

THE NEAREST STARS*

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ABSTRACT

In Table 1 a list is given of the known stars with $p \geq 0''.095$; its chief purpose is to show which data are still lacking. The data at hand define the distribution of $M(v)$ and S_p shown in Figure 1. Figure 2 shows the incompleteness of our knowledge of the nearest stars fainter than $M = 11$; but rapid progress may be made by continuing the spectrographic survey which has already added about 25 per cent to the number previously known. Some results are derived from the nearest binaries and multiple stars; but larger numbers are required for a proper statistical treatment. It is found that of the masses exceeding that of the sun, at least two-thirds have divided into stable binary or multiple systems.

1. It is of interest to summarize from time to time the observational data collected for the nearest stars. These stars make up the best sample available for the study of all but the rarer subdivisions; they provide data on the luminosity function; the distribution of stars in the Hertzsprung-Russell diagram (including such problems as the width of the main sequence); the empirical mass-luminosity relation; the total amount of stellar matter per unit volume and hence the amount of interstellar matter (the sum being known); and finally, the velocity distribution of the dwarfs and binary-star statistics.

The chief purpose of this article is to present a list of the known stars nearer than 10.5 parsecs (parallaxes $0''.095$ and larger); this list is found in Table 1. We hope that it will stimulate observations of the quantities still lacking. In addition, some of the problems mentioned above are briefly reviewed.

2. *Table 1.*—The following explanations may suffice. Components of visual binaries are listed separately because their magnitudes, and usually other quantities, may be determined. Proper-motion and parallax data are listed only once for each system, the weighted mean having been used in each case. But magnitude, spectral, and radial-velocity data (spectroscopic binaries!) are given for each component.

The magnitude measures were reduced to the IP v system; half-weight was given to the reduction based on Mrs. Gaposchkin's compilation¹ and half-weight to that based on the Potsdam catalogue.² For three stars (Nos. 148, 149, 225) the unchanged HD magnitudes were used. Some measures were taken from the *General Catalogue* without change. For fainter stars data by Willis³ and by Seyfert⁴ could be used, while much unpublished material by the writer was incorporated. Photographic magnitudes, by Luyten,⁵ are in italics.

The spectral types are the writer's, with the following exceptions: the Sirius companion, No. 36, and the stars south of -50° ; for the latter the Harvard types were used when available. Miss Hoffleit has revised some of the Harvard types⁶ and has very kindly supplied revisions for a few additional stars. All her revised types are designated by an asterisk in Table 1. The unchanged HD types are italicized. For a few stars Luyten's color class⁵ is given.

* *Contributions from the McDonald Observatory, University of Texas*, No. 44.

¹ *Harvard Obs. Mimeograms*, Ser. III, Nos. 1 and 2, 1938.

² *Pub. Astr. Obs. Potsdam*, 17, 1907.

³ *Ap. J.*, 80, 319, 1934.

⁴ *Ap. J.*, 91, 117, 1940.

⁵ *Pub. Obs. Minnesota*, 3, No. 1, 1941.

⁶ *Harvard Ann.*, 105, 45, 1937.

TABLE 1

No.	Name	α (1900) δ	$m(v)$	Sp	μ	θ	$p(t)$	$p(Sp)$	V_r	$M(v)$
1...	+43°44 A	0 ^h 12 ^m 7 +43°27'	8.1	M2	2".90	82°	284±5	250	+ 8±2	10.4
2...	 B	.....	10.9	M5+	.....	.....	.....	.....	.....	13.2
3...	ζ Tuc	0 14.9 -65 28	4.38	Go*	2.07	56	138±7	.....	+ 9±0	5.1
4...	β Hyi	0 20.5 -77 49	2.93	Gr*	2.25	82	143±6	.....	+ 23±0	3.7
5...	+66°34 A	0 26.3 +66 42	10.38	M2+	1.76	96	103±7	96	- 4±6†	10.4
6...	 B	.....	12.3	M4+	.....	.....	.....	.....	.....	12.4
7...	54 Psc	0 34.2 +20 43	5.97	K1	0.59	232	104±6	110	- 34±1	6.1
8...	η Cas A	0 43.0 +57 17	3.60	Go	1.22	115	182±5	143	+ 9±0	4.9
9...	η Cas B	.....	7.34	K6	.....	.....	.....	.....	+ 13±2	8.6
10...	HR 222	0 43.1 + 4 46	5.86	K2	1.37	147	148±6	134	- 13±1	6.7
11...	vMaanen 2	0 43.9 + 4 55	12.4	wG	3.00	155	243±6	.....	(+238)	14.3
12...	-31°325	0 48.1 -30 54	7.17	K3	0.62	86	107±9	84	.....	7.3
13...	+70°68b	0 55.1 +71 09	9.9	M3	1.78	102	109±5	140	0±5†	10.1
14...	+61°195	0 56.3 +61 48	9.5	M1+	0.74	82	.....	120	- 6±4†	9.9
15...	Wolf 47	0 57.0 +61 50	13.7	M7	0.82	80	.....	140	.....	14.4
16...	μ Cas	1 01.6 +54 26	5.19	G5	3.77	115	133±5	105	- 97±0	5.8
17...	-68°41	1 06.7 -68 00	11.4	k	0.71	33	111±10	.....	.....	(11.6)
18...	p Eri A	1 36.0 -56 42	6.03	K2*	0.27	85	150±5	.....	.....	6.9
19...	p Eri B	.....	6.07	K2*	.....	.....	.....	.....	.....	7.0
20...	107 Psc	1 37.1 +19 47	5.37	K0	0.73	204	132±6	130	- 33±0	6.0
21...	τ Cet	1 39.4 -16 28	3.66	G5	1.92	297	298±6	210	- 16±0	6.0
22...	HR 511	1 40.5 +63 22	5.66	K1	0.64	113	111±5	130	+ 2±1	5.9
23...	Ross 555	1 46.8 -11 17	11.2	M4	0.80	135	.....	110	.....	11.4
24...	Ross 15	1 52.5 +58 14	12.1	M5	0.39	130	.....	110	.....	12.3
25...	+2°348	2 07.4 + 3 10	10.3:	M2	2.58	223	95±7	95	.....	10.2
26...	HR 753 A	2 30.6 + 6 25	6.00	K3	2.32	51	144±5	150	+ 23±0	6.8
27...	 B	.....	11.5	M6	.....	.....	.....	.....	.....	12.3
28...	Ross 556	2 38.4 +25 06	10.5	M4	0.90	112	.....	150	.....	11.4
29...	HR 857	2 47.7 -13 11	6.10	K2:	0.43	113	134±10	120:	+ 28±3†	6.7
30...	κ Cet	3 14.1 + 3 00	5.07	G4	0.28	70	106±5	100	+ 19±0	5.2
31...	ζ^2 Ret	3 16.0 -62 53	5.19	G3*	1.48	64	105±8	.....	+ 12±0	5.3
32...	ζ^1 Ret	.....	5.51	G4*	.....	.....	.....	.....	+ 12±1	5.6
33...	82 Eri	3 15.9 -43 27	4.29	G5	3.15	76	159±7	160	+ 87±0	5.3
34...	ϵ Eri	3 28.2 - 9 48	3.75	K2	0.98	271	303±6	350	+ 15±0	6.2
35...	-45°1184	3 29.6 -45 03	11.0:	M4	0.35	294	83±11	120:	.....	10.6:
36...	-48°1011	3 31.9 -48 46	9.3	K5	0.50	51	107±12	.....	.....	9.4
37...	δ Eri	3 38.5 -10 06	3.63	K0	0.75	353	110±4	.....	- 6±0	3.8
38...	-1°565 A	3 52.4 - 1 27	8.6	K4	0.24	229	101±10	58	.....	8.6
39...	 B	.....	12.0	M3+	.....	.....	.....	.....	.....	12.0
40...	Wolf 1322	3 53.8 +25 49	12.2	M5	0.80	94	.....	95	.....	12.1
41...	40 Eri A	4 10.7 - 7 49	4.52	K1	4.08	213	202±3	220	- 42±0	6.0
42...	 B	.....	9.62	wA	.....	.....	.....	.....	.....	11.1
43...	 C	.....	11.1	M6	.....	.....	.....	.....	.....	12.6
44...	Ross 594	4 23.6 +39 39	13.7	M6	0.53	180	.....	100	.....	13.7
45...	+18°683	4 37.0 +18 47	9.8	M2+	1.25	149	104±6	130	.....	9.9
46...	π^3 Ori	4 44.4 + 6 47	3.32	F6	0.47	88	128±5	130	+ 25±0	3.9
47...	Wolf 1539	4 46.7 + 6 19	11.8	M5	0.32	152	.....	115	.....	12.1
48...	HR 1614	4 55.9 - 5 52	6.38	K4	1.22	153	107±4	140	+ 24±1	6.5
49...	-45°1841	5 07.7 -44 59	8.8	Mo	8.72	131	262±6	.....	+242±1	10.9
50...	Ross 41	5 22.6 + 9 35	12.5	M5	0.89	192	108±5	91	.....	12.7
51...	-3°1123	5 26.4 - 3 42	8.1	M1	2.24	160	166±4	200	+ 11±1	9.2
52...	Ross 42	5 26.7 + 9 45	11.4	M6	0.30	243	.....	250	.....	13.4
53...	HR 1925 A	5 33.2 +53 26	6.30	K2	0.52	179	97±5	100	+ 1±1	6.2
54...	 B	.....	9.8	M1	.....	.....	.....	.....	.....	9.7
55...	Ross 47	5 36.4 +12 29	11.7	M5+	2.54	127	166±8	170	.....	12.8
56...	Wolf 237	5 39.5 +44 06	12.4	M5	0.67	235	.....	100	.....	12.5
57...	γ Lep A	5 40.3 -22 29	3.83	F6	0.47	219	122±4	115	- 10±0	4.3
58...	γ Lep B		6.30	K3					- 10±1	6.7
59...	χ^1 Ori	5 48.5 +20 15	4.52	Go	0.20	245	104±6	100	- 14±0	4.6

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TABLE 1—Continued

No.	Name	α (1900) δ	$m(v)$	Sp	μ	θ	$p(l)$	$p(Sp)$	V_r	$M(v)$
60...	AC 82°1111	5 ^h 49 ^m 1 +82°08'	10.1	M2+	1".30	5°	108±8	115	— 21±2†	10.3
61...	Ross 79	6 05.4 +10 21	10.4	M3+	0.93	174	.....	130	.....	11.0
62...	— 21°1377	6 06.4 — 21 49	8.2	Mo	0.72	191	183±6	150	.....	9.5
63...	α Men	6 13.2 — 74 43	5.12	G9*	0.25	151	118±10	.....	+ 35±0	5.3
64...	Ross 417	6 14.5 — 6 36	12.8	M5+	0.67	187	.....	100	.....	12.8
65...	Ross 64	6 18.6 +23 30	13.6	M6	0.49	128	117±8	110	.....	13.9
66...	Ross 614	6 24.3 — 2 44	11.3	M6+	1.01	135	260±5	360	.....	13.4
67...	+17°1320	6 31.5 +17 38	9.5	Mo	0.86	293	100±5	83	— 59±2	9.5
68...	α CMa A	6 40.7 — 16 35	— 1.52	A1	1.32	204	376±3	360	— 8±0	1.4
69...	 B	.....	8.54	wA5	.....	.....	.....	.....	(+12)	11.4
70...	— 5°1844	6 47.4 — 5 03	6.60	K3	0.54	270	95±7	110	— 10±2	6.5
71...	Wolf 204	6 48.4 +33 24	9.9	M3	0.86	240	161±9	140	.....	10.9
72...	— 44°3045	6 54.9 — 44 09	10.8	M5	1.13	264	.....	170	.....	12.3
73...	Ross 986	7 03.3 +38 43	12.0	M5	1.12	208	.....	130	.....	12.5
74...	+5°1668	7 22.0 + 5 32	10.0	M4+	3.75	171	262±6	240	+ 22±2†	12.1
75...	+36°1638	7 25.4 +36 26	10.8	M4	0.41	224	.....	130	.....	11.4
76...	Ross 989	.....	12.2	M5+	.....	.....	.....	.....	.....	12.8
77...	α CMi A	7 34.1 + 5 29	0.53	F4	1.25	214	291±4	400	— 3±0	2.8
78...	 B	.....	10.8	.....	.....	.....	.....	.....	.....	13.1
79...	L 745-46	7 35.8 — 17 10	13.1	wF	1.29	117	177±14	.....	.....	14.3
80...	β Gem	7 39.2 +28 16	1.34	G8	0.62	265	100±10	.....	+ 3±0	1.3
81...	Ross 882	7 39.4 + 3 48	11.6	M6	0.64	218	.....	230	.....	13.4
82...	L 97-12	7 52.6 — 67 30	14.5	f-g	2.05	135	170±30	.....	.....	15.6
83...	Ross 619	8 06.5 + 9 11	12.5	M6	5.40	167	154±7	140	.....	13.4
84...	L 829-19 A	8 49.2 — 12 45	12.4	M6	0.62	144	.....	130	.....	12.9
85...	 B	.....	12.7	.....	.....	.....	.....	.....	.....	13.2
86...	Ross 686	8 55.6 + 5 38	12.1	M5	0.47	221	.....	100	.....	12.1
87...	Ross 687	.....	12.5	M5	.....	.....	.....	.....	.....	12.5
88...	+53°1320	9 07.6 +53 07	7.90	K7	1.68	248	162±3	130	+ 10±1	8.9
89...	+53°1321	.....	8.01	K9	.....	.....	.....	.....	+ 11±1	9.0
90...	— 59°1362	9 19.2 — 59 52	10.0	Mo	0.87	282	120±11	.....	.....	10.4
91...	Ross 439	9 24.0 — 6 55	11.6	M4+	0.71	191	.....	115	.....	11.9
92...	— 12°2018	9 26.5 — 13 03	10.2	M4	0.75	92	79±12	170	.....	11.
93...	11 LMi A	9 29.7 +36 16	5.48	G8	0.75	250	95±5	91	+ 13±0	5.4
94...	 B	.....	13.0	.....	.....	.....	.....	.....	.....	12.9
95...	— 45°5378	9 40.7 — 45 17	10.6	M4	0.75	218	103±11	140	.....	10.7
96...	— 45°5627s	9 54.6 — 45 57	11.6	M4+	0.69	135	.....	115	.....	11.9
97...	+50°1725	10 05.3 +49 58	6.54	K8	1.45	249	220±8	260	— 27±1	8.2
98...	+20°2465	10 14.2 +20 22	9.46	M5	0.49	265	193±8	330	+ 9±2	10.9
99...	+1°2447	10 23.9 + 1 21	9.6	M2	0.98	219	130±7	130	— 3±5†	10.2
100...	L 1113-55	10 30.9 + 5 38	12.2	M6	0.68	280	.....	170	.....	13.4
101...	Wolf 358	10 45.8 + 7 22	11.5	M5	1.21	224	136±7	150	.....	12.2
102...	Wolf 359	10 51.6 + 7 36	13.5	M8	4.76	234	403±10	360	— 90	16.5
103...	Ross 104	10 54.8 +23 22	10.3	M3	0.45	238	.....	120	.....	10.7
104...	+36°2147	10 57.9 +36 38	7.47	M2+	4.78	187	388±6	380	— 87±2	10.4
105...	+44°2051 A	11 00.5 +44 02	8.7	Mo+	4.53	282	174±8	140	+ 64±4	9.9
106...	 B	.....	14.8	M8	.....	.....	.....	.....	.....	16.0
107...	ξ UMa A	11 12.9 +32 06	4.41	F9	0.73	216	138±6	90	— 16±0	5.1
108...	 B	.....	4.87	Go	.....	.....	.....	.....	— 16±0	5.6
109...	+66°717	11 14.8 +66 23	9.3	M1	2.95	273	120±5	115	+ 47±2	9.7
110...	61 UMa	11 35.8 +34 46	5.34	G4	0.39	182	109±9	90	— 5±0	5.5
111...	L 1405-28	11 36.9 +27 17	10.9	M3	1.06	138	.....	95	.....	10.8
112...	I(UC37)	11 40.5 — 64 17	12.5	b	2.68	97	193	.....	.....	(13.9)
113...	AC 79°3888	11 41.3 +79 14	11.0	M4+	0.87	57	201±10	150	.....	12.5
114...	Ross 128	11 42.6 + 1 23	11.0	M5+	1.40	151	.....	230	.....	12.8
115...	β Vir	11 45.5 + 2 20	3.73	F8	0.79	110	101±7	120	+ 5±0	3.8
116...	HR 4550	11 47.2 +38 26	6.42	G6	7.04	145	108±4	.....	— 98±1	6.6
117...	L 901-10	11 48.2 — 6 49	11.9	M4+	0.54	196	.....	100	.....	11.9
118...	— 26°8883	11 53.0 — 27 08	7.00	K4	1.25	240	98±11	110	.....	7.0

TABLE 1—*Continued*

No.	Name	α (1900) δ	$m(v)$	Sp	μ	θ	$p(t)$	$p(Sp)$	V_r	$M(v)$
119...	Ross 689	12 ^h 00 ^m 6 +70°06'	13.1	M6	0".59	258°	.....	110	.....	13.3
120...	Ross 690	12 18.4 +64 35	11.2	M4	0.73	305	.....	110	.....	11.4
121...	Ross 695	12 19.6 -17 38	11.7	M4+	2.53	154	.....	110	.....	11.9
122...	L 68-28	12 22.8 -70 56	15.7	.....	1.17	339	152±47	.....	.....	(16.6)
123...	L 68-29	.....	17.7	.....	.....	.....	.....	.....	.....	(18.6)
124...	Wolf 414	12 23.9 + 8 59	11.8	M5	0.70	232	.....	115	.....	12.1
125...	Wolf 424 A	12 28.4 + 9 34	12.7	M7	1.84	278	225±7	250	.....	14.5
126...	 B	.....	12.7							
127...	β CVn	12 29.0 +41 54	4.32	Go	0.76	292	108±6	110	+ 7±0	4.5
128...	Wolf 427	12 30.0 +10 23	11.1	M4	0.56	236	.....	115	.....	11.4
129...	-51°6859	12 32.5 -51 27	11.2	.....	1.02	271	117±11	.....	.....	(11.5)
130...	Wolf 437	12 43.0 +10 18	11.13	M4	1.06	243	106±8	130	.....	11.3
131...	AC 66°3955	12 45.1 +66 40	10.5	M3	0.44	259	117±9	110	-18±4†	10.8
132...	+0°2989	12 45.6 - 0 13	8.50	K8	0.40	186	98±7	105	.....	8.5
133...	Wolf 461	12 55.6 + 6 13	13.2	M6	1.01	290	.....	120	.....	13.6
134...	+13°2618	12 55.9 +12 54	9.9	M1	0.70	268	.....	95	.....	9.8
135...	β Com	13 07.2 +28 23	4.30	Go	1.19	318	121±6	110	+ 6±0	4.7
136...	61 Vir	13 13.2 -17 45	4.83	G5	1.52	225	116±6	125	- 8±0	5.2
137...	Ross 486 A	13 23.2 - 1 50	11.4	M4+	0.51	160	.....	100	.....	11.4
138...	 B	.....	14.2	M6:	.....	.....	.....	.....	.....	14.2
139...	+11°2576	13 24.9 +10 55	9.2	M1	1.51	137	123±10	115	+ 12±2†	9.6
140...	Wolf 489	13 31.8 + 4 13	14.5	Con	3.94	252	130±9	.....	.....	15.1
141...	+15°2620	13 40.7 +15 26	8.58	M1+	2.30	129	191±8	180	+ 15±1	10.0
142...	η Boo	13 49.9 +18 54	2.85	F9	0.37	190	116±11	.....	0±0	3.2
143...	Ross 845	14 07.8 -11 33	13.5	M6	0.79	236	.....	95	.....	13.4
144...	-58°5467	14 12.0 -58 54	6.7	K0	0.96	209	114±9	.....	.....	7.0
145...	Ross 848	14 14.8 - 9 09	12.7	M5+	1.13	213	.....	105	.....	12.8
146...	Prox. Cen	14 22.8 -62 15	11.3	m	3.85	282	762±5	.....	.....	15.7
147...	-11°3759	14 28.9 -12 06	11.4	M4	0.69	334	.....	100	.....	11.4
148...	α Cen A	14 32.8 -60 25	0.33	G4*	3.67	281	756±7	.....	-22±0	4.7
149...	 B	.....	1.70	K1*	.....	.....	.....	.....	.....	6.1
150...	ξ Boo A	14 46.8 +19 31	4.81	G6	0.17	129	147±6	150	+ 4±0	5.7
151...	 B	.....	6.77	K6	.....	.....	.....	.....	+ 6±2	7.6
152...	HR 5568 A	14 51.6 -20 58	5.90	K4	1.99	149	172±4	180	+ 20±0	7.1
153...	 B	.....	8.08	Mo+	.....	.....	.....	.....	+ 25±4	9.2
154...	-7°4003	15 14.2 - 7 21	10.6	M4	1.25	266	151±5	140	- 30±2	11.5
155...	-40°9712	15 25.7 -40 54	10.2	M4:	1.57	229	166±5	170	.....	11.3
156...	λ Ser	15 41.6 + 7 40	4.45	G1	0.24	252	95±5	110	- 66±0	4.3
157...	Gron. 20	16 21.1 +48 36	10.3	M2+	1.23	111	132±14	105	.....	10.9
158...	-12°4523	16 24.7 -12 25	9.8	M4	1.17	186	255±5	210	.....	11.8
159...	ζ Her A	16 37.5 +31 47	3.06	Go	0.61	309	113±5	.....	- 71±0	3.3
160...	 B	.....	5.86	.....	.....	.....	.....	.....	.....	6.1
161...	+33°2777	16 41.4 +33 41	8.21	K6	0.37	352	113±6	91	- 31±2	8.5
162...	-8°4352 A	16 50.1 - 8 09	9.90	M3+	1.19	222	148±4	150	+ 11±2	10.8
163...	 B	.....	10.00							
164...	 C	.....	11.5	M5+	.....	.....	.....	.....	.....	12.4
165...	+45°2505 A	17 09.2 +45 50	10.04	M3+	1.59	171	143±6	140	- 19±3	10.8
166...	 B	.....	10.34							
167...	36 Oph A	17 09.2 -26 27	5.17	K2	1.24	203	179±5	180	- 1±0	6.4
168...	 B	.....	5.20	K1	.....	.....	.....	.....	- 1±0	6.5
169...	 C	.....	6.53	K6	.....	.....	.....	.....	- 10±1	7.8
170...	HR 6416 A	17 11.5 -46 32	5.62	K0	1.00	78	132±6	120	+ 19	6.2
171...	 B	.....	8.8	Mo+	.....	.....	.....	.....	.....	9.4
172...	HR 6426 A	17 12.1 -34 53	6.28	K3	1.18	99	147±6	120	0±1	7.1
173...	 B	.....	7.0	K4	.....	.....	.....	.....	.....	7.8
174...	 C	.....	10.16	M2+	.....	.....	.....	.....	.....	11.0
175...	Ross 868	17 16.0 +26 42	11.2	M5	0.47	342		130		11.8
176...	Ross 867		13.4	M6						14.0
177...	+2°3312	17 20.8 + 2 14	7.53	K7	1.33	206	124±5	140	- 29±1	8.0

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TABLE 1--Continued

No.	Name	α (1900) δ	$m(v)$	Sp	μ	θ	$p(t)$	$p(Sp)$	V_r	$M(v)$
178...	-46°11540	17 ^h 21 ^m 1 -46°47'	9.7	M3+	1.07	148°	225±6	180		11.5
179...	-44°11909	17 29.8 -44 14	10.9	M5	1.15	217	208±6	190	.....	12.5
180...	Slocum An.	17 33.4 +18 37	9.8	Mo+	1.39	43	113±9	83	- 10±1	10.1
181...	+68°946	17 37.0 +68 26	9.13	M3+	1.31	196	213±5	240	- 17±3	10.8
182...	I(UC 48)	17 38.2 -57 14	12.7	.....	1.72	219	158±7	.....	.....	(13.7)
183...	+43°2796	17 40.9 +43 26	10.41	M2	0.61	181	102±7	91	.....	10.4
184...	μ Her A	17 42.5 +27 47	3.47	G7	0.81	203	109±6	.....	- 16±0	3.7
185...	 B	.....	10.36	M4	.....	.....	.....	150	.....	10.6
186...	 C	.....	10.66		.....	.....	.....	.....	.....	10.8
187...	+4°3561	17 52.9 + 4 25	9.46	M5+	10.25	356	543±3	440	- 110±4	13.1
188...	-3°4233	17 59.8 - 3 02	9.2	M1	0.62	112	131±9	120	.....	9.8
189...	70 Oph A	18 00.4 + 2 31	4.19	K1	1.13	167	196±4	230	- 7±0	5.7
190...	 B	.....	5.87	K5	.....	.....	.....	.....	- 7±0	7.3
191...	HR 6806	18 06.3 +38 27	6.39	K2	0.57	213	98±7	105	- 18±2	6.4
192...	L 1064-75	18 11.3 + 1 29	12.4	M5	0.73	213	.....	95	.....	12.3
193...	χ Dra	18 22.9 +72 41	3.62	F8	0.63	125	122±7	120	+ 33±0	4.3
194...	α Lyr	18 33.6 +38 41	0.17	A0	0.34	35	121±4	140	- 14±0	0.6
195...	+59°1915 A	18 41.7 +59 29	8.92	M3+	2.28	324	282±4	240	0±2	11.2
196...	 B	.....	9.73	M4	.....	.....	.....	.....	+ 7±3	12.0
197...	Ross 154	18 43.6 -23 56	10.5	M5+	0.67	106	350±6	290	.....	13.2
198...	Ross 730	19 02.9 +20 44	10.7	M1+	0.57	234	115±8	66	.....	11.0
199...	Ross 731	.....	10.7	M1+	.....	.....	.....	.....	.....	11.0
200...	17 Lyrae C	19 03.8 +32 21	11.77	M5	1.66	49	127±4	120	.....	12.3
201...	 D	.....	12.07		.....	.....	.....	.....	.....	12.6
202...	Wolf 1062	19 07.0 + 2 44	11.3	M4	1.95	103	105±7	105	.....	11.4
203...	+4°4048	19 12.1 + 5 02	9.2	M3	1.46	204	170±4	200	.....	10.4
204...	L 347-14	19 13.4 -45 42	13.4	m	2.94	168	182±9	.....	.....	(14.7)
205...	σ Dra	19 32.6 +69 29	4.73	G9	1.84	162	181±4	170	+ 27±0	6.0
206...	Ross 165 A	19 41.7 +26 55	12.7	M5+	1.34	183	116±11	110	.....	13.0
207...	 B	.....	13.7	.....	.....	.....	.....	.....	.....	14.0
208...	α Aql	19 45.9 + 8 36	0.91	A5	0.66	54	208±5	170	- 26±2	2.5
209...	δ Pav	19 58.9 -66 26	3.67	G7*	1.65	134	174±8	.....	- 22±0	4.9
210...	HR 7703 A	20 04.6 -36 21	5.24	K2	1.63	164	177±9	170	- 131±0	6.5
211...	 B	.....	11.5	M5	.....	.....	.....	.....	.....	12.7
212...	-45°13677	20 06.7 -45 28	8.4	Mo	0.80	102	145±9	140	.....	9.2
213...	HR 7722	20 09.1 -27 20	5.56	K1	1.25	98	110±6	130	- 56±1	5.8
214...	AC 65°6955	20 29.1 +65 05	10.56	M3+	0.53	58	136±8	120	.....	11.2
215...	-32°16135 A	20 35.6 -32 47	10.9	M5	0.45	140	.....	200	+ 5	12.4
216...	 B	.....	11.1	M5+	.....	.....	.....	.....	.....	12.6
217...	-31°17815	20 39.0 -31 42	8.7	M1+	0.45	140	.....	170	+ 10	9.9
218...	Wolf 1084	20 40.5 +54 57	15.3	M7+	1.87	21	.....	110	.....	15.5
219...	Furuj. 53	20 41.5 +44 08	10.6	M3	0.50	58	.....	105	.....	10.7
220...	+61°2068	20 51.3 +61 48	8.7	Mo+	0.77	180	138±5	140	- 9±2	9.4
221...	Furuj. 54 A	20 56.2 +39 41	10.26	M2	0.67	113	97±8	95	- 57±3	10.2
222...	 B	.....	12.3	.....	.....	.....	.....	.....	.....	12.2
223...	61 Cyg A	21 02.4 +38 15	5.35	K3	5.20	52	296±3	200	- 65±0	7.7
224...	 B	.....	6.05	K5	.....	.....	.....	.....	- 63±1	8.4
225...	-39°14192	21 11.4 -39 15	6.65	Mo	3.47	251	257±7	310	+ 22±2	8.7
226...	γ Pav	21 18.2 -65 49	4.35	F8*	0.80	6	124±9	.....	- 30±0	4.8
227...	Ross 775	21 24.8 +17 12	10.4	M4+	1.10	69	150±10	200	.....	11.3
228...	Wolf 922	21 25.8 -10 14	11.5	M4+	1.19	93	161±10	120	.....	12.5
229...	-49°13515	21 26.9 -49 26	8.9	M3	0.82	185	207±10	230	.....	10.5
230...	-60°7528	21 52.3 -60 13	11.4	K:	0.87	96	97±9	.....	.....	(11.3)
231...	ϵ Ind	21 55.8 -57 12	4.70	K5*	4.69	123	288±6	.....	- 40±0	7.0
232...	Ross 265	21 57.0 +16 07	10.7	M3	0.36	67	.....	100	.....	10.7
233...	+0°4810	21 57.1 + 0 56	9.24	Mo+	0.55	248	.....	110	+ 20±6†	9.6
234...	-5°5715	22 04.4 - 5 08	10.2	M4	1.03	91	.....	170	.....	11.4
235...	Wolf 1561 A	22 12.1 - 9 18	13.5	M6	0.55	240	.....	100	.....	13.5
236...	 B	.....	14.5	M7	.....	.....	.....	.....	.....	14.5

TABLE 1—*Continued*

No.	Name	α (1900) δ	$m(v)$	Sp	μ	θ	$p(t)$	$p(Sp)$	V_r	$M(v)$
237...	+56°2783 A	22 ^h 24 ^m 4 +57°12'	9.87	M4	0".90	245°	256±4	220	— 24±2	11.9
238...	 B	.....	11.3	M6	.....	.....	.....	.....	.....	13.3
239...	I(UC 53)	22 31.5 -65 54	12.8	.....	0.82	102	96±10	.....	.....	(12.7)
240...	L 789-6	22 33.0 -15 52	12.3	M6+	3.27	46	328±11	230:	.....	14.9
241...	+43°4305	22 42.5 +43 49	10.25	M5	0.85	237	207±7	250	+ 2±2	11.8
242...	-15°6290	22 47.9 -14 47	10.27	M5	1.11	123	220±11	250	.....	12.0
243...	HR 8721	22 50.8 -32 06	6.33	K3	0.36	117	121±10	135	.....	6.7
244...	+15°4733	22 51.8 +16 02	8.6	M2	1.10	255	161±7	210	- 19±1†	9.6
245...	α PsA	22 52.1 -30 09	1.37	A3	0.37	117	135±8	120	+ 6±0	2.0
246...	-23°17609	22 55.0 -23 04	8.11	K0	0.92	274	125±7	140	+ 16±2	8.6
247...	-36°15693	22 59.4 -36 26	7.23	Mo+	6.90	79	278±6	270	+ 10±1	9.4
248...	HR 8832	23 08.5 +56 37	5.55	K3	2.09	82	146±6	180	- 20±1	6.4
249...	-73°2299	23 33.7 -73 15	7.36	K0	0.74	170	135±10	.....	.....	8.0
250...	Ross 248	23 37.0 +43 39	12.2	M6+	1.82	176	314±7	240:	.....	14.7
251...	+1°4774	23 44.0 + 1 52	9.10	M2	1.37	134	167±6	170	- 64±3	10.2
252...	85 Peg A	23 56.9 +26 33	5.91	G5	1.30	140	95±5	76	- 36±1	5.8
253...	 B	.....	8.7	.....	.....	.....	.....	.....	.....	8.6
254...	-37°15492	23 59.5 -37 51	8.57	M3	6.11	112	222±7	260	+ 24±2	10.3

NOTES TO TABLE 1

Double-star notes refer to the discoverer of the companion, to ADS or SDS, the distance and the position angle, or the orbital elements if the latter are known.

- 1, 2. OΣ, no number = ADS 246; A = Groombridge 34; 38", 53°-58°.
- 5, 6. Vyssotsky; ADS 440 = ADS 433; 3".0, 98°-122°.
- 8, 9. Σ60 = ADS 671; $P = 526^a$, $a = 12".53$, $e = 0.53$; masses 0.72 and 0.46.
13. Found to have common proper motion with the binary 5, 6, at Greenwich (*Astr. Cat.*, 5, 146, 1929) in spite of large angular distance ($5".1 = 18500''$); the near-equality of the p values, as well as Popper's V_r values, enhances the probability of nearly parallel space motions. But, since the velocity of escape is only 0.1 km/sec, the physical connection is still uncertain, and the star has not been included in the counts. $D = 0.84$ parsecs; $\log D = 5.24$ (in astronomical units).
- 14, 15. Probably common proper motion; $d = 294''$.
- 18, 19. Dunlop 5, SDS; orbit indeterminate (Finsen, *Union Circ.*, No. 100).
- 26, 27. Van Maanen; 164'', 100°.
- 31, 32. Meridian catalogues; $d = 309".8$ (G.C.).
- 38, 39. β 543 = ADS 2894; 11', 32°-26°; p (dyn.) = 0".095 (Russell and Moore).
- 41, 42. Σ 518 AB = ADS 3093; 83'', 105°.
- 42, 43. Σ 518 BC; $P = 248^a$, $a = 6".80$, $e = 0.40$; masses 0.45 and 0.20.
48. Probably spectroscopic binary (*Lick Obs. Pub.*, Vol. 18); confirmed by high value of $p(Sp)$.
49. Kapteyn's star; nearest subdwarf.
- 53, 54. Burnham (β PM); 97'', 70°.
- 57, 58. S 408 = ADS 4334; 95'', 350°.
66. Reuyl found this star to have a "dark" companion.
- 68, 69. A. C. Clark 1 = ADS 5423; $P = 49.94^a$, $a = 7".62$, $e = 0.59$; masses 2.35 and 0.98. Reality of duplicity of B still doubtful; cf. *Observatory*, 52, 22-25, 1929.
72. Double ($d = 1".5$) according to Luyten (*Pub. Obs. Minnesota*, 3, 1941).
- 75, 76. Ross; 38".6, 354°.
- 77, 78. Schaeberle 1 = ADS 6251; $P = 40.23^a$, $a = 4".26$, $e = 0.31$; masses 1.48 and 0.46.
82. Parallax and color class by Luyten (*Harvard Anno. Card*, No. 602, 1941).
- 84, 85. Stearns 9 (*A.J.*, No. 1101; cf. also Luyten, *Harvard Bull.*, No. 906); $d = 2''$.
- 86, 87. Ross; 29".2, 115°.
- 88, 89. Σ1321 = ADS 7251; 19'', 48°-75°.
92. Poor agreement between $p(Sp)$ and $p(t)$; close binary?
- 93, 94. Hu 1128 = ADS 7441; 6''-2'', 35°-26°.
103. Possibly close binary.
- 105, 106. Van Maanen; 28".1, 134°. B variable (van Maanen, *Ap. J.*, 91, 505, 1940).
- 107, 108. Σ1523 = ADS 8119; $P = 59.86^a$, $a = 2".536$, $e = 0.41$; combined mass 1.7 (presumably A = 1.0 and B = 0.7, roughly). A was found to be a spectroscopic binary by W. H. Wright; $P = 669^d$. Van

den Bos found $a_1 = 0''.051$, $e = 0.53$. B is also a spectroscopic binary (Lick); $P = 3^d.98$. The mass function of Bb is excessively small, giving for b 's mass 0.03 as lower limit.

112. Color class by Luyten (*Harvard Ann. Card*, No. 602, 1941), who also quotes a parallax derived at the Cape.

122, 123. Luyten, $d = 15''$; rough parallax by Luyten (*Harvard Bull.*, No. 910).

125, 126. Reuyl, $d = 1''$; rapid motion. Unpublished Yerkes parallax incorporated by courtesy of Dr. Titus.

137, 138. Kuiper; $d = 10''$.

140. Color class about $g8$.

142. Spectroscopic binary (J. H. Moore); $P = 492^d$, $e = 0.23$. Orbit should be measurable photographically ($a_1 \geq 0''.04$).

146, 148. Innes; $d = 2''.2 = 7849''$.

148, 149. Richaud, SDS; $P = 80.09^a$, $a = 17''.665$, $e = 0.52$; masses 1.10 and 0.89.

150, 151. $\Sigma 1888 = \text{ADS } 9413$; $P = 150^a$, $a = 4''.88$, $e = 0.51$; masses 0.88 and 0.75.

152, 153. Herschel; $\text{ADS } 9446$; $10''-20''$, $251^\circ-300^\circ$.

159, 160. $\Sigma 2084 = \text{ADS } 10157$; $P = 34.42^a$, $a = 1''.35$, $e = 0.46$; masses 0.89 and 0.55.

162, 163. Kuiper; $P = 1.72^a$, $a = 0''.19$, $e = 0.04$; average mass 0.36. The most rapid visual binary known.

162, 164. Wolf; $d = 72''$.

165, 166. Kuiper; unpublished orbit by Van Biesbroeck: $P = 13.37^a$, $a = 0''.74$, $e = 0.75$; average mass 0.39.

167, 168. $\text{Sh } 243 = \text{ADS } 10417$; $4''$, $227^\circ-178^\circ$. Remarkably small $p(\text{dyn.})$, $0''.045$, indicating high orbital inclination.

167, 169. Meridian catalogues; $732''.1$, $74^\circ.2$. Difference in V_r unexplained.

170, 171. Brs 13, SDS; orbit indeterminate (Finsen).

172, 173. Mlb. 4, SDS; $P = 42.2^a$, $a = 1''.83$, $e = 0.55$. Total mass 1.1.

172, 174. h 4935, SDS; $31''$, 134° .

175, 176. Ross; $15''.9$, 268° .

184, 185. $\Sigma 2220 = \text{ADS } 10786$; $30''-33''$, $241^\circ-246^\circ$.

185, 186. A. C. 7 = $\text{ADS } 10786$; $P = 43.02^a$, $a = 1''.287$, $e = 0.18$; average mass 0.44.

187. Barnard's star; largest proper motion known.

189, 190. $\Sigma 2272 = \text{ADS } 11046$; $P = 87.85^a$, $a = 4''.56$, $e = 0.50$; masses 0.90 and 0.73.

193. Spectroscopic binary (W. H. Wright); $P = 281^d$, $e = 0.42$. Alden found $a_1 = 0''.056$.

195, 196. $\Sigma 2398 = \text{ADS } 11632$; $12''-17''$, $134^\circ-157^\circ$.

198, 199. Ross; $114''.7$, 111° . Either $p(t)$ is too large, or stars are below main sequence.

200, 201. Kuiper; $d < 1/3''$, rapid motion; unpublished Yerkes parallax included, courtesy of Dr. Titus.

206, 207. Duplicity suspected by van Maanen, confirmed by Kuiper (*Ap. J.*, **84**, 360, 1936); $0''.5-0''.6$, $145^\circ-191^\circ$ (seven-year interval).

210, 211. h 5173, SDS; $d = 8''$.

215, 216. Duplicity found by Adams, Humason, and Joy (*Pub. A.S.P.*, **39**, 367, 1927); $3''$, 240° .

215, 217. Luyten found common proper motion, in spite of large distance ($1''.3 = 4700''$). Confirmed by Mount Wilson radial velocities and spectroscopic parallaxes; again confirmed here. All three components have strong emission lines, and p may be somewhat less than found here (cf. text, sec. 3).

221, 222. Kuiper; $1''$, $82^\circ-112^\circ$ (seven years).

223, 224. $\Sigma 2758 = \text{ADS } 14636$; $15''-26''$, $90^\circ-138^\circ$.

235, 236. Kuiper (*Ap. J.*, **92**, 126, 1940); $d = 8''$.

237, 238. Burnham discovered this important pair but called it Krüger 60 AB after a wide, faint optical pair without further interest. $P = 44.52^a$, $a = 2''.36$, $e = 0.41$; masses 0.25 and 0.14.

243, 245. Luyten (*A.J.*, **47**, 115, 1938) pointed out that these stars have nearly common motion and parallax; $d = 1''.96 = 7060''$. But measured radial velocities differ somewhat (Popper, unpublished).

252, 253. $\beta 733 = \text{ADS } 17175$; $P = 26.46^a$, $a = 0''.82$, $e = 0.41$. Included because of $p(t)$, though resulting masses indicate that p is probably well below $0''.095$. Abnormal mass ratio, $A/B = 1$, indicating that B may be double.

We have used all ten subdivisions of type K in order to avoid the need of half-tenths; but in class M the accuracy of the classification warrants the use of half-tenths. The M stars were classified by the strength of the red TiO band, which gives accurate results (cf. Fig. 1) and makes stars as faint as 18 mag. photographic easily accessible with the 82-inch telescope.

The proper motions are from the *General Catalogue* or, if not included therein, are based on all other published data. For several stars only the original "blink" results

were available; measurement of μ_δ as well as of μ_α in parallax determinations would supply the needed information.

The parallaxes are expressed in units of $0''.001$. The trigonometric results include two unpublished values kindly supplied by Dr. Titus. The spectral parallaxes were computed by supposing the star to be central on the main sequence; their usefulness is apparent from Table 1 (in the computation an extra decimal in the type was carried, the value being usually the mean of two or more independent determinations). However, in case of unresolved binaries they will, of course, be too large.

The radial velocities are mostly those in Moore's catalogue.⁷ Dr. Popper has generously made available several unpublished results, usually based on two plates per star; they are designated by a dagger. The dispersion used was 76 Å/mm at H γ . Much valuable work remains to be done in this field. The last column gives the absolute visual magnitude, computed from m and $p(t)$; if p has not yet been measured $p(Sp)$ was used, i.e., it was assumed that the star lies on the main sequence. In the case of binaries the weighted mean of $p(Sp)$ was used, and the components may then deviate somewhat from the main sequence, in the opposite sense. Values of M based on $p(Sp)$ are printed in italics. Parentheses indicate photographic M values.

Many additional details, especially with regard to duplicity, are found in the footnotes to the table.

3. *The Hertzsprung-Russell diagram.*—Figure 1 is based on the columns $M(v)$ and Sp . All spectral types except those printed in italics were used. White dwarfs have been plotted according to their color indices. The open circles correspond to italicized M values and should therefore be disregarded in the study of the scatter across the main sequence. The sun is added at 4.73 G2.⁸

Figure 1 shows one giant (No. 80), two subgiants (Nos. 37 and 184), and two or three "bright dwarfs" (Nos. 159, 142, and 77). (The run of the upper part of the main sequence was determined from a much larger number of stars than are shown in Fig. 1). Below the main sequence we find, first, seven white dwarfs and, further, two or more subdwarfs (Nos. 49, 116, and possibly 198 and 199), none of which is very extreme.

The vertical width of the main sequence is not much over 1 mag., so that the central line represents M with a p.e. not over ± 0.3 mag. The true width must be even less; but it is not zero, because some of the best-determined stars are definitely either somewhat below the central line (Nos. 21, 107, 108, 223, 224) or somewhat above (e.g., No. 98). In this connection it is of interest to mention the following preliminary result: There appears to be a correlation, for a fixed spectral type, between the strength of the emission lines and the deviation from the main sequence, in the sense that stars with stronger emission lines lie higher. In addition, there is an increase of the average strength of the emission lines with advancing type; types later than M6 seem all to have emission. Barnard's star is one of the latest types without pronounced emission. While this correlation rests only on a few dozen stars and needs further study, it seems to show that the emission is caused by certain astrophysical conditions smoothly varying over the Hertzsprung-Russell diagram and not by *mechanical* conditions (such as duplicity), which would inevitably entail an additional parameter (separation), which presumably would be independent of M and Sp . The astrophysical parameters might include, in addition to T and g , the hydrogen content, which, on the basis of evidence supplied by clusters, would be higher for the stars showing emission. A fuller discussion of this problem will be given in another paper.

4. *The luminosity function for the main sequence.*—Figure 2 shows three curves: the full-drawn curve a shows the numbers of main-sequence stars within 10.5 parsecs with $p(t)$ known (components of visual binaries are counted separately); b shows all the main-sequence stars known in that volume, the difference $b-a$ being the numbers added

⁷ *Pub. Lick Obs.*, 18, 1932.

⁸ *Ap. J.*, 88, 438, 1938.

spectroscopically in the writer's survey; while c (dashed line) gives a preliminary determination of the luminosity function of main-sequence stars, valid for the same volume of space. Curve c is based on a discussion, soon to be published of all data now available for the stars of large proper motion, including m and Sp observations of about 2000 stars by the writer. The difference $c-b$ shows how much remains to be discovered even for the nearest stars.

5. *Binary stars*.—While the sample of Table 1 is too small for a detailed study of the frequency of binary stars, some approximate results may nevertheless be obtained. First,

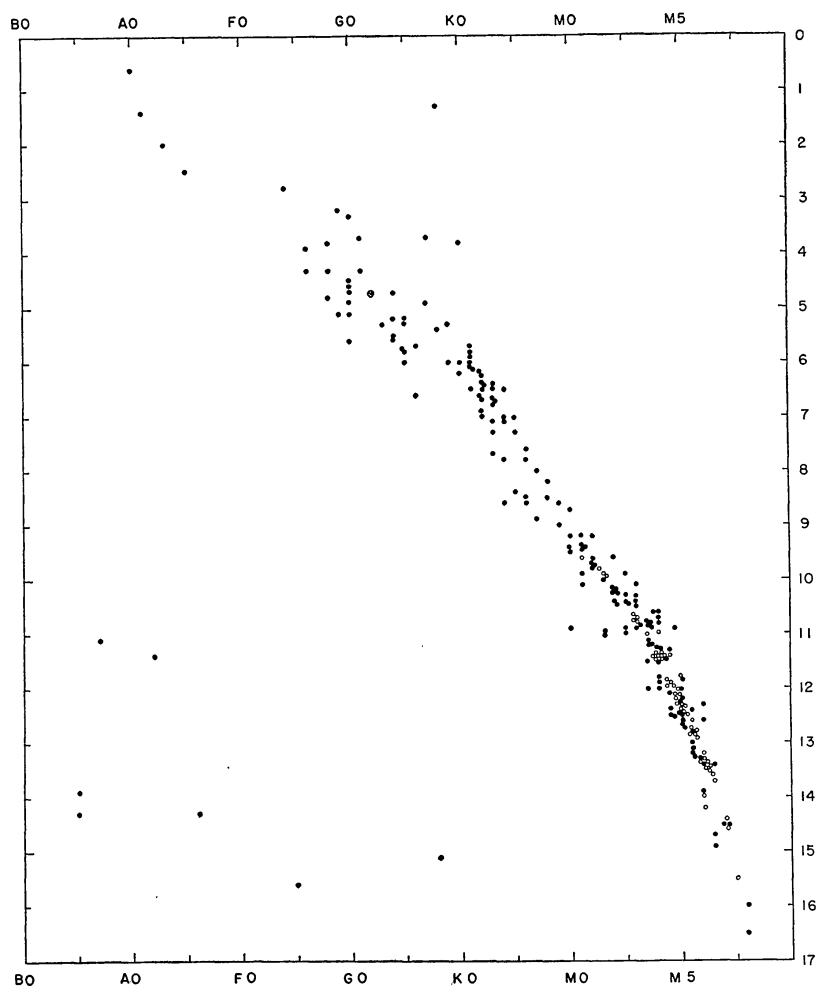


FIG. 1.—Hertzsprung-Russell diagram for the nearest stars

we subdivide the systems by spectral type; in case of duplicity or multiplicity the type of the primary is used. The counted numbers are in Table 2, the sun has been included. The 73 systems of types A–K have 36 known companions (109 components), or 50 per cent known doubles (in this way of counting, a triple counts as two doubles, a quadruple as three). This value is still well below the 80 per cent found several years ago,⁹ in a study which took account of the observational-selection factors; the amount of the difference seems not unreasonable.

Whether the M dwarfs have actually a smaller fraction of double stars, as Table 2

⁹ *Pub. A.S.P.*, 47, 139, 1935.

would indicate, or whether the result is wholly due to the faintness of these objects remains as yet an open question.

More significant than a subdivision by spectral type is a subdivision by total mass. For instance, if a binary with two dMo components were replaced by a single star having the combined mass, it would be a star closely resembling the sun. In order to be able to perform a count between limits of total mass we need to know the mass-luminosity relation expressed in terms of $M(v)$. Table 3 gives the relation for the main sequence, based on data compiled earlier.¹⁰

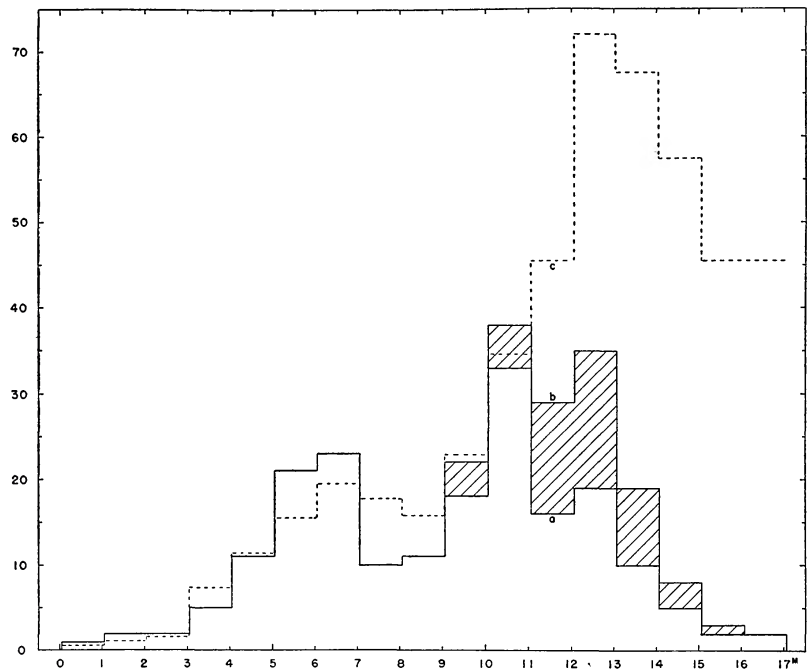


FIG. 2.—Luminosity function for the main sequence

TABLE 2

Type	A, F, G	K	A-K	M	WD	Type	A, F, G	K	A-K	M	WD
Single.....	24	20	44	99	5	Triple.....	2	3	5	2	0
Double.....	12	11	23	22	0	Quadruple.....	1	0	1	0	0

Table 4 gives the numbers between limits of total mass. The sun is included, but the five white dwarfs of Table 2 are omitted. It now appears that *of the masses larger than the sun more than two-thirds (0.68) are known to have divided up into two or more parts*; for the intervals 1.0-0.5-0.25-0.10 the fractions are, respectively, 0.3, 0.15, and 0.08. The true values must be higher than the minimum values found here, at least if we ignore the white dwarfs. While the latter are not very frequent if we classify stars by $M(v)$, as they account for only 3 per cent of the known near-by stars, they become of considerable prominence if stars are classified by mass; in fact, they are about as frequent as F dwarfs, and their masses are not very different. More data on the trigonometric parallaxes of the known white dwarfs¹¹ are urgently needed.

¹⁰ *Ap. J.*, **88**, 484, 1938. ¹¹ Cf. *Pub. A.S.P.*, **53**, 249, 1941.

In addition to the frequency of binaries, their distribution over the various possible separations is of interest. Since these separations vary through a range of 10^7 , we shall plot them on a logarithmic scale. If the orbit is known, $\log a$ may be derived; because for a visual binary $a = a''/p''$, while in a spectroscopic binary Kepler's third law may be used, together with a sufficiently accurate estimate of the combined mass. But for wide binaries only the apparent separation, d'' , taken for a certain standard epoch, and the parallax are known. If $D = d''/p''$, we may ask what correction should be made to

TABLE 3

$M(v)$	Mass	$M(v)$	Mass	$M(v)$	Mass
1.0.....	2.8	5.0.....	0.97	11.0.....	0.33
1.5.....	2.3	6.0.....	0.83	12.0.....	0.25
2.0.....	1.9	7.0.....	0.71	13.0.....	0.17
2.5.....	1.6	8.0.....	0.60	14.0.....	0.12:
3.0.....	1.4	9.0.....	0.51	15.0.....	0.09:
4.0.....	1.15	10.0.....	0.42		

TABLE 4

Mass	I.O 0.5 0.25 0.10					Mass	I.O 0.5 0.25 0.10				
Single.....	12	33	61	33	4	Triple.....	5	2	0	0	0
Double.....	20	11	11	3	0	Quadruple.....	1	0	0	0	0

$\log D$ in order that a correct average value of $\log a$ may be found. We shall use an earlier result,¹²

$$\log a = \log D + 0.11 \pm 0.14 \text{ (p.e.)}.$$

Because the individual values of $\log a$, or $\log D + 0.11$, are of interest, they are listed in Table 5. The standard epoch was taken to be 1940. Three possible binaries (Nos. 48, 92, and 103) were counted somewhat arbitrarily as two binaries with $\log a = +\frac{1}{2}$ and $-\frac{1}{2}$. They were included in Figure 3 together with the data of Table 5.

The broken curves of Figure 3 show the counted numbers grouped in two different ways; the smooth curve (open circles) gives the best representation. The curve is roughly Gaussian with a maximum near $\log a = 1.7$. In an earlier investigation,¹³ which took account of observational selection, a similar result was found, except that the maximum was at $\log a = 1.3$. The two results would seem to be quite consistent, in view of the fact that the higher value found here is distorted because of very incomplete discoveries of spectroscopic and close visual binaries. A larger volume of space than that considered here would be required for a proper statistical treatment, eliminating selection factors; even then only rough results could be expected, pending the completion of surveys now in progress.

¹² *Pub. A.S.P.*, 47, 127, 1935. In the text of this article the words "harmonic mean" should be replaced by "geometric mean."

¹³ *Ibid.*, pp. 128 and 138.

Finally, the seven triples and the one quadruple, giving effectively nine triples, may be used to determine a rough value of the geometric-mean ratio of the separations in the wide pair and the close pair. From the data in Table 5 we find

$$\overline{\Delta \log a} = 2.07 \pm 0.21 \text{ (p.e.)},$$

in which the p.e. refers to the mean itself, not to individual deviations. The geometric-mean ratio is therefore roughly 100; it may be slightly affected by the selection, which distorted certain results found earlier.

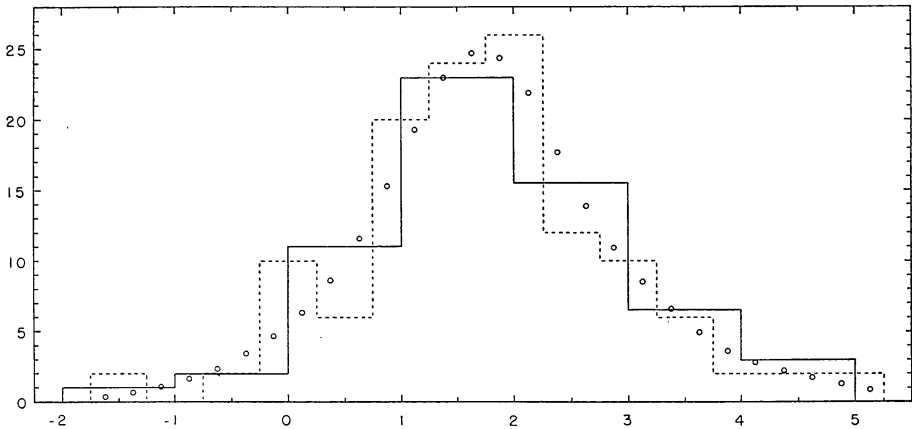


FIG. 3.—Numbers of observed binaries for unit interval of log *a*

TABLE 5

Pair	log <i>a</i> *	Pair	log <i>a</i>	Pair	log <i>a</i>	Pair	log <i>a</i>
1, 2.....	2.23	75, 76.....	2.58	148, 149.....	1.37	189, 190.....	1.37
5, 6.....	1.57	77, 78.....	1.17	150, 151.....	1.52	193.....	—0.03
8, 9.....	1.84	84, 85.....	1.37	152, 153.....	2.19	195, 196.....	1.88
14, 15.....	3.46	86, 87.....	2.58	159, 160.....	1.08	198, 199.....	3.11
18, 19.....	1.89	88, 89.....	2.17	162, 163.....	0.11	200, 201.....	0.2
26, 27.....	3.17	93, 94.....	1.53	162, 164.....	2.80	206, 207.....	0.84
31, 32.....	3.58	105, 106.....	2.32	165, 166.....	0.71	210, 211.....	1.78
38, 39.....	2.14	107, 108.....	1.26	167, 168.....	1.50	215, 216.....	1.31
41, 42.....	2.72	107.....	0.18	167, 169.....	3.72	215, 217.....	4.52
42, 43.....	1.53	108.....	—1.36	170, 171.....	1.52	221, 222.....	1.07
53, 54.....	3.11	122, 123.....	2.10	172, 173.....	1.10	223, 224.....	2.05
57, 58.....	3.00	125, 126.....	0.80	172, 174.....	2.44	235, 236.....	1.99
66.....	0.4	137, 138.....	2.11	175, 176.....	2.20	237, 238.....	0.97
68, 69.....	1.31	142.....	0.12	184, 185.....	2.59	243, 245.....	4.84
72.....	1.06	146, 148.....	4.12	185, 186.....	1.07	252, 253.....	0.94

* Figures in italics indicate that log *D* + 0.11 was used.

It is clear that for some of the problems discussed the volume considered here is really too small. Double the radius (i.e., *p* ≥ 0".05), or eight times the volume, would appear adequate. Fortunately, trigonometric parallaxes of some accuracy may be determined up to just that limit.

YERKES OBSERVATORY
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