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Publisher's version / Version de l'éditeur:

Publications of the Dominion Astrophysical Observatory Victoria, 14, 18, pp. 379-410, 1979

NATIONAL RESEARCH COUNCIL OF CANADA

HERZBERG INSTITUTE OF ASTROPHYSICS

PUBLICATIONS

of the

Dominion Astrophysical Observatory

VICTORIA, B.C.

Volume XIV, No. 18

THE SPECTROSCOPIC BINARY CHARACTERISTICS OF THE MERCURY-MANGANESE STARS

by G.C.L. Aikman

ABSTRACT

The 80 confirmed and suspected mercury manganese stars identified prior to 1974 and north of declination -20° have been studied from 654 high dispersion spectrograms (2.4 - 15 Å mm $^{-1}$) for velocity and degree of peculiarity. The binary frequency based on velocity variability criteria alone appears to be a normal main sequence value of about 50 per cent, and is probably independent of the degree of enhancement of the mercury and manganese lines. New spectroscopic orbital elements are given for six systems: α And, 2 Per, κ Cnc, ϕ Her, HR 6620 and 46 Dra. The Hg Mn spectroscopic binaries appear to be fairly normal in their orbital characteristics, except that periods less than 3 days are conspicuously absent; there is also weak evidence for more nearly circular orbits amongst the short period Hg Mn binaries than in comparable normal binaries.

RÉSUMÉ

L'auteur a étudié les 80 étoiles à spectre particulier en mercure et manganèse au nord de la déclinaison -20° qui ont été identifiées avant 1974, à partir des 654 spectrogrammes à grandes dispersions (2.4 - 15 A mm $^{-1}$). Il a trouvé que la fréquence des étoiles binaires, déterminée seulement à partir de la variabilité des vitesses radiales, est à 50 pour cent près - semblable à la valeur trouvée pour les étoiles de la série principale. Cette fréquence est probablement indépendante de l'augmentation de l'intensité des raies spectrales de Hg II et Mn II. Il donne des éléments orbitaux nouveaux pour six étoiles: α And, 2 Per, κ Cnc, ϕ Her, HR 6620 et 46 Dra. Il deduit que les characteristiques orbitales des étoiles binaires de type spectrale Hg Mn sont semblables a celles des binaires à étoiles normales, sauf qu'il n'y a pas de périodes de moins de 3 jours parmi les binaires à étoiles de type particulier. Il est aussi possible que les orbites des binaires à étoiles de type Hg Mn ont des valeurs d'excentricité inférieures à celles des binaires à étoiles de type normal.

NRC No. 15161

INTRODUCTION

A number of interesting if somewhat puzzling results have emerged from surveys of spectroscopic binary frequency amongst normal and chemically peculiar stars. Jaschek and Gomez (1970) analysed a large body of published velocities and found a constant binary frequency of 47 per cent ± 5 per cent all along the main sequence from B0 to M, based on the statistics of velocity variability. For chemically peculiar subgroups on the upper main sequence, some remarkable deviations from this "normal" binary frequency have been found. Abt and Snowden (1973) found a low incidence of duplicity among magnetic Ap stars, 16 per cent for Sr Cr Eu stars and 25 per cent for Si stars, and a "normal" incidence (40 per cent) for Hg, Mn stars, while the Am subgroup shows an anomalously high incidence of 80 per cent (Abt, 1961). For the known binaries, variations also occur amongst the subgroups in the period distribution: magnetic Ap binaries rarely occur with periods less than 10 days, Hg Mn binaries may avoid the shortest periods (Preston 1974), and whilst Am binaries occur over a wide period range, normal stars of the same temperature - luminosity domain (A4 - F1, main sequence) are totally lacking in the binary period range 2.5 - 100 days (Abt and Bidelman, 1969). Since the Abt and Snowden sample of Hg Mn stars was small (15 stars), the purpose of this paper is to extend the observational base for determining the binary frequency in this subgroup, using spectroscopic (i.e. velocity variability) criteria alone. Abt and Snowden have already shown that the frequency of visual binaries appears to be normal for all Ap subgroups.

OBSERVATIONS

The observing program included all stars north of declination -20° which were noted or suspected as peculiar in mercury and/or manganese by Osawa (1965), Cowley, Cowley, Jaschek and Jaschek (1968, 1969), Cowley (1968, 1972), Cowley and Crawford (1971), Slettebak and Nassau (1959), Ianna (1970), Garrison (1972), Dworetsky (1974a), Wolff and Wolff (1974) and Gulliver and MacRae (1975). A few magnetic Ap stars (such as α^2 Canum Venaticorum, classified by Osawa (1965) as Si Hg Cr Eu) also show enhanced mercury; these stars have radically different spectra from the usual Hg, Mn subgroup, and were excluded from the program. No magnitude limit was applied in selecting the program stars, beyond the limits inherent in the above classification surveys (many of which were confined to samples drawn from the Catalogue of Bright Stars). Nonetheless only 3 program stars were fainter than magnitude 8.0, a fact which testifies both to the incompleteness of the searches for Hg, Mn stars at magnitudes fainter than the Bright Star Catalogue limit, and also to the difficulty of identifying Hg, Mn stars from low dispersion spectra.

In all, 654 plates were obtained of 80 program stars. The number of plates per star varies over a considerable range (from 1 to 37), because some of the program stars have been observed over a twelve year interval, while others have only recently been recognized as peculiar and therefore were quite recently placed on the observing program. Also, more emphasis was placed on observing those stars with marked peculiarities. All plates were taken with the all-reflection, grating dispersion spectrographs at Victoria. Plates at 15 Å/mm. reciprocal dispersion were obtained on the 1.84 metre telescope; a variety of reciprocal dispersions from 10 to 2.4 Å/mm. (but principally 6.5 Å/mm.) were employed on the 1.22 metre telescope.

TABLE 1.

STELLAR LINES MEASURED FOR VELOCITY.

Line	Wavelength (Å)	Line	Wavelength (Å)
H9	3835.386	Si II	4130.893
Mn II	3844.167	Mn II	4136.950
Si II	3853.664	Mn II	4206.375
Si II	3856.017	Sr II	4215.524
Si II	3862.595	Fe II	4233.167
H8	3889.051	Mn II, Cr II blend	4242.35
Ca II	3933.664	Mn II	4259.203
Mn II blend	3943.82	Mn II	4292.246
Y II	3950.35	Mn II	4326.633
Y II	3982.59	Hγ	4340.466
Sr II	4077.714	Mg II doublet	4481.228
Hδ	4101.738	Cr II	4558.629
Si II	4128.067		

In measuring the plates for velocity, the variable-scan feature of the Observatory's oscilloscope measuring machine ARCTURUS proved an invaluable aid in compensating for the variety of dispersions and rotational line widths encountered in the spectra. Before commencing measurement of each plate, the scan of the oscillating mirror of the measuring machine was adjusted (within the range of 50 - 500 microns of plate scan) to match the stellar line width on that particular spectrogram; this makes the visibility of the stellar lines on the oscilloscope display roughly independent of rotational velocity and plate dispersion, except for the enhanced signal-to-noise ratio attained by use of a higher dispersion. The procedure was then to search for, and measure if possible, the stellar lines listed in Table 1. For some of the earliest plates and for some of the 2.4 Å/mm. plates, additional lines were measured as well as those included in Table 1, while for the sharp-lined spectra (with $v \sin i$ less than 10 or 20 km/sec, cf. Abt and Snowden (1973), Wolff and Wolff (1974) for rotational velocities of many of these stars) the Balmer lines H9 and H8 and occasionally Hδ and Hγ were not measured. Nonetheless, the number of lines measured per plate is a rough index of the degree of manganese peculiarity, and shall be used as such in the discussion later. The Hg II λ 3984 line was measured on each plate where possible, but was not used in determining the stellar velocity because of the isotopic shifts which affect its rest wavelength (cf. Cowley and Aikman, 1975).

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
ALPHA AND	6272	6.5	30 09 70	40859.8625	-7.76	0.62	13			
ALPHA AND	7139	6.5	20 09 71	41214.9619	-27.39	0.74	12			
ALPHA AND	7191	6.5	30 09 71	41224.9392	-19.47	0.85	8			
ALPHA AND	72102	15.	19 02 72	41366.6438	20.72	1.96	8			
ALPHA AND	73139	15.	26 08 72	41556.0023	12.11	0.92	15			
ALPHA AND	73170	15.	30 08 72	41560.0316	19.01	2.63	14			
ALPHA AND	73274	15.	13 09 72	41573.9058	-8.39	0.93	15			
ALPHA AND	73315	15.	16 09 72	41576.6945	-26.22	1.06	16			
ALPHA AND	73597	15.	16 10 72	41606.8249	-22.88	1.14	14			
ALPHA AND	7798	6.5	11 11 72	41632.8213	-5.46	1.53	14			
ALPHA AND	73879	15.	27 11 72	41648.6995	5.85	1.57	15			
ALPHA AND	73939	15.	08 12 72	41659.6993	24.73	0.91	16			
ALPHA AND	74043	15.	18 01 73	41700.5876	-23.19	1.54	15			
ALPHA AND	9427	2.4	14 10 74	42334.0065	20.60	1.82	10			
ALPHA AND	9517	2.4	17 12 74	42396.8384	-12.83	0.74	13			
			MEANS OF 15 PLATES		-3.37	1.26	13.			
				SIGMAS	18.97	0.56	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 15.01									
HD 1009	63825	15.	14 08 67	39716.9805	-5.83	1.26	16			
HD 1009	64071	15.	14 10 67	39777.8628	-5.45	0.65	18			
HD 1009	71988	15.	03 01 72	41319.6936	-8.52	0.64	17			
HD 1009	73166	15.	30 08 72	41559.9601	-10.30	0.69	20			
HD 1009	73275	15.	13 09 72	41573.9333	-7.34	0.67	20			
HD 1009	73316	15.	16 09 72	41576.9296	-5.13	0.61	14			
HD 1009	73596	15.	16 10 72	41606.8007	-4.78	0.59	16			
HD 1009	77070	15.	14 09 74	42304.9330	-4.83	0.63	22			
HD 1009	77691	15.	23 12 74	42404.6837	-7.90	0.59	19			
			MEANS OF 9 PLATES		-6.68	0.70	18.			
				SIGMAS	1.94	0.21	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.76									
HD 2019	75100	15.	11 07 73	41874.9392	-68.32	2.12	10			
HD 2019	8506	6.5	04 08 73	41898.9743	46.99	1.89	9			
HD 2019	8752	6.5	03 10 73	41958.9610	-73.11	0.76	11	+129.39	5.13	2
HD 2019	77069	15.	14 09 74	42304.9112	-69.05	1.88	7	+117.01	6.56	9
HD 2019	77693	15.	23 12 74	42404.7182	-35.14	2.18	8	+98.52	9.20	5
			MEANS OF 5 PLATES		-39.73	1.77	9.			
				SIGMAS	50.82	0.58	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 28.78									
HR 149	67757	15.	16 08 69	40449.9981	5.63	1.10	26			
HR 149	70166	15.	23 08 70	40821.9639	0.98	1.18	17			
HR 149	70244	15.	29 08 70	40827.9768	1.31	0.63	16			
HR 149	70276	15.	06 09 70	40835.9256	-2.73	1.00	16			
HR 149	70469	15.	24 10 70	40883.8282	14.17	0.79	16			
HR 149	70897	15.	20 02 71	41002.6130	4.38	1.01	12			
HR 149	71406	15.	19 07 71	41151.9753	-1.85	1.18	15			
HR 149	7140	6.5	20 09 71	41214.9741	-1.98	0.68	16			
HR 149	7192	6.5	04 11 71	41224.9487	-2.11	0.76	14			
HR 149	7555	6.5	29 07 72	41527.9398	0.59	1.07	10			
HR 149	73140	15.	26 08 72	41556.0097	-0.98	0.67	13			
HR 149	73167	15.	30 08 72	41559.9970	-2.69	0.86	15			
HR 149	73273	15.	13 09 72	41573.8943	-0.31	0.68	16			
HR 149	73314	15.	16 09 72	41576.6802	0.64	0.66	17			
HR 149	73598	15.	16 10 72	41606.8349	-1.66	0.98	13			
HR 149	7756	6.5	19 10 72	41609.9473	-0.66	0.54	16			
HR 149	7799	6.5	11 11 72	41632.8377	2.31	0.59	15			
HR 149	7815	6.5	14 11 72	41635.6979	0.32	0.54	16			
HR 149	73936	15.	08 12 72	41659.6699	10.53	0.81	16			
HR 149	8753	6.5	03 10 73	41959.0049	-0.51	0.83	17			
			MEANS OF 20 PLATES		1.27	0.83	16.			
				SIGMAS	4.41	0.21	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 5.33									
HR 205	5026	6.5	15 09 69	40479.8967	8.34	0.31	12			
HR 205	70167	15.	23 08 70	40821.9724	5.11	0.74	18			
HR 205	70319	15.	10 09 70	40839.9916	3.64	0.73	19			
HR 205	6271	6.5	30 09 70	40859.8387	2.21	0.44	19			

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STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 205	70698	15.	20 02 71	41002.6347	-0.84	0.61	16			
HR 205	7141	6.5	20 09 71	41214.9921	-0.80	0.41	18			
HR 205	7193	6.5	30 09 71	41224.9598	-0.46	0.44	20			
HR 205	71855	15.	10 10 71	41234.9156	-0.96	0.70	18			
HR 205	71989	15.	03 01 72	41319.7459	-2.88	0.93	18			
HR 205	7556	6.5	29 07 72	41527.9456	-1.88	0.35	16			
HR 205	7757	6.5	19 10 72	41609.9851	-1.99	0.60	22			
HR 205	7802	6.5	11 11 72	41632.9169	-2.62	0.36	19			
HR 205	73680	15.	27 11 72	41648.7135	-3.77	0.51	20			
HR 205	8878	6.5	14 03 74	42120.6494	-3.97	0.33	17			
HR 205	8868	6.5	18 03 74	42124.6551	-4.84	0.45	19			
HR 205	9135	2.4	01 08 74	42260.9756	-5.33	0.45	21			
HR 205	9558	6.5	27 01 75	42439.7606	11.87	0.25	15			
				MEANS OF 17 PLATES	0.05	0.51	18.			
				SIGMAS	4.75	0.18	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 9.39							
HD 5342	77071	15.	14 09 74	42304.9598	-12.80	0.52	21			
HD 5342	77692	15.	23 12 74	42404.7035	-23.05	0.65	23			
				MEANS OF 2 PLATES	-17.93	0.58	22.			
				SIGMAS	7.25	0.09	1.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 12.39							
87 PISCIUM	2781	6.5	03 10 66	39401.9035	-14.86	0.18	14			
87 PISCIUM	2784	6.5	04 10 66	39402.8153	-14.60	0.34	19			
87 PISCIUM	73600	15.	16 10 72	41606.8519	-19.37	0.59	16			
87 PISCIUM	7800	6.5	11 11 72	41632.8613	-18.52	0.37	14			
87 PISCIUM	73936	15.	08 12 72	41659.6895	-19.91	0.75	17			
87 PISCIUM	7934	6.5	21 02 73	41734.6332	-18.23	0.58	17			
87 PISCIUM	77072	15.	14 09 74	42304.9749	-14.52	0.49	18			
				MEANS OF 7 PLATES	-17.14	0.47	16.			
				SIGMAS	2.39	0.19	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 5.07							
HR 438	64542	15.	16 02 68	39902.6424	-1.37	1.33	10			
HR 438	6403	10.	27 10 70	40886.8230	1.65	1.26	11			
HR 438	70599	15.	17 11 70	40907.7775	0.22	1.05	10			
HR 438	6479	10.	20 11 70	40910.6431	-3.47	1.00	9			
HR 438	6511	10.	04 12 70	40924.6170	-1.80	1.53	10			
HR 438	73599	15.	16 10 72	41606.6441	-1.39	2.48	8			
				MEANS OF 6 PLATES	-1.03	1.44	10.			
				SIGMAS	1.76	0.54	1.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.22							
2 PERSEI	70321	15.	10 09 70	40840.0066	29.85	0.61	20			
2 PERSEI	6274	6.5	30 09 70	40859.9248	-10.62	0.42	19			
2 PERSEI	70899	15.	20 02 71	41002.6505	14.15	0.53	18			
2 PERSEI	6637	6.5	16 03 71	41026.7203	35.41	0.51	13			
2 PERSEI	70982	15.	20 03 71	41030.6332	9.18	0.98	16			
2 PERSEI	7142	6.5	20 09 71	41215.0083	-15.32	0.44	18			
2 PERSEI	7194	6.5	30 09 71	41224.9675	5.57	0.38	19			
2 PERSEI	71856	15.	10 10 71	41234.9280	35.96	0.76	16			
2 PERSEI	71990	15.	03 01 72	41319.7581	26.02	0.63	19			
2 PERSEI	7557	6.5	29 07 72	41527.9502	28.81	0.35	17			
2 PERSEI	73142	15.	26 08 72	41556.0236	30.97	0.46	17			
2 PERSEI	73169	15.	30 08 72	41560.0225	22.68	0.62	17			
2 PERSEI	73277	15.	13 09 72	41574.0141	0.20	0.68	16			
2 PERSEI	73601	15.	16 10 72	41606.8574	26.30	0.36	18			
2 PERSEI	7746	6.5	19 10 72	41609.7089	-3.14	0.49	16			
2 PERSEI	7795	6.5	11 11 72	41632.7473	10.71	0.38	21			
2 PERSEI	7801	6.5	11 11 72	41632.8824	15.20	0.33	21			
2 PERSEI	7816	6.5	14 11 72	41635.7386	4.98	0.46	19			
2 PERSEI	73881	15.	27 11 72	41648.7349	-11.84	0.78	20			
2 PERSEI	73942	15.	08 12 72	41659.7686	-15.12	0.68	18			
2 PERSEI	7938	6.5	21 02 73	41734.7841	31.67	0.37	19			
2 PERSEI	8014	6.5	15 03 73	41756.6790	15.26	0.31	18			
				MEANS OF 22 PLATES	13.04	0.52	18.			
				SIGMAS	16.93	0.17	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 32.30							

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STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HD 11336	77073	15.	14 09 74	42304.9622	-12.21	0.64	20			
HD 11336	77694	15.	23 12 74	42404.7297	-15.05	0.40	17			
				MEANS OF 2 PLATES	-13.63	0.52	18.			
				SIGMAS	2.01	0.17	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 3.86							
HR 562	73141	15.	26 08 72	41556.0170	-6.15	1.10	13			
HR 562	73168	15.	30 08 72	41560.0118	-6.33	1.13	17			
HR 562	73276	15.	13 09 72	41574.0285	-12.16	1.53	18			
HR 562	73602	15.	16 10 72	41606.8669	-6.79	0.81	14			
HR 562	7604	6.5	11 11 72	41632.9471	-5.89	0.49	16			
HR 562	73940	15.	08 12 72	41659.7102	-7.17	0.96	15			
HR 562	8869	6.5	18 03 74	42124.7086	-7.28	0.79	13			
				MEANS OF 7 PLATES	-7.40	0.97	15.			
				SIGMAS	2.16	0.33	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.22							
NGC 752-#209	77695	15.	23 12 74	42404.7856	50.72	1.49	11			
HR 746	63911	15.	31 08 67	39733.9958	-10.49	1.69	21			
HR 746	68135	15.	02 11 69	40527.8691	-9.30	1.09	26			
HR 746	68228	15.	02 12 69	40557.7717	-7.32	1.08	23			
HR 746	70169	15.	23 08 70	40822.0048	-9.97	0.75	16			
HR 746	70245	15.	29 08 70	40827.9817	-10.91	1.00	17			
HR 746	70279	15.	06 09 70	40835.9890	-9.98	0.67	16			
HR 746	70604	15.	18 11 70	40908.8549	-9.25	1.48	11			
HR 746	7143	6.5	20 05 71	41215.0255	-8.62	0.65	16			
HR 746	7195	6.5	30 09 71	41224.9782	-10.88	0.32	14			
HR 746	71857	15.	10 10 71	41234.9486	-9.89	0.85	16			
HR 746	73605	15.	16 10 72	41606.9149	-10.96	0.64	15			
				MEANS OF 11 PLATES	-9.78	0.93	17.			
				SIGMAS	1.11	0.40	4.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.20							
HD 16693	73276	15.	13 09 72	41573.9858	-5.43	0.69	14			
HD 16693	73603	15.	16 10 72	41606.8890	-8.68	0.92	15			
HD 16693	73941	15.	08 12 72	41659.7439	-9.92	1.23	18			
				MEANS OF 3 PLATES	-8.01	0.95	16.			
				SIGMAS	2.32	0.27	2.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.45							
11 PERSEI	73604	15.	16 10 72	41606.9072	-4.25	0.29	10			
11 PERSEI	8016	6.5	15 03 73	41756.7604	-2.88	0.39	15			
11 PERSEI	8848	6.5	06 03 74	42112.6913	-2.76	0.37	10			
11 PERSEI	8879	6.5	14 03 74	42120.6827	-3.28	0.36	9			
11 PERSEI	77074	15.	14 09 74	42304.9897	-0.18	0.90	14			
				MEANS OF 5 PLATES	-2.67	0.46	12.			
				SIGMAS	1.51	0.25	3.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 3.28							
HD 17280	75947	15.	08 03 74	42114.6934	6.48	0.54	16			
HD 17280	77075	15.	14 09 74	42304.9996	10.00	0.60	20			
				MEANS OF 2 PLATES	8.24	0.57	18.			
				SIGMAS	2.49	0.04	3.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 4.37							
HR 1063	73606	15.	16 10 72	41606.9209	-7.43	1.73	9			
HR 1063	8849	6.5	06 03 74	42112.7135	-8.83	1.15	10			
				MEANS OF 2 PLATES	-8.13	1.44	9.			
				SIGMAS	0.99	0.41	1.			
			RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.69							
HR 1185	70324	15.	10 09 70	40840.0323	3.78	2.00	9			
HR 1185	6278	6.5	30 09 70	40860.0347	6.15	0.83	8			

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STAR	PLATE #	DISP Å/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 1185	70900	15.	20 02 71	41002.6655	4.24	1.91	10			
HR 1185	70964	15.	19 03 71	41029.6574	7.00	2.98	13			
HR 1185	70983	15.	20 03 71	41030.6468	2.49	2.65	8			
HR 1185	7196	6.5	30 09 71	41224.9868	7.24	1.72	7			
HR 1185	71658	15.	10 10 71	41234.9631	6.72	2.36	8			
HR 1185	71991	15.	03 01 72	41319.7696	3.84	2.80	9			
HR 1185	7805	6.5	11 11 72	41632.9723	7.26	1.73	11			
			MEANS OF	5 PLATES	5.41	2.11	9.			
				SIGMAS	1.82	0.67	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.86									
53 TAURI	70984	15.	20 03 71	41030.6561	7.99	0.56	19			
53 TAURI	6685	6.5	25 03 71	41035.7223	18.41	0.24	18			
53 TAURI	7144	6.5	20 09 71	41215.0405	19.09	0.28	18			
53 TAURI	7197	6.5	30 09 71	41224.9942	5.01	0.26	18			
53 TAURI	71995	15.	03 01 72	41319.0314	6.98	0.57	18			
53 TAURI	72126	15.	25 03 72	41401.6771	19.42	0.38	17			
			MEANS OF	6 PLATES	12.82	0.38	18.			
				SIGMAS	6.82	0.15	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 17.87									
HR 1445	70905	15.	20 02 71	41002.7553	8.86	2.00	11			
HR 1445	70965	15.	19 03 71	41029.6686	8.29	1.80	10			
HR 1445	70985	15.	20 03 71	41030.6652	11.24	2.04	10			
HR 1445	71032	15.	03 04 71	41044.6755	14.42	1.54	9			
HR 1445	71077	15.	21 04 71	41062.6758	13.06	0.94	8			
HR 1445	7198	6.5	30 09 71	41225.0025	9.85	1.06	12			
HR 1445	71660	15.	10 10 71	41234.9974	10.32	2.03	13			
HR 1445	71996	15.	03 01 72	41319.8479	6.95	1.40	10			
HR 1445	72127	15.	25 03 72	41401.6956	14.28	1.44	8			
HR 1445	73608	15.	16 10 72	41606.9428	11.12	1.15	9			
HR 1445	7806	6.5	11 11 72	41632.9931	7.71	1.60	10			
			MEANS OF	11 PLATES	10.55	1.55	10.			
				SIGMAS	2.56	0.40	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.65									
93 TAURI	77076	15.	14 09 74	42305.0060	15.70	1.49	10			
93 TAURI	9652	6.5	31 03 75	42502.6885	15.93	2.25	11			
			MEANS OF	2 PLATES	15.82	1.87	10.			
				SIGMAS	0.16	0.54	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.09									
MU LEPORIS	6664	6.5	25 03 71	41035.6950	27.08	0.46	14			
MU LEPORIS	7200	6.5	30 09 71	41225.0239	26.13	0.30	18			
MU LEPORIS	7803	6.5	11 11 72	41632.9279	25.78	0.36	19			
MU LEPORIS	9321	2.4	18 09 74	42309.0385	26.42	0.19	20			
MU LEPORIS	9518	2.4	17 12 74	42398.9061	26.92	0.28	22			
			MEANS OF	5 PLATES	26.47	0.32	19.			
				SIGMAS	0.54	0.10	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.70									
HR 1759	77078	15.	14 09 74	42305.0217	22.37	0.94	8			
HR 1800	70966	15.	19 03 71	41029.6809	-10.58	0.65	18			
HR 1800	70986	15.	20 03 71	41030.6839	-9.83	0.79	16			
HR 1800	7199	6.5	30 09 71	41225.0143	-11.71	0.33	20			
HR 1800	71997	15.	03 01 72	41319.8757	-13.49	0.71	17			
HR 1800	72012	15.	10 01 72	41326.8320	-11.71	0.45	13			
HR 1800	7345	6.5	24 01 72	41340.8591	-11.70	0.26	21			
HR 1800	7807	6.5	11 11 72	41633.0156	-11.29	0.19	20			
HR 1800	9431	2.4	14 10 74	42334.9876	-13.10	0.13	24			
			MEANS OF	8 PLATES	-11.68	0.44	19.			
				SIGMAS	1.20	0.25	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.74									
HR 1846	73610	15.	16 10 72	41606.9724	0.50	1.06	9			

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 1846	8380	6.5	14 03 74	42120.7154	-0.50	0.40	9			
HR 1846	9653	6.5	31 03 75	42502.7451	0.83	1.22	9			
			MEANS OF	3 PLATES	0.28	0.89	9.			
				SIGMAS	0.69	0.43	0.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.78										
HR 1883	73612	15.	16 10 72	41606.9917	47.50	0.77	10			
HR 1883	8850	6.5	06 03 74	42112.7375	32.19	0.55	11			
			MEANS OF	2 PLATES	39.84	0.66	10.			
				SIGMAS	10.83	0.16	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 16.40										
HR 1938	73613	15.	16 10 72	41606.9985	0.48	4.95	3			
HR 1938	8851	6.5	06 03 74	42112.7614	13.58	0.89	4			
HR 1938	8890	6.5	18 03 74	42124.7645	-1.32	2.42	4			
HR 1938	77770	15.	04 03 75	42475.7335	8.35	2.19	5			
			MEANS OF	4 PLATES	5.27	2.61	4.			
				SIGMAS	6.95	1.70	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.66										
HR 1951	72014	15.	10 01 72	41326.9018	18.48	1.58	9			
HR 1951	72128	15.	25 03 72	41401.7268	17.87	0.77	9			
HR 1951	73614	15.	16 10 72	41607.0051	18.80	1.70	8			
HR 1951	77771	15.	04 03 75	42475.7443	20.72	1.16	9			
			MEANS OF	4 PLATES	18.97	1.30	9.			
				SIGMAS	1.23	0.42	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.94										
129 TAURI	70968	15.	19 03 71	41029.7106	16.64	1.73	13			
129 TAURI	70968	15.	20 03 71	41030.7347	13.12	1.81	7			
129 TAURI	6686	6.5	25 03 71	41035.7808	16.52	1.08	5			
129 TAURI	71033	15.	03 04 71	41044.7043	17.64	1.25	13			
129 TAURI	71078	15.	21 04 71	41062.6940	14.96	1.29	12			
129 TAURI	7201	6.5	30 09 71	41225.0296	16.28	0.89	6			
129 TAURI	7809	6.5	11 11 72	41633.0577	18.42	1.94	8			
			MEANS OF	7 PLATES	16.23	1.43	9.			
				SIGMAS	1.75	0.40	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.22										
HR 2202	70967	15.	19 03 71	41029.6969	17.28	2.17	11			
HR 2202	70987	15.	20 03 71	41030.7202	17.75	1.71	8			
HR 2202	7202	6.5	30 09 71	41225.0371	18.60	1.10	8			
HR 2202	73616	15.	16 10 72	41607.0250	21.56	2.39	9			
HR 2202	7808	6.5	11 11 72	41633.0384	20.65	0.81	9			
HR 2202	77772	15.	04 03 75	42475.7593	19.69	2.71	11			
			MEANS OF	6 PLATES	19.25	1.81	9.			
				SIGMAS	1.68	0.75	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.92										
53 AURIGAE	4258	6.5	23 01 69	40244.8354	14.35	1.22	12			
53 AURIGAE	6641	6.5	16 03 71	41026.8506	10.89	3.06	11			
53 AURIGAE	70991	15.	20 03 71	41030.7585	11.83	1.52	8			
53 AURIGAE	6687	6.5	25 03 71	41035.8379	16.64	3.59	11			
53 AURIGAE	71034	15.	03 04 71	41044.7238	16.30	3.22	11			
53 AURIGAE	7203	6.5	30 09 71	41225.0454	9.77	1.40	12			
53 AURIGAE	72129	15.	25 03 72	41401.7631	16.50	1.86	9			
53 AURIGAE	7810	6.5	11 11 72	41633.0708	8.65	1.94	12			
53 AURIGAE	74045	15.	18 01 73	41700.8123	9.26	2.04	11			
			MEANS OF	9 PLATES	12.69	2.21	11.			
				SIGMAS	3.29	0.86	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.49										
33 GEM	77702	15.	23 12 74	42404.9080	10.30	0.63	15			
PSI 8 AUR	66639	15.	29 03 69	40309.6856	31.52	1.59	10			

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INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
PSI 8 AUR	68311	15.	15 01 70	40601.8290	31.28	1.26	10			
PSI 8 AUR	68321	15.	15 01 70	40601.9721	32.41	1.46	10			
PSI 8 AUR	68337	15.	28 01 70	40614.8921	30.38	0.88	8			
PSI 8 AUR	68510	15.	24 02 70	40641.8435	30.29	2.30	11			
PSI 8 AUR	68525	15.	25 02 70	40642.8277	29.44	1.14	8			
PSI 8 AUR	68633	15.	08 03 70	40653.7963	28.45	1.38	10			
PSI 8 AUR	68791	15.	21 03 70	40666.7288	30.40	1.10	9			
PSI 8 AUR	68905	15.	01 04 70	40677.7582	32.72	1.27	12			
PSI 8 AUR	69015	15.	21 04 70	40697.7134	28.36	0.91	11			
PSI 8 AUR	70477	15.	24 10 70	40884.0620	27.62	1.22	12			
PSI 8 AUR	70610	15.	18 11 70	40909.0404	29.27	0.36	9			
PSI 8 AUR	70992	15.	20 03 71	41030.7674	26.10	0.95	11			
				MEANS OF 13 PLATES	29.86	1.22	10.			
				SIGMAS	1.92	0.45	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.58									
40 GEM	77079	15.	14 09 74	42305.0271	6.10	1.18	11			
40 GEM	77678	15.	22 12 74	42403.9452	4.62	1.13	10			
40 GEM	77773	15.	04 03 75	42475.7712	4.45	1.51	13			
40 GEM	9654	6.5	31 03 75	42502.7861	1.46	0.91	9			
				MEANS OF 4 PLATES	4.16	1.18	11.			
				SIGMAS	1.95	0.25	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.64									
HR 2844	5614	6.5	30 03 70	40675.8613	21.17	0.31	19			
HR 2844	6640	6.5	16 03 71	41026.8323	17.16	0.76	16			
HR 2844	70990	15.	20 03 71	41030.7518	15.51	0.61	18			
HR 2844	6689	6.5	25 03 71	41035.9150	16.02	0.75	19			
HR 2844	71036	15.	03 04 71	41044.7517	15.17	0.72	20			
HR 2844	71079	15.	21 04 71	41062.7157	16.08	0.55	19			
HR 2844	7204	6.5	30 09 71	41225.0512	17.35	0.64	16			
HR 2844	72001	15.	03 01 72	41319.9767	17.04	0.69	16			
HR 2844	72096	15.	13 02 72	41360.8062	16.43	0.56	15			
HR 2844	72130	15.	25 03 72	41401.7840	17.98	0.54	19			
HR 2844	7369	6.5	30 04 72	41437.7295	18.97	0.62	13			
HR 2844	73621	15.	16 10 72	41607.0739	22.65	0.64	18			
HR 2844	7812	6.5	11 11 72	41633.1001	21.08	0.52	21			
HR 2844	73886	15.	29 11 72	41651.0069	20.08	0.36	21			
HR 2844	74047	15.	18 01 73	41700.8516	20.39	0.81	21			
HR 2844	7905	6.5	14 02 73	41727.8637	20.06	0.59	18			
HR 2844	7941	6.5	21 02 73	41734.8709	19.92	0.48	20			
HR 2844	7988	6.5	08 03 73	41749.7921	21.86	0.70	17			
HR 2844	8892	2.4	18 03 74	42124.8315	25.37	0.86	8			
HR 2844	9655	6.5	31 03 75	42502.8189	22.71	0.58	25			
				MEANS OF 20 PLATES	19.15	0.62	18.			
				SIGMAS	2.82	0.14	4.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 4.52									
HR 2859C	75948	15.	08 03 74	42114.7519	30.57	1.34	16			
HR 3361	72015	15.	10 01 72	41326.9696	56.77	2.20	8			
HR 3361	72131	15.	25 03 72	41401.8086	4.95	0.91	14			
HR 3361	73689	15.	29 11 72	41651.0588	20.27	1.22	11			
HR 3361	74048	15.	18 01 73	41700.8754	48.51	2.39	8			
HR 3361	74051	15.	21 01 73	41703.8720	53.22	0.94	12			
HR 3361	7992	6.5	08 03 73	41749.8759	42.77	0.72	13			
HR 3361	75949	15.	08 03 74	42114.7967	38.51	1.28	11			
HR 3361	77679	15.	22 12 74	42403.9559	58.56	2.56	9	DOUBLE LINES?		
HR 3361	77700	15.	23 12 74	42404.8809	54.65	1.70	17	-47.51	2.98	?
HR 3361	9563	6.5	27 01 75	42440.0290	-43.28	1.61	4			
HR 3361	77774	15.	04 03 75	42475.7820	48.31	1.18	17			
				MEANS OF 11 PLATES	34.84	1.52	11.			
				SIGMAS	30.70	0.63	4.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 20.21									
14 HYDRAE	4260	6.5	23 01 69	40244.9615	27.26	0.78	19			
14 HYDRAE	5556	6.5	21 03 70	40666.7923	27.92	0.69	19			
14 HYDRAE	6639	6.5	16 03 71	41026.8174	26.70	0.61	15			

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INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
14 HYDRAE	70989	15.	20 03 71	41030.7476	29.08	1.20	13			
14 HYDRAE	6688	6.5	25 03 71	41035.8834	27.88	2.00	9			
14 HYDRAE	71035	15.	03 04 71	41044.7393	26.20	0.65	20			
14 HYDRAE	71060	15.	21 04 71	41062.7306	24.48	0.79	15			
14 HYDRAE	71097	15.	24 04 71	41065.7104	27.12	1.38	13			
14 HYDRAE	72098	15.	13 02 72	41360.8564	26.90	0.78	14			
14 HYDRAE	72218	15.	04 05 72	41441.7016	30.19	1.46	13			
14 HYDRAE	72232	15.	05 05 72	41442.6997	27.75	0.60	14			
14 HYDRAE	7811	6.5	11 11 72	41633.0837	26.51	0.90	18			
				MEANS OF 12 PLATES	27.33	1.00	15.			
				SIGMAS	1.44	0.42	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.43										
KAPPA CANCRI	646	5.8	12 03 63	38100.6019	82.60	0.27	17			
KAPPA CANCRI	1620	5.8	09 12 64	38738.9613	71.45	0.22	17			
KAPPA CANCRI	1745	5.8	18 04 65	38868.7448	59.85	0.22	16			
KAPPA CANCRI	2413	6.5	04 04 66	39219.7044	80.79	0.33	15			
KAPPA CANCRI	64622	15.	28 02 68	39914.8775	54.48	0.85	9			
KAPPA CANCRI	4348	6.5	07 03 69	40287.8059	66.36	0.20	17			
KAPPA CANCRI	66641	15.	29 03 69	40309.7584	-35.21	0.37	18			
KAPPA CANCRI	66656	15.	03 04 69	40314.7319	-22.96	0.39	16			
KAPPA CANCRI	68340	15.	28 01 70	40614.9290	3.52	0.63	16			
KAPPA CANCRI	68359	15.	01 02 70	40618.8665	77.64	0.74	18			
KAPPA CANCRI	5389	2.4	11 02 70	40628.8550	-51.57	0.17	15			
KAPPA CANCRI	68469	15.	21 02 70	40638.8267	84.79	1.14	17			
KAPPA CANCRI	68545	15.	26 02 70	40643.8279	56.82	0.49	17			
KAPPA CANCRI	68663	15.	09 03 70	40654.8131	-42.45	0.66	17			
KAPPA CANCRI	6642	6.5	16 03 71	41026.8707	30.50	0.26	18			
KAPPA CANCRI	72219	15.	04 05 72	41441.7719	-15.24	0.80	17			
KAPPA CANCRI	72233	15.	05 05 72	41442.7213	46.65	0.31	18			
KAPPA CANCRI	7813	6.5	11 11 72	41633.1069	-36.98	0.19	16			
				MEANS OF 18 PLATES	28.39	0.46	16.			
				SIGMAS	49.88	0.28	2.			
RATIO OF EXTERNAL/INTERNAL SIGMAS=108.96										
36 LYNCIS	73622	15.	16 10 72	41607.0779	25.78	2.49	8			
36 LYNCIS	7943	6.5	21 02 73	41734.9102	22.03	0.78	14			
36 LYNCIS	8071	6.5	03 04 73	41775.8580	21.15	2.50	12			
36 LYNCIS	8799	6.5	26 01 74	42074.0752	17.38	1.14	14			
36 LYNCIS	77680	15.	22 12 74	42403.9645	20.95	2.70	13			
36 LYNCIS	9656	6.5	31 03 75	42502.8450	23.91	1.33	10			
				MEANS OF 6 PLATES	21.87	1.82	12.			
				SIGMAS	2.86	0.83	2.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.57										
HR 4072	4261	6.5	23 01 69	40245.0047	16.33	0.27	20	-35.23	1.27	8
HR 4072	68693	15.	10 03 70	40655.8239	-8.91	0.59	10			
HR 4072	5615	6.5	30 03 70	40675.8180	-29.17	0.22	20	+35.19	2.75	12
HR 4072	6644	6.5	16 03 71	41026.8937	-2.31	0.25	18			
HR 4072	9657	2.4	31 03 75	42502.8950	15.20	0.21	24	-32.86	1.00	12
				MEANS OF 5 PLATES	-1.77	0.31	18.			
				SIGMAS	18.83	0.16	5.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 61.12										
HR 4493	68736	15.	17 03 70	40662.8858	3.15	1.14	9			
HR 4493	68830	15.	25 03 70	40670.8821	1.53	1.91	8			
HR 4493	69011	15.	20 04 70	40696.7709	3.09	0.87	11			
HR 4493	6646	6.5	16 03 71	41026.9178	5.69	1.01	9			
HR 4493	70970	15.	19 03 71	41029.8496	4.58	2.00	8			
HR 4493	70996	15.	20 03 71	41030.9222	0.48	1.15	10			
HR 4493	6690	6.5	25 03 71	41035.9449	2.73	1.10	10			
HR 4493	71038	15.	03 04 71	41044.8018	2.63	1.51	11			
HR 4493	71082	15.	21 04 71	41062.7602	3.65	1.74	11			
HR 4493	6790	6.5	08 05 71	41079.8300	0.75	0.87	8			
HR 4493	6814	6.5	06 06 71	41108.7657	1.08	1.45	11			
HR 4493	72007	15.	03 01 72	41320.0608	-1.46	1.13	10			
HR 4493	7372	6.5	30 04 72	41437.8544	5.10	2.76	5			
HR 4493	72223	15.	04 05 72	41441.7740	1.99	1.29	14			
HR 4493	72239	15.	05 05 72	41442.8548	5.96	0.56	12			

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STAR	PLATE #	DISP A/MM	UT DATE D	M	Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 4493	7946	6.5	21	02	73	41734.9488	4.52	1.34	11			
						MEANS OF 16 PLATES	2.84	1.36	10.			
						SIGMAS	2.06	0.54	2.			
						RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.51						
GAMMA CORVI	7371	6.5	30	04	72	41437.7969	-4.93	0.68	7			
GAMMA CORVI	7944	6.5	21	02	73	41734.9280	-4.75	0.40	14			
GAMMA CORVI	7993	6.5	08	03	73	41749.9048	-3.82	0.47	13			
GAMMA CORVI	8070	6.5	03	04	73	41775.8389	-4.88	0.98	7			
GAMMA CORVI	8798	6.5	26	01	74	42074.0232	-4.73	0.53	13			
						MEANS OF 5 PLATES	-4.62	0.61	11.			
						SIGMAS	0.46	0.23	3.			
						RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.75						
PI BOO A	737	5.8	18	05	63	38167.8351	-1.77	0.23	20			
PI BOO A	789	5.8	29	05	63	38178.7894	-2.72	0.38	21			
PI BOO A	795	5.8	03	06	63	38183.7538	-2.57	0.40	14			
PI BOO A	829	5.8	18	06	63	38198.7446	-2.78	0.42	12			
PI BOO A	1258	5.8	18	04	64	38503.8599	-1.99	0.30	17			
PI BOO A	3737	2.4	15	02	68	39902.0264	-1.78	0.10	26			
PI BOO A	3772	2.4	18	03	68	39933.9650	-2.50	0.27	20			
PI BOO A	3792	2.4	16	04	68	39962.9078	-2.40	0.10	25			
PI BOO A	4386	6.5	10	03	69	40290.9731	-0.88	0.39	23			
PI BOO A	4434	10.	11	04	69	40322.9039	-2.11	0.33	22			
PI BOO A	68674	15.	09	03	70	40655.0565	-1.01	0.71	15			
PI BOO A	68913	15.	03	04	70	40679.9120	-0.11	0.82	16			
PI BOO A	69257	15.	23	05	70	40729.7831	-0.40	0.64	19			
PI BOO A	69542	15.	07	07	70	40774.7354	-1.51	0.76	16			
PI BOO A	6631	6.5	05	03	71	41015.9780	-0.49	0.32	20			
PI BOO A	6934	2.4	17	07	71	41149.7561	-1.32	0.18	24			
PI BOO A	8074	6.5	03	04	73	41775.9582	-2.67	0.35	13			
						MEANS OF 17 PLATES	-1.71	0.39	19.			
						SIGMAS	0.88	0.22	4.			
						RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.23						
IOTA COR BOR	797	5.8	03	06	63	38183.8181	-20.01	0.22	15			
IOTA COR BOR	1261	5.8	18	04	64	38503.9427	-19.50	0.21	17			
IOTA COR BOR	1714	10.	23	03	65	38842.8220	-21.41	0.72	7			
IOTA COR BOR	1741	10.	12	04	65	38862.8867	-20.91	0.48	7			
IOTA COR BOR	1966	6.5	17	07	65	38956.7446	-19.78	0.15	19			
IOTA COR BOR	1988	6.5	28	07	65	38969.7269	-18.66	0.33	12			
IOTA COR BOR	2467	2.4	08	05	66	39253.8857	-20.05	0.14	22			
IOTA COR BOR	2569	2.4	30	06	66	39306.7658	-20.77	0.14	23			
IOTA COR BOR	2592	2.4	09	07	66	39315.7958	-20.16	0.12	22			
IOTA COR BOR	2910	6.5	21	02	67	39543.0078	-21.29	0.31	20			
IOTA COR BOR	4390	6.5	10	03	69	40291.0502	-22.53	0.39	22			
IOTA COR BOR	4562	2.4	23	05	69	40364.8891	-22.42	0.11	28			
IOTA COR BOR	4612	6.5	06	06	69	40378.8065	-20.57	0.18	17			
IOTA COR BOR	4621	6.5	07	06	69	40379.7852	-20.49	0.17	19			
IOTA COR BOR	4702	6.5	01	07	69	40403.9076	-21.01	0.20	20			
IOTA COR BOR	4726	6.5	05	07	69	40407.8619	-20.73	0.21	20			
IOTA COR BOR	5829	6.5	08	06	70	40745.8394	-20.38	0.19	19			
IOTA COR BOR	5891	6.5	26	06	70	40763.8002	-20.94	0.17	18			
IOTA COR BOR	6650	6.5	16	03	71	41026.9738	-21.10	0.38	20			
IOTA COR BOR	6692	6.5	25	03	71	41035.9954	-22.81	0.32	21			
IOTA COR BOR	6867	6.5	02	07	71	41134.7413	-22.06	0.13	21			
IOTA COR BOR	6935	2.4	17	07	71	41149.7509	-20.78	0.10	25			
IOTA COR BOR	7523	2.4	24	07	72	41522.8379	-19.80	0.13	22			
IOTA COR BOR	7997	6.5	08	03	73	41749.9980	-22.16	0.25	21			
						MEANS OF 24 PLATES	-20.85	0.24	19.			
						SIGMAS	1.02	0.14	5.			
						RATIO OF EXTERNAL/INTERNAL SIGMAS= 4.27						
UPSILON HER	4356	6.5	07	03	69	40288.0460	3.02	0.19	18			
UPSILON HER	4391	6.5	10	03	69	40291.0652	3.51	0.21	14			
UPSILON HER	4429	6.5	24	03	69	40305.0344	3.20	0.29	16			
UPSILON HER	4526	2.4	15	05	69	40356.8086	3.92	0.12	22			
UPSILON HER	4628	6.5	08	06	69	40380.8359	4.42	0.23	13			
UPSILON HER	4703	6.5	01	07	69	40403.9158	3.66	0.36	14			

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TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
UPSILON HER	4727	6.5	05 07 69	40407.8697	2.90	0.31	17			
UPSILON HER	5830	6.5	08 06 70	40745.8533	3.56	0.24	17			
UPSILON HER	5871	6.5	22 06 70	40759.8175	2.81	0.26	17			
UPSILON HER	5892	6.5	26 06 70	40763.8076	3.31	0.26	15			
UPSILON HER	6648	6.5	16 03 71	41026.9577	3.46	0.34	19			
UPSILON HER	6869	6.5	02 07 71	41134.7574	2.96	0.28	18			
UPSILON HER	6936	2.4	17 07 71	41149.7589	3.58	0.16	19			
UPSILON HER	7536	2.4	29 07 72	41527.7070	3.78	0.09	21			
UPSILON HER	7998	6.5	08 03 73	41750.0044	2.70	0.27	19			
			MEANS OF	15 PLATES	3.39	0.24	17.			
				SIGMAS	0.47	0.08	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS=	1.95									
PHI HERCULIS	1742	10.	12 04 65	38862.9364	-13.66	0.60	12			
PHI HERCULIS	1796	10.	30 05 65	38910.7884	-16.10	0.34	12			
PHI HERCULIS	2616	2.4	22 07 66	39328.7297	-15.94	0.12	21			
PHI HERCULIS	3116	3.3	27 05 67	39637.8759	-17.96	0.21	21			
PHI HERCULIS	3166	3.3	16 06 67	39657.7890	-17.64	0.19	20			
PHI HERCULIS	3168	3.3	17 06 67	39658.8948	-17.63	0.18	21			
PHI HERCULIS	3719	2.4	10 02 68	39897.0577	-16.03	0.08	25			
PHI HERCULIS	3793	2.4	16 04 68	39962.9980	-13.85	0.12	26			
PHI HERCULIS	3816	2.4	10 05 68	39986.7324	-13.59	0.15	26			
PHI HERCULIS	3818	2.4	11 05 68	39987.7414	-13.87	0.08	26			
PHI HERCULIS	3820	2.4	12 05 68	39988.7903	-14.05	0.10	23			
PHI HERCULIS	3821	2.4	13 05 68	39989.7716	-13.74	0.11	23			
PHI HERCULIS	3844	2.4	30 05 68	40006.8033	-14.77	0.13	24			
PHI HERCULIS	3875	2.4	04 07 68	40041.9075	-16.23	0.12	27			
PHI HERCULIS	3917	4.8	29 07 68	40066.7294	-16.27	0.17	17			
PHI HERCULIS	4357	6.5	07 03 69	40288.0550	-18.04	0.38	22			
PHI HERCULIS	4528	2.4	15 05 69	40356.8535	-17.70	0.08	25			
PHI HERCULIS	4534	2.4	16 05 69	40357.9518	-17.50	0.12	24			
PHI HERCULIS	4699	2.4	01 07 69	40403.8423	-17.43	0.09	25			
PHI HERCULIS	4728	6.5	05 07 69	40407.8790	-17.18	0.30	19			
PHI HERCULIS	5831	6.5	08 06 70	40745.8653	-18.29	0.29	22			
PHI HERCULIS	5893	6.5	26 06 70	40763.8147	-18.59	0.28	20			
PHI HERCULIS	6649	6.5	16 03 71	41026.9650	-16.03	0.29	16			
PHI HERCULIS	6868	6.5	02 07 71	41134.7499	-15.36	0.22	18			
PHI HERCULIS	6937	2.4	17 07 71	41149.7702	-14.93	0.10	26			
PHI HERCULIS	7126	6.5	20 09 71	41214.7197	-17.01	0.27	20			
PHI HERCULIS	7524	2.4	24 07 72	41522.8695	-17.45	0.14	22			
PHI HERCULIS	7537	2.4	29 07 72	41527.7210	-17.58	0.11	24			
PHI HERCULIS	7593	2.4	25 08 72	41554.6734	-16.93	0.11	26			
PHI HERCULIS	7790	2.4	11 11 72	41632.5999	-13.11	0.14	26			
PHI HERCULIS	7947	6.5	21 02 73	41735.0464	-16.96	0.19	20			
PHI HERCULIS	7999	6.5	08 03 73	41750.0084	-16.88	0.24	20			
PHI HERCULIS	8073	6.5	03 04 73	41775.9408	-17.82	0.35	15			
PHI HERCULIS	8117	6.5	21 04 73	41793.8875	-17.23	0.37	18			
PHI HERCULIS	8423	6.5	20 07 73	41883.7190	-18.00	0.33	21			
PHI HERCULIS	8498	6.5	04 08 73	41898.7083	-17.78	0.12	17			
PHI HERCULIS	8679	6.5	04 09 73	41929.6650	-18.00	0.14	17			
			MEANS OF	37 PLATES	-16.41	0.20	21.			
				SIGMAS	1.61	0.11	4.			
RATIO OF EXTERNAL/INTERNAL SIGMAS=	8.07									
MU OPH	7948	6.5	21 02 73	41735.0560	-18.65	1.16	8			
MU OPH	8001	6.5	08 03 73	41750.0226	-20.58	2.32	9			
MU OPH	76631	15.	05 07 74	42233.8257	-13.50	1.45	7			
			MEANS OF	3 PLATES	-17.58	1.64	8.			
				SIGMAS	3.66	0.60	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS=	2.23									
HR 6620	69829	15.	21 07 70	40788.8163	22.85	1.34	10			
HR 6620	71190	15.	11 05 71	41082.9379	-80.14	0.91	11			
HR 6620	6877	6.5	02 07 71	41134.8452	-51.30	0.45	9			
HR 6620	6938	2.4	17 07 71	41149.8159	18.55	0.79	8			
HR 6620	7125	6.5	20 09 71	41214.6868	34.20	0.87	9			
HR 6620	72244	15.	05 05 72	41442.9678	-69.57	0.72	10			
HR 6620	73128	15.	26 08 72	41555.6870	-75.57	1.08	11			
HR 6620	73159	15.	30 08 72	41559.6824	-10.04	1.07	9			

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP Å/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 6620	73260	15.	13 09 72	41573.6568	28.44	0.72	12			
			MEANS OF 9 PLATES		-20.29	0.88	10.			
				SIGMAS	48.54	0.26	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 54.95										
HR 6997	831	5.8	16 06 63	38198.8347	-29.84	1.11	14			
HR 6997	843	5.8	03 07 63	38215.8407	-28.99	1.08	9			
HR 6997	3205	10.	30 06 67	39671.9230	-28.19	1.28	9			
HR 6997	3233	10.	05 07 67	39676.8133	-30.81	0.83	14			
HR 6997	3405	10.	31 08 67	39733.6731	-28.96	1.07	14			
HR 6997	4531	2.4	15 05 69	40356.9465	-29.09	0.49	18			
HR 6997	4618	6.5	06 06 69	40378.6962	-28.94	0.68	10			
HR 6997	4704	6.5	01 07 69	40403.9285	-28.76	0.61	14			
HR 6997	5833	6.5	08 06 70	40745.8914	-30.97	0.57	11			
HR 6997	5874	6.5	22 06 70	40759.8746	-31.84	0.63	13			
HR 6997	6266	6.5	30 09 70	40859.6761	-31.39	0.86	13			
HR 6997	6791	6.5	08 05 71	41079.8646	-30.96	0.77	11			
HR 6997	6818	6.5	06 06 71	41108.8816	-30.96	0.58	14			
HR 6997	6863	6.5	02 07 71	41134.9150	-28.84	0.63	11			
HR 6997	6939	2.4	17 07 71	41149.8659	-28.84	0.59	16			
HR 6997	7127	6.5	20 09 71	41214.7328	-29.04	0.97	11			
			MEANS OF 16 PLATES		-29.78	0.80	13.			
				SIGMAS	1.17	0.24	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.47										
HR 7028	6819	6.5	06 06 71	41108.9019	-22.63	1.37	12			
HR 7028	6884	6.5	02 07 71	41134.9227	-22.42	1.07	12			
HR 7028	6940	2.4	17 07 71	41149.8973	-22.19	0.55	16			
HR 7028	7130	6.5	20 09 71	41214.7694	-21.23	0.77	10			
HR 7028	7184	6.5	30 09 71	41224.8174	-23.06	0.56	14			
HR 7028	72231	15.	04 05 72	41441.9942	-22.59	1.04	10			
HR 7028	7540	6.5	29 07 72	41527.8119	-24.20	0.58	11			
HR 7028	7749	6.5	19 10 72	41609.7433	-25.34	0.72	16			
HR 7028	7793	6.5	11 11 72	41632.6924	-22.92	0.69	13			
			MEANS OF 9 PLATES		-22.95	0.82	13.			
				SIGMAS	1.19	0.28	2.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.46										
46 DRACONIS	832	5.8	18 06 63	38198.8895	-53.76	0.57	12	+0.57	0.36	8
46 DRACONIS	875	5.8	15 07 63	38225.7755	-29.21	0.21	12	BLENDED LINES		
46 DRACONIS	2593	2.4	09 07 66	39315.9304	-53.97	0.15	15	+0.47	0.45	11
46 DRACONIS	2617	2.4	22 07 66	39328.8443	-27.57	0.29	21	SINGLE LINES		
46 DRACONIS	4563	2.4	23 05 69	40364.9392	-42.33	0.10	23	-16.09	0.14	14
46 DRACONIS	4632	6.5	08 06 69	40380.8984	-9.46	0.23	17	-52.50	0.29	12
46 DRACONIS	4705	6.5	01 07 69	40403.9386	-37.49	0.30	12	-21.94	0.58	10
46 DRACONIS	4730	6.5	05 07 69	40407.9064	-29.96	0.16	18	SINGLE LINES		
46 DRACONIS	5049	6.5	29 09 69	40493.7067	-60.71	0.20	13	+3.28	0.49	11
46 DRACONIS	5191	6.5	26 11 69	40551.7118	-50.72	0.21	14	-8.55	0.38	12
46 DRACONIS	5632	6.5	14 04 70	40690.8648	-56.46	0.21	17	-4.63	0.29	11
46 DRACONIS	5834	6.5	08 06 70	40745.9002	-18.87	0.37	15	-46.54	0.37	11
46 DRACONIS	5875	6.5	22 06 70	40759.8875	-50.08	0.25	14	-10.51	0.51	12
46 DRACONIS	6267	6.5	30 09 70	40859.7057	-23.73	0.25	16	-40.86	0.27	10
46 DRACONIS	6941	2.4	17 07 71	41149.9328	-47.52	0.10	11	-14.77	0.51	6
46 DRACONIS	7128	6.5	20 09 71	41214.7423	-12.37	0.32	17	-54.72	0.50	11
46 DRACONIS	9423	2.4	14 10 74	42334.6126	-13.22	0.27	11	-50.87	0.16	8
			MEANS OF 17 PLATES		-36.32	0.25	15.			
				SIGMAS	17.02	0.11	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 69.22										
112 HERCULIS	65256	15.	22 07 68	40059.7866	-6.76	1.69	10			
112 HERCULIS	4633	6.5	08 06 69	40380.9140	-38.86	0.37	12			
112 HERCULIS	5836	6.5	08 06 70	40745.9408	-11.49	0.30	12			
112 HERCULIS	5876	6.5	22 06 70	40759.9054	-6.77	0.29	11			
112 HERCULIS	6265	6.5	30 09 70	40859.6535	-23.86	0.29	12			
112 HERCULIS	6942	2.4	17 07 71	41149.9694	-29.09	0.14	6			
112 HERCULIS	7129	6.5	20 09 71	41214.7531	-41.57	0.41	14			
112 HERCULIS	9662	2.4	31 03 75	42503.0284	-6.32	0.14	17			
			MEANS OF 8 PLATES		-20.59	0.45	12.			
				SIGMAS	14.76	0.51	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 32.54										

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INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
64 SERPENTIS	7949	6.5	21 02 73	41735.0781	-10.37	3.00	7			
64 SERPENTIS	8002	6.5	08 03 73	41750.0365	-10.93	3.03	7			
64 SERPENTIS	76633	15.	05 07 74	42233.8413	-6.72	2.74	6			
			MEANS OF	3 PLATES	-9.34	2.92	7.			
				SIGMAS	2.29	0.16	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.78									
HR 7230	5635	6.5	08 06 70	40745.9224	-31.14	1.17	5			
HR 7230	6680	6.5	02 07 71	41134.8862	-24.95	2.33	6			
			MEANS OF	2 PLATES	-28.05	1.75	5.			
				SIGMAS	4.38	0.82	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 2.50									
21 AQUILAE	7792	6.5	11 11 72	41632.6683	-4.71	0.42	9			
21 AQUILAE	8075	6.5	03 04 73	41775.9876	-7.80	0.56	8			
21 AQUILAE	76634	15.	05 07 74	42233.8479	-8.37	0.42	10			
21 AQUILAE	77053	15.	14 09 74	42304.7192	-5.84	0.30	8			
			MEANS OF	4 PLATES	-6.68	0.42	9.			
				SIGMAS	1.70	0.11	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 4.01									
HR 7361	69836	15.	21 07 70	40768.9158	-21.38	0.46	17			
HR 7361	70309	15.	10 09 70	40839.8727	-21.84	0.40	19			
HR 7361	6792	6.5	08 05 71	41079.8929	-22.60	0.26	14			
HR 7361	6820	6.5	06 06 71	41108.9169	-21.97	0.20	17			
HR 7361	6881	6.5	02 07 71	41134.8953	-22.52	0.28	18			
HR 7361	7131	6.5	20 09 71	41214.7908	-21.88	0.28	16			
HR 7361	7160	6.5	30 09 71	41224.6449	-22.45	0.37	17			
HR 7361	7541	6.5	29 07 72	41527.8207	-22.38	0.27	15			
HR 7361	7750	6.5	19 10 72	41609.7632	-22.75	0.14	16			
			MEANS OF	9 PLATES	-22.20	0.30	17.			
				SIGMAS	0.45	0.10	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.52									
HR 7664	69833	15.	21 07 70	40788.8761	-26.97	1.49	10			
HR 7664	70308	15.	10 09 70	40839.8557	-24.65	0.62	11			
HR 7664	6693	6.5	25 03 71	41036.0103	-22.92	0.51	12			
HR 7664	71093	15.	21 04 71	41063.0088	-25.52	0.40	10			
HR 7664	6793	6.5	08 05 71	41079.9286	-25.46	0.40	14			
HR 7664	6821	6.5	06 06 71	41108.9341	-18.06	0.22	12			
HR 7664	6882	6.5	02 07 71	41134.9076	-25.69	0.17	9			
HR 7664	7132	6.5	20 09 71	41214.8141	-24.65	0.31	13			
HR 7664	7161	6.5	30 09 71	41224.6545	-21.33	0.27	10			
HR 7664	72663	15.	02 07 72	41500.9132	-26.05	0.33	9			
HR 7664	7525	6.5	24 07 72	41522.9439	-24.50	0.19	10			
HR 7664	7542	6.5	29 07 72	41527.8335	-23.98	0.34	12			
HR 7664	73131	15.	26 08 72	41555.7677	-23.57	0.24	9			
HR 7664	73161	15.	30 08 72	41559.8468	-26.21	0.45	10			
HR 7664	73264	15.	13 09 72	41573.7430	-26.61	0.63	11			
HR 7664	73305	15.	16 09 72	41576.7487	-25.92	0.48	9			
HR 7664	7751	6.5	19 10 72	41609.7873	-21.14	0.41	10			
HR 7664	7794	6.5	11 11 72	41632.7195	-25.10	0.24	12			
HR 7664	74866	15.	14 05 73	41816.9395	-24.75	0.71	10			
HR 7664	8242	6.5	17 05 73	41819.9328	-25.30	0.32	11			
HR 7664	8681	6.5	04 09 73	41929.6955	-23.74	0.15	10			
HR 7664	8733	6.5	17 09 73	41942.7084	-26.29	0.24	10			
HR 7664	8781	6.5	13 11 73	41999.6204	-25.73	0.38	10			
HR 7664	9072	6.5	15 07 74	42243.8323	-24.65	0.27	9			
HR 7664	9133	2.4	01 08 74	42260.8730	-24.06	0.29	13			
HR 7664	9314	2.4	18 09 74	42308.6541	-24.46	0.15	6			
			MEANS OF	26 PLATES	-24.51	0.39	10.			
				SIGMAS	1.94	0.27	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS= 4.95									
HR 7694	76636	15.	05 07 74	42233.8678	-60.95	0.62	15	+46.13	1.82	9
HR 7694	77057	15.	14 09 74	42304.7690	40.60	0.78	14	-64.06	0.81	9
			MEANS OF	2 PLATES	-10.17	0.70	14.			
				SIGMAS	71.81	0.11	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=102.58									

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
3 CAP	6885	6.5	02 07 71	41134.9390	-14.88	1.69	5			
3 CAP	7543	6.5	29 07 72	41527.8456	-19.60	2.08	7			
3 CAP	76637	15.	05 07 74	42233.8827	-18.86	2.37	6			
			MEANS OF	3 PLATES	-17.78	2.05	6.			
				SIGMAS	2.54	0.34	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				1.24					
HR 7911	73589	15.	16 10 72	41606.6600	-11.07	1.54	10			
HR 7911	8119	6.5	21 04 73	41793.9310	-28.90	0.93	12			
HR 7911	76635	15.	05 07 74	42233.8524	-36.36	2.13	9			
			MEANS OF	3 PLATES	-25.44	1.53	10.			
				SIGMAS	12.99	0.60	2.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				8.47					
HD 200311	63586	15.	03 07 67	39674.9347	-18.37	0.92	11			
HD 200311	71404	15.	19 07 71	41151.9047	-22.25	0.52	13			
HD 200311	71757	15.	19 09 71	41213.8231	-24.14	0.89	14			
HD 200311	7182	6.5	30 09 71	41224.6785	-22.41	0.35	11			
HD 200311	71987	15.	03 01 72	41319.6104	-26.71	0.83	13			
HD 200311	72230	15.	04 05 72	41441.9685	-22.70	0.61	12			
HD 200311	72665	15.	02 07 72	41500.9586	-22.49	0.30	11			
HD 200311	73133	15.	26 08 72	41555.8273	-23.89	0.42	11			
HD 200311	73162	15.	30 08 72	41559.8733	-25.00	0.49	11			
HD 200311	76629	15.	05 07 74	42233.7937	-21.79	0.38	11			
HD 200311	77062	15.	14 09 74	42304.8384	-22.17	0.85	15			
			MEANS OF	11 PLATES	-22.90	0.60	12.			
				SIGMAS	2.11	0.24	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				3.54					
HR 8118	69834	15.	21 07 70	40788.8898	-5.41	2.01	10			
HR 8118	70307	15.	10 09 70	40839.8373	-6.57	1.92	11			
HR 8118	6964	6.5	21 07 71	41153.9519	-4.72	0.93	10			
HR 8118	72664	15.	02 07 72	41500.9358	-5.77	1.24	11			
HR 8118	72719	15.	15 07 72	41513.9607	-7.76	0.94	11			
HR 8118	7544	6.5	29 07 72	41527.8629	-5.33	0.67	13			
HR 8118	73132	15.	26 08 72	41555.7972	-4.70	0.75	9			
HR 8118	73265	15.	13 09 72	41573.7690	-5.88	0.93	10			
			MEANS OF	8 PLATES	-5.77	1.17	11.			
				SIGMAS	1.01	0.52	1.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				0.86					
30 CAP	76644	15.	05 07 74	42233.9489	-12.02	1.08	11			
30 CAP	77055	15.	14 09 74	42304.7443	-9.88	0.73	11			
30 CAP	9515	6.5	12 12 74	42393.5601	-11.73	0.50	11			
			MEANS OF	3 PLATES	-11.21	0.77	11.			
				SIGMAS	1.16	0.29	0.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				1.51					
HR 8349	67754	15.	16 08 69	40449.9399	-3.18	0.66	14			
HR 8349	69555	15.	07 07 70	40774.9468	-4.65	0.87	17			
HR 8349	69839	15.	21 07 70	40788.9454	-4.08	0.59	17			
HR 8349	70159	15.	23 08 70	40821.8470	-3.95	0.50	22			
HR 8349	70227	15.	29 08 70	40827.8176	-5.53	0.41	19			
HR 8349	70270	15.	06 09 70	40835.8444	-4.77	0.40	21			
HR 8349	70311	15.	10 09 70	40839.8968	-5.84	0.43	20			
HR 8349	7133	6.5	20 09 71	41214.8302	-6.96	0.29	16			
HR 8349	7185	6.5	30 09 71	41224.8415	-7.14	0.33	17			
HR 8349	7526	6.5	24 07 72	41522.9585	-6.40	0.29	12			
HR 8349	7545	6.5	29 07 72	41527.8736	-7.14	0.22	17			
HR 8349	7752	6.5	19 10 72	41609.8114	-6.82	0.28	17			
HR 8349	7796	6.5	11 11 72	41632.7686	-6.54	0.25	18			
			MEANS OF	13 PLATES	-5.62	0.42	17.			
				SIGMAS	1.36	0.19	3.			
	RATIO OF EXTERNAL/INTERNAL SIGMAS=				3.20					
HD 208513	75098	15.	11 07 73	41874.9049	0.62	3.55	6			

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HD 208513	76639	15.	05 07 74	42233.9011	30.80	2.30	7			
HD 208513	77061	15.	14 09 74	42304.8257	-21.48	2.14	15			
			MEANS OF	3 PLATES	3.31	2.66	9.			
				SIGMAS	26.24	0.77	5.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 9.85								
HR 8434	5023	6.5	15 09 69	40479.8249	-19.64	1.62	9			
HR 8434	5837	6.5	06 06 70	40745.9548	-28.10	2.28	9			
			MEANS OF	2 PLATES	-23.87	1.95	9.			
				SIGMAS	5.98	0.47	0.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 3.07								
HR 8473	69837	15.	21 07 70	40788.9231	-4.68	0.80	6			
HR 8473	70310	15.	10 09 70	40839.8856	-4.54	1.11	13			
HR 8473	6694	6.5	25 03 71	41036.0427	-1.89	0.93	11			
HR 8473	6794	6.5	08 05 71	41079.9618	-2.02	0.76	11			
HR 8473	6965	6.5	21 07 71	41153.9661	-3.17	1.33	13			
HR 8473	7134	6.5	20 09 71	41214.8459	-1.96	1.07	11			
HR 8473	7186	6.5	30 09 71	41224.8649	-3.64	0.66	14			
HR 8473	72721	15.	16 07 72	41514.9694	-0.88	1.99	12			
HR 8473	7546	6.5	29 07 72	41527.8793	-4.83	2.06	11			
HR 8473	73135	15.	26 08 72	41555.9286	-2.83	0.75	13			
HR 8473	73163	15.	30 08 72	41559.9002	-2.59	1.10	13			
HR 8473	73269	15.	13 09 72	41573.8367	-2.55	1.04	16			
HR 8473	73308	15.	16 09 72	41576.7934	-6.00	1.18	10			
HR 8473	73592	15.	16 10 72	41606.7388	-4.66	1.17	13			
HR 8473	7753	6.5	19 10 72	41609.8603	-2.72	1.16	16			
			MEANS OF	15 PLATES	-3.26	1.14	12.			
				SIGMAS	1.41	0.41	2.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.24								
RHO AQUARII	73593	15.	16 10 72	41606.7548	3.31	1.43	7			
RHO AQUARII	73933	15.	08 12 72	41659.5846	-16.31	1.13	7			
RHO AQUARII	8735	6.5	17 09 73	41942.8012	-16.53	1.55	9			
RHO AQUARII	76645	15.	05 07 74	42233.9605	12.17	1.39	11			
RHO AQUARII	77056	15.	14 09 74	42304.7550	-6.45	0.93	10			
RHO AQUARII	77683	15.	23 12 74	42404.5981	-13.70	2.33	9			
			MEANS OF	6 PLATES	-6.25	1.46	9.			
				SIGMAS	11.77	0.49	2.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 8.06								
56 AQUARII	77058	15.	14 09 74	42304.7919	-26.55	0.69	15			
56 AQUARII	9516	6.5	12 12 74	42393.5921	-26.12	0.55	11			
56 AQUARII	77681	15.	23 12 74	42404.5752	-26.62	0.56	15			
			MEANS OF	3 PLATES	-26.43	0.60	14.			
				SIGMAS	0.27	0.08	2.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.45								
74 AQUARII	77059	15.	14 09 74	42304.8080	-7.09	0.93	12			
74 AQUARII	77682	15.	23 12 74	42404.5890	-58.83	0.88	9	+60.37	1.87	6
			MEANS OF	2 PLATES	-32.96	0.90	10.			
				SIGMAS	36.59	0.04	2.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 40.43								
HR 8723	76641	15.	05 07 74	42233.9216	-3.82	1.12	11			
HR 8723	77063	15.	14 09 74	42304.8550	-1.55	1.19	11			
HR 8723	77684	15.	23 12 74	42404.6083	-4.09	1.87	11			
			MEANS OF	3 PLATES	-3.15	1.39	11.			
				SIGMAS	1.40	0.41	0.			
		RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.00								
HR 8753	7135	6.5	20 09 71	41214.8982	3.20	1.05	13			
HR 8753	7187	6.5	30 09 71	41224.8922	-0.37	0.92	14			
HR 8753	72245	15.	05 05 72	41442.9834	2.37	1.33	13			
HR 8753	7547	6.5	29 07 72	41527.8910	2.82	0.63	12			
HR 8753	73136	15.	26 08 72	41555.9564	1.28	1.03	14			

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 8753	73164	15.	30 08 72	41559.9183	2.20	1.01	15			
HR 8753	73266	15.	13 09 72	41573.7967	3.69	0.72	13			
HR 8753	7797	6.5	11 11 72	41632.8020	2.63	0.62	15			
			MEANS OF	8 PLATES	2.23	0.91	14.			
				SIGMAS	1.27	0.24	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.39										
HR 8902	76642	15.	05 07 74	42233.9279	-25.10	0.95	15			
HR 8902	77064	15.	14 09 74	42304.8649	-6.09	0.74	16			
HR 8902	77685	15.	23 12 74	42404.6178	-7.19	0.30	14			
			MEANS OF	3 PLATES	-12.79	0.66	15.			
				SIGMAS	10.67	0.33	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 16.09										
13 AND	76643	15.	05 07 74	42233.9344	-2.66	2.33	8			
13 AND	77065	15.	14 09 74	42304.8758	-0.84	2.16	12			
13 AND	77688	15.	23 12 74	42404.6530	-9.33	2.46	11			
			MEANS OF	3 PLATES	-4.28	2.32	10.			
				SIGMAS	4.47	0.15	2.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.93										
69 PEGASI	69840	15.	21 07 70	40786.9518	-16.15	1.34	11			
69 PEGASI	70312	15.	10 09 70	40839.9053	-15.44	1.42	13			
69 PEGASI	7136	6.5	20 09 71	41214.9173	-18.93	0.85	11			
69 PEGASI	7168	6.5	30 09 71	41224.9086	-16.26	1.07	10			
69 PEGASI	7306	6.5	23 11 71	41278.5896	-15.68	1.13	9			
69 PEGASI	72720	15.	15 07 72	41513.9688	-17.26	1.79	12			
69 PEGASI	7548	6.5	29 07 72	41527.8970	-19.23	0.63	12			
69 PEGASI	73267	15.	13 09 72	41573.8134	-16.34	0.57	11			
			MEANS OF	8 PLATES	-17.16	1.10	11.			
				SIGMAS	1.49	0.41	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.35										
HD 222207	75099	15.	11 07 73	41874.9249	73.31	0.70	12			
HD 222207	8751	6.5	03 10 73	41958.9072	46.77	0.16	13			
HD 222207	8847	6.5	06 03 74	42112.6455	-13.60	0.41	10			
HD 222207	77068	15.	14 09 74	42304.9026	-28.78	0.50	15	+46.33	0.77	2
HD 222207	77690	15.	23 12 74	42404.6673	-40.79	0.86	16	+64.25		1
			MEANS OF	5 PLATES	7.38	0.53	13.			
				SIGMAS	49.91	0.27	2.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 94.89										
HR 9086	71758	15.	19 09 71	41213.8625	-11.22	0.99	11			
HR 9086	7137	6.5	20 09 71	41214.9337	-12.05	1.58	8			
HR 9086	7189	6.5	30 09 71	41224.9211	-8.40	1.47	9			
HR 9086	7549	6.5	29 07 72	41527.9016	-9.44	0.80	8			
HR 9086	73137	15.	26 08 72	41555.9767	-9.89	1.34	11			
HR 9086	73268	15.	13 09 72	41573.8255	-10.53	1.48	11			
HR 9086	73313	15.	16 09 72	41576.8586	-7.93	0.98	9			
HR 9086	7755	6.5	19 10 72	41609.9114	-10.15	1.22	11			
			MEANS OF	8 PLATES	-9.95	1.23	10.			
				SIGMAS	1.37	0.28	1.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.11										
29 PISCIUM	77066	15.	14 09 74	42304.8852	15.41	1.75	11			
29 PISCIUM	77689	15.	23 12 74	42404.6574	17.58	1.47	7			
			MEANS OF	2 PLATES	16.49	1.61	9.			
				SIGMAS	1.53	0.20	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 0.95										
HR 9110	5024	6.5	15 09 69	40479.8511	-2.54	0.65	13			
HR 9110	70313	15.	10 09 70	40839.9131	-3.18	0.93	11			
HR 9110	6795	6.5	08 05 71	41079.9917	-2.29	2.06	7			
HR 9110	6822	6.5	06 06 71	41108.9428	-2.19	1.64	17			
HR 9110	6886	6.5	02 07 71	41134.9426	-5.31	1.23	14			
HR 9110	6966	6.5	21 07 71	41153.9766	-2.82	1.87	13			

TABLE 2.

INDIVIDUAL RADIAL VELOCITIES.

STAR	PLATE #	DISP A/MM	UT DATE D M Y	HELIOCENTRIC JULIAN DATE	PRIMARY VELOCITY	ME	N	SECONDARY VELOCITY	ME	N
HR 9110	7138	6.5	20 09 71	41214.9502	-6.07	0.90	17			
HR 9110	7190	6.5	30 09 71	41224.9308	-3.96	0.92	12			
HR 9110	7527	6.5	24 07 72	41522.9702	-4.04	0.91	9			
HR 9110	7550	6.5	29 07 72	41527.9055	-5.96	0.69	8			
HR 9110	73138	15.	26 08 72	41555.9908	-7.90	0.95	16			
HR 9110	73165	15.	30 08 72	41559.9289	-3.77	1.13	11			
HR 9110	73272	15.	13 09 72	41573.8760	-4.73	1.87	13			
HR 9110	73310	15.	16 09 72	41576.8209	-0.50	1.89	8			
HR 9110	73595	15.	16 10 72	41606.7749	-3.94	1.18	12			
HR 9110	7754	6.5	19 10 72	41609.8867	-4.92	2.10	10			
				MEANS OF 16 PLATES	-4.01	1.31	12.			
				SIGMAS	1.81	0.51	3.			
RATIO OF EXTERNAL/INTERNAL SIGMAS= 1.36										

The plate measures were reduced to velocity in the usual way by computer, and heliocentric corrections calculated to the nearest 0.01 km/sec. from the computer routines given by Ball (1969) were applied. The complete journal of observations is given in Table 2, and contains the following data: star name, plate number, reciprocal dispersion, U.T. date, heliocentric Julian Date (-2,400,000) plus the heliocentric velocity, internal error (standard error of the mean) and number of lines measured for both primary and (where measured in double-lined systems) secondary spectra. After the observations for each star, the means followed by their standard errors are given for each of the last three columns (primary velocity, internal error, number of lines) for that star. This is followed by the ratio of external to internal velocity errors: where this ratio is unity or at least less than two the star may be considered to be constant in velocity; where it exceeds two the star is suspect as variable, and a much larger value may be taken as confirmation of variability. In the case of intermediate values of this ratio (eg. 2 to 5), it is often possible to distinguish whether a star is intrinsically constant or variable by looking for time structure in the run of velocities: random variation implies an intrinsic constancy, while periodic variation confirms the variability. Particularly useful in the search for periodicities is the computer routine described by Morbey (1973), which was applied to the time-velocity data of Table 2 for many of the newly discovered variables and suspected variables. This search revealed a period near 560 days in the velocity variation of ϕ Her, and suggested possible periods for HR 149($\sim$400 days), HR 205($\sim$3000 days), HR 2844($\sim$1000 days) and ι Cr B($\sim$384 days?).

ORBITAL SOLUTIONS

The velocity data of Table 2 made feasible new orbital solutions for a number of stars. In many cases, earlier published velocities are available (as found in the Abt and Biggs (1972) Bibliography of Stellar Radial Velocities, or in Abt and Snowden (1973)), and serve to refine the period determination. However, these earlier velocities were used in the solution for the other orbital elements as well, wherever their use resulted in smaller formal errors for all the elements.

TABLE 3.

NEWLY DERIVED ORBITAL ELEMENTS AND THEIR STANDARD ERRORS.

Star	P	T	ω	e	K	V_0	#	Dates
		Julian Date 2,400,000+	°		km/sec.	km/sec.	of velocities	Spanned
α And	96.6960 ±0.0013	42056.32 ±0.28	77.1 ±1.3	0.521 ±.008	30.8 ±0.3	—11.6 ±0.2	273	1901-1974
2 Per	5.62698 ±0.00002	40281.38 ±0.87	214 ±56	0.013 ±.012	26.5 ±0.3	+11.2 ±0.2	64	1941-1974
κ Cnc	6.39326 ±0.00002	40001.95 ±.05	157 ±3	0.126 ±.007	67.4 ±0.5	+24.5 ±0.3	51 222*	1963-1972 1904-1972*
φ Her	560.5 ±1.7	40525.2 ±5.5	357 ±5	0.47 ±.03	2.39 ±0.12	—16.79 ±.06	37	1965-1973
HR 6620	12.4515 ±0.0008	41083.06 ±0.03	180+	0.0+	59.7 ±0.6	—19.5 ±0.5	9 51*	1970-1972 1962-1972*
46 Dra	9.81073 ±0.00004	40003.22 ±0.10	primary 173 secondary 353 ±4	0.200 ±.015	primary 25.1±0.4 secondary 29.5±0.5	—30.95 ±0.28	16 57*	1963-1974 1919-1974*

+ fixed in this solution; the orbit appears to be circular.

* used for determination of the period only.

The new elements which were so derived for six systems are given in Table 3; comments on each system follow:

α Andromedae: Previous orbit by Pearce (1936). The velocities of Table 2 are poorly distributed in phase, and so were combined with the early Lowell, Lick, Allegheny and Yerkes velocities referenced by Abt and Biggs, plus 92 unpublished velocities by Pearce, plus Abt and Snowden's velocities to yield the elements given in Table 3. Separately, the above sources give elements in good agreement except for V_0, which is more negative for the earlier data. The velocities of this study alone when used in an orbital solution imply a V_0 = 9.6 km/sec., identical to the value found by Abt and Snowden from their data.

2 Persei: The orbit of Heard and Krautter (1975) closely resembles this solution, which incorporates both their velocities and mine.

κ Cancri: Previous orbits were by Struve (1943) and Pearce and Riddle (1940). This solution is based on the velocities of Preston et al. (1969), Abt and Snowden (1973) and this paper, once the period had been fixed in a solution which also incorporated the earlier observations as referenced by Abt and Biggs. The Allegheny velocities and those of Struve yield a more negative systemic velocity, but all the other data are in good agreement with the present value, so a third body in the system appears unlikely.

φ Herculis: The binary nature of this star was discovered independently by the Hale observers (Babcock 1971) and in this study.

HR 6620: An orbit has been published by Hube (1969); his data were used only to fix the period in this solution.

46 Draconis: This double-lined system has an orbit published by Petrie (1935). His data, plus that of Conti (1970), Abt and Snowden, and this paper were used to refine the period; the other elements are based on Table 2 velocities (except for the observation of JD 2438225, for which the lines of both components blend seriously) only. Both primary and secondary velocities were used equally to determine the present elements. The mass ratio m_1/m_2 is 1.18.

Published orbits are also available for the single-lined binary 53 Tauri (Dworetsky 1972), and for the double-lined systems HD 2019 (Heard 1949), HR 4072 (Nariai 1970), 112 Herculis (Conti 1970), HR 7694 (Dworetsky 1974a) and 74 Aquarii (Wolff 1974); the data of this paper are insufficient to warrant new orbital solutions for these stars. Another star, HR 6997 has preliminary orbital elements with P = 1675 days, K = 3.2 km/sec published by Abt and Snowden, but appears to be of constant velocity from this study. If convergence is forced in an orbital solution from Table 2 velocities by fixing the period and epoch at Abt and Snowden's values, a K of 1.9 ± 2.6 km/sec. results, which is not significant. Thus it appears doubtful that HR 6997 is a spectroscopic binary.

DEGREE OF PECULIARITY

As expected from the criteria used in the selection of program stars, many of the stars observed in this survey show only a weak or negligible enhancement of the mercury and manganese lines (although the presence of *any* Hg II λ 3984 feature in the spectrum implies large overabundances of this element; cf. Cowley and Aikman, 1975). As mentioned above, the average number of lines measured per plate for each star is a rough index of peculiarity, principally measuring the degree of enhancement of the manganese (but also of the strontium, chromium and yttrium) lines. In order to provide a more objective, more specific index of peculiarity, the best plates of each star (from the 15 and 6.5 Å/mm plate material) were examined visually on a two-spectrum comparator, and eye estimates were made of the line strengths of the Hg II λ 3984 line and the Mn II lines. The scale used for each ion was as follows: 5= very strongly present, 4 = strongly present, 3= moderate strength, 2 = weakly present, 1 = possibly present, 0 = absent. These indices approximate a scale of equivalent width for the Hg II λ 3984 line and the Mn II λ 4136 and λ 4206 lines; usually the former line is found to be as strong or slightly stronger than the latter two lines. The weaker Mn II lines of Table 1 were also used in estimating the Mn II strength, and as there are a number of them of comparable strength, the Mn II index should be the more reliable.

The results of this classification are given in Table 4, which summarizes all the observational data of this study. Tabulated are the following: star name, HD number, original peculiarity type classification followed by a reference number (as identified in the table footnotes) for the source of this classification, Hg II and Mn II line strength indices (on the scale 0 — 5 outlined above), average number of stellar lines measured per plate (as in Table 2), mean velocity (also from Table 2), or alternately the systemic velocity for systems with orbital solutions, and finally, the variability of the velocity. Symbols denoting the velocity variability are as follows: C = constant, PC = probably constant, PV = probably variable (or PC: and PV: to denote increased uncertainty), V = variable, SB1 and SB2 for single- and double-lined systems with available orbital elements (followed by the period in days in brackets), and ? = the variability or constancy is unknown.

TABLE 4.

PECULIARITY AND VELOCITY VARIABILITY OF THE PROGRAM STARS.

STAR NAME	HD	PECULIARITY TYPE	* SOURCE	Hg II STRENGTH	Mn II STRENGTH	# OF LINES MEASURED	VELOCITY km/sec.	VELOCITY VARIABILITY	NOTES
α And	358	Hg Mn	1	4	5	13	—11.6	SB1(96.d7)	
	1009	Mn	9	5	5	18	—6.7	PC:	
	2019	Hg	7	3	2	9	+4.8	SB2(3.11)	
HR 149	3322	Hg Mn	1	5	4	16	+1.3	V	
HR 205	4335	Hg (Cr?)	3	5	4	18	+0.1	V	
	5342	Hg (Mn)	7	5	4	22	—17.9	V	
87 Psc	7374	Hg	5	4	4	16	—17.1	V	
HR 438	9298	(Hg Mn)	5	0	0	10	—1.0	C	
2 Per	11291	Hg Mn	2	5	4	18	+11.2	SB1(5.63)	
	11336	Hg (Mn)	7	5	4	18	—13.6	PV:	
HR 562	11905	Hg Mn	6	3	3	15	—7.4	PC	**
NGC 752-209		Hg??	11	1	0	11	+50.7	?	
HR 746	16004	Hg Mn 4200	1	4	3	17	—9.8	C	
	16693	Hg Mn	10	4	4	16	—8.0	PC	
11 Per	16727	(Hg) ?	5	2	1	12	—2.7	PV:	
	17280	Hg Mn	7	5	4	18	+8.2	PV	
HR 1063	21699	Mn	5	0	1	9	—8.1	PC	**
HR 1185	23950	Hg Mn Cr	2	2	3	9	+5.4	C	**
53 Tau	27295	Mn	12	0	5	18	+12.5	SB1(4.45)	**
HR 1445	28929	B8V; Hg (Mn)	1;2	2	2	10	+10.6	PC	
93 Tau	29589	Hg Mn	6	2:	1:	10	+15.8	PC	
HR 1690	33647	Hg Mn	6	—	—	—	—	—	**
μ Lep	33904	Hg Mn	1	5	5	19	+26.5	C	
HR 1759	34880	Mn	6	1	0	8	+22.4	?	
HR 1800	35548	Hg Si	2	5	4	19	—11.7	PC	
HR 1846	36404	(Hg)?	5	0	0	9	+0.3	C	
HR 1883	36881	(Hg Mn)?	5	0	1	10	+39.8	V	
HR 1938	37519	(Hg)?	5	1:	1:	4	+5.3	PV	
HR 1951	37752	(Hg)	2	0	1	9	+19.0	C	

STAR NAME	HD	PECULIARITY TYPE	* SOURCE	Hg II STRENGTH	Mn II STRENGTH	# OF LINES MEASURED	VELOCITY km/sec.	VELOCITY VARIABILITY	NOTES
129 Tau	38478	Hg	1	3	2	9	+16.2	C	
HR 2202	42657	Hg Mn	2	2	2	9	+19.3	C	
53 Aur	47152	Hg 4077	1	2	1	11	+12.7	PC	**
33 Gem	49606	—	14	2	2	15	+10.3	?	**
ψ^8 Aur	50204	Hg Mn; Si	1; 2	0	0	10	+29.9	C	**
40 Gem	51688	Hg Mn	6	1	1	11	+4.2	C	
HR 2844	58661	Hg Mn	2	5	5	18	+19.2	V	
HR 2859 C	59067 C	Hg (Mn?)	4	3	3	16	+30.6	?	
HR 3361	72208	(Hg)	2	1	3	11	+34.8	V	
14 Hya	75333	Hg Mn 4205	1	4	4	15	+27.3	C	
κ Cnc	78316	Hg	1	4	4	16	+24.5	SB1(6.39)	
36 Lyn	79158	Mn	5	0	0	12	+21.9	C	**
HR 4072	89822	Hg 4077	1	4	2	18	—2.6	SB2(11.6)	
HR 4493	101391	Hg (Mn)	2	3	2	10	+2.8	C	
γ Crv	106625	(Hg)	4	3	2	11	—4.6	C	
π Boo A	129174	Hg Mn	1	5	5	19	—1.7	PC	
ι Cr B	143807	Hg 4012,4077	1	3	3	19	—20.9	PV	**
ν Her	144206	Hg Mn 4012	1	4	5	17	+3.4	C	
ϕ Her	145389	Hg Mn	1	3	4	21	—16.8	SB1(560.)	
μ Oph	159975	(Hg?)	3	0	0	8	—17.6	PV:	
HR 6620	161701	Hg Mn	2	3	1	10	—19.5	SB1(12.5)	
HR 6997	172044	Hg Mn	1	5	4	13	—29.8	C	**
HR 7028	172883	Hg?	2	2	2	13	—23.0	C	
46 Dra	173524	Hg	1	4/3	4/1	15	—31.0	SB2(9.81)	
112 Her	174933	Hg	1	4	2	12	—21.3	SB2(6.36)	
64 Ser	175869	(Hg)	3	1:	1:	7	—9.3	C	
HR 7230	177517	Hg Si	1	1:	1:	5	—28.1	PV:	
21 Aql	179761	B7*V*; (Hg?)	1; 5	0	0	9	—6.7	PV	
HR 7361	182308	Hg Mn	2	4	5	17	—22.2	C	
HR 7664	190229	Hg Mn	2	3	1	10	—24.5	V	
HR 7694	191110	Hg	13	5/4	5/2	14	—8.4	SB2(9.35)	
3 Cap	192666	Hg?	2	2:	1:	6	—17.8	PC	
HR 7911	197018	Mn	5	0	0	10	—25.4	V	
	200311	Hg Mn	1	2	1	12	—22.9	PV	**
HR 8118	202149	Hg (Mn?)	2	3	1	11	—5.8	C	
30 Cap	202671	Mn	6	1	2	11	—11.2	PC	
HR 8349	207857	Hg Mn 4205	1	5	5	17	—5.6	PV	

STAR NAME	HD	PECULIARITY TYPE	* SOURCE	Hg II STRENGTH	Mn II STRENGTH	# OF LINES MEASURED	VELOCITY km/sec.	VELOCITY VARIABILITY	NOTES
	208513	Hg??	8	2	2	9	+3.3	V	
HR 8434	210071	Hg 3955	1	0:	1:	9	—23.9	PV	
HR 8473	210873	Hg (Mn)	2	3	3	12	—3.3	C	
ρ Aqr	211838	(Hg Mn)?	5	0	0	9	—6.3	V	
56 Aqr	213236	Hg Mn	6	1	5	14	—26.4	PC	**
74 Aqr	216494	Hg Mn	6	2:	2	10	—7.3	SB2 (3.43)	
HR 8723	216831	Hg Mn	6	1	3	11	—3.2	PC	
HR 8753	217477	Mn?	2	3	4	14	+2.2	C	
HR 8902	220575	Hg Mn	6	2	2	15	—12.8	V	
13 And	220855	Hg Mn	6	1:	1:	10	—4.3	PC:	
69 Peg	220933	Hg (Mn)	2	3	1	11	—17.2	C	
	222207	Hg (Mn)	7	4	3	13	+7.4	V	
HR 9086	224906	(Hg Mn)?	2	2	2	10	—10.0	C	
29 Psc	224926	Mn	6	0	1	9	+16.5	PC:	
HR 9110	225289	Hg (Mn)	2	3	3	12	—4.0	C	

* The source references for the peculiarity types given are numbered as follows:

1. Osawa (1965)
2. Cowley, Cowley, Jaschek and Jaschek (1969)
3. Cowley, Cowley, Hiltner, Jaschek and Jaschek (1968)
4. Cowley and Crawford (1971)
5. Cowley (1972)
6. Wolff and Wolff (1974)
7. Gulliver and MacRae (1975)
8. Gulliver (1971)
9. Slettebak and Nassau (1959)
10. Ianna (1970)
11. Garrison (1972)
12. Dworetsky (1972)
13. Dworetsky (1974a)
14. This paper

**Notes on individual stars:

HR 562: Hube (1970) found this star to be velocity variable.
HR 1063: A helium-weak silicon-enhanced star (Molnar 1972).
HR 1185: Hube (1970) found this star to be velocity variable.

53 Tau: This star has been repeatedly classified as normal from low dispersion spectra, since Hg II is absent; however Mn II is strongly present.

HR 1690: A close visual binary; the spectrum is composite and unmeasurable at high dispersion (shows late type absorptions).

53 Aur: Eu, Cr enhanced (Cowley, Cowley, Jaschek and Jaschek, 1969).

33 Gem: Helium weak star (Molnar, 1972).

ψ^8 Aur: No Hg, Mn or Si anomaly; the spectrum may be normal.

36 Lyn: α Scl type helium-weak star (Jaschek and Jaschek, 1974).

ι CrB: If truly velocity variable, a period near 384 days is suggested.

HR 6997: Abt and Snowden (1973) found this star to be velocity variable.†

HD 200311: A hot magnetic Ap star; Si, Cr and Fe lines are enhanced, as well as those of many other elements. The λ 3984 line is present, and Adelman (1974) identifies some Mn II lines in the spectrum.

56 Aqr: May resemble 53 Tauri.

BINARY FREQUENCY

Table 4 lists 81 stars, but nothing is known from this study of the velocity or peculiarity of HR 1690 on account of its composite spectrum. Also NGC 752 - #209, 33 Gem, HR 1759 and HR 2859C must be excluded from further discussion, since they are unexamined for velocity variability (only one plate per star). Furthermore, HR 1063, 36 Lyn, 53 Aur and HD 200311 appear to represent peculiarities other than the usual Hg, Mn phenomenon, so should be excluded also. This leaves a working sample of 72 stars, ranging in sequence from normal to strongly Hg Mn peculiar, for which velocity constancy or variability is reasonably established. Amongst these stars, the Hg and Mn line strengths correlate closely, the only conspicuous exceptions being 53 Tauri and 56 Aquarii, so it is reasonable to sum the individual Hg II and Mn II indices of Table 4 to form a single peculiarity parameter on a scale of 0 — 10 for each star. The incidence of velocity variability as a function of this combined Hg Mn index is given in Table 5. It appears that the spectroscopic-binary frequency is independent of the degree of enhancement of the mercury and manganese lines. A similar but less convincing result is obtained when the binary frequency is compared for normal, weakly and strongly peculiar groups as discriminated by the average number of lines measured per plate, which, as noted earlier, forms a crude index of peculiarity. Of the whole sample of 72 stars, 35 are considered to have variable velocity, yielding an overall spectroscopic binary frequency of 49 per cent. This value is in remarkable agreement with the 47 ± 4 per cent figure obtained by Jaschek and Gomez (1970) for main sequence A and B stars, and to the 45 ± 5 per cent figure obtained by Hill et al. (1976) for A and F stars in the direction of the north galactic pole, both results being obtained by

†A strong interstellar component in the red wing of the *K* line in the spectrum of HR 6997 = ADS 11504A probably accounts for the more positive velocities reported by other observers for this star.

purely statistical analyses of the distribution of the velocity dispersion for individual stars. The data of this paper are not amenable to such a statistical analysis, since the average internal plate errors vary by more than a factor of ten from one star to another, and because the number of plates per star ranges even more widely.

TABLE 5.

SPECTROSCOPIC BINARY FREQUENCY FOR DIFFERENT DEGREES OF PECULIARITY.

a) As a function of the summed Hg Mn line strength index:

Peculiarity	Hg Mn index	# variables / # in sample	= Binary Frequency
Probably normal	0 - 2	8/16 = 50%	15/33 = 45%
Weak	3 - 4	7/17 = 41%	
Medium	5 - 7	7/17 = 41%	20/39 = 51%
Strong	8 - 10	13/22 = 59%	

b) As a function of average number of lines measured per plate:

Average # of lines	# variables / # in sample	= Binary Frequency
≤ 9	8/16 = 50%	
10 - 13	10/27 = 37%	27/56 = 48%
≥ 14	17/29 = 59%	

ORBITAL CHARACTERISTICS

Since Hg Mn and normal stars appear to be indistinguishable on the basis of binary frequency, we may well ask if the orbital characteristics of those systems which are binaries are also indistinguishable. That is, are the period distributions, eccentricity distributions, light and mass ratios comparable for both normal and peculiar systems?

Only twelve Hg Mn stars observed in this study have reliable orbital determinations; however an additional four Hg Mn binaries are now known which already have orbits in the *Sixth Catalogue of Spectroscopic Binary Orbits* (Batten, 1967). These systems are 41 Eri, which is too far south to have been observed in this study, and three others only recently identified as Hg Mn peculiar: 66 Eri and HR 6532 (Dworetsky 1974b), and AR Aur (Dworetsky, private communication 1975), an eclipsing system. This gives a sample of 16 Hg Mn binaries with known orbital characteristics, as listed in Table 6 in order of increasing period.†

†The double-lined southern Hg Mn binary Chi Lupi (period 15.3 days, $e = .003$, $m_1/m_2 = 1.42$, studied by Dworetsky in *Publ. Astr. Soc. Pacific* **84,** 254 (1972)) was inadvertently omitted from Table 6 and subsequent analysis.

TABLE 6.

Hg Mn BINARIES WITH PUBLISHED ORBITS IN ORDER OF INCREASING PERIOD.

Star	Period (Days)	Eccentricity	Mass Ratio m_1/m_2
HD 2019	3.11	0.026	1.69
74 Aqr	3.43	0.058	1.21
AR Aur	4.13	0.009	1.14
53 Tau	4.45	0.005	
41 Eri	5.01	0.014	1.02
66 Eri	5.52	0.074	1.14
2 Per	5.63	0.013	
112 Her	6.36	0.116	2.08
κ Cnc	6.39	0.126	
HR 6532	6.80	0.069	
HR 7694	9.35	0.012	1.11
46 Dra	9.81	0.200	1.18
HR 4072	11.6	0.260	1.67
HR 6620	12.5	0.0	
α And	96.7	0.521	
ϕ Her	560.	0.47	

This sample is compared in Table 7 to the 41 binaries with chemically normal, main sequence B6 to B9.5 primaries as found in the *Sixth Catalogue*. One outstanding difference between the normal and peculiar samples is seen to be in the period distribution: the normal binaries have a smaller mean (log period) value, and 39 per cent of them have periods less than three days; whilst no Hg Mn binaries have periods shorter than the 3.11 day value for HD 2019. An obvious explanation is that the two samples are not really comparable, for the binary nature of many of the objects in the *Sixth Catalogue* was discovered by their eclipsing nature; eclipsing systems are usually close systems and so tend to have shorter periods (at least for main-sequence objects as are now being considered). Indeed 46 per cent of our "normal" binary sample of stars do show eclipses, as compared to only 6 per cent (one star) for the Hg Mn sample. One way to correct for this bias is to exclude from the normal sample all the eclipsing systems, thus ensuring that the duplicity was recognized by spectroscopic criteria alone, as was the case for 15 of the 16 Hg Mn binaries.

A comparison (in Table 7) of normal non-eclipsing binaries and the Hg Mn binary sample shows them to be much more comparable. The incidence of line duplicity is similar in both, and in fact would be identical at 50 per cent for both samples if 112 Her were to be counted as single-lined, since its secondary lines were not even detected in this study (with the line list of Table 1). This probably implies similar light ratios for both samples, although one might note that the high frequency of sharp-lined spectra amongst the Hg Mn stars does favour the detection of faint secondary lines for these stars. The average mass ratios found in both groups are also very close. The mean eccentricity appears to be less for the Hg Mn binaries; this point bears further discussion later. And the means of the (log period) values are very close for both samples. Still it seems very unlikely that the period distributions are identical, for 23 per cent of the normal non-eclipsing sample have periods less than three days. There is good reason to believe that the absence of Hg Mn binaries with periods short of three days is real, and not merely a sampling effect.

TABLE 7.

COMPARISON OF NORMAL AND Hg Mn - PECULIAR BINARIES WITH DETERMINED ORBITS.

	Systems with normal B6-B9.5, V primaries (Batten, 1967)	Non-eclipsing systems with normal B6-B9.5, V primaries (Batten, 1967)	Hg Mn Binaries (from Table 6)
No. of sample stars	41	22	16
% with eclipses	46%	(0%)	6%
% with periods < 3 days	39%	23%	0%
log (period, days): mean	0.78	1.02	0.99
σ	0.54	0.51	0.58
eccentricities: mean	0.15	0.23	0.13
σ	0.21	0.25	0.16
Double lined systems:			
— number	15	11	9
— per cent of sample	37%	50%	56%
— mass ratios m_1/m_2: mean	1.41	1.32	1.36
σ	0.50	0.49	0.36

Preston (1974) has previously noted the peculiar distribution of Hg Mn binary periods. It appears as a natural consequence of the well-established fact that Hg Mn stars are slow rotators: the observed surface abundance anomalies are either destroyed or inhibited from developing in the atmospheres of rapidly rotating stars. Binaries of short period are generally in synchronous rotation; for $P=$ 3 days, $R=3R_{\odot}$, the equatorial velocity for synchronous rotation is 50 km/sec., which is the approximate upper limit in $v \sin i$ above which the Hg Mn phenomenon is not found. Preston notes that 70 per cent of the Hg Mn stars actually have $v \sin i < 20$ km/sec.

Because slow rotation is the common characteristic feature of all chemically peculiar groups on the upper main sequence, such a lower limit in binary period is shared by other types of peculiar star also. Few of the magnetic Ap stars have binary periods less than 10 days; the shortest is HR 710 with a period of 2.998 days. Amongst the Am stars, Abt and Bidelman (1969) have shown 2.5 days to be the limiting period, short of which value normal spectra may again appear in binary systems with primaries in the temperature-luminosity domain of the Am stars.

Since the overall binary frequency for all periods appears to be normal for the Hg Mn stars, while a sizeable fraction (23 per cent?) of the "normal" period distribution shortward of three days is missing for these stars, one must conclude that in compensation the incidence of the Hg Mn phenomenon is enhanced in binaries of longer period over that for single stars. That is, the presence of a companion may hinder or help the development of surface abundance anomalies, depending on the orbital period, i.e., separation. However, the enhancement for periods > 3 days must be a subtle effect indeed, since normal, slowly rotating binaries exist in the same orbital period and temperature-luminosity domains as for peculiar stars. The enhancement that does occur is likely the result of tidally induced synchronism, leading to slow rotation and a more stable stellar atmosphere (Preston, 1974). The concentration of Hg Mn binary periods in the range 3 - 12 days is particularly striking since for much longer periods the tidal interaction becomes rather weak and ineffective. However even if the incidence of peculiarity is enhanced in this binary period range, there is little evidence that the degree of peculiarity is enhanced, for as has been shown above, the binary frequency for the stars with the greatest Hg Mn enhancement is not significantly larger than that for normal stars.

TABLE 8.

MEAN (LOG PERIOD) AND MEAN ECCENTRICITIES FOR NORMAL AND Hg Mn BINARIES.

(Errors given are 80 per cent confidence intervals; sample sizes are in brackets.)

Period Interval	Normal B6-B9.5V Binaries (Batten, 1967)		Hg Mn Binaries (from Table 6)	
Days	$<\log P>$	$<e>$	$<\log P>$	$<e>$
<3	0.28	.053 ± .028 (16)	—	—
3 - 6	0.61	.095 ± .039 (9)	0.64	.036 ± .014 (7)
6 - 20	1.07	.196 ± .089 (9)	0.94	.112 ± .052 (7)
>20	1.72	.373 ± .192 (7)	2.37	.50 (2)

Because a statistical relation exists between orbital period and eccentricity (Bouigue, 1974), it may not be very meaningful to compare mean eccentricities of samples of different period distribution as has been done in Table 7. Instead, the period-eccentricity relations of each sample should be intercompared, as tabulated in Table 8 and plotted in Figure 1. The coarse nature of the period-eccentricity relation and the small sample sizes for the data of Table 7 hardly allow firm conclusions to be drawn, but such evidence as exists suggests a different relationship holds for Hg Mn stars than for normal stars in the period range from three to perhaps ten or twenty days. In this range the peculiar stars tend to have the more nearly circular orbits. Qualitatively this might be expected, for it is believed that whatever the origin of the peculiarities, the abundance anomalies are confined to the outermost layers of the star, and can be destroyed or lessened by mixing with the deeper layers as would result from time-dependent tidal perturbations on the synchronously rotating components of an eccentric binary system. The available evidence is at least not in conflict with the notion that moderate-to-large orbital eccentricity may preclude the development or maintenance of surface abundance anomalies in the range of shortest binary periods in which Hg Mn stars are found (3 - 6 days). This suggests that overall stability of the atmosphere, and not merely slow rotation, is the necessary condition for the Hg Mn phenomenon.

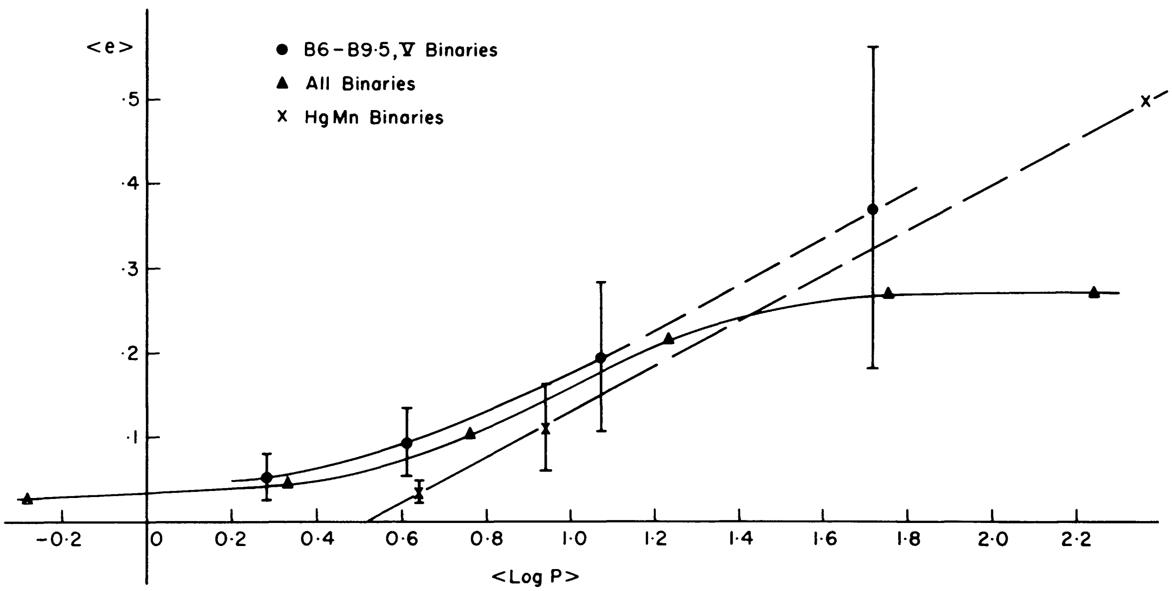

FIGURE 1.

The period-eccentricity relations for normal B6-B9.5 V binaries and for Hg Mn binaries; errors shown are 80 per cent confidence intervals.
The data for all known binary orbits from Table 1 of Bouigue (1974) are also plotted for comparison.

CONCLUSIONS

This survey confirms the results of earlier studies that the spectroscopic binary frequency of the Hg Mn stars is close to the value found for normal main sequence stars, i.e., 45 - 50 per cent. In addition the Hg Mn binaries are largely indistinguishable in their orbital characteristics from those of normal binaries of the same temperature-luminosity domain except that (i) no peculiar binaries have been found with a period less than three days, and (ii) the shorter period (3 - 12 days) Hg Mn binaries *may* tend to have more nearly circular orbits than do normal binaries.

This suggests that the mercury-manganese stars are basically normal stars which are rotating slowly and not subject to strong tidal perturbations. The lack of confirmed light and spectrum variations and of strong magnetic fields amongst these stars also marks their normality relative to the magnetic Ap stars. These facts taken alone would tend to support a diffusive separation mechanism in the stellar atmosphere as the cause of the observed abundance anomalies in these stars (cf. Michaud, Reeves and Charland, 1974). Still one should note that the tidal perturbations in a binary like κ Cancri with $P = 6.4$ days, $e = 0.126$ must lead to motions in the stellar atmosphere considerably larger than any diffusive separation velocity suggested to date, particularly as there is evidence that this star either rotates more slowly than the synchronous rate, or that the axis of rotation is not perpendicular to the orbital plane (Guthrie, 1971).

The binary mass-transfer hypotheses (van den Heuvel 1967, 1968, and Guthrie 1968, 1971) which have been suggested for the origin of the abundance peculiarities in Ap stars hardly seem compatible with the generally normal binary characteristics of the Hg Mn stars. The lack of large radial motions for these stars is also incompatible with the notion that they are runaways from supernova companions. And the existence of many double-lined Hg Mn systems with both components apparently on the main sequence is perhaps the most direct evidence against the hypothesis that these stars all have or once had evolved companions.

It would be instructive as a future project to compare the sample of Hg Mn binaries to a corresponding sample of normal binaries chosen to have low rotational velocities. This would provide a more meaningful test of the hypothesis that the eccentricity can regulate the onset of the Hg Mn phenomenon in short period (3 - 6 days), slowly rotating binary stars.

Observations are continuing at Victoria on a number of stars found to be velocity variable in this study, but for which the observations were insufficient to warrant or allow orbital determinations. Of particular interest in this regard are HD 2019, HR 149, HR 205, HD 5342, HR 2844, HR 3361, ι Cr B, HR 7664, HR 8902 and HD 222207.

Forty of the eighty stars in this study are "moderately to strongly peculiar", i.e., they have Hg Mn line strength indices in the range 5 - 10. These stars should prove to be the most interesting in future studies of the abundance anomalies of Hg Mn stars.

ACKNOWLEDGMENTS

This paper was originally presented at the I.A.U. Colloquium #32 on the physics of Ap stars, held in Vienna in September 1975, and was revised in the light of the many interesting comments and discussions arising from that meeting. Particular thanks must go to C. and M. Jaschek for their stimulating paper on the binary characteristics of Ap stars. Thanks are due also to A.P. Cowley, to A.F. Gulliver and D.A. MacRae, to M.M. Dworetsky and to S.C. and R.J. Wolff for communicating their results in advance of publication, and to C.R. Cowley who obtained some of the recent 2.4 Å/mm spectrograms used in this study.

1976 April

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