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BY

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By Nancy G. Roman*

A search in recent literature for high-velocity stars revealed about fifty stars whose radial velocities were unknown but whose proper motions and spectral types indicated large space velocities. Many of these were A- and F-type stars for which the high proper motions, if correct, were particularly unusual. Thus it seemed desirable to complete the observational data for these stars by obtaining radial velocities as well as spectroscopic parallaxes and magnitudes. Dr. John F. Heard, Director of the David Dunlap Observatory, kindly agreed to the co-operation of that institution in this project. The author hoped originally that she could complete the major portion of the observing for the programme during a two and a half month visit to the David Dunlap Observatory early in 1953, but the faintness of the stars and unfavourable weather made this impossible. Instead, members of the observatory staff co-operated in securing the necessary plates during the following year.

The spectra were photographed with the 12½-inch camera on the one-prism spectrograph which gives a dispersion of 66 A./mm. at Hγ. These plates were taken and measured in the same manner as those for the large programme being carried out by the observatory on the radial velocities of stars in the A.G. zone, +25° to +30°. The measurement of a large number of standard stars taken in connection with both programmes indicates that the velocities are on the international system.[1] At least three good plates were obtained for each star. In addition, a number of less well exposed plates were also measured. These showed no systematic difference when compared with the stronger plates, but, as the accidental errors proved to be larger in most cases, the velocities from these weaker plates were included in the mean with half weight.

Table I contains the data for thirty-seven of these stars. The designation is either the H.D. number or the B.D. number. V, B-V and U-B are respectively the photoelectric yellow magnitude, the blue-yellow colour, and the ultra-violet-blue colour, on the

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V, B, U system[2] measured at the McDonald Observatory with the 13-inch reflector. The spectral types have been determined from plates of lower dispersion (near 120 A./mm. at Hγ) taken with either the 40-inch refractor of the Yerkes Observatory or the 82-inch reflector of the McDonald Observatory and are on the MK system.[2] For stars earlier than F2, it is impossible to distinguish between luminosity classes IV and V on the plates used, and for these stars the symbol "V" is used to indicate that the star is not a giant. It is likely that all of these stars are dwarfs. The probable errors are computed from the range of the individual velocities according to the factors given by Schlesinger.[3] An asterisk refers to a note at the end of the table.

For a few stars on the original list the high tangential velocities were found to be spurious because of errors in the published spectral types; several stars proved to be too faint for the programme; and two are in the *General Catalogue of Stellar Radial Velocities*[4] which appeared while the programme was in progress. Table II lists the data for eight of these stars for which at least one good plate was obtained before they were dropped from the list. These velocities are of much lower weight than those in Table I and are given only because, where no other measure is available, these might prove useful for statistical discussions. The arrangement of the data is the same as that in Table I.

Table III lists the proper motions, spectroscopic parallaxes, space velocities, and the elements of the galactic orbits for the stars in Tables I and II. The sources of the proper motions are as follows: Yale, the photographic repetition of the AG zones;[5] GC, the Boss *General Catalogue*;[6] Yerkes, a Yerkes parallax series; AGK_2, the *Zweiter Katalog der Astronomishen Gesellschaft*;[7] Oxf., the *Astrographic Catalogue*, Oxford Section;[8] and GFH, proper motions computed from the positions in the *Geschichte des Fixsternhimmels*,[9] in the *Index der Sternörter*,[10] and the Yale positions. X, Y, and Z are the velocities relative to the local centroid in the directions ($l = 57°.5$, $b = 0°$), ($l = 147°.5$, $b = 0°$), and $b = 90°$ respectively. In computing the orbits, it is assumed that they are Newtonian orbits passing through the sun's neighbourhood which is 8.2 kpc. from the galactic centre and at which the circular velocity is 216 km./sec. A more careful investigation of the proper motions of the stars on this programme indicates that some of the motions were based on erroneous AG positions and that hence, the high

velocities originally derived were fictitious. This is the case for B.D. + 53° 104, H.D. 24000, H.D. 27821, B.D. + 29° 734, H.D. 36542, B.D. + 50° 1359, and H.D. 104817. The high velocity for B.D. + 53° 104 now results from the very small parallax and is probably not significant. As is indicated in the notes to Table I, the observational data for H.D. 11397 appear to be contradictory.

The occurrence of radial velocities larger than 60 km./sec. for one quarter of the stars in Table I (although these were chosen for high tangential motions) substantiates the fact that most of these stars are really high-velocity stars. The subdwarfs have already been discussed and shown to belong to an extreme high-velocity group.[11] Several of the stars show their membership in the high-velocity class by the decided weakness of their spectral lines; as indicated in the notes, two of the latter may be somewhat below the main sequence. Perhaps the most interesting stars are the apparently normal A dwarfs, H.D. 60778, 74721, 86986 and 117880, whose space velocities relative to the sun are 258, 323, 363 and 384, km./sec. respectively. Although effectively all of these motions are in the tangential direction, the proper motions have been checked and the stars would have to lie appreciably below the main sequence to reduce these velocities to values of the order of 40 km./sec.

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Richmond Hill, Ontario
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TABLE I

PHOTOMETRIC AND SPECTROSCOPIC DATA FOR PROGRAMME STARS

Name	α (1900)	δ (1900)	Mag. (V)	B–V	U–B	Sp. Type	No. of Plates	Wt.	Rad. Vel. km./sec.	P.E. km./sec.
	h m									
1368	0 12.7	− 0°11′	8.86	+0.53	−0.00	F9 V	4	3½	+ 43.7	1.7
+53° 104	0 31.2	+54 5	10.55	+0.15	+0.01	A0 V	5	4½	− 12.1	5.4
3567	0 33.5	− 8 51	9.27	+0.45	−0.14	F5 V*	4	4	− 50.3	2.3
11397	1 46.9	−16 48	8.93	+0.68	+0.10	G8 III*	4	4	+ 38.5	2.9
13721	2 8.6	−10 13	8.55	+0.28	0.00	F0 V	3	3	+ 0.8	2.5
21543	3 23.4	− 6 52	8.22	+0.62	+0.03	G2 V*	4	4	+ 59.4	1.1
24000	3 44.3	+29 26	8.76	+0.34	+0.24	A2 V	4	4	+ 11.7	2.4
26298	4 4.5	−16 40	8.14	+0.34	−0.05	F2 V	4	3½	+ 81.9	1.0
27821	4 18.4	+ 6 8	8.69	+0.32	0.00	A7 V	4	3½	+ 12.7	2.8
+24° 659	4 21.8	+24 13	9.37	+0.94	+0.51	K3 V	3	2½	+ 62.9	2.4
+29° 734	4 40.3	+29 7	9.88	+0.29	−0.08	B9 V	4	4	+ 12.1	4.3
+55° 960	5 0.2	+55 18	9.33	+0.63	−0.01	G2 V	4	3½	−121.4	3.4
36283	5 25.6	+15 43	8.64	+0.67	+0.12	G5 V	4	3	+ 48.9	2.5
36542	5 27.3	−10 5	8.66	0.00	−0.12	B9 V	4	3½	− 2.0	7.2
+50°1359	6 44.6	+50 46	10.06	+0.20	+0.12	A5 V*	4	4	− 16.7*	13.1
59374	7 24.6	+19 10	8.50	+0.53	−0.10	F8 V*	4	3½	+ 79.9	0.8
60778	7 31.0	+ 0 4	9.10	+0.10	+0.14	A1 V	3	3	+ 39.4	10.5
+25°1981	8 38.5	+25 10	9.35	+0.30	−0.12	F2 sd	4	3½	+ 47.0	4.4
74721	8 40.4	+13 38	8.72	+0.03	+0.13	A0 V	4	3½	+ 9.0	6.4
86986	9 57.1	+15 4	7.99	+0.12	+0.16	A1 V	4	3½	+ 5.7	3.4
97916	11 10.7	+ 2 37	9.22	+0.42	−0.13	F5 V*	4	4	+ 55.4	3.8
+51°1664	11 20.6	+50 55	10.09	+0.83	+0.40	K2 V	6	5	− 80.2	3.4
100363	11 27.8	−11 29	8.64	+0.30	+0.02	F2 V	4	3½	+130.9	4.7
104817	11 59.1	+ 2 1	7.68	+0.22	+0.08	A7 m*	4	4	+ 12.1	2.5
+22°2442	12 3.9	+22 21	9.49	+0.66	+0.04	G2 V	4	3½	− 9.2	1.0

TABLE I (*Continued*)

+13°2698	13 35.0	+13 6	9.36	+0.58	−0.06	F9 V	5	4	− 20.6	4.8
+14°2771	14 36.7	+14 2	8.40	+0.59	+0.06	G2 V	4	4	− 18.3	0.9
136161	15 14.0	− 1 48	8.88	+0.32	+0.19	A3 V	6	5	− 5.8	6.5
142575	15 50.2	+ 5 23	8.62	+0.38	−0.08	F0 V	5	4½	− 64.8	3.0
+26°3578	19 28.4	+26 11	9.36	+0.37	−0.23	F4 sd	4	4	−128.3	4.0
191069	20 2.9	−16 0	8.11	+0.67	+0.22	G5 V	5	4½	− 2.1	0.9
192031	20 7.7	−15 43	8.66	+0.72	+0.16	G8 V	4	4	+ 19.7	2.2
198273	20 44.1	− 9 1	8.42	+0.60	0.00	G2 V	4	3½	+ 27.9	1.3
205027	21 27.3	+ 0 34	8.29	+0.61	+0.06	G2 V	4	4	+ 16.0	0.9
+ 4°4762	21 49.1	+ 4 30	9.30	+0.64	+0.03	G3 V	4	4	− 44.0	1.8
+17°4708	22 6.7	+17 36	9.47	+0.43	−0.21	F6 sd	4	4	−295.6	4.1
224383	23 52.3	−10 12	7.88	+0.63	+0.14	G2 V	4	4	− 27.8	1.3

NOTES TO TABLE I

H.D. 3567 The lines are weak.

H.D. 11397 The star has very weak cyanogen and unusually strong CH. This is typical of the high-velocity giants. The strength of the Sr II indicates that the star is class III but this is inconsistent with the very large proper motion of the star. (See Table III.) The colour is also too blue for a normal G8 giant.

H.D. 21543 This star may be below the main sequence.

B.D. + 50° 1359 The star shows a G-band in spite of its early type. There is no other evidence that the spectrum is composite although the large range in velocity (−63 to +23) may indicate that it is a spectroscopic binary.

H.D. 59374 This star may be below the main sequence.

H.D. 97916 The lines are weak.

H.D. 104817 A metallic line star. The K-line would indicate the type A3.

TABLE II

STARS DROPPED FROM PROGRAMME

Name	α (1900)	δ (1900)	Mag. (V)	B–V	U–B	Sp. Type	No. of Plates	Wt.	Rad. Vel. km./sec.
	h m								
3556	0 33.4	+ 5°29′	8.77	+0.59	+0.10	G0 V	1	1	+30.0
11592	1 48.7	+10 8	6.78	+0.46	−0.05	F5 V	1	1	−20.6
19618	3 4.4	+15 1	9.05	+0.84	+0.51	K0 IV–V	1	1	−23.2
75530*	8 45.4	− 5 9	9.18	+0.74	+0.22	G8 V	1	1	+40.1
+58°1199	9 29.5	+58 23	9.96	+0.63	+0.03	G3 V	2	1½	−16.2
107452	12 16.0	−10 55	8.25	+0.29	+0.10	F0 p*	2	1½	−15.5
107813	12 18.2	− 6 29	9.41	+0.35	−0.11	F2 V*	2	1½	−24.8
117880	13 28.1	−18 0	9.08	+0.04	+0.06	A0 V	3	2½	−44.6

NOTES TO TABLE II

H.D. 75530 One McDonald plate gives the velocity +30.2 km./sec.
H.D. 107452 A strontium star.
H.D. 107813 The lines are very weak although not quite as weak as in an F-type subdwarf.

TABLE III

SPACE VELOCITIES AND GALACTIC ORBITS

Star	μ_α	μ_δ	Source	π_{sp}	X	Y	Z	e	a
					(kilometres/second)				kpc.
	″	″		″					
1368	+0.339	+0.093	Yale	0.011	− 14	+169	− 33	0.74	15.7
+53°104	−0.025	+0.036	AGK$_2$-Yale	0.00088	+ 89	− 85	+205	1.14	54.1
3567	+0.012	−0.564	Yale	0.0063	−359	−183	+199	0.79	9.5
11397	+0.135	−0.327	Yale	0.0017	−939	−229	−133	10.9	0.8
13721	+0.031	−0.118	Yale	0.0076	− 67	− 3	− 11	0.51	5.3
21543	+0.353	−0.205	GC	0.024*	− 77	+ 68	− 11	0.61	5.4
24000	−0.041	0.000	GFH	0.0030	+ 53	+ 2	− 38	0.54	18.0
26298	+0.044	+0.182	Yale	0.0105	+ 18	+133	− 9	0.68	18.0
27821	−0.019	+0.007	BAN 274	0.0096	+ 14	+ 28	− 4	0.14	9.5
+24°659	+0.367	+0.100	Yale	0.032	− 9	+ 93	+ 39	0.40	9.0
+29°734	−0.025	−0.042	Oxf-Yale	0.00105	− 67	+ 8	−202	0.51	5.3
+55°960	−0.049	−0.366	GC	0.0115	−136	− 27	−117	0.86	4.4
36283	−0.038	−0.374	GC	0.020	− 69	+ 45	− 54	0.54	5.4
36542	−0.014	+0.008	GFH	0.0018	+ 2	+ 29	+ 45	0.14	8.5
+50°1359	−0.033	+0.014	AGK$_2$-Yale	0.0026	+ 55	+ 39	− 31	0.61	20.4
59374	+0.038	−0.452	GC	0.012	−185	+ 48	− 24	0.98	4.2
60778	−0.036	−0.116	Yale	0.0022	−182	− 38	−179	0.98	4.1
+25°1981	−0.103	−0.334	GC	0.013	−119	+ 29	− 23	0.80	4.5
74721	−0.043	−0.142	GC	0.0021	−271	− 21	−175	0.93	4.2
86986	+0.139	−0.227	GC	0.0036	−233	−230	+ 39	1.00	9.3
97916	+0.218	−0.011	GC	0.0066	+ 25	−119	+103	0.65	17.8
+51°1664	−0.454	+0.074	Yale	0.018	− 37	+ 96	−107	0.47	7.2
100363	+0.038	−0.149	Yale	0.0083	−120	− 51	+ 50	0.81	4.6
104817	−0.114	−0.029	Yale	0.0087	− 40	+ 62	− 1	0.39	6.4
+22°2442	−0.394	+0.044	Yale	0.0105	− 58	+181	− 25	0.76	10.5

TABLE III (*Continued*)

Star	μ_α	μ_δ	Source	π_{sp}	X	Y	Z	e	a
					(kilometres/second)				kpc.
+13°2698	+0.127	−0.286	Yale	0.0087	− 73	−130	− 30	0.68	6.7
+14°2771	−0.382	−0.087	Yale	0.0175	− 74	+ 80	+ 29	0.61	5.6
136161	+0.091	−0.101	Yale	0.0038	− 8	−105	−116	0.46	9.6
142575	−0.289	+0.034	GC	0.0076	−110	+ 32	+ 93	0.76	4.6
+26°3578	−0.004	−0.174	Yale	0.013	−130	+ 29	− 29	0.84	4.4
191069	+0.168	−0.412	Yale	0.025	− 58	+ 15	− 47	0.45	5.5
192031	−0.350	−0.272	Yale	0.024	− 44	− 51	+ 35	0.39	6.1
198273	−0.341	−0.150	Yale	0.0175	− 18	− 77	+ 46	0.34	7.8
205027	−0.290	−0.322	Yale	0.018	− 42	− 87	+ 8	0.46	6.8
+4°4762	+0.280	−0.008	Yale	0.0125	− 8	+ 65	− 62	0.27	8.2
+17°4708	+0.510	+0.071	Yerkes	0.0125	−260	+241	+ 74	0.98	11.3
224383	+0.461	−0.159	GC	0.022	− 75	+ 88	+ 4	0.62	5.7
3556	+0.135	−0.092	Yale	0.0125	+ 24	− 32	− 19	0.25	10.8
11592	−0.177	−0.288	GC	0.020	− 21	− 70	− 30	0.32	7.4
19618	−0.069	−0.297	Yale	0.014	− 54	− 42	− 56	0.44	5.7
75530	−0.209	−0.519	Yale	0.019	−107	+ 5	− 81	0.74	4.6
+58°1199	+0.219	−0.310	Yale	0.0069*	−191	− 78	+149	0.86	4.3
107452	−0.019	−0.034	GC	0.0058	− 7	+ 24	− 29	0.06	7.4
107813	+0.110	−0.071	Yale	0.0058	− 84	+ 66	− 24	0.65	5.2
117880	−0.061	−0.135	Yale	0.0017	−290	+ 51	−247	0.88	4.4

NOTES TO TABLE III

H.D. 21543 This assumes that the absolute magnitude is 5.1.

B.D. +58°1199 A.D.S. 7447, a triple star. To allow for the other components, $0^m.6$ has been added to the magnitude given in Table II.