	*8.4*	Bone
129...	39478	992	5 47.8	+26 24	151	+ 2	8.4	B2ne
130...	39557	1203	5 48.3	+ 0 46	173	−11	8.9	B(8)ne
131...	40978	1091	5 57.2	+46 33	134	+13	7.0	B3ne
132...	41117	χ^2 Ori	5 58.0	+20 8	157	+ 1	4.7	B1seα
133...	41335	1391	5 59.4	− 6 42	181	−12	5.1	B2(n)e
134...	42054	2655	6 3.5	−34 18	208	−22	5.9	B5ne
135...	253214	1309	6 6.4	+20 7	158	+ 2	*9.4*	Bone
136...	43285	1172	6 10.3	+ 6 6	171	− 4	6.0	B5ne
137...	....	MW 229	6 13.0	+15 19	163	+ 1	*11.2*	Pec.
138...	44458	1460	6 16.8	−11 44	188	−11	5.5	B2ne
139...	44637	1176	6 17.7	+15 9	164	+ 2	7.7	B3e
140...	45314	1296	6 21.6	+14 57	165	+ 3	7.1	B2ne
141...	45542	ν Gem	6 23.0	+20 17	160	+ 6	4.1	B5ne
142...	45677	*1500*	6 23.7	−13 0	190	−10	7.5	Bep
143...	45725	β Mon Pr	6 24.0	− 6 58	184	− 7	4.7	B3ne
144...	45727	β Mon Fl	6 24.0	− 6 58	184	− 7	5.6	B3ne
145...	45910	1267	6 25.2	+ 5 57	173	0	6.7	Beq
146...	45995	1204	6 25.6	+11 19	168	+ 2	5.8	B2ne
147...	259431	1172	6 27.6	+10 24	169	+ 2	*9.0*	B2e
148...	259440	1291	6 27.6	+ 5 52	173	0	*9.6*	B(5)ne

* *Harvard Bulletin,* No. 891, received after the completion of Table I, lists two additional stars of the P Cygni type in the Large Magellanic Cloud.

Desig.	R.A. (1900)	Dec. (1900)	Mag.
C.P.D.−69°427	$5^h14^m39^s$ 5 37 32	−69°38′.2 −69 38.1	11.6 11.1

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.	Type
149...	259597	1388	$6^h28^m.1$	+8° 24′	171°	+1°	*8.8*	B(0)ne
150...	47054	1710	6 31.6	−5 8	184	−4	5.5	B8ne*a*
151...	....	R Mon	6 33.7	+8 49	171	+3	13 v	Pec.
152...	48917	10 CMa	6 40.7	−30 58	208	−14	5.2	B3ne
153...	49787	1815	6 45.0	−5 24	185	−1	7.3	B3e
154...	49977	*1682*	6 45.9	−14 0	193	−5	7.9	B2ne
155...	50013	κ CMa	6 46.1	−32 23	210	−13	3.8	B2ne
156...	50083	1448	6 46.5	+5 13	176	+4	6.8	B2e
157...	50123	3717	6 46.6	−31 36	209	−13	5.6	B8ne
158...	50138	1775	6 46.7	−6 51	187	−2	6.6	B8e
159...	50209	1468	6 47.1	−0 10	181	+1	8.3	B(5)ne
160...	51354	1423	6 51.9	+18 2	165	+11	7.1	B(3)ne
161...	51480	1774	6 52.4	−10 41	191	−2	7.0	B8eq
162...	51585	....	6 52.8	+16 28	167	+10	......	Beq?
163...	52244	1694	6 55.3	−16 3	196	−4	9.0	B5e
164...	52721	1747	6 57.2	−11 9	192	−1	6.6	B3e
165...	53179	Z CMa	6 59.0	−11 24	192	−1	9.1	Beq
166...	53367	1848	6 59.7	−10 18	191	−1	7.0	B1ne
167...	54309	4908	7 3.2	−23 41	204	−6	5.8	B3ne
168...	55135	1908	7 6.6	−10 16	192	+1	7.2	B4ne
169...	55271	1791	7 7.1	−21 38	202	−4	6.7	B5ne
170...	56014	27 CMa	7 10.2	−26 10	207	−6	4.7	B5e
171...	56139	ω CMa	7 10.7	−26 35	207	−6	3.8	B3e
172...	56806	1769	7 13.4	−18 39	200	−2	9.3	Be
173...	57150	v^1 Pup	7 14.8	−36 33	216	−10	4.7	B3ne
174...	57386	1856	7 15.9	−8 15	192	+4	8.1	B5ne
175...	58011	4439	7 18.6	−25 49	207	−4	7.0	B1e
176...	58050	1564	7 18.8	+15 43	170	+16	6.4	B3e
177...	58343	*1810*	7 20.1	−16 0	199	+1	5.2	B3se
178...	58715	β CMi	7 21.7	+8 29	177	+13	3.1	B8ne
179...	58978	1874	7 22.8	−22 53	205	−2	5.5	B2ne
180...	....	2040	7 24.5	−13 34	197	+3	9.0	B2ne
181...	59497	1962	7 25.1	−21 38	204	−1	8.4	B3ne
182...	59773	1979	7 26.4	−21 35	204	0	8.1	B3e
183...	60606	z Pup	7 30.2	−36 7	217	−7	5.5	B5e
184...	60848	1623	7 31.4	+17 7	170	+19	7.7	O7ne
185...	62753	3379	7 40.4	−40 5	222	−7	6.7	B2ne
186...	63462	o Pup	7 43.9	−25 42	210	+1	4.6	B3e
187...	64109	1843	7 47.2	+4 5	184	+17	8.3	B8ne
188...	65079	1848	7 51.9	+3 14	186	+17	7.7	B3ne
189...	65176	1900	7 52.4	−1 20	190	+15	8.1	B(5)ne
190...	65875	2379	7 55.8	−2 36	192	+15	6.4	B2e
191...	66700	5452	7 59.6	−31 24	217	+1	8.0	B3e
192...	68980	r Pup	8 9.7	−35 35	221	0	4.8	B3ne
193...	69404	3951	8 11.7	−46 10	230	−6	6.6	B3e
194...	72754	3621	8 29.4	−49 16	234	−5	7.3	Be
195...	75311	f Car	8 44.1	−56 25	241	−8	4.6	B3ne
196...	78764	E Car	9 4.8	−70 8	253	−15	4.9	B3ne
197...	83953	I Hya	9 36.7	−23 8	224	+22	4.7	B3ne
198...	87643	1865	10 1.1	−58 11	250	−2	9.1	Be
199...	88661	2781	10 8.3	−57 34	251	−1	6.1	B2e
200...	89249	*3389*	10 12.6	−55 5	250	+1	9.1	Be
201...	89890	J Vel	10 17.2	−55 33	251	+1	4.6	B5e

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.	Type
202...	90177	*2145*	10h19m4	−59° 8′	253°	− 2°	7.9	Be
203...	....	3261	10 23.8	−57 9	252	0	*9.2*	Be
204...	90966	1595	10 24.9	−62 40	255	− 5	6.7	B3e
205...	91120	*3181*	10 26.1	−13 5	227	+38	5.5	B9neα
206...	....	Anon	10 26.7	−71 34	260	−12	......	Pec.
207...	....	2193	10 28.0	−59 46	254	− 2	*8.9*	Be
208...	91465	p Car	10 28.5	−61 11	255	− 3	3.6	B5ne
209...	92714	*3671*	10 37.2	−58 3	254	0	*9.4*	Be
210...	....	2160	10 37.6	−60 15	255	− 2	*9.2*	Be
211...	92964	2581	10 38.9	−58 42	255	0	5.4	B1se
212...	93128,9	*2617,8*	10 40.1	−59 2	255	0	7.1	Be
213...	93190	2637	10 40.5	−58 46	255	0	8.9	Be
214...	93308	η Car	10 41.2	−59 10	255	− 1	7 v	Pec.
215...	94878	2855	10 52.0	−59 52	257	− 1	8.5	Beq
216...	94910	2860	10 52.2	−59 55	257	− 1	7.6	Beq
217...	97151	3100	11 5.8	−59 33	258	0	8.0	B2e
218...	102776	j Cen	11 44.8	−63 14	264	− 2	4.5	B5ne
219...	105435	δ Cen	12 3.2	−50 10	264	+11	2.9	B3ne
220...	105675	2166	12 4.8	−63 26	266	− 2	9.4	Be
221...	107348	ζ Crv	12 15.4	−21 39	263	+40	5.3	B8ne
222...	109387	κ Dra	12 29.2	+70 20	92	+48	3.9	B5e
223...	110335	4393	12 36.2	−59 8	270	+ 3	5.0	B8e
224...	110432	2898	12 36.9	−62 30	270	0	6.0	B1ne
225...	112091	μ² Cru	12 48.8	−56 37	271	+ 5	5.5	B3ne
226...	113120	1553	12 56.3	−70 56	271	− 9	6.0	B3ne
227...	114200	1567	13 3.9	−70 16	272	− 8	9.6	Be
228...	116781	3270	13 20.7	−62 8	275	− 1	8.8	Be
229...	120324	μ Cen	13 43.6	−41 59	282	+18	3.3	B3e
230...	120991	8931	13 47.7	−46 39	282	+14	5.9	B3e
231...	124367	6206	14 8.0	−56 37	282	+ 3	5.2	B3ne
232...	127972,3	η Cen	14 29.2	−41 43	291	+16	2.6	B3ne
233...	128293	2622	14 30.9	−67 47	280	− 8	6.9	B3e
234...	135160	5698	15 8.5	−60 32	287	− 4	6.0	B1e
235...	137387	κ¹ Aps	15 20.6	−73 2	281	−15	5.6	B5ne
236...	138403	1889	15 26.7	−71 34	283	−14	*9.0*	Beq
237...	138749	θ CrB	15 28.9	+31 42	16	+53	4.2	B5ne
238...	141969	3171	15 46.7	−65 52	288	−10	*9.2*	Beq
239...	142983	4302	15 52.6	−13 59	324	+27	4.7	Apeα
240...	143448	6348	15 55.2	−60 13	292	− 7	*7.8*	B3e
241...	148184	χ Oph	16 21.2	−18 14	326	+19	4.8	B3e
242...	151895	....	16 45.1	−64 4	293	−14	*12.5*	Beq
243...	152236	ζ¹ Sco	16 47.0	−42 12	311	0	4.9	B1seq
244...	153222	11105	16 52.9	−49 6	306	− 5	9.5	Boe
245...	153261	6964	16 53.2	−58 48	298	−11	6.3	Boe
246...	153879	10676	16 56.9	−51 15	305	− 7	8.6	B3e
247...	....	MW 168	16 58.1	−33 50	319	+ 3	*12.5*	Bep
248...	154154	11424	16 58.6	−48 17	307	− 6	8.6	Boe
249...	154218	11217	16 59.0	−36 36	317	+ 1	7.7	B5ne
250...	154243	11221	16 59.2	−36 27	317	+ 1	8.3	B2e
251...	154450	11320	17 0.4	−35 37	317	+ 2	8.5	Boe
252...	155806	11875	17 8.7	−33 26	320	+ 2	5.5	O8e
253...	155851	12518	17 9.0	−32 34	321	+ 2	8.0	Bone
254...	156325	12573	17 11.8	−32 27	321	+ 2	6.4	B6neα

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	l	b	Mag.	Type
255...	156468	11463	17h12m6	−37° 54′	317°	− 2°	8.0	B2e
256...	....	11482	17 13.8	−35 39	319	− 1	9.6	Be
257...	156702	11773	17 14.0	−38 33	316	− 2	8.4	B5e
258...	157042	ι Ara	17 15.8	−47 23	310	− 7	5.5	B3ne
259...	157832	11530	17 20.5	−46 57	310	− 8	7.3	B2e
260...	158319	4526	17 23.5	−16 31	336	+ 8	8.7	B5ne
261...	158427	α Ara	17 24.1	−49 48	308	−10	3.0	B3ne
262...	159684	11750	17 30.9	−35 17	321	− 3	7.6	B2e
263...	160095	12319	17 32.9	−33 29	323	− 3	8.7	B8e
264...	160202	13086	17 33.5	−32 9	324	− 2	6.9	B(1)ne
265...	....	RT Ser	17 34.3	−11 53	342	+ 8	12 v	Pec.
266...	160529	12361	17 35.3	−33 27	323	− 3	6.7	A4seα
267...	161044	11816	17 38.2	−46 3	313	−10	11.0	Beq
268...	161103	11872	17 38.5	−27 12	329	0	7.9	B0ne
269...	161114	XX Oph	17 38.6	− 6 14	347	+10	10 v	Pec.
270...	....	MW 174	17 39.5	−30 10	327	− 2	*11.5*	Bep
271...	161306	4598	17 39.7	− 9 46	344	+ 8	8.3	B(0)ne
272...	....	11944	17 41.9	−27 59	329	− 1	9.0	Beq
273...	162718	13585	17 47.3	−24 45	332	− 1	9.0	B0ne
274...	163181	13517	17 49.7	−32 27	326	− 5	6.6	B1se
275...	163296	4779	17 50.3	−21 56	335	0	6.6	A2e
276...	163454	*14987*	17 51.1	−31 0	327	− 5	7.9	B1ne
277...	163868	12700	17 53.3	−33 24	325	− 6	7.2	B2ne
278...	164284	66 Oph	17 55.3	+ 4 22	359	+12	4.8	B5ne
279...	164447	3494	17 56.1	+19 31	13	+18	6.4	B9e
280...	164906	13832	17 58.3	−24 24	334	− 3	9.0	B(0)ne
281...	165285	4836	18 0.1	−19 58	338	− 1	8.7	B2ne
282...	166188	4815	18 4.4	−18 13	340	− 1	9.4	B2e
283...	166256	3540	18 4.7	+13 28	8	+14	8.4	A0ne
284...	166566	4856	18 6.1	−15 42	342	0	8.1	B1se
285...	166666	4861	18 6.6	−15 36	342	0	9.4	B2e
286...	166734	4625	18 6.9	−10 46	347	+ 2	8.3	B0eα
287...	....	5060	18 9.7	−20 23	339	− 3	9.0	B(0)ne
288...	167362	15469	18 9.7	−30 54	329	− 8	11.8	Pec.
289...	168135	4991	18 13.2	−12 29	346	0	8.1	B8neα
290...	168229	4909	18 13.6	−18 16	341	− 3	9.7	B(1)ne
291...	168607	4829	18 15.5	−16 25	343	− 2	8.9	A0se
292...	168957	*3395*	18 17.3	+25 1	20	+16	6.9	B5e
293...	169226	5034	18 18.6	−12 15	347	− 1	9.1	Be(q)
294...	169454	5039	18 19.6	−14 2	345	− 2	6.8	B0se
295...	169515	RY Sct	18 19.9	−12 45	346	− 2	9 v	Pec.
296...	169805	5007	18 21.3	−19 1	341	− 5	8.7	B1ne
297...	....	MW 181	18 22.4	− 3 55	354	+ 2	*11.0*	Be
298...	170061	5062	18 22.4	−14 47	345	− 3	10.6	B0ne
299...	170235	13170	18 23.2	−25 19	336	− 8	6.2	B2e
300...	....	MW 182	18 24.0	− 6 9	353	+ 1	*10.0*	Bep
301...	171012	4994	18 27.3	−18 26	342	− 6	7.0	B0seα
302...	171348	4790	18 29.3	−22 10	339	− 8	8.1	B3e
303...	172694	5063	18 36.5	−15 57	345	− 7	8.3	Bpe
304...	173219	4689	18 39.1	− 7 13	354	− 3	8.3	B1e
305...	174105	3573	18 43.8	+15 17	14	+ 6	6.9	B8ne
306...	174638,9	β Lyr	18 46.4	+33 15	31	+14	4 v	Bep
307...	174886	4848	18 47.7	−10 21	352	− 6	8.1	B3e

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.	Type
308...	175863	1929	$18^{h}52^{m}3$	+59° 53′	57°	+22°	6.9	B4e
309...	177015	5381	18 57.7	−20 16	344	−13	7.6	B3e
310...	177648	3549	19 0.5	+23 11	23	+ 6	6.9	B3e
311...	178175	5312	19 2.4	−19 27	345	−14	5.4	B3e
312...	180398	3861	19 11.3	+12 56	15	− 1	7.7	B(3)ne
313...	181615,6	υ Sgr	19 16.0	−16 8	350	−15	4.6	Ave
314...	....	3887	19 17.0	+14 42	17	− 1	9.5	Pec.
315...	....	MW 187	19 19.9	+29 28	31	+ 6	*10.0*	Bep
316...	....	3687	19 20.5	+22 35	25	+ 2	8.6	B2e
317...	183143	4085	19 23.0	+18 5	21	− 1	6.9	B9seα
318...	183362	3465	19 24.1	+37 44	38	+ 9	6.4	B3ne
319...	184279	4065	19 28.6	+ 3 34	9	− 9	6.8	B2se
320...	....	4285	19 41.3	+ 5 44	12	−11	8.5	B5ne
321...	187399	3754	19 44.7	+29 10	33	+ 1	7.7	B9eβ
322...	187567	4252	19 45.5	+ 7 39	15	−11	6.4	B3ne
323...	187811	12 Vul	19 46.8	+22 21	27	− 3	4.9	B5ne
324...	....	3723	19 51.1	+26 19	31	− 2	8.7	B(5)ne
325...	190073	4393	19 58.1	+ 5 28	14	−14	7.9	A0ep
326...	190603	3925	20 0.7	+31 56	37	− 1	5.7	B0seα
327...	227611	3950	20 2.0	+35 37	40	+ 1	*9.5*	Be
328...	190944	2846	20 2.3	+46 24	49	+ 7	8.8	B(2)e
329...	191610	b^2Cyg	20 5.7	+36 33	41	+ 1	4.8	B3ne
330...	228041	3998	20 6.2	+35 12	41	0	*9.6*	B(3)ne
331...	192044	20 Vul	20 7.8	+26 11	33	− 5	5.9	B8ne
332...	192445	*4026*	20 9.8	+36 2	42	0	7.1	B2ne
333...	228438	3946	20 10.1	+36 20	42	0	*9.0*	B0ne
334...	228548	4098	20 11.4	+39 40	45	+ 2	*10.8*	B(2)ne
335...	192954	4120	20 12.6	+15 33	25	−12	7.3	A2e
336...	193009	*4018*	20 12.9	+32 4	39	− 3	7.0	B0ne
337...	....	MW 195	20 13.8	+36 34	43	0	*10.0*	B(2)e
338...	193237	P Cyg	20 14.1	+37 43	43	0	4.9	B1eq
339...	193516	3881	20 15.5	+37 28	43	0	8.8	B1(e)
340...	....	*4124*	20 17.0	+41 2	47	+ 2	9.5	B(2)e
341...	193911	25 Vul	20 17.7	+24 7	33	− 8	5.4	B8ne
342...	....	MW 197	20 19.5	+39 10	45	0	*10.8*	Be
343...	194335	3916	20 20.0	+37 10	44	− 1	5.7	B3ne
344...	229221	4062	20 20.1	+38 11	45	0	*10.0*	B(0)e
345...	194883	2348	20 23.0	+54.22	58	+ 9	7.2	B3e
346...	195407	4095	20 26.0	+36 39	44	− 2	7.7	B3e
347...	195592	3630	20 27.2	+43 59	50	+ 2	7.2	B1se
348...	195907	4126	20 29.0	+31 19	40	− 6	7.6	B2e
349...	....	MW 203	20 29.2	+40 19	47	0	*13.2*	Bep
350...	196712	5328	20 34.0	− 2 46	12	−26	6.3	B9e
351...	197345	α Cyg	20 38.0	+44 55	52	+ 1	1.3	A2seα
352...	198183	λ Cyg	20 43.5	+36 7	46	− 5	4.5	B6e
353...	198478	3291	20 45.5	+45 45	53	+ 1	4.9	B2seα
354...	198512	2495	20 45.7	+53 32	59	+ 6	8.0	B2ne
355...	198895	*2429*	20 48.4	+55 7	61	+ 7	8.3	B2e
356...	199218	4354	20 50.7	+40 20	50	− 3	6.5	B5ne
357...	199356	4368	20 51.6	+39 55	50	− 4	7.0	B3ne
358...	199478	*3111*	20 52.4	+47 2	55	+ 1	5.8	B8seα
359...	200120	f^1 Cyg	20 56.4	+47 8	56	0	4.9	B3ne
360...	200310	60 Cyg	20 57.6	+45 46	55	− 1	5.2	B3ne

1933ApJ....78...87M

TABLE I—*Continued*

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	l	b	Mag.	Type
361...	200775	1283	21h 0m4	+67° 47′	71°	+14°	7.2	B5e
362...	201522	3198	21 5.1	+46 51	57	− 1	7.8	B3ne
363...	201733	*3718*	21 6.4	+45 6	56	− 2	6.5	B5e
364...	202904	υ Cyg	21 13.8	+34 29	49	−11	4.4	B3ne
365...	203025	*2309*	21 14.6	+58 10	66	+ 6	6.4	B3e
366...	203374	2112	21 16.7	+61 25	68	+ 8	6.6	B0ne
367...	203467	6 Cep	21 17.3	+64 27	70	+10	5.2	B3ne
368...	203699	4692	21 18.8	+13 37	34	−26	6.7	B5e
369...	203731	4503	21 19.0	+40 16	54	− 7	7.4	B3ne
370...	204722	3941	21 25.5	+43 54	57	− 5	7.5	B3ne
371...	205060	4123	21 27.7	+42 16	56	− 7	7.1	B5(n)e
372...	239703	*2289*	21 31.5	+59 1	68	+ 5	9.0	B(3)ne
373...	205637	ε Cap	21 31.5	−19 54	0	−46	4.7	B5pe
374...	....	3487	21 32.2	+47 28	60	− 4	9.1	B3eq
375...	235565	*3384*	21 34.3	+51 3	63	− 1	8.8	B2ne
376...	206773	2374	21 39.3	+57 17	67	+ 3	7.0	B0ne
377...	207232	3430	21 42.4	+50 12	63	− 2	7.0	B8ne
378...	207329	3144	21 43.1	+51 39	64	− 1	7.4	B2e
379...	207757	*4673*	21 46.2	+12 9	38	−32	7.6v	Bep
380...	208392	*2216*	21 50.9	+62 8	72	+ 6	7.1	B3ne
381...	208682	1607	21 52.9	+64 52	73	+ 8	5.8	B3ne
382...	235683	3211	21 55.6	+51 55	66	− 2	9.0	B3e
383...	209296	2676	21 57.2	+56 14	69	+ 1	8.1	B(5)e
384...	209409	o Aqr	21 58.1	− 2 38	26	−44	4.7	B6ne
385...	210129	25 Peg	22 3.1	+21 13	48	−28	5.7	B8ne
386...	212044	3341	22 16.4	+51 21	68	− 5	7.1	B2e
387...	212076	31 Peg	22 16.6	+11 42	44	−37	4.9	B3e
388...	212571	π Aqr	22 20.2	+ 0 52	35	−46	4.6	B1ne
389...	213088	3213	22 23.9	+52 28	70	− 4	8.2	B8ne
390...	214168	8 Lac	22 31.4	+39 7	64	−16	5.8	B3ne
391...	214197	RZ Lac	22 31.6	+52 14	71	− 5	9 v	B9e
392...	214748	ε PsA	22 35.1	−27 34	353	−62	4.2	B8eα
393...	216057	2993	22 44.6	+53 53	73	− 4	6.1	B8ne
394...	217050	*3985*	22 52.7	+48 9	72	−10	5.2	B3ne
395...	217543	*4744*	22 56.3	+38 10	69	−20	6.4	B3ne
396...	217891	β Psc	22 58.8	+ 3 17	48	−50	4.6	B5e
397...	218393	4045	23 2.6	+49 40	74	− 9	6.8	Ave
398...	220058	2942	23 15.7	+55 15	78	− 5	8.5	B(1)ne
399...	220116	2724	23 16.1	+57 43	79	− 2	8.8	B5ne
400...	....	Comp R Aqr	23 38.6	−15 50	37	−71	9 v	Pec.
401...	223387	3094	23 44.0	+56 40	82	− 5	9.2	B(0)ne
402...	223501	2537	23 45.0	+61 39	84	0	8.2	B3e
403...	223960	2636	23 48.9	+60 18	84	− 1	7.0	A0seα
404...	224055	2562	23 49.7	+61 17	84	0	7.2	B2seα
405...	224424	*2676*	23 52.7	+59 9	84	− 2	7.8	B0seα
406...	224544	5012	23 53.7	+31 48	79	−29	6.4	B5ne
407...	224559	4381	23 53.8	+45 52	82	−15	6.5	B3ne
408...	225094	*2356*	23 58.3	+63 5	85	+ 1	6.3	B2seα
409...	225095	*3103*	23 58.3	+55 0	84	− 7	7.6	B1e
410...	225160	2585	23 58.9	+61 40	85	0	8.6	O8eα

TABLE II

STARS WITH PECULIAR SPECTRA HAVING DARK *TiO* BANDS AND BRIGHT λ 4686 (*He* II)

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	*l*	*b*	Mag.
411	....	AX Per	$1^h30^m.0$	$+53°45'$	97	− 8	*11.0*
412	117970	RW Hya	13 28.8	−24 53	284	+36	*10* v
413	143454	T CrB	15 55.3	+26 13	9	+47	Nova
414	162214	RS Oph	17 44.8	− 6 40	348	+ 9	Nova
415	....	CI Cyg	19 46.5	+35 26	39	+ 4	*11.0*
416	221650	Z And	23 28.8	+48 16	78	−12	10 v

NOTES TO TABLES I AND II

The following notes, in addition to recording unpublished data, indicate the chief features of a few of the more interesting peculiar spectra.

MWC

1. H.D. 108. This is the only star in Table I in whose spectrum we have noticed emission at λλ 4634, 4640, and 4686. These bright lines are the features for which the Victoria observers have recently used the suffix "f." The bright hydrogen lines, however, are well marked and not greatly different from those found in certain Be stars. The classification symbol might be O6fe.

2. H.D. 144. Not previously announced. On a grating spectrogram (dispersion 66 A per millimeter) taken at Mount Wilson on September 18, 1932, $H\alpha$ appears as an emission line of low intensity centrally superposed on broad absorption. A bright $H\alpha$ had been suspected on an objective-prism plate taken September 20, 1925.

9. H.D. 5394, γ Cassiopeiae. Material published prior to 1915 given in reference 32 is omitted from Table I. A slit spectrogram taken at Lowell Observatory on November 27, 1912, and forwarded to us through the courtesy of Dr. V. M. Slipher shows well-marked bright lines at $H\beta$, $H\gamma$, and $H\delta$. Dr. Dean B. McLaughlin writes that plates taken at the Observatory of the University of Michigan during the fall of 1932 show the violet emission components of $H\beta$ and $H\gamma$ to be definitely more intense than the red components.

13. H.D. 9105. The bright lines seem to have disappeared since the Harvard observations were made.

16. H.D. 10516, ϕ Persei. Material published prior to 1913 given in reference 2 is omitted from Table I.

17. M.W. 101. The bright lines are extraordinarily intense and include forbidden lines of ionized iron as in η Carinae. The nebular line λ 4658 also is bright.

31. H.D. 13854. Not previously announced. On a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on October 12, 1932, $H\alpha$ appears as an emission line of low intensity centrally superposed on weak absorption.

32. H.D. 14134, Boss 519. The companion star H.D. 14143, B1s, probably has emission at $H\alpha$; a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on October 13, 1932, shows an indistinct bright component, but we do not

NOTES TO TABLES I AND II—*Continued*

MWC

consider it sufficiently well marked to justify the inclusion of the star in the catalogue.

35. Companion to *o* Ceti (H.D. 14386). Irregular variable, magnitude 10–11. Approximately 0″.8 from the long-period variable *o* Ceti; position angle 130°.

45. H.D. 14818, 10 Persei. Not previously announced. A bright $H\alpha$ of low intensity was detected by O. C. Wilson, Jr., on one-prism slit spectrograms taken at Mount Wilson on September 19 and October 13, 1932. The observation was confirmed by a grating spectrogram (dispersion 34 A per millimeter) taken December 16, 1932.

49. H.D. 15472. The description by Adams and Joy in reference 55 refers to slit spectrograms taken at Mount Wilson on September 19, 22, and 25, 1915. The spectrum appears to be essentially the same on a low-dispersion plate taken August 29, 1923.

65. H.D. 20336, H.R. 985. Some doubt exists concerning the actual discoverer of bright lines in the spectrum of this star. W. W. Campbell's paper dated June 28, 1894 (undoubtedly a typographical error; 1895 probably is correct), printed in the *Astrophysical Journal* for October, 1895, gives a list of Be stars "possibly all, ... , up to January, 1895," with the statement that unless otherwise specified $H\beta$ had been observed to be bright by the Harvard College observers. This star, B.D.+65°340, is in the list and is not otherwise specified, implying that $H\beta$ was observed to be bright by Harvard prior to January, 1895. In *Harvard Annals*, **56**, 182 (Table IV), 1912, however, the discoverer is stated to be Espin, 1896 (*Astronomische Nachrichten*, **140**, 243, 1896). This reference gives Espin's observation as follows: "1895, Sept. 22. F bright?" A detailed account of Espin's observation, quoted by Lockyer (*Monthly Notices of the Royal Astronomical Society*, **91**, 225, 1930), shows Espin's discovery to have been independent, but does not explain the presence of the star on Campbell's observing program at an earlier date.

69. H.D. 22192, ψ Persei. The spectrograms from which Adams determined the radial velocity of this star (*Mt. Wilson Contr.*, No. 105; *Astrophysical Journal*, **42**, 172, 1915) were taken at Mount Wilson on January 10, 11, 16, 17, 1911, and October 20, 1912. $H\beta$ is a distinct double bright line superposed on diffuse absorption. At $H\gamma$ the bright portions appear as fringes to a well-marked central core. In both lines the two bright components have approximately equal intensities. Their measured separations are: $H\beta$, 3.1 A; $H\gamma$, 2.5 A.

73. H.D. 23480, Merope, 23 Tauri. On slit spectrograms taken at Mount Wilson on December 7, 1916, and February 28, 1917, $H\beta$ appears as a diffuse absorption line on which there may be superposed two bright components of extremely low intensity.

74. H.D. 23630, Alcyone, η Tauri. On slit spectrograms taken at Mount Wilson on December 7, 1916, and February 28, 1917, $H\beta$ appears as a broad absorption line within which incipient emission is barely visible. The emission may be double with components of nearly equal intensity.

75. H.D. 23862, Pleione, 28 Tauri. The bright lines seem to have disappeared since the time of the early Harvard observations.

NOTES TO TABLES I AND II—*Continued*

MWC

77. H.D. 24479. The absorption lines of hydrogen and helium are diffuse, but λ 4481 *Mg* II is much better defined.
78. H.D. 24534, X Persei. Variable of the R Coronae type. Magnitude 6–7. D. B. McLaughlin writes that a spectrogram taken at Ann Arbor 1932.8 shows $V/R=1.4$, indicating that the relative intensities of the emission components have been changing in the same direction since 1930.
81. H.D. 25940, c Persei. Moderately strong emission, possibly double but not clearly resolved, appears at $H\beta$ on slit spectrograms taken at Mount Wilson on January 7, 10, 19, 1911, and January 27, 1912. At $H\gamma$, emission of lower intensity is visible; on the last plate, which is the best of the series, it is clearly double, the separation being about 2.2 A.
84. M.W. 143. The bright lines of hydrogen are very intense, and in addition lines of neutral helium and ionized iron are bright.
93. H.D. 31293, AB Aurigae. Variable of the R Coronae type. Magnitude *7.2–8.4*. The cores of the hydrogen lines change their positions independently of the wings.
95. H.D. 32256. It is not certain that this object should be included in the *Catalogue*. Remark in the *Henry Draper Catalogue:* "The continuous spectrum is strong and several bright lines are distinctly seen, two of which are $H\beta$ and $H\gamma$. The spectrum may belong to the P Cygni Class."
96. H.D. 32343, 11 Camelopardalis. Narrow emission lines of considerable strength are present at $H\beta$ and $H\gamma$ on slit spectrograms taken at Mount Wilson on January 11, March 17, December 14, 1911; November 26, December 23, 1912; January 24, 1913; and March 9, 1914.
97. H.D. 32763. It is not certain that this object should be included in the *Catalogue*. Remark in the *Henry Draper Catalogue:* "This spectrum contains bright hydrogen lines, but the image is too faint and indistinct to determine its true nature."
98. H.D. 32991, 105 Tauri. $H\beta$ appears as a fairly narrow bright line of moderate intensity on slit spectrograms taken at Mount Wilson on February 11, March 6 and 7, 1914; January 2, December 21, 1915; and November 2, 1917. Incipient emission appears at $H\gamma$ on the best plates.
99. H.D. 33152. The bright lines are unusually narrow.
100. H.D. 33232. The spectrum is somewhat peculiar, and the type appears to vary. The cores of the hydrogen lines are strong and well defined; their displacements, which are correlated with the behavior of the bright components, appear to vary in a period of more than ten years. The star is under investigation at Mount Wilson.
102. H.D. 33540. See remark in *Harvard Bulletin*, No. 891, p. 4, quoted in a footnote to Table VII.
108. H.D. 35343, S Doradus. Irregular variable, magnitude *8.2–9.8*. In the Greater Magellanic Cloud; spectrum of the P Cygni type. Said by H. Shapley to be "probably the most luminous star now [March 18, 1925] known."
109. H.D. 35345. The bright hydrogen lines are unusually narrow and well defined.
114. H.D. 37115. Brighter component of A.D.S. 4202. The spectral type of the ninth-magnitude companion (P.A. 180°; Sep. 1″) is A0.
115. H.D. 37202, ζ Tauri. Bright lines were apparently first noticed by V. M. Slipher on slit spectrograms taken at the Lowell Observatory in 1912. Excellent nega-

NOTES TO TABLES I AND II—*Continued*

MWC

tives taken November 14 and 18, 1912, were forwarded to us through the courtesy of Dr. Slipher. Emission is plainly visible on the violet edge of $H\beta$, and less distinctly on the red edge. The violet edge of $H\gamma$ is faintly bright. It is well known that the ultra-violet members of the Balmer series are remarkably strong and well-defined dark lines. Thirty members of the series, including m=32, have been measured by Miss Losh on spectrograms taken at Ann Arbor.

137. M.W. 229. The bright hydrogen lines are extraordinarily intense. The type is uncertain.

140. H.D. 45314. D3 (helium) is bright on a grating spectrogram (dispersion 66 A per millimeter) taken at Mount Wilson on January 7, 1933.

142. H.D. 45677. The spectrum is very peculiar and interesting. In addition to the lines of hydrogen and ionized iron (normal and forbidden), the nebular lines λ 4068 [*S* II] and λλ 6300, 6363 [*O* I] are bright.

143, 144. H.D. 45725, 7; β Monocerotis. The following approximate data concerning this well-known triple star are taken from Aitken's *Double Star Catalogue:*

	P.A.	Dist.	Mag.
AB	132°	7″3	5.0–5.5
BC	105	2.8	5.5–6.0

All observers agree that the spectra of the preceding and following components have emission lines, but some doubt exists in regard to the intermediate star, B, concerning which Frost, Barrett, and Struve (*Astrophysical Journal*, **64**, 24, 1926) say: "The hydrogen lines show two bright components of small intensity. The red component is stronger than the violet." O. Struve (*ibid.*, **73**, 98, 1931) says of bright $H\beta$, "Narrow double." Struve writes that both these notes refer to a plate taken by Professor Frost on November 13, 1905. D. B. McLaughlin (*Publications of the Observatory of the University of Michigan*, **4**, 183, 1932) says: "All three components of this visual triple are emission-line stars. . . . . When a spectrogram is being taken the separation of the images of the two fainter components, β^2 and β^3, on the slit of the spectrograph is approximately one-half the length of the slit as usually employed. As the position angle is close to 90°, it is possible to take the spectra of these two stars simultaneously, and with careful guiding and good seeing the spectra appear with little or no overlapping. Three such spectrograms have been taken, in October, 1928; October, 1930; and November, 1931. . . . . β^2 has double emission at $H\beta$ with a width of about 7.5 A and a central absorption line somewhat stronger and wider than that of β^3." The question is whether the bright lines which have been seen in the spectrum of the intermediate component are inherent in its light or whether the appearance has been caused by the partial overlapping of the light of the following component. A plate was taken at Mount Wilson on January 28, 1926, with the intermediate and following components on the slit according to the method mentioned by McLaughlin. $H\beta$ is definitely bright in the spectrum of the following component, but probably not in that of the intermediate component, although a very slight defect in the emulsion makes it impossible to be absolutely certain on this point. The hydrogen absorption seems considerably stronger in the intermediate component. At our request Dr. Struve and Dr. McLaughlin have reviewed their observations of this star. Both report their continued impression that the bright line in the intermediate com-

NOTES TO TABLES I AND II—*Continued*

MWC

ponent may be real, but agree that for the time being the star should be omitted from the catalogue.

The best test of the real existence of bright components at $H\beta$ is the presence of a stronger bright line at $H\alpha$, and here all available evidence is negative. Campbell (*Astrophysical Journal*, **2**, 180 n., 1895) says: "The intermediate star does not show a bright $H\alpha$ line." Merrill (*Lick Observatory Bulletin*, **7**, 169, 1913) says: "1912, October 6.02, no indication of a bright line at $H\alpha$." On a plate taken at Mount Wilson on October 14, 1932, with the grating spectrograph (dispersion 34 A per millimeter), $H\alpha$ is an absorption line near its normal position apparently without emission components.

The intermediate component has therefore been omitted from the catalogue pending confirmation of the evidence of bright lines in its spectrum. The type of the intermediate component is B2 or B3. The absorption lines of H and He are more intense than in the spectrum of the following component.

145. H.D. 45910. The structure of the hydrogen lines is very remarkable and is subject to variation as are also other features of the spectrum.

146. H.D. 45995, A.D.S. 5153. P.A. 4°; Sep. 16″. The spectral type of the eighth-magnitude companion is A0.

147. H.D. 259431, B.D.+10°1172, N.G.C. 2247. Fourteen slit spectrograms taken at Mount Wilson during the years 1920–1928 are described by R. F. Sanford as follows: "The classification is uncertain. Neither helium nor λ 4481 of magnesium is at all conspicuous. Double bright lines appear at $H\beta$ and $H\gamma$, and there is some evidence of variability in their intensity."

151. R Monocerotis. In N.G.C. 2261. Irregular variable, possibly of the R Coronae type. Magnitude 9–14.

158. H.D. 50138. The violet component of the double bright $H\beta$ line exhibits extraordinary variations of intensity.

165. H.D. 53179, Z Canis Majoris. Variable of the R Coronae type. Magnitude 8.4–11.5. The behavior of this spectrum, which has numerous lines of iron and titanium, resembles, in a measure, that of the "iron star," XX Ophiuchi, H.D. 161114.

166. H.D. 53367. A bright line of low intensity is seen at $H\beta$ on slit spectrograms taken at Mount Wilson on December 29 and 30, 1920, and February 26, 1921.

169. H.D. 55271, A.D.S. 5863. P.A. 233°; Sep. 13″. The spectral type of the eighth-magnitude companion is A0.

170. H.D. 56014, 27 Canis Majoris. O. Struve has shown that if the displacements of dark lines are caused by orbital motion, the minimum total mass of the whole system is approximately two thousand times the mass of the sun. Referring to three slit spectrograms of the blue-violet region taken at Mount Wilson on December 7 and 8, 1927, R. F Sanford says: "Emission, if present, consists of very weak red components." On a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on December 17, 1932, the dark core of $H\alpha$ has a positive displacement. Conspicuous emission occurs on its violet side; on the other side the emission is much less intense.

173. H.D. 57150, v^1 Puppis. A slit spectrogram taken at Mount Wilson on October 30, 1922, shows fairly narrow bright lines diminishing in intensity from $H\beta$ to $H\epsilon$.

NOTES TO TABLES I AND II—*Continued*

MWC

177. H.D. 58343. Dr. F. C. Jordan writes that bright lines were first photographed at Allegheny Observatory in 1908. Fairly strong lines were seen at $H\beta$ and $H\gamma$ on slit spectrograms taken December 28, 1908; March 1, 5, 15, 1910; December 28, 1911; February 23, December 12, 1912; February 21, 1914. On some of these plates bright $H\delta$ and $H\epsilon$ also appeared. On January 27, 1912, however, the emission appeared to have been weaker, as it was then barely visible, although the exposure was moderately strong. On a slit spectrogram taken at Lick Observatory on November 29, 1912, emission at $H\alpha$ and $H\beta$ was well marked. Slit spectrograms taken at Mount Wilson on December 23, 1910; January 19, February 11, 1911; and December 26, 1912, show $H\beta$ and $H\gamma$ as conspicuous narrow bright lines superposed on broad absorption.
178. H.D. 58715, β Canis Minoris. $H\alpha$ is a conspicuous double bright line on grating spectrograms taken at Mount Wilson on February 15, 1930, and March 24, 1932.
197. H.D. 83953, I Hydrae. A bright line of moderate intensity is seen at $H\beta$ on a slit spectrogram taken at Mount Wilson on February 22, 1926.
214. H.D. 93308, η Carinae, Nova Carinae No. 1. The spectrum is very peculiar and interesting. The forbidden lines of ionized iron are very strong.
221. H.D. 107348, ζ Corvi. Not previously announced. Mr. O. C. Wilson, Jr., found a bright $H\alpha$ line on a one-prism slit spectrogram taken at Mount Wilson on May 12, 1932. Re-examination of a slit spectrogram taken June 1, 1912, shows a weak double bright line at $H\beta$.
229. H.D. 120324, μ Centauri. This star offers a most striking example of changing intensities of the hydrogen lines. R. H. Curtiss summarized the early observations as follows: "Apparently the strong emission of the nineties was distinct in 1904, evanescent in 1912, and non-existent in 1918." For several years after 1918 the bright lines were absent or of low intensity. Grating spectrograms taken at Mount Wilson on June 20, 1929; February 14, 1930; May 6, 1931; and February 27, 1932, show $H\alpha$ to be a conspicuous bright line, apparently gradually increasing in intensity.
237. H.D. 138749, θ Coronae Borealis. A grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on May 5, 1931, shows $H\alpha$ as a wide, diffuse absorption line. One-prism slit spectrograms taken at Mount Wilson by O. C. Wilson, Jr., on February 26 and June 13, 1932, show $H\alpha$ and $H\beta$ as strong absorption lines without visible emission.
239. H.D. 142983. The spectrum is peculiar and may vary. The structure of $H\alpha$ is interesting. Remark in the *Henry Draper Catalogue:* "The spectrum is peculiar in combining sharply defined hydrogen lines with wide and ill-defined helium lines. In this respect it resembles the spectrum of ϵ Capricorni."
241. H.D. 148184, χ Ophiuchi. The bright hydrogen lines are unusually narrow.
251. H.D. 154450. The bright hydrogen lines are unusually narrow and sharp.
263. H.D. 160095. This star may belong to that small group of Be stars which have α Cygni lines of variable intensity.
265. RT Serpentis. The spectrum of this nova-like variable has undergone extraordinary changes. In 1928 the forbidden lines of ionized iron were outstanding.
266. H.D. 160529. On the slit spectrograms taken at Mount Wilson the α Cygni lines are very strong.

NOTES TO TABLES I AND II—*Continued*

MWC

269. H.D. 161114, XX Ophiuchi. Variable of the R Coronae type. Magnitude *9.6–10.7*. The "iron star." The spectrum is peculiar and variable.
270. M.W. 174. The bright hydrogen lines are very intense.
272. M.W. 54, D.M. $-27°11944$. The lines exhibit the P Cygni characteristics in a very marked degree. The spectrum may be said to be intermediate between that of P Cygni and of a typical nova.
275. H.D. 163296. The cores of the hydrogen lines probably change their positions independently of the wings. The behavior apparently resembles that of H.D. 31293.
279. H.D. 164447. Not previously announced. A description of the spectrum will be published by G. Shajn in the *Circulars* of the Poulkovo Observatory.
280. H.D. 164906. In N.G.C. 6523 = M 8.
292. H.D. 168957. Slit spectrograms taken at Victoria on May 20, 1924, and April 24, 1925, and forwarded to us through the courtesy of Dr. J. A. Pearce show a narrow emission component of low intensity superposed nearly centrally on broad absorption at $H\beta$ and $H\gamma$. Dr. C. S. Beals writes that a plate taken by him on May 14, 1932, shows no indication of emission lines.
293. H.D. 169226. On a slit spectrogram taken at Mount Wilson on July 20, 1924, the line $H\beta$ appears to be of the P Cygni type.
294. H.D. 169454. The spectrum is notable for the prominence of dark lines of ionized oxygen. $H\alpha$ and $H\beta$ have, to a certain extent, the P Cygni characteristics. They may be variable in structure and intensity.
295. H.D. 169515, RY Scuti. Irregular variable. Magnitude *8.3–9.2*. The nebular line λ 4658 is bright.
300. M.W. 182. The forbidden lines of neutral oxygen $\lambda\lambda$ 6300, 6363 are bright.
303. H.D. 172694. The absorption spectrum is peculiar. The dark line λ 4471 *He* is unusually strong and well defined.
306. H.D. 174638, 9; β Lyrae. Eclipsing variable. Period 12.9 days. Magnitude 3.4–4.1. The spectrum is very peculiar and varies with the light-phase. Material published prior to 1911 given in reference 1 is omitted from Table I.
311. H.D. 178175. Forty-nine slit spectrograms taken at Mount Wilson during the years 1912–1929 are described by R. F. Sanford as follows: "Double emission components of the hydrogen lines vary from slightly stronger than the adjacent continuous spectrum to an intensity so low that the effect upon the absorption line is nearly negligible."
313. H.D. 181615, 6; υ Sagittarii. The spectrum is peculiar and variable.
314. M.W. 74, B.D. $+14°3887$. The bright hydrogen lines are unusually strong and narrow. Eight or ten enhanced lines of iron are bright.
315. M.W. 187. The bright hydrogen lines are very intense. The decrement in intensity from $H\beta$ to $H\zeta$ appears to be unusually small.
316. M.W. 75, B.D. $+22°3687$, βG.C. 9287. P.A. 138°, Sep. 16″. The spectral type of the tenth-magnitude companion is A(0).
317. H.D. 183143. This star is remarkable for its large color excess.
319. H.D. 184279. The dark line λ 4471 *He* is unusually intense.
325. H.D. 190073. This star has a most peculiar spectrum. The sodium lines D1,2 are bright, and the structure of the H and K lines is very remarkable.

NOTES TO TABLES I AND II—*Continued*

MWC

331. H.D. 192044, 20 Vulpeculae. On slit spectrograms taken at Mount Wilson on July 7, 10, 13, 18 and October 6, 7, 1911, $H\beta$ consists of a broad absorption line on which are symmetrically superposed two faint emission components (separation approximately 3.7 A) of nearly equal intensity. Their distinctness varies on different plates and the changes may be intrinsic.

335. H.D. 192954. Not previously announced. $H\alpha$ was suspected to be bright on an objective-prism photograph taken at Mount Wilson on July 12, 1929. M. L. Humason noticed, independently, that $H\beta$ appeared to have weak bright edges on a slit spectrogram taken August 3, 1930. The presence of bright lines was definitely established by a slit spectrogram taken November 15, 1932, which shows $H\alpha$ as a strong bright line. The decrease from the intensity of emission at $H\alpha$ to that at $H\beta$ is remarkably great. The absorption lines are well defined.

338. H.D. 193237, P Cygni, Nova Cygni 1600. In the spectrum of this star, which serves as a prototype for a group of peculiar spectra, strong bright lines in approximately their normal positions are accompanied by dark companions on their violet edges.

341. H.D. 193911, 25 Vulpeculae. Slit spectrograms taken at Mount Wilson on August 10, 16, 17, 1911; July 30, October 19, November 25, 1912; and August 23, 1921, show $H\beta$ as a fairly strong absorption line on which is centrally superposed a bright line of moderate intensity. On the best plates the bright line has the appearance of an unresolved double with components of nearly equal intensity.

347. H.D. 195592. The dark helium line λ 4471 is unusually strong.

349. M.W. 203. In addition to bright lines of hydrogen and neutral helium, the nebular line λ 4658 is bright.

350. H.D. 196712. A description of the spectrum will be published by G. Shajn in the *Circulars* of the Poulkovo Observatory.

351. H.D. 197345, α Cygni. $H\alpha$ consists of a displaced dark line with emission on the long wave-length edge. The normal position of $H\alpha$ lies between the effective centers of the bright and dark components. Articles referring to the presence of emission are the only ones included in the bibliography. O. Struve states that observations made at the Perkins Observatory in December, 1932, show the $H\alpha$ line in β Orionis, cB8, to be peculiar, apparently resembling the same line in α Cygni (*Astrophysical Journal*, **77**, 67, 1933).

352. H.D. 198183, λ Cygni. A slit spectrogram taken at Mount Wilson on September 20, 1926, shows $H\beta$ to be a broad absorption line with a narrow bright component of low intensity superposed nearly centrally. $H\gamma$, $H\delta$, and $H\epsilon$ appear wholly dark. On a grating spectrogram (dispersion 66 A per millimeter) taken August 1, 1928, $H\alpha$ is a clearly marked bright line, although of moderate intensity, superposed on broad weak absorption. Another grating plate (dispersion 34 A per millimeter) taken May 5, 1931, shows $H\alpha$ to be a weak absorption line without definite bright components. The intensity of the bright component is certainly less on the later date.

353. H.D. 198478, 55 Cygni. On a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on August 18, 1932, $H\alpha$ appears as an emission line of very low intensity with a dark companion on its violet edge.

NOTES TO TABLES I AND II—*Continued*

MWC

358. H.D. 199478. Slit spectrograms taken at Mount Wilson on July 8, 1911; July 25, August 21, October 31, 1912; and October 13, 1930, show slight variations in the appearance of $H\beta$.

360. H.D. 200310, 60 Cygni. Slit spectrograms were taken at Mount Wilson on July 10, 1911; July 26, August 25, September 18, 1912; October 3, 1917. On the last plate, $H\beta$ has two bright components (separation 5.1 A) of low and nearly equal intensity. They may be faintly present on the first plate but cannot be seen on the 1912 plates.

361. H.D. 200775, N.G.C. 7023. About forty slit spectrograms taken at Mount Wilson during the years 1920–1929 are described by R. F. Sanford as follows: "$H\beta$ appears to have two emission components of approximately equal intensity. The profile of $H\gamma$ points to a similarity in its structure."

368. H.D. 203699. On slit spectrograms taken at Mount Wilson on September 26, October 23, November 16, 1912; October 18, 19, 1921, $H\beta$ is a rather narrow bright line superposed on broad absorption. $H\gamma$ is hazy as if partly neutralized by emission, but bright components are not clearly seen.

373. H.D. 205637, ϵ Capricorni. The spectrum is peculiar and variable.

379. H.D. 207757, B.D.$+11^\circ$4673, AG Pegasi. Irregular variable. Magnitude 6.3–7.7. The spectrum is very peculiar and interesting. Prior to 1920 the helium lines were dark; since then they have been bright with dark borders on the violet edge. Lines of various elements exhibit variable displacements which have a common period of eight hundred days but differ in phase, amplitude, and "center-of-mass" velocity.

381. H.D. 208682. Slit spectrograms taken at Victoria on July 26, August 28, November 25, 1919, and forwarded to us through the courtesy of Dr. J. A. Pearce show at $H\beta$ two weak bright lines superposed on broad absorption. Traces of emission are visible at $H\gamma$ also. On slit spectrograms taken at Mount Wilson on August 5, 1922; August 18, September 20, October 22, November 20, 1923; July 21, September 14, 1926, the bright components are absent or extremely weak, and the dark hydrogen lines appear more intense than on the Victoria plates.

385. H.D. 210129, 25 Pegasi. Slit spectrograms taken at Mount Wilson on October 12, November 1, December 13, 1911, show $H\beta$ to be a bright line of moderate width and intensity (probably an unresolved double) superposed on wider absorption. Incipient emission is probably present within the broad absorption at $H\gamma$.

390. H.D. 214168, 8 Lacertae; northern and brighter component, A.D.S. 16095. P.A. 186°; Sep. 22″. The spectral type of the fainter component is B2; the dark lines are stronger and narrower than in the northern component. On slit spectrograms of the northern component taken at Mount Wilson on August 11, 14, 17 and October 7, 1911; September 20, 1926, ill-defined emission of low intensity is present at $H\beta$; $H\gamma$ is nearly neutral. Dr. Dean B. McLaughlin writes that two slit spectrograms taken at Ann Arbor 1932.8 show V/R to be 1.3, and that the change in the relative intensity of the emission components has been continuing in the same direction since 1930.

391. H.D. 214197, RZ Lacertae. Irregular variable. Magnitude 8.6–9.2. Near Nova Lacertae 1910. Not previously announced. Bright lines were discovered by R. F. Sanford on slit spectrograms taken at Mount Wilson. Six plates taken during the years 1926–1929 are described by Dr. Sanford as follows: "A weak emission line

NOTES TO TABLES I AND II—*Continued*

MWC

appears centrally upon the absorption line $H\beta$. Some plates also show similar structure for $H\gamma$."

397. H.D. 218393. The spectrum has α Cygni lines of variable intensity. Mr. W. E. Harper writes that 6 slit spectrograms were taken at Victoria between September 23, 1931, and October 1, 1932. The mean velocity from the hydrogen absorption, H and K, λ 4481, and enhanced lines, including some rather widely discordant values, is −18 km/sec.; from helium λ 4471, −110 km/sec. "Emission seems to be present for the hydrogen lines, largely the redward component."

400. Companion to R Aquarii (H.D. 222800). Irregular variable. Magnitude 8–10. The position of this star appears to be identical with that of the long-period variable R Aquarii. The spectrum is peculiar and variable to a remarkable extent.

403. H.D. 223960. On a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on August 20, 1932, $H\alpha$ appears as a narrow dark line displaced toward the violet; emission is not clearly seen and is less intense than on October 12, 1929.

404. H.D. 224055. Classified Bo by Harvard, B8s by Victoria. Perhaps the spectrum changes.

405. H.D. 224424. Not previously announced. An emission line of low intensity is seen at $H\alpha$ on a grating spectrogram (dispersion 66 A per millimeter) taken at Mount Wilson on September 19, 1932.

406. H.D. 224544. $H\alpha$ is an intense bright line on a grating spectrogram (dispersion 34 A per millimeter) taken at Mount Wilson on September 16, 1932.

410. H.D. 225160. It is not certain that the characteristics of the Balmer lines are those typical of Be stars. They may resemble those of late O-type spectra in which bright lines of low intensity are seen at $\lambda\lambda$ 4634, 4640, 4686. As these bright lines are not definitely seen in this spectrum, however, the classification symbol "e" is used and the star is included in Table I.

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The bibliography lists references that give observational material concerning the objects in Tables I and II. Our intention has been to make it complete for spectroscopic observations; lists of data concerning magnitude, position, proper motion, and parallax have not been included. A few selected references to the light-curves of variable stars have, however, been added. Several references to the discovery of variable radial velocity were omitted because they are found in Moore's *Third Catalogue of Spectroscopic Binary Stars* (ref. 267). The tables and notes in the *Revised Harvard Photometry* and in the monumental *Henry Draper Catalogue* include data for many Be stars and should be consulted as a matter of course. These catalogues are mentioned at the beginning of the bibliography, but specific references to them are omitted from the key.

Publications included in the bibliography are arranged alphabetically either by author, by title of periodical, or, in case of observatory publications, by location of the observatory; under each publication the order of entries is chronological.

TABLE III

REFERENCES TO BE STARS

Before 1870	2	1900–1909	24
1870–1879	2	1910–1919	71
1880–1889	1	1920–1929	150
1890–1899	37	1930–1932	73

The total number of references to published material is 364. Two unnumbered references precede the 363 numbered items, while No. 49 refers to unpublished material. The increase during recent years in the frequency of appearance is shown by Table III.

KEY TO BIBLIOGRAPHY

The following section lists for each star of Tables I and II those items of the bibliography (p. 114) that contain information concerning its spectrum or light-curve. The numbers in bold-face type are the current numbers of the stars in the *Catalogue*, Tables I and II.

1 59, 275, 280, 295, 323, 354, 362 **2** 274, 275 **3** 295 **4** 59, 275, 280, 295, 339 **5** 295 **6** 70, 280, 295 **7** 95, 109, 110, 114, 140, 145, 150, 157, 158, 161, 166, 267, 270, 274, 275, 305, 307, 312, 361, 362 **8** 95, 145, 158, 239, 274, 275, 308, 361, 362 **9** 32, 38, 39, 40, 47, 87, 107, 117, 118, 145, 152, 155, 158, 161, 165, 167, 169, 176, 183, 201, 267, 270, 274, 275, 279, 280, 284, 295, 302, 310, 313, 316, 321, 324, 325, 326, 329, 331, 337, 343, 353, 362 **10** 295 **11** 295 **12** 59, 275, 280, 295, 362 **13** 66, 275, 280, 295, 323, 354, 361, 362 **14** 63, 280, 295 **15** 295 **16** 2, 38, 40, 43, 47, 49, 87, 109, 111, 112, 145, 155, 161, 165, 180, 183, 257, 267, 270, 274, 275, 280, 284, 295, 310, 324, 326, 327, 334, 341, 353, 362 **17** 295 **18** 295 **19** 63, 280, 295 **20** 295 **21** 275, 295, 362 **22** 295 **23** 295 **24** 295 **25** 295 **26** 59, 280, 295 **27** 295 **28** 295 **29** 295 **30** 295 **31** 50, 275 **32** 50, 275, 295, 361, 362 **33** 295 **34** 295 **35** 12, 13, 57, 60, 73, 76, 77, 161, 192, 282, 284, 291 **36** 85 **37** 230 **38** 85 **39** 85 **40** 85, 295 **41** 295 **42** 295 **43** 295 **44** 295 **45** 275, 338 **46** 295 **47** 295 **48** 230, 280, 295 **49** 55 **50** 295 **51** 295 **52** 295 **53** 295 **54** 295 **55** 295 **56** 295 **57** 295 **58** 295 **59** 295 **60** 295 **61** 58, 59, 275, 280, 295, 361, 362 **62** 295 **63** 295 **64** 295 **65** 7, 17, 20, 35, 38, 46, 47, 58, 106, 114, 128, 145, 155, 161, 165, 168, 172, 180, 239, 257, 267, 275, 280, 284, 295, 310, 312, 324, 326, 328, 334, 353, 362 **66** 295 **67** 284, 295 **68** 275, 295, 361, 362 **69** 31, 38, 47, 128, 155, 161, 165, 172, 180, 239, 240, 242, 257, 274, 275, 280, 284, 295, 310, 324, 326, 331, 353, 362 **70** 67, 280, 295 **71** 295 **72** 47, 134, 145, 155, 158, 172, 174, 183, 237, 238, 239, 240, 241, 251, 257, 270, 274, 275, 280, 324, 331, 362, 363 **73** 28, 47, 134, 145, 155, 158, 172, 174, 183, 237, 238, 239, 241, 251, 257, 274, 275, 280, 295, 324, 331, 362, 363 **74** 47, 128, 134, 145, 155, 174, 180, 183, 237, 238, 240, 241, 251, 257, 268, 269, 270, 274, 275, 280, 324, 331, 362, 363 **75** 4, 20, 39, 47, 52, 98, 122, 128, 145, 158, 172, 174, 175, 180, 183, 237, 242, 251, 257, 274, 275, 280, 363 **76** 295 **77** 95, 145, 158, 274, 275 **78** 17, 47, 106, 126, 128, 180, 275, 280, 295, 361, 362 **79** 295 **80** 67, 280, 295 **81** 28, 38, 47, 51, 109, 133, 145, 155, 158, 165, 178, 180, 222, 239, 257, 267, 270, 274, 275, 280, 292, 295, 306, 310, 312, 324, 331, 353, 362 **82** 295 **83** 230, 280, 295 **84** 295, 296 **85** 295 **86** 124, 128, 178, 180, 257, 274, 275, 362 **87** 295 **88** 61, 275, 280, 290, 295, 361, 362 **89** 275, 361, 362 **90** 295 **91** 295 **92** 47, 59, 135, 139, 145, 155, 157, 158, 239, 267, 274, 275, 280, 300, 312, 323, 332, 361, 362 **93** 194, 233, 295 **94** 295 **95–96** 28, 38, 41, 47, 51, 145, 155, 157, 158, 161, 165, 178, 180, 219, 257, 274, 275, 276, 280, 284, 295, 310, 353, 362 **97** 180, 216 **98** 28, 47, 53, 55, 275, 295, 361, 362 **99** 61, 275, 280, 295, 362 **100** 61, 280, 295 **101** 63, 280, 295 **102** 195, 250 **103** 61, 275, 280, 295, 361, 362 **104** 275, 361, 362 **105** 180, 186, 195, 212 **106** 195 **107** 228, 275, 280, 295, 361, 362 **108** 180, 186, 195, 198, 212, 214, 235 **109** 228, 280, 284, 295 **110** 17, 20, 26, 45, 46, 47, 133, 145, 155, 161, 165, 178, 180, 221, 255, 257, 274, 275, 284, 295, 310, 312, 324, 326, 353, 361, 362 **111** 28, 47, 145, 155, 165, 178, 180, 224, 274, 275, 280, 295, 310, 361, 362 **112** 195 **113** 195 **114** 59, 280, 295 **115** 15, 17, 20, 27, 29, 40, 41, 43, 44, 47, 132, 136, 145, 155, 158, 161, 247, 267, 270, 274, 275, 280, 284, 292, 295, 301, 312, 322, 324, 326, 331, 347, 348, 352, 362, 363 **116** 295 **117** 8, 47, 142, 145, 155, 257, 267, 274, 275, 295, 309, 312, 362 **118** 61, 275, 280, 295, 361, 362 **119** 145, 164, 174, 175, 180, 211, 257, 274, 275, 362 **120** 295 **121** 180, 195, 216 **122** 61, 275, 280, 295, 361, 362 **123** 180, 186, 195, 212 **124** 228, 275, 280, 361, 362 **125** 67, 280 **126** 180, 186, 195, 212 **127** 63, 280, 295 **128** 63, 280 **129** 67, 280, 295 **130** 295 **131** 275, 361, 362 **132** 47, 49, 63, 109, 113, 145, 155, 157, 158, 267, 274, 275, 280, 295, 300, 307, 312, 338, 362 **133** 8, 28, 47, 100, 128, 145, 155, 161, 172, 180, 257, 274, 275, 280, 284, 295, 361, 362 **134** 271, 275, 295 **135** 63, 280 **136** 70, 275, 280, 295, 361, 362 **137** 295 **138** 28, 47, 145, 155, 178, 180, 218, 257, 274, 275, 295, 362 **139** 63, 280, 295 **140** 63, 267, 275, 280, 295, 354, 362 **141** 37, 47, 115, 137, 145, 155, 267, 275, 295, 304, 312, 324, 331, 362 **142** 78, 161, 180, 215, 275, 284, 288, 295, 337, 362 **143** 28, 31, 33, 38, 40, 47, 120, 128, 144, 145, 155, 161, 165, 171, 172, 180, 257, 274, 275, 280, 284, 295, 310, 353, 362 **144** 47, 128, 144, 145, 155, 180, 257, 274, 275, 312, 362 **145** 61, 71, 72, 215, 275, 280, 284, 295, 354, 356, 357, 360, 362 **146** 59, 267, 275, 280, 290, 295, 323, 354, 362 **147** 277, 279, 280, 295 **148** 295 **149** 295 **150** 145, 164, 274, 275, 295 **151** 246, 279, 284 **152** 8, 179, 180, 257, 274, 275, 295, 362 **153** 275, 361, 362 **154** 295 **155** 8, 127, 128, 161, 174, 175, 180, 203, 257, 274, 275, 295, 362 **156** 228, 275, 280, 295, 361, 362 **157** 295 **158** 61, 161, 275, 280, 291, 292, 295 **159** 63, 280, 295 **160** 275, 280, 295, 361, 362 **161** 125, 128, 180, 275, 280, 281, 284, 295, 361, 362 **162** 295 **163** 295 **164** 295 **165** 184, 226, 228, 233, 284, 295 **166** 275, 277, 279, 295, 361, 362 **167** 8, 174, 175, 180, 216, 257, 295 **168** 61, 275, 280, 295, 361, 362 **169** 61, 280, 295 **170** 3, 8, 127, 128, 145, 146, 147, 148, 151, 156, 158, 159, 160, 161, 174, 175, 180, 213, 257, 267, 272, 274, 275, 280, 295, 332, 362 **171** 8, 128, 145, 155, 158, 161, 164, 172, 174, 175, 180, 257, 267, 272, 273, 274, 275, 280,

284, 295, 362 **172** 67, 280 **173** 8, 121, 128, 174, 175, 180, 257, 274, 275, 280, 295, 362 **174** 295 **175** 228, 280, 295 **176** 275, 361, 362 **177** 8, 51, 257, 274, 275, 276, 280, 295, 362 **178** 37, 47, 144, 145, 155, 158, 240, 268, 269, 270, 274, 275, 280, 312, 331 **179** 161, 178, 180, 203, 219, 257, 274, 275, 280, 295, 362 **180** 67, 280, 295 **181** 67, 280, 295 **182** 67, 280, 295 **183** 79, 228, 271, 275, 280, 295 **184** 267, 275, 295, 323, 354, 362 **185** 67, 280, 295 **186** 8, 174, 175, 180, 211, 257, 274, 275, 295, 362 **187** 295 **188** 295 **189** 295 **190** 228, 275, 280, 284, 295, 361, 362 **191** 295 **192** 8, 121, 128, 161, 174, 175, 180, 257, 274, 275, 280, 284, 295, 362 **193** 174, 180, 217 **194** 229 **195** 83, 274, 275, 362 **196** 8, 11, 174, 175, 180, 211, 274, 275, 362 **197** 178, 180, 219, 257, 274, 275, 362 **198** 226 **199** 180, 217 **200** 184, 225 **201** 3, 8, 39, 174, 175, 180, 215, 232, 274, 275, 362 **202** 180, 216 **203** 202 **204** 179, 180 **205** 145, 178, 275, 295 **206** 231 **207** 202 **208** 8, 11, 39, 105, 174, 175, 180, 232, 241, 274, 275, 362 **209** 202 **210** 202 **211** 174, 202, 271, 274, 275, 362 **212** 180, 215 **213** 202 **214** 24, 82, 88, 174, 181, 182, 187, 200, 261, 264, 274, 275, 284, 287, 318, 319, 320, 336, 337, 345, 346, 351, 359, 360 **215** 174, 180, 186, 209 **216** 121, 174, 180, 186 **217** 202 **218** 83, 174, 274, 275, 362 **219** 84, 99, 128, 161, 174, 175, 180, 203, 241, 242, 274, 275, 352, 362 **220** 232 **221** 274, 275 **222** 9, 17, 18, 20, 38, 42, 46, 47, 108, 109, 128, 145, 155, 158, 162, 172, 180, 203, 239, 240, 242, 257, 259, 267, 269, 270, 274, 275, 280, 308, 312, 324, 331, 332, 353, 355, 362 **223** 262, 274, 275 **224** 11, 179, 180, 191, 222, 271, 275 **225** 174, 175, 180, 211, 274, 275, 362 **226** 101, 174, 175, 180, 271, 275 **227** 231 **228** 180, 222 **229** 8, 11, 39, 91, 99, 128, 161, 174, 175, 176, 180, 182, 205, 231, 241, 242, 248, 273, 274, 275, 280, 284, 337, 349, 350, 352, 362 **230** 8, 100, 128, 174, 175, 180, 271, 275 **231** 174, 175, 180, 211, 241, 274, 275, 362 **232** 3, 8, 100, 128, 174, 175, 180, 216, 249, 254, 267, 273, 274, 275, 280, 362 **233** 202, 223 **234** 202 **235** 3, 161, 174, 175, 180, 203, 216, 271, 275 **236** 180, 186, 215 **237** 145, 257, 259, 274, 275, 312, 333, 361, 362 **238** 180, 216, 232 **239** 145, 164, 178, 274, 275, 292, 295, 362 **240** 179, 180, 222 **241** 28, 47, 87, 102, 128, 145, 155, 158, 161, 165, 178, 180, 219, 253, 257, 267, 270, 274, 275, 276, 284, 295, 310, 353, 362 **242** 232 **243** 174, 175, 180, 210, 274, 275, 280, 362 **244** 202 **245** 228 **246** 232 **247** 295 **248** 202 **249** 67, 280, 295 **250** 68, 280, 295 **251** 68, 280, 295 **252** 179, 180, 222, 274, 275, 280, 295, 362 **253** 180, 226, 280, 295 **254** 271, 275, 295 **255** 68, 280, 295 **256** 295 **257** 202 **258** 161, 179, 180, 203, 222, 274, 275, 362 **259** 179, 180, 222 **260** 295 **261** 174, 175, 180, 210, 241, 267, 274, 275, 362 **262** 295 **263** 70, 280, 290, 295 **264** 68, 280, 295 **265** 74, 90, 92, 267, 275, 278 **266** 295 **267** 104, 181, 186, 209, 232 **268** 68, 280, 295 **269** 75, 81, 119, 180, 207, 224, 234, 236, 280, 284, 293, 295 **270** 295 **271** 68, 280, 295 **272** 68, 196, 280, 281, 284, 295 **273** 295 **274** 70, 161, 275, 280, 286, 295, 362 **275** 280, 290, 295 **276** 70, 280, 295 **277** 68, 280, 295 **278** 83, 144, 145, 274, 275, 309, 312, 361, 362 **279-280** 70, 280, 295 **281** 295 **282** 295 **283** 295 **284** 68, 280, 295 **285** 280, 295 **286** 280, 295 **287** 295 **288** 129, 181, 186, 232, 280, 295 **289** 295 **290** 68, 280, 295 **291** 70, 280, 295 **292** 275, 361, 362 **293** 280, 295 **294** 70, 280, 290, 295 **295** 65, 69, 70, 280, 285, 295 **296** 70, 280, 295 **297** 295 **298** 280, 295 **299** 180, 209, 259, 280, 295 **300** 93, 295 **301** 295 **302** 295 **303** 280, 290, 295 **304** 180, 211, 280, 295 **305** 280, 295 **306** 1, 16, 19, 22, 30, 47, 49, 143, 161, 170, 267, 275, 280, 303, 312, 316, 329 **307** 295 **308** 275, 280, 295, 361, 362 **309** 295 **310** 275, 361, 362 **311** 83, 274, 275, 295, 362 **312** 280, 290, 295 **313** 3, 5, 10, 23, 47, 49, 103, 128, 130, 145, 172, 178, 180, 199, 257, 259, 263, 267, 274, 280, 295, 311, 315, 329, 332, 338, 356, 357, 358 **314** 280, 284, 295 **315** 295 **316** 275, 280, 295, 362 **317** 275, 280, 290, 295, 361, 362 **318** 275, 295, 361, 362 **319** 275, 295, 361, 362 **320** 295 **321** 280, 295 **322** 275, 280, 295, 361, 362 **323** 274, 275, 361, 362 **324** 295 **325** 295, 297, 351 **326** 267, 275, 295, 362 **327** 280, 295 **328** 229, 280, 284, 295 **329** 7, 17, 20, 21, 38, 47, 48, 145, 155, 158, 178, 180, 221, 239, 257, 267, 274, 275, 280, 295, 324, 353, 362 **330** 295 **331** 47, 51, 257, 267, 275, 276, 295 **332** 275, 280, 295, 361, 362 **333** 280, 295 **334** 295 **335–336** 275, 280, 295, 361, 362 **337** 295 **338** 4, 6, 25, 40, 47, 49, 52, 71, 87, 116, 123, 128, 131, 138, 149, 158, 163, 172, 173, 180, 186, 187, 204, 206, 239, 243, 252, 256, 260, 270, 275, 280, 292, 295, 299, 312, 324, 342, 352, 357, 360, 361, 362 **339** 231, 280, 295 **340** 295 **341** 47, 51, 259, 274, 275, 276, 295 **342** 295 **343** 267, 275, 295, 361, 362 **344** 295 **345** 275, 295, 361, 362 **346** 280, 290, 295 **347** 275, 295, 361, 362 **348** 295 **349** 295 **350** 314 **351** 176, 258, 265, 266, 267, 274 **352** 28, 47, 80, 145, 155, 239, 274, 275, 295, 361, 362 **353** 145, 157, 158, 239, 267, 274, 275, 295, 309, 340, 362 **354** 280, 295 **355** 295 **356** 59, 275, 280, 295 **357** 181, 218, 231, 275, 280, 295, 361, 362 **358** 145, 155, 157, 275, 295 **359** 7, 20, 34, 38, 39, 46, 47, 87, 109, 145, 155, 178, 180, 219, 239, 257, 267, 270, 274, 275, 295, 324, 330, 331, 338, 353, 361, 362 **360** 145, 155, 161, 274, 275, 361, 362 **361** 54, 56, 275, 279, 280, 295, 361, 362 **362** 295 **363** 275, 295, 361, 362 **364** 17, 20, 47, 49, 103, 109, 128, 145, 155, 161, 165, 172, 180, 203, 239, 257, 274, 275, 280, 295, 309, 310, 312, 324, 331, 362 **365** 74, 267, 275, 280, 283, 295, 361, 362 **366** 230, 275, 280, 295, 361, 362 **367** 47, 114, 145, 155, 165, 178, 180, 218, 257, 267, 274, 275, 280, 295, 310, 361, 362 **368** 53, 275, 295, 361, 362 **369** 275, 295, 361, 362 **370** 295 **371** 275, 361, 362 **372** 295 **373** 3, 47, 145, 155, 161, 174, 180, 245, 257, 259, 267, 274, 275, 362 **374** 295 **375** 295 **376** 226, 275, 280, 295, 361, 362 **377** 280, 295 **378** 275, 361, 362 **379** 36, 40, 116, 126, 128, 180, 186, 189, 275, 280, 284, 289, 294, 295, 337, 360, 362 **380** 158, 275, 295, 361, 362 **381** 114, 275, 362 **382** 295 **383** 295 **384** 17, 20, 47, 145, 155, 161, 178, 239, 240, 257, 274, 275, 280, 295, 310, 324, 331, 353, 361, 362 **385** 28, 47, 267, 275, 276 **386** 275, 280, 295, 361, 362 **387** 8, 28, 47, 145, 155, 157, 161, 165, 178, 180, 221, 239, 257, 274, 275, 280, 295, 310, 324, 331, 353, 362 **388** 8, 17, 20, 26, 38, 45, 47, 128, 145, 153, 154, 155, 158, 161, 172, 173, 180, 239, 242, 257, 274, 275, 280, 284, 312, 324, 326, 331, 352, 353, 361, 362 **389** 295 **390** 28, 47, 51, 145, 155, 178, 180, 184 257, 267, 275, 276, 295, 361, 362 **391–392** 59, 155, 274, 275, 280 **393** 295, 335, 338 **394** 39, 47, 141, 145, 267, 274, 275, 280, 295, 338, 361, 362 **395** 275, 361, 362 **396** 8, 28, 38, 47, 52, 58, 133, 145, 155, 161, 165, 178, 180, 239, 240, 257, 274, 275, 280, 284, 309, 310, 312, 324, 331, 353, 361, 362 **397** 290, 295 **398** 295 **399** 295 **400** 86, 284 **401** 295 **402** 295 **403** 295 **404** 275, 295, 361, 362 **405–406** 275, 333, 338, 361, 362 **407** 275, 280, 295, 361, 362 **408** 275, 295, 361, 362 **409** 178, 180, 218, 280, 284, 295 **410** 295 **411** 94, 208, 295, 296 **412** 94, 197, 296 **413** 62, 64, 96, 177, 187, 188, 244, 317, 344 **414** 89, 177, 185, 188, 217, 220 **415** 94, 190, 295, 296 **416** 14, 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DISCUSSION

Discovery.—Table IV shows the distribution of the discoveries of Be stars, beginning with γ Cassiopeiae and β Lyrae by Secchi in 1866. Only 5 of the 410 stars in Table I were discovered visually. The photographic surveys with the objective prism inaugurated at the Harvard Observatory by E. C. Pickering in 1886 produced rich results in this as in other fields of stellar spectroscopy. The lines used for the detection of hydrogen emission were $H\beta$ and $H\gamma$. At Mount Wilson, on the other hand, it has been possible to take advantage of the much stronger $H\alpha$ line, because of the development of rapid panchromatic emulsions not available to the early observers.

Distribution in type and magnitude.—The distribution of the types and apparent magnitudes of the 410 stars is shown in Table V. The 13 variable stars, which are tabulated according to their median magnitudes, are included in the body of the table but are also given separately in the last line and the last column of the table. Five are of the R Coronae type, while 1, β Lyrae, is an eclipsing variable. The others are said to be irregular or like novae.

TABLE IV

DISCOVERY OF 410 Be STARS

	Visual	Photographic	
		Objective Prism	Slit Spectrograph
Secchi	γ Cassiop. β Lyrae	....	....
Le Sueur	η Carinae	....	....
Campbell	Alcyone	....	....
Espin	H.R. 985	....	....
Harvard	....	124	....
Mount Wilson	....	207*	30
Lockyer	....	2	....
Lick (including Chile)	....	....	15
Victoria	....	....	14
Yerkes	....	....	5
Lowell	....	....	3
University of Michigan	....	....	2
Simeis	....	....	2
Allegheny	....	....	1
Total	5	333	72

* All the Mount Wilson stars credited to the objective prism were confirmed on slit spectrograms. Without such confirmation a number of them could not have been announced as certainly having bright lines.

The data show the normal increase in the numbers of stars with magnitude down to the fifth magnitude, and a much slower progression thereafter, the maximum number being in the eighth magnitude. These numbers reflect chiefly the thoroughness with which stars of different magnitudes have been observed. In this connection Table I*a* in *Mount Wilson Contribution* No. 456[10] is instructive. It appears that for the detection of bright lines in B-type stars the Harvard surveys were most nearly complete among stars brighter

[10] *Astrophysical Journal*, 76, 156, 1932.

than magnitude 5.0, and that the Mount Wilson surveys were most effective for magnitudes 7 and 8. The relatively large number of peculiar (Pec.) and P Cygni (Beq) spectra among the fainter magnitudes arises from the great intensity of the hydrogen emission in these stars and the consequent ease of detection.

A more detailed distribution among the various spectral subdivisions is shown in Table VI, which also indicates the numbers hav-

TABLE V

DISTRIBUTION OF 410 Be STARS IN TYPE AND MAGNITUDE

Type	Magnitude														
	1*	2	3	4	5	6	7	8	9	10	11	12	13	?	Total	Variables
O6–O9	....	....	....	1	1	....	2	1	....	....	....	....	....	....	5	0
B0	....	1	....	2	1	4	6	10	10	2	....	....	....	....	36	1
B1	....	....	....	4	1	6	5	7	1	....	....	....	....	....	24	0
B2	....	....	1	1	4	8	15	16	7	2	....	....	....	....	54	0
B3	....	2	4	16	18	16	20	14	12	2	....	....	....	....	104	0
B4–B6	....	....	4	14	4	11	7	12	5	1	....	....	....	....	58	0
B8	....	1	1	1	9	3	4	8	....	....	....	....	....	....	27	0
B9	....	....	....	1	2	3	1	1	1	....	....	....	....	....	9	1
B	....	....	1	....	....	....	6	6	17	8	7	1	1	....	47	3
A	1	....	....	2	....	3	4	3	....	....	....	....	....	....	13	1
Pec	....	....	....	....	....	....	1	1	3	1	2	2	1	2	13	6
Beq†	....	....	....	....	....	1	1	1	6	1	4	4	1	1	20	1
Total	1	4	11	42	40	55	72	80	62	17	13	7	3	3	410	......
Variables	0	0	1	0	0	1	3	2	2	2	0	1	1	0	.....	13

* The magnitude intervals are 1.00–1.99, 2.00–2.99, etc.

† Four additional *q* stars are included in their assigned spectral subdivisions.

ing nebulous (n) and sharp (s) lines. The lower intensity of the hydrogen emission and the greater stellar luminosity are characteristics of the "s" stars[11] which should be kept in mind in general investigations of Be stars.

Very few bright-line stars of the kind under consideration are found in class O. The maximum frequency occurs at B3; the numbers then rapidly decline toward class A.

Twenty-eight stars of the P Cygni type are listed in Table VII. The first nine are in the Greater Magellanic Cloud. The last four have variable spectra which show P Cygni characteristics only at times. The high galactic latitudes of these stars suggest that their nature is not the same as that of the preceding stars. The approxi-

[11] *Publications of the Astronomical Society of the Pacific*, **45**, 49, 1933.

mate absolute magnitude of the companion to *o* Ceti is +7; that of the companion to R Aquarii, +2.

To examine the ratio of the total number of stars in the various spectral subdivisions to the number having bright lines, we may use the counts of stars in the *Henry Draper Catalogue* made by Charlier[12] and by Shapley and Miss Cannon.[13] Counting in Table I only those stars which are in the *Henry Draper Catalogue*, we have

TABLE VI

DETAILED DISTRIBUTION IN SPECTRAL TYPE OF 410 Be STARS

Class	n	s	Unclassified	Total
O6	0	0	1	1
O7	1	0	0	1
O8	0	0	2	2
O9	0	1	0	1
B0	24	5	7	36
B1	9	8	7	24
B2	24	4	26	54
B3	58	3	43	104
B4	5	0	2	7
B5	32	1	15	48
B6	2	0	1	3
B8	17	2	8	27
B9	3	1	5	9
B	6	0	61	67
A0	1	2	3	6
A2–A4	0	2	2	4
A	0	0	3	3
Pec	0	0	13	13
Totals	182	29	199	410

the data in Table VIII.[14] The ratio for B1 is unduly small because this subdivision is relatively little used in the *Henry Draper Catalogue* except for stars brighter than the fifth magnitude, whereas observers with slit spectrographs apparently have used B1 as freely as B0. Of the 24 H.D. stars classified as B1 in Table I, only 7 are thus classified in the *Henry Draper Catalogue*.[15] For this number, the ratio for all stars becomes 10.9, or 10.7 for those brighter than mag-

[12] *Meddelande från Lunds Astronomiska Observatorium*, No. 19, Table 3*c*, p. 14, 1926.

[13] *Harvard Circular*, No. 226, 1921.

[14] In Tables VIII–XI, B5 includes also the small number of B4 and B6 stars.

[15] Their average magnitude is 5.7, compared with 7.5 for the remaining 17 stars.

nitude 9.0. These values are probably more appropriate than the smaller ratios given in Table VIII. It thus appears that stars of class B2 have a more general tendency toward emission than those

TABLE VII

P CYGNI TYPE STARS

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	l	b	Mag.	Type
102...	33540*	....	5^h $5^m.8$	−71° 3′	249°	−34°	*12.3*	Beq
105...	34664	In N.G.C. 1871	5 14.0	−67 34	245	−34	*11.4*	Beq
106...	....	Anon	5 14.4	−69 28	247	−34	*11.4*	Beq
108...	35343	S Dor	5 18.9	−69 21	246	−33	9 v	Beq
		Anon	5 28.5	−69 4	246	−32	*13.0*	Beq
113...	....	(383)	5 29.0	−69 13	246	−32	*12.2*	Beq
121...	37836	401	5 36.2	−69 44	247	−32	*10.5*	Beq
123...	37974	420	5 37.2	−69 26	246	−32	*11.3*	Beq
126...	38489	478	5 41.0	−69 26	246	−31	*12.0*	Beq
145...	45910	1267	6 25.2	+ 5 57	173	0	6.7	Beq
161...	51480	1774	6 52.4	−10 41	191	− 2	7.0	B8eq
162...	51585	....	6 52.8	+16 28	167	+10	......	Beq?
165...	53179	Z CMa	6 59.0	−11 24	192	− 1	9.1	Beq
215...	94878	2855	10 52.0	−59 52	257	− 1	8.5	Beq
216...	94910	2860	10 52.2	−59 55	257	− 1	7.6	Beq
236...	138403	1889	15 26.7	−71 34	283	−14	*9.0*	Beq
238...	141969	3171	15 46.7	−65 52	288	−10	*9.2*	Beq
242...	151895	....	16 45.1	−64 4	293	−14	*12.5*	Beq
243...	152236	ζ^1 Sco	16 47.0	−42 12	311	0	4.9	B1seq
267...	161044	11816	17 38.2	−46 3	313	−10	11.0	Beq
272...	....	11944	17 41.9	−27 59	329	− 1	9.0	Beq
293...	169226	5034	18 18.6	−12 15	347	− 1	9.1	Be(q)
338...	193237	P Cyg	20 14.1	+37 43	43	0	4.9	B1eq
374...	....	3487	21 32.2	+47 28	60	− 4	9.1	B3eq

Stars at Times Resembling P Cygni

MWC	H.D.	Desig.	R.A. 1900	Dec. 1900	l	b	Mag.	Type
35...	....	Comp. *o* Cet	$2^h 14^m.3$	− 3° 26′	137°	−57°	10 v	Bep
269...	161114	XX Oph	17 38.6	− 6 14	347	+10	10 v	Pec.
379...	207757	*4673*	21 46.2	+12 9	38	−32	7.6v	Bep
400...	....	Comp. R Aqr	23 38.6	−15 50	37	−71	9 v	Pec.

* In *Harvard Bulletin* No. 891, received after the completion of the present manuscript, there is the following note: "H.D. 33540, hitherto assumed to be of the P Cygni class. On recent photographs, however, the nebular lines are clearly seen. $H\beta$ is twice as strong as the chief nebular line. On plates taken with the 10-inch telescope, the continuous spectrum is strong and several absorption lines are visible."

This *Bulletin* also lists two additional stars of the P Cygni type, as tabulated. These stars should be included in Table I, and possibly H.D. 33540 should be removed.

Desig.	R.A. (1900)	Dec. (1900)	Mag.
	$5^h 14^m 39^s$	−69°38′.2	11.6
C.P.D.−69°427	5 37 32	−69 33.1	11.1

of either earlier or later spectral subdivisions. The relative number of bright-line stars decreases very rapidly from B3 to A0.

TABLE VIII

STARS IN THE *Henry Draper Catalogue*

Type	All Stars			Stars Brighter than Mag. 9.0*		
	H.D.	Em.	Ratio	H.D.	Em.	Ratio
B0	376	26	14.5	289	21	13.8
B1	76	24	(3.2)†	75	23	(3.3)‡
B2	369	44	8.4	305	41	7.4
B3	1041	90	11.6	902	89	10.1
B0–B3	1862	184	10.1	1571	174	9.0
B5	1348	50	27.0	1021	49	20.8
B8	4395	25	176	2318	24	96.6
B9	8408	8	1051	4096	7	585
A0	30816	6	5136	11184	5	2237
A2, 3(4)	20630	4	5157	8734	4	2184

* For the last four lines the limiting magnitude is 8.75 instead of 8.99.
† 10.9 is considered a more representative value.
‡ 10.7 is considered a more representative value.

TABLE IX

DISTRIBUTION OF H.D. STARS IN TYPE AND MAGNITUDE
B0–B5

Type	Magnitude							
	Br.–4.9		5.0–6.9		7.0–8.9		9.0–Ft.	
	H.D.	Em.	H.D.	Em.	H.D.	Em.	H.D.	Em.
B0	19	3	69	5	201	13	87	5
B1	30	4	26	7	19	12	1	1
B2	35	2	68	12	202	27	64	3
B3	116	22	387	34	399	33	139	1
B0–B3	200	31	550	58	821	85	291	10
B5	72	18	288	15	661	16	327	1

The distribution of the H.D. stars among the spectral subdivisions and several intervals of apparent magnitude is shown in Tables IX and X. The ratios, all stars to those having bright lines, computed from Tables IX and X, are in Table XI, which brings out several facts of interest. The rapid increase of the ratios from B3 to A0, already remarked upon, corresponds to the physical behavior of stars with decreasing surface temperature, whereas, in any given type,

TABLE X

DISTRIBUTION OF H.D. STARS IN TYPE AND MAGNITUDE
B8–A3

Type	Magnitude							
	Br.–6.25		6.26–7.75		7.76–8.75		8.76–Ft.	
	H.D.	Em.	H.D.	Em.	H.D.	Em.	H.D.	Em.
B8	274	13	772	6	1272	5	2077	1
B9	280	3	1448	4	2368	0	4312	1
A0	736	0	2824	2	7624	3	19632	1
A2, 3, (4)	728	1	2264	3	5742	0	11896	0

TABLE XI

DISTRIBUTION OF RATIOS, ALL/EMISSION, IN TYPE AND MAGNITUDE

Mag. \ Type	Charlier		*Harvard Circular*, No. 226			
	B0–B3	B5	B8	B9	A0	A2, 3, (4)
Br.–4.9	6.4	4.0	....	....	....	....
Br.–6.25	....	....	21.1	93.3	>736	728
5.00–6.99	9.5	19.2	....	....	....	....
6.26–7.75	....	....	129	362	1412	755
7.00–8.99	9.7	41.3	....	....	....	....
7.76–8.75	....	....	254	>2368	2541	>5742
8.76–Ft.	....	....	2077	4312	19632	>11896
9.00–Ft.	29.1	327	....	....	....	....
All	10.1	27.0	176	1051	5136	5157

the increase of ratio with apparent magnitude indicates a declining discovery factor. For classes B0–B3 this factor changes slowly until magnitude 9.0 is reached, below which, of course, surveys for bright lines are as yet wholly inadequate.[16] For classes B5–A0 the ratios

[16] Among such faint stars the plates of the Mount Wilson $H\alpha$ survey are, for the most part, competent to disclose only those objects with unusually intense bright lines.

increase with magnitude much more rapidly than for classes B0–B3, probably because of the low intensity of the hydrogen emission in the later classes and the consequent difficulty of detection in objective-prism spectra of low dispersion. In the more thorough examination given the spectra of the brighter stars, the relative disadvantage of the emission-line stars of classes B5–A0 is less marked.

The *Hα* survey has not included the southern sky, and many bright-line stars in the northern sky have undoubtedly as yet been missed. In view of these facts it seems probable that among the early B stars, at least those in class B2, one star in every five or six actually has bright lines. The data suggest that a relatively large number of bright-line stars remain to be discovered in classes B5–A0. For the detection of bright lines in these classes observations with slit spectrographs will be especially effective.

Galactic distribution.—To a first approximation the galactic distribution of B-type stars whose spectra have emission lines resembles that of other B stars, although the emission stars have, perhaps, a somewhat stronger tendency to appear in condensed groups (Fig. 2*a*). A comparison of the distribution of the brighter emission stars of types B0–B5 with that of non-emission stars of the same types shows, however, a certain general difference. Such a comparison is conveniently made by using the data and charts in *Harvard Circular* No. 239 by Harlow Shapley and Annie J. Cannon. The normal stars exhibit a systematic departure from the galactic circle, attributed to a "local system" or flattened condensation of stars in the neighborhood of the sun, whose plane is inclined some 15° to that of the galaxy. The angular departure is greatest for the brightest stars and disappears in the magnitude interval 7.26–8.25 (Fig. 3). Be stars brighter than magnitude 5.26 and those in the interval 5.26–6.25 show the effects of the local system, although less strongly than do the corresponding non-emission stars; but for Be stars of magnitudes 6.26–7.25, as well as those of magnitudes 7.26–8.25, the average galactic latitudes are small and not suggestive of the local system. It appears, therefore, that the divergence from the galactic plane characteristic of the local system is less strongly marked for emission than for non-emission stars of the same apparent magnitudes, and disappears at a brighter magnitude. This is probably

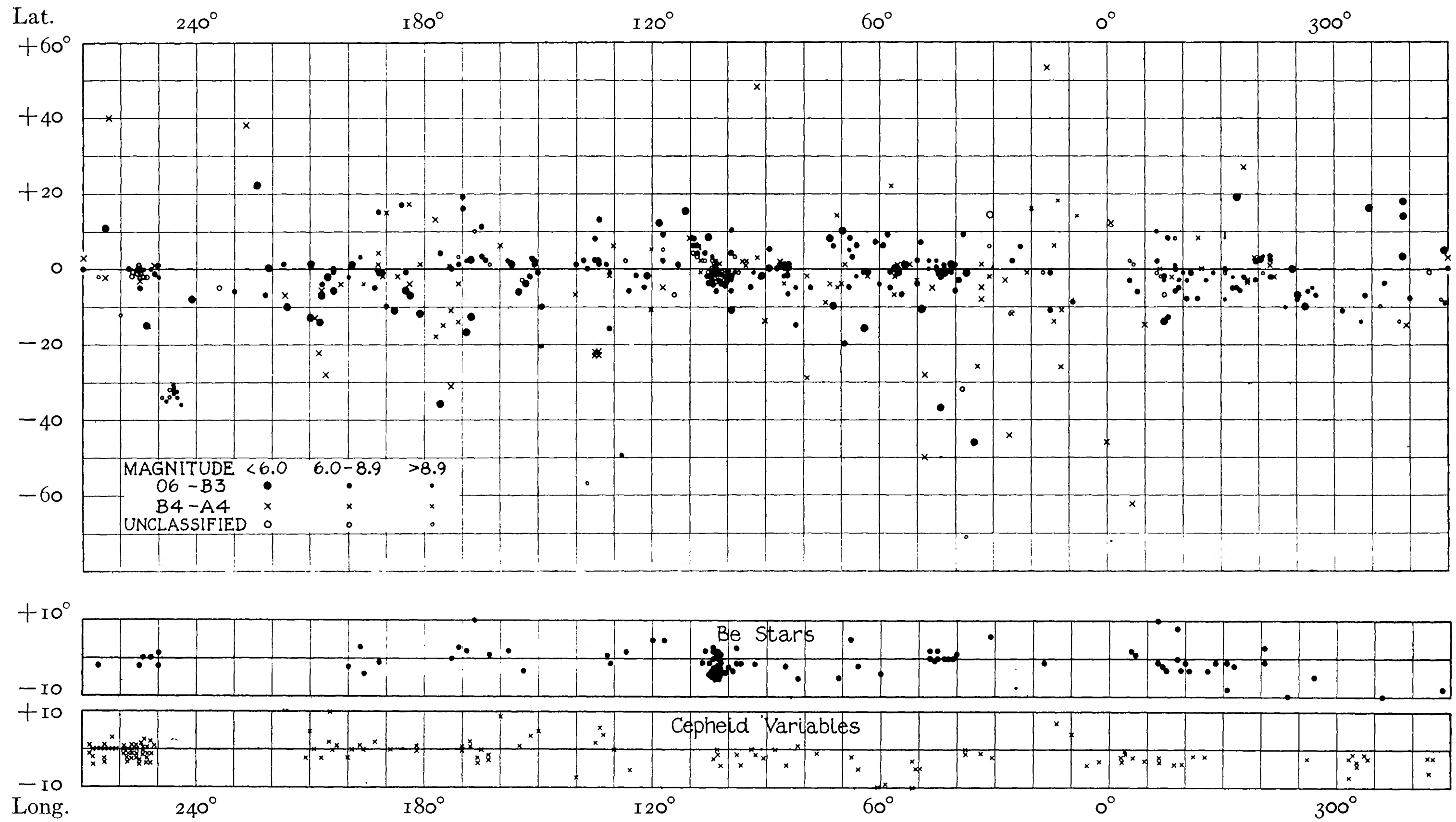


FIG. 2*a* (above).—Galactic distribution of Be stars

FIG. 2*b* (below).—Galactic distribution of faint Be stars and faint Cepheid variables because the emission stars are intrinsically brighter than the others, and consequently the boundary of the local system is reached at a somewhat brighter apparent magnitude. The difference in luminosity may be about 1 mag.

The numbers of stars in various galactic zones are shown in Table XII. Seventy-seven per cent are within 10° of the galactic circle.

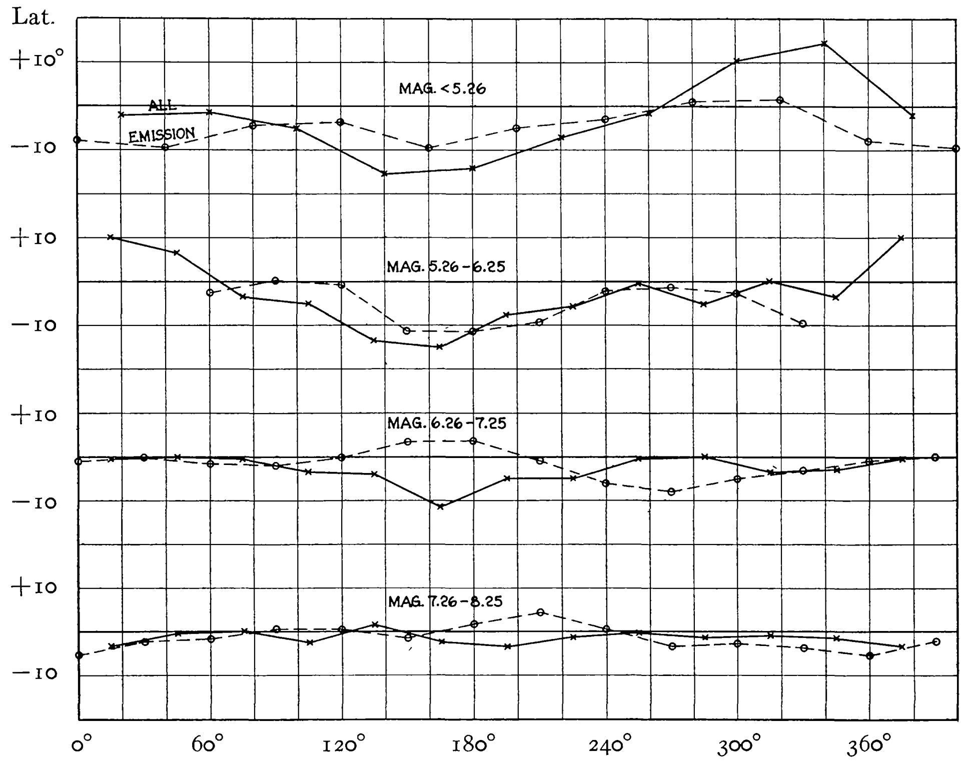


FIG. 3.—Mean galactic latitudes and longitudes of stars of types B0–B5

The galactic positions of the stars in Table I are plotted in Figure 2*a*. The irregularities in distribution are striking; the Be stars exhibit to a high degree that property to which Miss Clerke applied the adjective "gregarious." Table XIII lists 12 areas in which Be stars are particularly numerous. Some of them, e.g., Nos. 1, 7, 8, probably represent clusters relatively near us, while others, notably Nos. 2 and 10, are apparently portions of the Milky Way clouds which chance to suffer relatively little dimming by absorbing material. Wolf-Rayet stars are numerous in areas 2 and 10, while few are found in groups of the other type.

Group 10 is marked by a well-defined boundary at longitude 250°. An abrupt rise in the general stellar density is shown at this point

TABLE XII

NUMBERS OF STARS AT VARIOUS GALACTIC LATITUDES

Gal. Lat.	North	South
90°–30°	4	22*
30 –20	3	10
20 –10	22	32
10 – 0	127	190
90 – 0	156	254

* Including 11 stars in the Greater Magellanic Cloud.

TABLE XIII

AREAS RICH IN Be STARS

No.	G. Long.	G. Lat.	R.A.	Dec.	Remarks
1	40°	−40°	22^h14^m	+ 7°	Scattered group of bright stars
2	44	0	20 16	+38	Near γ and P Cygni
3	54	0	20 52	+46	Small group of bright stars
4	85	0	0 0	+62	Cassiopeia
5	103	− 3	2 16	+57	Region of double cluster in Perseus
6	107	+ 3	3 2	+60	
7	135	−22	3 44	+24	Pleiades
8	206	− 5	7 10	−25	Group of bright stars
9	247	−33	5 22	−70	Greater Magellanic Cloud
10	254	− 1	10 30	−59	Near η Carinae
11	320	− 1	17 16	−35	Scorpius
12	342	− 2	18 12	−17	Sagittarius

by sixteenth-magnitude stars but not by those down to magnitude 13.5.[17] This presumably indicates that the Be stars in this region are much brighter intrinsically than the average background stars. The region of the double cluster in Perseus, area 5, is extraordinarily

[17] F. H. Seares and M. C. Joyner, *Mt. Wilson Contr.*, No. 346; *Astrophysical Journal*, **67**, 24, 1928.

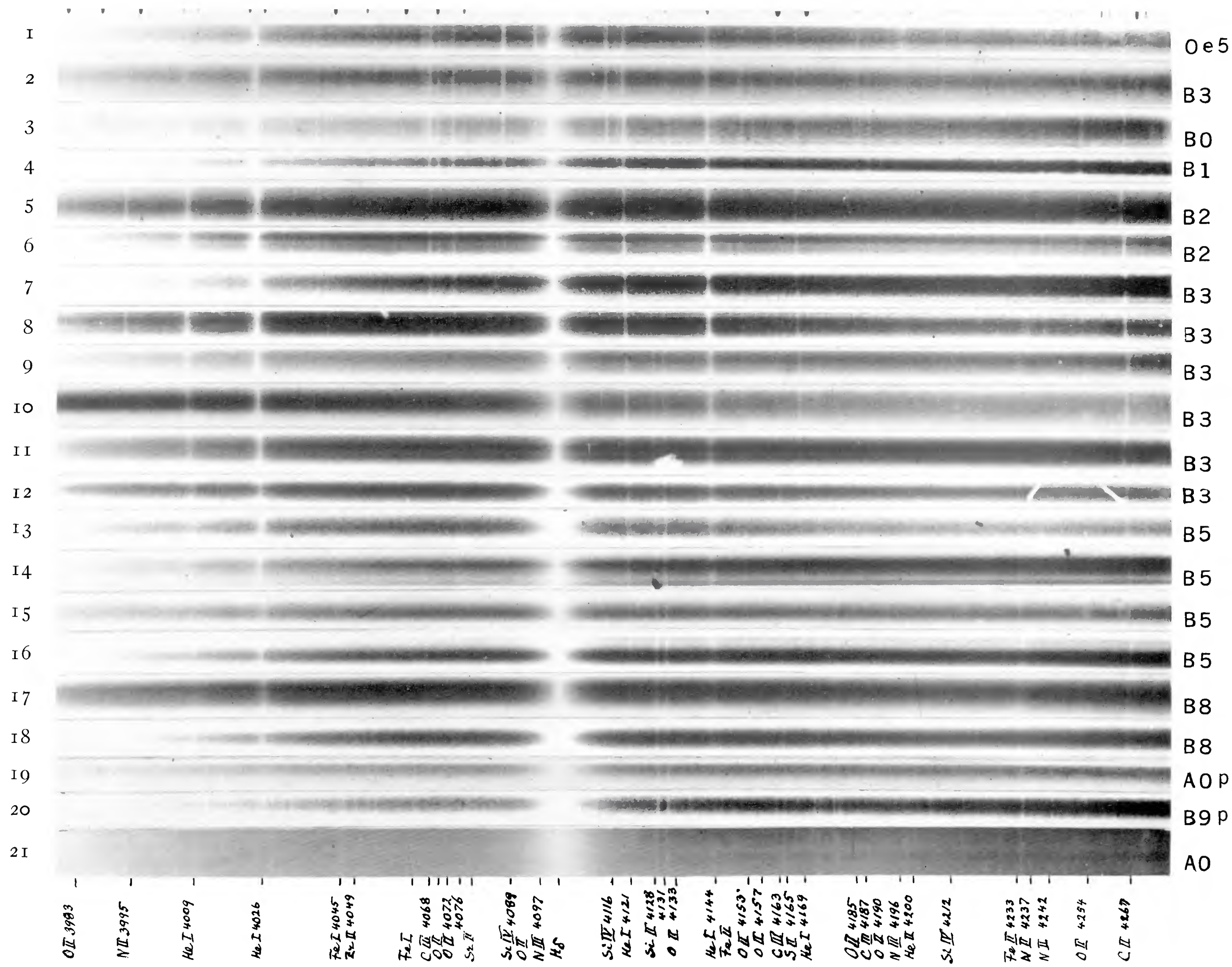
rich in Be stars, although the general stellar density is scarcely equal to the average for the galaxy. The characteristic spectroscopic properties of the stars in this region invite detailed investigation.

The following areas along the Milky Way are deficient in Be stars: longitudes 355°–15°, 140°–150°, 220°–250°, 285°–310°. In these regions dark clouds may hide the more distant stars.

The distribution of faint Cepheid variables is remarkably similar to that of faint Be stars (Fig. *2b*). This is probably because these intrinsically bright objects are so distant that their apparent distribution is largely governed by the location of dark absorbing clouds.

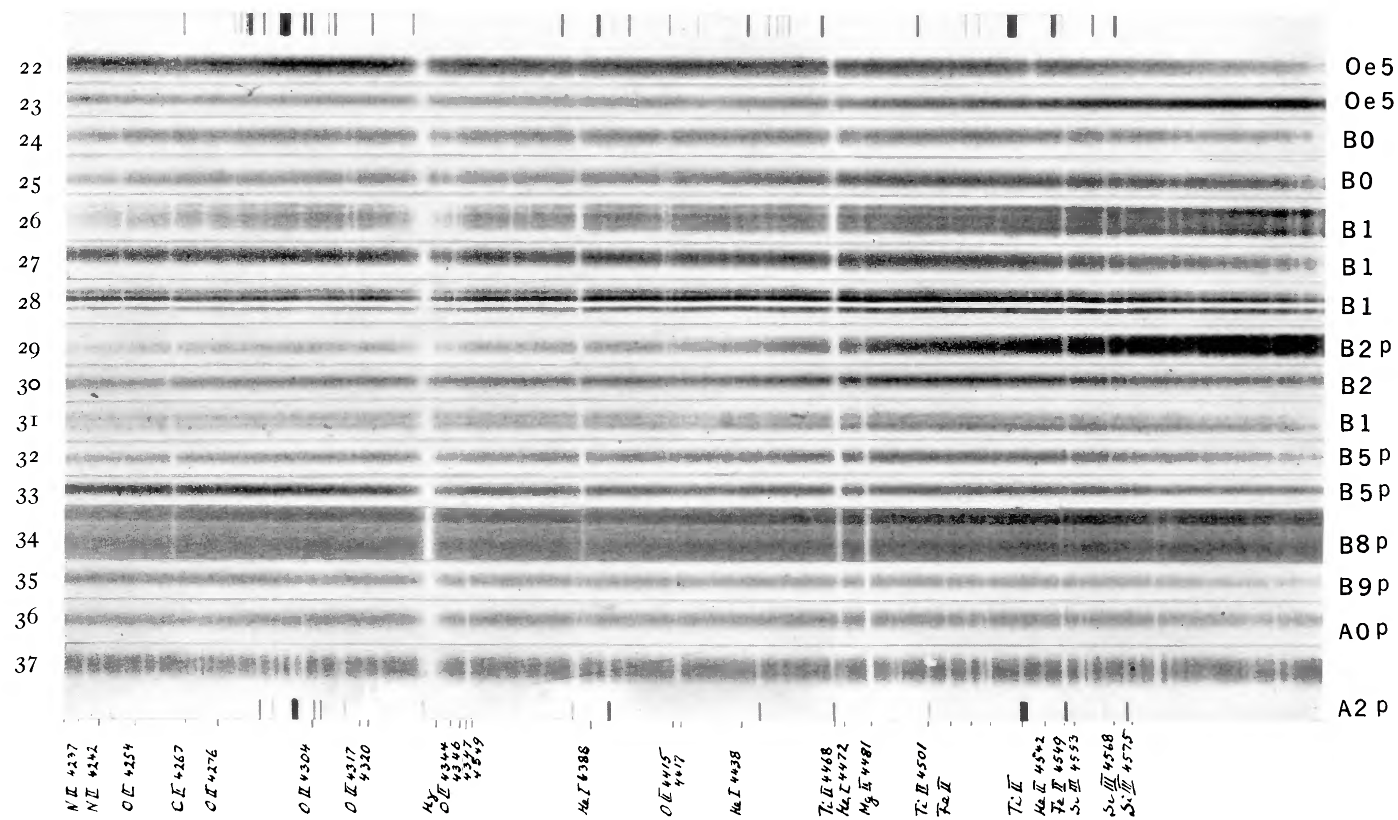
Carnegie Institution of Washington
Mount Wilson Observatory
March 1933

PLATE III



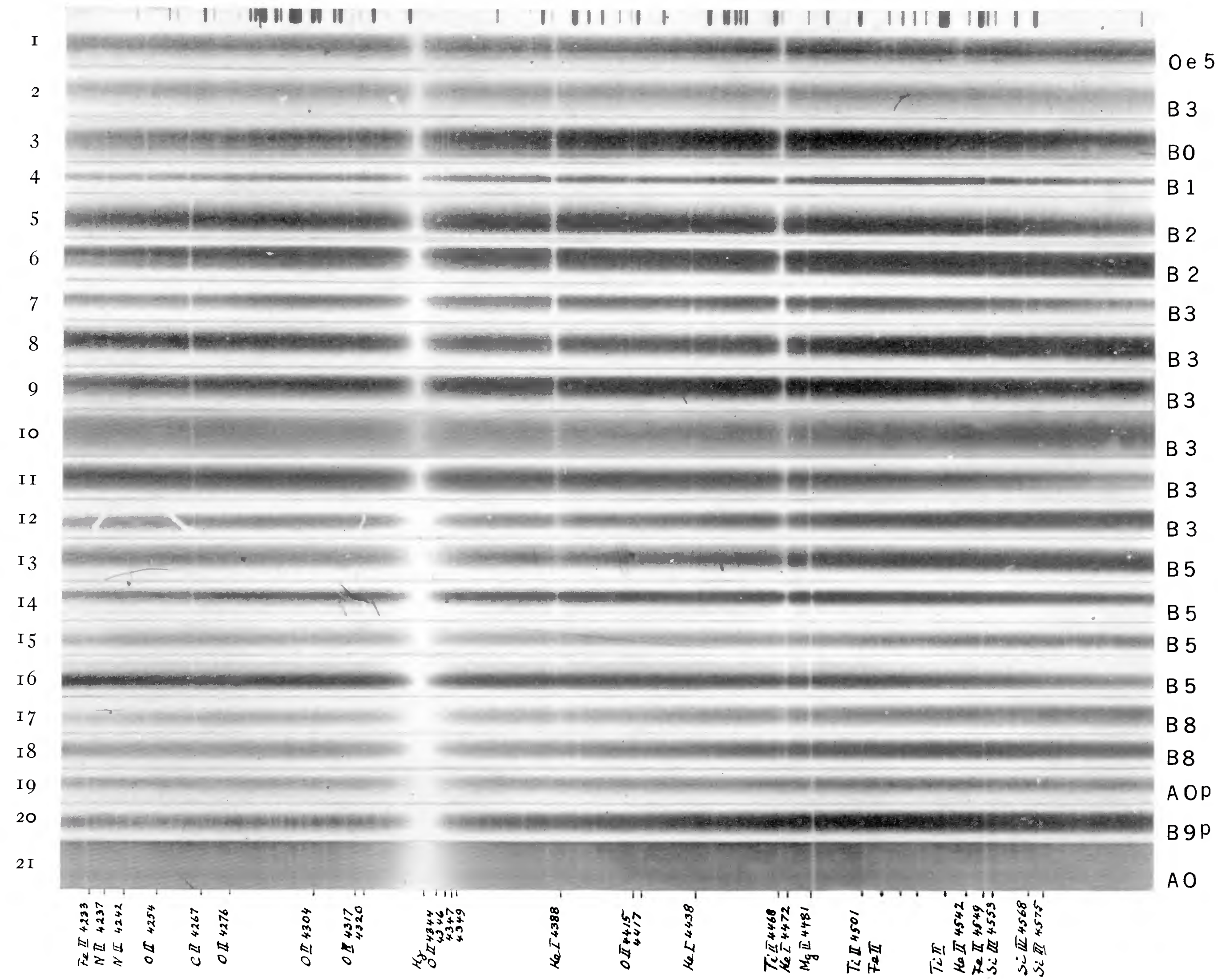
Spectra of B-Type Dwarfs

PLATE IV



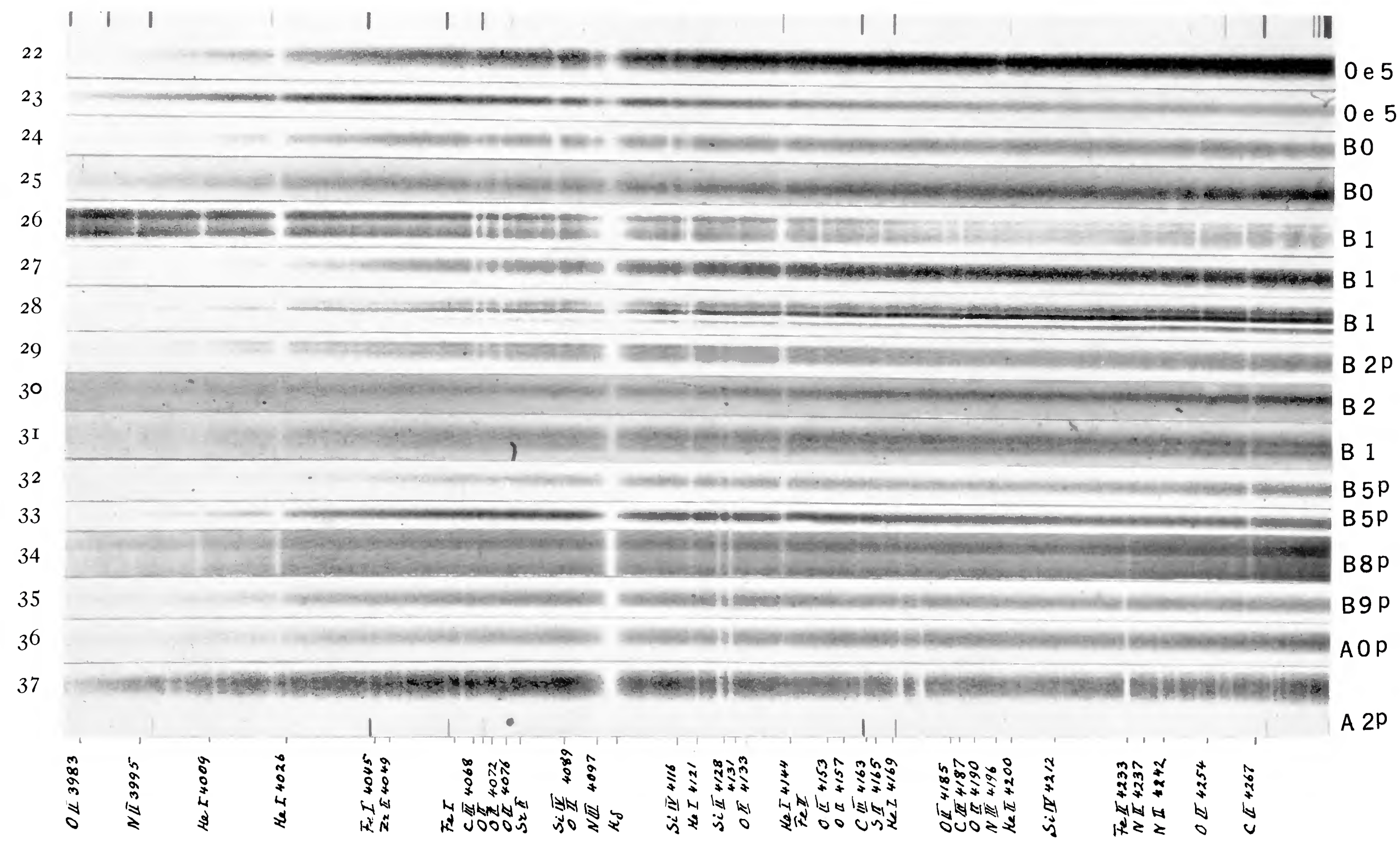
SPECTRA OF B-TYPE GIANTS

PLATE V



Spectra of B-Type Dwarfs

PLATE VI



Spectra of B-Type Giants