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RADIAL VELOCITIES OF SOUTHERN HR STARS, II

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Photoelectric measurements of the radial velocities of an additional 106 southern HR stars are reported. This study detects 15 new possible velocity variables and one new double-line spectroscopic binary. Follow-up observations of suspected velocity variables in the first group of southern HR stars are reported.

Key words: HR stars—radial velocities—spectroscopic binaries

I. Introduction

Presented here is Fick Observatory's second major installment of radial-velocity measurements of bright southern stars for which no velocity is given in the *Catalogue of Bright Stars* (Hoffleit 1964). Together with the earlier report (Beavers and Eitter 1980) this constitutes nearly all of our anticipated results from this project. Only a few stars on our original program lists have insufficient observations to be included here. However, the variable velocity objects in both the first and second reports will be monitored as opportunity permits until complete velocity curves have been obtained. The stars are spectral type F5 or later, with an approximate southern declination limit of −30. The present work contains 373 radial-velocity measurements for 90 stars in Table I which were obtained during the period between June 1978 and June 1981. Only those program stars with at least three observations in two or more observing seasons are reported here. Combined with our earlier southern HR observations, and those previously reported by Griffin (1972) this comprises a total of 280 HR objects with new radial-velocity determinations.

II. Observations

The equipment and procedures are identical to those used in our previous southern HR star study. The photoelectric radial-velocity spectrometer (Beavers and Eitter 1977) is employed at the coudé focus of the Erwin W. Fick Observatory 60-cm reflector. The nightly zero-point correction to the Lick Observatory system of velocities is determined by observing approximately five stars from the constant velocity list of Beavers and Eitter (1979) each evening. For every observation the observed velocity "dip" has been assigned a quality A, B, C, or D. Results over the past five years have shown that the standard deviations for individual A- and B-quality observations with this system are $\sigma_A = 1.0$ km sec^{-1} and $\sigma_B = 1.8$ km sec^{-1}, respectively. For the C-quality dip records we estimate $\sigma_C = 4.5$ km sec^{-1}. D-quality dips are quite broad and noisy. They are not used in the calculations of mean velocities. Some of these stars are observed at maximum altitudes as low as 18 degrees, so bad seeing and image motion contribute to a higher proportion of low-quality dip records than are usually encountered with this system. In previous radial-velocity spectrometer tests for declinations north of −20°, no declination dependence of the error has been found. For the present study we estimate that possible declination dependent systematic errors should not exceed about 1 km sec^{-1} for the southernmost objects observed.

III. Results

The individual velocity measurements are reported in Table I. HR and HD numbers are in the first line. Heliocentric Julian Date (−2440000) of the observation, the measured radial velocity in km sec^{-1}, and the assigned dip quality for each observation are in the first, second, and third columns, respectively, of succeeding lines. The last line of each entry in the table contains the weighted mean velocity, and its estimated error.

Table II contains a list of the program stars suspected of velocity variability. The designation "possible variable" has been used in those cases where there is considerable scatter in the measurements, usually substantiated by one of two A or B quality measurements far from the mean velocity. Past experience has shown that a few stars in this category will later prove not to be variable. The other stars in Table II have more convincing evidence of variability, some with numerous additional confirming observations. It is intended to monitor these stars until sufficient observations have been obtained to explain their nature.

HD 1782 appears to be a double-line spectroscopic binary (SB2). However, it will not be an easy system to study with our instrument. Five observations of double dips produce BB, BB, CD, CB, and BB quality pairs. The stronger feature seems to remain in the 50 to 55 km sec^{-1} region with the secondary dip measured between −5 and −15 km sec^{-1}. At times a single A or B quality dip has been measured near 50 km sec^{-1}.

Subsequent velocity measurements of stars in our first southern HR study produce the following revisions: (a)

TABLE I

JD	V	Q
HR 0172 HD 3794		
3751.8384	48.9	A
3808.6740	49.7	B
3855.5850	48.4	A
4511.7686	46.1	B
4569.6031	49.0	B
V=	48.5	0.6
HR 0268 HD 5445		
3721.9157	18.8	C
3805.7028	23.3	B
4511.7973	22.8	B
4569.6090	20.6	B
V=	22.0	1.0
HR 0394 HD 8350		
3751.8503	-8.4	C
3805.7222	-5.8	B
3805.7277	-9.8	C
4569.6204	-8.3	B
V=	-7.3	1.2
HR 0786 HD 16733		
3751.9044	-3.2	C
4159.8090	-7.3	C
4569.6795	-2.1	B
4606.5947	-4.9	B
V=	-3.7	1.2
HR 1013 HD 20853		
3751.9529	25.6	A
3808.8188	23.9	B
4569.7134	26.9	B
4593.6700	23.8	B
V=	25.2	0.7
HR 1263 HD 25700		
3785.9104	31.7	A
4159.8462	29.8	B
4569.7420	31.7	B
4604.6553	32.8	B
V=	31.6	0.7
HR 1267 HD 25803		
3785.9172	-3.5	B
4159.8523	-5.3	B
4569.7480	-5.9	B
4604.6641	-3.2	B
V=	-4.5	0.9
HR 1274 HD 25944		
3785.9242	14.9	B
4159.8606	13.1	B
4569.7542	13.4	B
4604.6731	13.8	B
V=	13.8	0.9
HR 1345 HD 27362		
3785.9371	23.7	B
3785.9420	25.0	B
4569.7619	26.6	B
4569.7681	21.8	C
4593.7120	26.7	B
V=	25.3	0.9
HR 1384 HD 27881		
3785.9487	33.2	A
4569.7741	30.2	B
4604.6821	28.5	B
V=	31.8	0.8
HR 1655 HD 32890		
3854.7599	-3.4	A
4159.8830	-1.2	B
4569.7808	-3.2	B
4593.7279	-1.5	B
V=	-2.7	0.7
HR 1694 HD 33667		
3854.7662	42.6	B
4159.8899	45.3	B
4569.7871	42.1	A
4593.7453	40.5	B
4633.6077	41.0	A
V=	41.9	0.6
HR 1838 HD 36255		
4159.9095	61.4	B
4222.7680	62.3	B
4569.8269	57.9	B
4611.7030	57.9	B
V=	59.9	0.9
HR 1965 HD 38054		
4159.9166	64.8	B
4222.7765	61.0	B
4569.8339	61.6	A
4611.7151	58.3	B
V=	61.5	0.7
HR 1980 HD 38382		
4159.9227	41.4	B
4569.8407	38.9	B
4611.7253	35.8	B
V=	38.7	1.0
HR 2000 HD 38713		
4159.9297	8.9	A
4614.6630	6.1	A
4628.6743	5.8	A
V=	6.9	0.6
HR 2036 HD 39385		
4159.9357	26.5	B
4606.7364	25.7	A
4614.6765	26.5	B
V=	26.0	0.8
HR 2043 HD 39543		
4159.9424	2.2	B
4614.6837	1.4	B
4628.6833	1.1	B
V=	1.6	0.8
HR 2090 HD 40235		
4159.9488	-3.2	A
4628.6928	-7.4	B
4639.6354	-6.4	B
V=	-4.6	0.8
HR 2136 HD 41125		
4159.9558	45.6	B
4614.6917	45.3	B
4633.6313	44.2	B
V=	45.0	1.0
HR 2192 HD 42486		
4159.9685	-11.9	B
4632.6530	-6.8	B
4639.6548	-5.5	B
V=	-8.1	1.0
HR 2225 HD 43162		
4159.9748	23.7	A
4611.7399	21.8	B
4614.7009	23.4	B
4632.6630	20.8	B
4633.6386	21.6	B
V=	22.7	0.7
HR 2243 HD 43429		
4220.8382	63.9	A
4569.8537	63.0	B
4604.7577	64.0	B
4633.6535	63.2	B
V=	63.7	0.7
HR 2252 HD 43636		
4221.7144	35.7	B
4614.7109	37.8	B
4639.6617	35.5	A
V=	36.0	0.8
HR 2301 HD 44816		
4220.8463	32.9	B
4606.7568	29.4	B
4633.6610	30.3	B
V=	30.9	1.0
HR 2303 HD 44891		
4221.7231	39.4	B
4614.7210	38.2	B
4639.6723	37.9	B
V=	38.5	1.0
HR 2318 HD 45184		
4221.7291	-5.4	A
4614.7298	-2.9	B
4639.6827	-5.0	B
V=	-4.8	0.8
HR 2349 HD 45588		
4221.7362	37.9	B
4611.7613	35.1	B
4639.6940	35.5	A
V=	35.9	0.8
HR 2359 HD 45765		
4220.8527	18.4	A
4604.7675	19.3	B
4632.6760	15.0	B
V=	17.9	0.8
HR 2367 HD 45976		
4221.7441	20.5	A
4568.8581	17.9	B
4633.6680	18.3	B
V=	19.6	0.8
HR 2428 HD 47182		
4221.7668	-11.8	B
4568.8669	-13.2	B
4633.6825	-11.8	B
V=	-12.2	1.0
HR 2437 HD 47366		
4220.8599	11.4	B
4606.7664	9.3	B
4653.6302	9.0	A
V=	9.5	0.8
HR 2493 HD 48938		
4221.7797	-8.9	C
4222.8166	-13.9	C
4632.6853	-12.6	B
4694.5727	-12.1	B
V=	-12.2	1.2
HR 2495 HD 49001		
4221.7870	35.9	A
4632.6946	34.3	A
4694.5817	33.1	B
V=	34.8	0.7
HR 2567 HD 50648		
4221.7999	-12.2	C
4606.7787	-13.1	B
4639.7193	-14.3	B
V=	-13.6	1.2
HR 2599 HD 51424		
4220.8669	-5.0	B
4604.7882	-4.4	A
4633.6997	-5.2	B
V=	-4.6	0.8
HR 2622 HD 52265		
4220.8740	55.3	B
4632.7026	53.5	A
4694.5889	52.6	B
V=	53.7	0.8
HR 2637 HD 52619		
4221.8087	7.6	B
4606.7931	8.2	C
4694.5987	7.2	C
V=	7.6	1.6
HR 2664 HD 53629		
4221.8154	76.9	A
4611.7749	77.6	B
4611.7867	77.7	A
4694.6085	77.6	A
V=	77.4	0.5
HR 2723 HD 55589		
4221.8375	9.8	B
4568.8824	9.4	B
4700.5700	8.5	A
V=	8.9	0.8
HR 2730 HD 55762		
4221.8444	-4.8	A
4653.6582	-5.6	A
4694.6219	-4.3	B
V=	-5.1	0.7
HR 2752 HD 56207		
4220.8805	-11.7	B
4568.8901	-12.4	B
4700.5770	-12.7	A
V=	-12.5	0.8
HR 2807 HD 57708		
4220.8878	-11.8	A
4653.6653	-14.3	A
4718.5859	-12.9	A
V=	-13.0	0.6
HR 2883 HD 59984		
3948.5847	57.6	B
4221.8569	54.7	B
4614.7695	52.9	B
4718.5967	54.8	B
V=	55.0	0.9
HR 2916 HD 60666		
3948.5906	-4.4	C
4221.8627	-5.7	B
4653.6715	-5.7	A
4694.6293	-8.2	B
V=	-6.1	0.8
HR 2933 HD 61227		
3948.6088	18.2	B
4221.8768	19.2	B
4626.7610	13.1	C
4694.6391	17.1	B
V=	17.9	1.0
HR 2976 HD 62082		
3948.6159	35.2	B
4221.8830	34.6	A
4614.7756	32.7	B
4700.5985	30.8	B
V=	33.8	0.7
HR 3027 HD 63323		
3948.6224	16.3	C
4221.8903	16.4	B
4633.7289	13.3	B
4712.5936	13.7	B
V=	14.5	1.0
HR 3048 HD 63754		
3948.6286	48.3	B
4221.8970	42.4	B
4653.6818	45.1	B
4712.6006	44.8	B
V=	45.1	0.9
HR 3051 HD 63822		
3948.6355	33.4	A
4221.9047	31.4	A
4653.6887	30.3	A
4712.6076	30.8	A
V=	31.5	0.5
HR 3054 HD 63894		
3948.6420	45.7	B
4221.9114	46.9	A
4614.7832	43.0	A
4712.6137	42.3	A
V=	44.2	0.5
HR 3271 HD 70110		
3948.6552	11.4	B
4614.7981	8.3	B
4718.6568	9.5	B
V=	9.8	1.0
HR 3276 HD 70302		
3948.6617	30.6	C
3948.6666	27.0	C
4653.7202	24.3	B
4700.6147	25.9	B
V=	25.6	1.2
HR 3317 HD 71231		
3948.6738	-10.0	B
4633.7581	-13.7	B
4700.6204	-11.1	A
V=	-11.4	0.8
HR 3767 HD 82180		
4351.5859	5.7	C
4351.5929	2.3	B
4352.5845	-2.2	D
4633.7965	-0.8	A
4694.6650	1.0	B
V=	0.3	0.8
HR 3788 HD 82477		
4351.5991	62.4	B
4352.5906	70.4	D
4639.7780	64.6	A
4712.6633	64.3	A
V=	64.1	0.7
HR 3802 HD 82660		
4351.6061	29.1	B
4352.5977	26.7	C
4639.7848	28.1	A
4712.6703	27.8	B
V=	28.2	0.8
HR 3901 HD 85380		
3948.6884	39.9	B
4351.6126	34.6	B
4639.7913	34.8	B
4712.6775	36.2	A
V=	36.3	0.7
HR 3956 HD 87199		
4351.6192	15.3	C
4633.8028	12.9	B
4694.6812	14.0	B
V=	13.6	1.2
HR 3959 HD 87262		
3948.7066	11.9	B
3986.5949	9.6	B
4639.8050	9.1	B
4694.6900	9.6	A
V=	9.9	0.7
HR 4034 HD 89033		
3948.7129	33.6	B
3986.6021	29.1	B
4341.6687	28.9	B
4639.8111	31.1	B
4694.6971	32.4	A
V=	31.5	0.7
HR 4040 HD 89169		
3948.7188	1.3	D
3948.7237	2.9	D
4341.6770	2.2	C
4633.8138	-2.6	C
4694.7067	-3.7	C
V=	-1.4	2.6

TABLE I (CONT.)

JD	V	Q
HR 4130 HD 91280		
4342.6375	-18.3	C
4351.6447	-22.3	C
4633.8152	-22.3	A
4660.7781	-16.8	B
	V= -20.9	0.8
HR 4190 HD 92770		
3948.7422	-7.0	B
3986.6172	-9.6	A
4342.6573	-9.6	A
4633.8298	-10.3	B
4660.7879	-7.3	A
	V= -8.8	0.5
HR 4252 HD 94386		
3948.7484	-0.9	A
3986.6236	0.6	A
4342.6644	2.0	A
4633.8366	-1.8	B
4660.7947	-2.3	B
	V= 0.1	0.5
HR 4261 HD 94619		
3948.7552	-15.4	D
3986.6306	-11.6	B
4351.6611	-10.6	B
4633.8425	-12.3	A
4660.8035	-10.3	B
	V= -11.6	0.7
HR 4297 HD 95441		
3948.7630	-3.9	B
3986.6369	-6.1	C
4351.6675	-2.7	B
4633.8497	-6.5	A
4660.8128	-5.7	A
	V= -5.4	0.6
HR 4308 HD 95870		
3948.7694	-5.8	B
3986.6439	-8.7	B
4342.6722	-11.0	B
4633.8567	-11.9	A
4660.8198	-9.8	A
	V= -10.1	0.6
HR 4348 HD 97428		
3948.7753	-21.8	B
3986.6579	-23.1	C
4351.6746	-25.8	B
4633.8631	-25.4	B
4660.8256	-22.3	B
	V= -23.8	0.9
HR 4440 HD 100219		
3948.7817	11.8	C
3986.6658	9.1	C
4341.7190	11.4	B
4351.6811	11.6	B
4639.8445	9.3	A
	V= 10.2	0.8
HR 4445 HD 100307		
3948.7883	38.0	C
4014.6114	34.5	B
4342.6869	34.3	B
4351.6873	33.3	C
4639.8511	36.0	B
	V= 35.0	1.0
HR 4489 HD 101259		
3947.7620	94.5	C
3947.7676	97.8	C
4639.8609	97.0	A
	V= 97.0	1.0
HR 4506 HD 101695		
3947.7546	-9.8	B
3986.6722	-14.7	B
4014.6247	-14.2	A
4367.6416	-13.8	A
4660.8332	-14.5	A
	V= -13.8	0.5
HR 4529 HD 102574		
3947.7743	18.6	C
4014.6316	14.9	B
4367.6485	16.9	B
4660.8405	14.0	B
	V= 15.5	1.0
HR 4539 HD 102845		
3947.7811	-1.9	C
3986.6856	-7.4	B
4014.6380	-2.3	B
4367.6556	-2.3	B
4660.8472	-3.8	C
	V= -3.9	1.0
HR 4542 HD 102888		
3947.7883	-0.9	B
4014.6451	-3.1	C
4342.7002	-3.2	A
4367.6618	-2.1	C
4660.8529	-2.2	A
	V= -2.5	0.6
HR 4723 HD 108110		
3947.8111	11.3	B
3986.7059	10.9	B
4014.6652	11.3	B
4342.7067	8.8	A
4351.7080	8.7	C
4358.6849	9.3	B
4669.7662	8.9	A
	V= 9.5	0.6
HR 4860 HD 111295		
3947.8248	-9.2	C
3986.7255	-9.4	C
4008.6464	-11.3	B
4023.6282	-11.9	B
4342.7270	-8.4	B
4351.7207	-9.7	A
4669.7799	-10.5	A
	V= -10.2	0.6
HR 4918 HD 112519		
3947.8326	1.8	B
3986.7319	3.8	A
4008.6535	3.5	B
4023.6352	3.2	B
4342.7410	0.7	C
4351.7271	4.1	C
4669.7863	-1.2	B
	V= 2.7	0.7
HR 5809 HD 139290		
3948.8885	27.9	B
3986.8266	28.8	C
4008.7432	31.8	B
4023.7286	32.1	B
4049.6513	26.8	B
4342.8226	25.3	B
4351.8328	29.1	B
4755.6870	32.8	B
	V= 29.4	0.7
HR 5965 HD 143619		
3948.9005	1.0	C
3986.8402	3.1	B
4008.7633	4.3	B
4023.7412	3.4	B
4049.6648	6.2	C
4342.8424	4.3	B
4351.8388	7.7	B
4755.7092	5.2	B
	V= 4.6	0.7
HR 5973 HD 143900		
3948.9075	26.2	A
3986.8465	23.4	C
4008.7703	26.8	A
4023.7482	24.6	B
4049.6711	28.7	B
4342.8488	22.8	B
4351.8458	25.0	B
4755.7197	26.0	B
	V= 26.0	0.5
HR 7991 HD 198751		
3720.7842	-7.0	A
3727.7286	-5.3	B
4437.7695	-6.9	B
4498.6607	-8.3	D
	V= -6.6	0.8
HR 7997 HD 198853		
3720.7905	25.3	B
3727.7349	26.0	B
4437.7765	24.8	B
4505.6269	23.5	C
	V= 25.3	1.0
HR 8340 HD 207552		
3748.7279	-1.4	B
3770.6930	-2.6	B
4080.8624	-4.9	A
4159.6281	2.4	B
4437.8642	0.1	A
4505.6587	2.9	B
	V= -1.4	0.6
HR 8365 HD 208285		
3748.7338	-89.3	C
3814.5446	-83.2	C
4437.8704	-82.4	C
4505.6694	-86.0	C
	V= -85.2	2.3
HR 8405 HD 209476		
3748.7408	20.4	B
3770.7031	27.3	C
3814.5518	23.8	A
4437.8772	20.8	C
4498.7074	21.7	C
	V= 23.0	0.8
HR 8764 HD 217703		
3720.8751	26.6	A
3751.7765	26.5	A
3805.6380	25.6	A
4469.8056	27.6	C
	V= 26.3	0.6
HR 8772 HD 217877		
3720.8818	-9.9	B
3751.7829	-16.0	A
3805.6449	-10.8	B
3856.5104	-11.0	B
4476.7995	-12.2	B
	V= -13.2	0.7
HR 8783 HD 218061		
3720.8882	-14.7	A
3751.7891	-16.2	B
3805.6514	-14.8	B
4469.8195	-15.6	B
	V= -15.1	0.7

Two stars, originally classified as "possible variables," have been reclassified as constant velocity objects.

HR 0745 $V = -6.0 \pm 0.6$ km sec^{-1} (6 obs.)

HR 5428 $V = 9.8 \pm 0.6$ km sec^{-1} (8 obs.)

(b) HR 0953

Although no variability was detected in the four observations of HR 0953 in our first study, the more recent two observations reveal it to be a definite velocity variable covering a range at least -1 to $+14$ km sec^{-1}. The earlier (1964) measurement of 9.0 km sec^{-1} reported in the Abt and Biggs bibliography (1972) does fall within this velocity range.

The Fick Observatory radial-velocity project has benefited from the contributions of many past and present participants. For the present project this includes especially Mr. Dean Ketelsen, Mr. Raza Hasan, Mr. David Oesper, Miss Karen Applequist, Mr. Anthony Lui, and instrument maker Mr. Ed Sexauer.

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TABLE II

VARIABLE VELOCITY OBJECTS

HR	Observed Velocity Range (km/sec)		# of Obs.	Comment
0251	-36	-1	6	Weak dips
1782	See Discussion		14	SB2
1785	-5	65	3	Weak dips
2242	45	66	3	
2392	-6	-14	5	
2403	-2	6	3	Possible Variable
2535	4	43	3	
2686	20	27	3	Possible Variable
2798	3	-8	3	Possible Variable
3150	-12	-23	3	
3908	3	11	4	Possible Variable
4068	-1	26	3	Possible Variable, Broad dips.
4588	-4	13	6	
4810	-3	-19	7	
5810	31	42	7	Possible Variable
6012	-30	-5	7	