

Astron. Astrophys. Suppl. Ser. 52, 479-482 (1983)

Radial velocities of bright southern stars. II. 53 late-type HR and FK4 stars (*)

J. Andersen and B. Nordström

Copenhagen University Observatory, Brorfeldevej 23, DK-4340 Tølløse, Denmark

Received January 3, accepted January 12, 1983

Summary. — We present new radial velocities for 53 bright southern late-type stars, based on 20 Å/mm coudé spectrograms taken at ESO, La Silla. This completes the radial velocity data for FK4 stars of spectral type F5 and later and provides radial velocities for some HR stars with composite spectra plus a few other stars observed for various reasons. The velocities have mean errors generally about 1 km/s.

Key words : radial velocities — bright stars — fundamental stars — late-type stars.

1. Introduction.

In order to contribute to alleviating the lack of radial velocity data for even bright southern stars as compared to stars in the northern hemisphere, an observing programme has been carried out at ESO, La Silla, to complete the radial velocity data for those stars in the Bright Star Catalogue (Hoffleit, 1964, 1982) without published radial velocity. The late-type stars are generally observed with the photoelectric scanner CORAVEL (Baranne *et al.*, 1979), while the stars earlier than spectral type F5 were observed by classical spectrographic techniques. Preliminary results from our programme for about 700 stars were made available for the fourth edition of the Bright Star Catalogue (Hoffleit, 1982).

The present series of papers gives our definitive results for these stars, which supersede the preliminary values just referred to. An accompanying catalogue (Andersen and Nordström, 1983a) gives the results obtained for the B-type stars, while forthcoming papers will deal with the A0-F5 and the bulk of the late-type stars, respectively.

A comprehensive investigation of instrument performance, standardization procedures, suitable sets of spectral lines and their wavelengths, and variability criteria, based on observations of numerous reference stars, was undertaken in preparation for this programme. The results are discussed in a separate paper (Andersen and Nordström, 1983b, referred to below as AN), to which we refer for documentation of the procedures adopted.

2. Programme.

In addition to the large group of the HR stars, there was a modest number of stars in the FK4 catalogue (Fricke and Kopff, 1963) without radial velocity data. It seemed absurd that these stars with their excellent astrometric record

should be without radial velocity at all, and they were added to our programme. Our results for the earlier-type FK4 stars are included with the HR stars in the appropriate catalogues, while this paper presents the data for the small group with spectral types later than F5. In addition it contains measurements for some composite stars catalogued under the spectral type of the early-type star, but presenting essentially late-type spectra from the point of view of radial velocity determination. The last few stars were observed for various reasons as noted in the remarks to table I.

Notes on peculiar stars and revised spectral types have been published earlier (Andersen and Nordström, 1977, 1978).

3. Observations.

For each programme star, at least 3 spectrograms were obtained with the coudé spectrograph of the ESO 1.5 m telescope at La Silla, Chile. The following characteristics were adhered to throughout : Dispersion 20 Å/mm, Ila-O emulsion developed in MWP 2 developer (Difley, 1968) and fixed in hardening fixer, spectrum width 0.4 mm, and projected slit width 20 μm. Wavelength calibration was provided by an iron arc spectrum. Any two plates were separated by a minimum of three days, the third plate being obtained during a different observing period.

The plates were measured for radial velocity on an impersonal oscilloscopic comparator, settings being made by superposing forward and reverse scans of the line profile displayed on an oscilloscope screen. The performance of the instrument and the measurement and reduction procedures followed are described in AN and will not be repeated here. Suffice it to say that typical internal mean errors for a velocity measured on a given plate (as computed from the interagreement of several lines measured) are about 0.4 km/s while plate-to-plate interagreement for constant stars is about 1.3 km/s rms. We use the ratio E/T between the actually observed plate-to-plate scatter and that expected for a constant star with the same measur-

(*) Based on observations collected at European Southern Observatory, La Silla, Chile.

Send offprint requests to : J. Andersen.

ing uncertainty as our variability criterion, $E/T = 1.75$ and 2.5 being adopted as the limits for possible and certain variability, respectively. Thus, for constant stars, the mean error of the radial velocity based on three plates is about 1 km/s or slightly better.

4. Catalogue.

Table I gives the mean radial velocity for each programme star and contains the following entries :

- Col. 1 : HD number, and visual binary component designation from Jeffers *et al.* (1963).
- Col. 2 : HR no.
- Col. 3 : FK number (Fricke and Kopff, 1963; Fricke, 1963).
- Col. 4 : Visual magnitude, mostly from Hoffleit (1964).
- Col. 5 : Reference code to source of spectral class.
- Col. 6 : Spectral class.
- Col. 7, 8, 9 : Mean radial velocity, with mean error and number of plates given. For the two double-lined binaries, we give the γ -velocity computed with the method of Wilson (1941).
- Col. 10 : E/T variability parameter, see AN.
- Col. 11 : Remarks : VAR ? or VAR : possible or certain velocity variable; REM : see remark following table I.

Remarks following table I gives information on individual interesting stars.

Table II contains the individual measurements, with the following entries :

- Col. 1 : HD no. and visual binary designation as in table I.
- Col. 2 : Heliocentric Julian Date of the observation.
- Col. 3 : Plate weight assigned during measurement.
- Col. 4, 5, 6 : Radial velocity, with mean error and no. of lines measured, for the (primary) star.
- Col. 7, 8, 9 : Radial velocity, with mean error and no. of lines measured, in the secondary star when observed.

Acknowledgements.

We have received indispensable support from several sources. Above all, ESO allocated the necessary large amount of observing time on the 1.5 m telescope, agreed to send two observers for maximum efficiency, and provided part of the measuring device at self cost. The Danish Natural Science Research Council, through grants no. 511-3621 and 511-5276, financed construction of the measuring instrument. We are most grateful to our colleague E. H. Olsen for volunteering to participate in some of the observing periods. We have profited from discussions and correspondence with several colleagues, including the late Dr. A. D. Thackeray. Last, but not least, we express our appreciation to the night assistants at La Silla, all of whom worked hard on our programme at one time or other.

References

- ABT, H. A., LEVATO, H. : 1977, *Publ. Astron. Soc. Pac.* **89**, 797.
- ABT, H. A., LEVY, S. G. : 1969, *Astron. J.* **74**, 908.
- ANDERSEN, J., NORDSTRÖM, B. : 1977, *Astron. Astrophys. Suppl. Ser.* **29**, 309.
- ANDERSEN, J., NORDSTRÖM, B. : 1978, *Bull. Inf. CDS Strasbourg*, No. 15, 39.
- ANDERSEN, J., NORDSTRÖM, B. : 1983a, *Astron. Astrophys. Suppl. Ser.*, in press.
- ANDERSEN, J., NORDSTRÖM, B. : 1983b, *Astron. Astrophys.*, in press.
- BARANNE, A., MAYOR, M., PONCET, J. L. : 1979, *Vistas Astron.* **23**, 279.
- COWLEY, A. P. : 1976, *Publ. Astron. Soc. Pac.* **88**, 95.
- DIFLEY, J. A. : 1968, *Astron. J.* **73**, 762.
- FRICKE, W. : 1963, *Veröff. Astron. Rechen-Inst., Heidelberg* **11**.
- FRICKE, W., KOPFF, A. : 1963, *Veröff. Astron. Rechen-Inst., Heidelberg* **10**.
- HARLAN, E. A. : 1974, *Astron. J.* **79**, 682.
- HOFFLEIT, D. : 1964, *Catalogue of Bright Stars*, 3rd ed., Yale Univ. Obs., New Haven.
- HOFFLEIT, D. : 1982, *Catalogue of Bright Stars*, 4th ed., Yale Univ. Obs., New Haven.
- HOUK, N. : 1978, *Mich. Cat. of Spectral Types for HD Stars*, vol. 2.
- HOUK, N., COWLEY, A. P. : 1975, *Mich. Cat. of Spectral Types for HD Stars*, vol. 1.
- JEFFERS, H. M., VAN DEN BOS, W. H., GREEBY, F. M. : 1963, *Publ. Lick Obs.*, vol. 21.
- KENNEDY, P. M. : 1977, *MK Cat., C.D.S., Strasbourg*.
- WILSON, O. C. : 1941, *Astrophys. J.* **93**, 29.
- WILSON, R. E. : 1953, *General Catalogue of Stellar Radial Velocities*, Carnegie Inst. of Washington, Washington, D.C.

TABLE I. — *Mean radial velocities for 53 late-type stars.*

HD	HR	FK	MV	REF	SP. CLASS	VEL	ME	N	E/T	REMARKS
1588		1007	6.88	11	K0 III	-63.8	0.8	3	0.7	
2438		1011	7.34	11	M6 III	-8.1	2.9	3	3.4	VAR
3059	138	1013	5.62	02	K2 III	-8.9	1.3	3	1.6	
4053		1016	7.21	02	M1 III	13.7	1.2	3	1.5	
5720		1024	6.70	11	K0 III	-27.4	12.6	3	16.3	VAR REM
6037		1025	6.58	11	K2-3 III-IV	-26.0	1.3	3	1.6	
6599	320	1029	6.29	11	G8-K0 III	25.9	1.0	3	1.3	
8599	406	1037	6.36	04	G8 III	-27.3	0.8	3	0.5	
14247		1062	6.74	11	G8 III-IV	26.5	0.8	3	0.8	
17134A		1078	6.87	11	G3-5 V	-2.2	2.0	3	2.5	VAR
17134B		9:		11	K1 V:	-12.7	1.4	1		REM
19589		1657	8.35	01	G6 IV	-6.7	1.0	3	1.3	
20301		1090	6.85	11	G2 III:	18.0	2.0	5	9.8	SB2 REM
21563	1093		6.15	01	A3/5 V + G0/5	17.5	0.8	3	0.9	
24497	1206	2276	6.22	10	A + K:	20.2	1.2	4	1.8	VAR?
35877			6.77	01	F8 V	4.8	1.4	1		
37530		1153	6.75	11	K5-M0 III:	23.7	0.8	3	0.3	
42556		1660	6.74	01	G8 III	10.1	0.9	3	1.2	
52619	2637		6.38	00	F8	9.7	1.0	3	1.2	
57853	2814		6.99	11	G0 V:	34.7	2.1	3	2.5	VAR REM
66242	3150	1213	6.30	11	G0 III	-17.3	1.0	3	1.3	
70003A	3267		6.70	10	A0-2 + G:	14.3	1.1	3	0.8	
73072	3402		5.96	10	A2 + G:	9.7	5.0	3	22.7	SB2 REM
73451	2416		6.51	02	A1 V + G	29.3	8.1	3	8.7	VAR
76376A	3554	1231	5.90	11	K2-3 III	37.4	0.9	3	1.1	
83095	3821	362	5.52	01	K4 III	14.3	1.0	3	1.3	
83380	3833	1248	5.63	11	K0 III	-2.7	0.8	3	0.5	
85563	3910	1256	5.72	09	K2 III	26.4	0.8	3	1.1	
95695A		1285	7.13	11	G8 III	-4.2	0.8	3	0.1	
97393	4346	1290	6.46	11	M1 III	26.7	0.8	3	1.1	
99923		1298	6.79	11	K3 III	53.2	1.3	3	1.7	
108110	4723	1319	6.34	11	K1 III	5.8	0.8	3	0.8	
122250	5261	1363	6.10	01	M7 III	9.8	0.9	3	0.7	
131476		1388	6.69	11	K2 III	-24.6	0.8	3	0.7	
136703		1404	6.78	11	K0 III	-8.9	0.8	3	0.6	
152260		1443	7.00	01	G0 IV/V	-15.8	1.0	3	1.3	
156513	6429	1435	5.93	01	M3 III	-18.9	0.8	3	0.8	
162319		1466	6.79	11	K4 III	-16.3	1.5	3	2.0	VAR?
163153		1467	6.87	04	G8 IV	-74.2	0.8	3	0.7	
170010			8.21	07	G0 IIIA + A3:V:	-40.1	7.7	2	7.5	VAR REM
172103		7000	6.49	03	F5 III	-24.9	0.7	4	1.0	
184499			6.63	02	G0 V	-165.8	1.0	2	0.2	REM
186154	7494	1667	6.32	01	K3/4 III	-6.1	0.8	3	0.5	
187420	7548		6.14	01	G8/K0 III	-17.9	1.1	3	1.5	
192827	7745	1528	6.28	09	M1 III	-44.3	1.6	3	2.1	VAR?
193302	7765	1530	6.51	11	K3-4 III	-14.7	0.8	3	1.0	
195909		1537	6.68	11	K0-1 I-III	-26.4	2.1	3	2.7	VAR
198272		1545	6.53	11	M5 III	9.9	0.8	3	0.6	
200932		1553	7.10	11	K3 I:	-37.0	2.1	3	2.7	VAR
202501		1557	6.70	09	K2 III	11.0	1.0	3	1.3	
209278B	8396		7.15	11	K0 III:	15.7	0.9	3	1.2	REM
215749		1598	7.58	11	K2 III	18.6	0.7	4	0.5	
223429		1624	7.14	11	K0 III	53.3	1.8	3	2.4	VAR?

Remarks to Table I:

The following papers are referred to by number in col. 5 and below:

00	Hoffleit (1964)
01	Houk and Cowley (1975)
02	Kennedy (1977)
03	Cowley (1976)
04	Harlan (1974)
07	Abt and Levato (1977)
09	Houk (1978)
10	Andersen and Nordström (1977)
11	Andersen and Nordström (1978)

Remarks on individual stars:

HD 5720	H and K emission (11).
17134B	Companion to 17134A.
20301	Double-lined eclipsing binary TZ For (10). Gamma velocity given, Mass ratio: $M_2/M_1 = 0.97 \pm 0.16$. Full photometric and spectroscopic study in progress.
57853	H and K emission (11)
73072	Composite (10), found to be SB2 during measurement. Mass ratio approx. 1.0; more observations needed.
170010	Composite. See remarks in (07) and (10).
184499	Intermediate Pop. II. Wilson (1953) gives $RV = -163.3$. Abt and Levy (1969) give -164.5 .
209278B	Companion to DX Aqr.

TABLE II. — *Individual observations of the stars in table I.*

HD	HJD	W	VEL 1	ME N	VEL 2	ME N	HD	HJD	W	VEL 1	ME N	VEL 2	ME N
1988	2372.6813 0.5		-64.7 0.5 15				89563	2384.8517 1.0		27.9 0.3 14			
	2377.6144 1.0		-62.9 0.4 15					3264.6132 1.0		26.2 0.4 14			
	2669.8033 1.0		-64.3 0.6 15					3268.5964 1.0		25.1 0.5 10			
2438	2375.5745 1.0		-12.9 0.6 11				95695A	2869.6610 1.0		-4.1 0.5 14			
	2378.5938 1.0		-5.8 0.6 11					3266.6327 1.0		-4.4 0.4 14			
	2668.7379 0.5		-3.2 0.8 11					3271.5254 1.0		-4.0 0.3 15			
3059	2373.6183 1.0		-9.2 0.3 14				97393	2881.5733 1.0		27.4 0.5 14			
	2377.6248 1.0		-6.6 0.7 13					3266.6868 1.0		25.1 0.4 13			
	2669.8268 1.0		-10.9 0.5 14					3271.5410 1.0		27.7 0.2 13			
4053	2375.7155 1.0		15.6 0.4 13				99923	2881.6186 1.0		55.2 0.2 14			
	2378.6264 1.0		11.6 0.5 13					3261.5868 1.0		50.7 0.4 14			
	2671.7292 1.0		13.9 0.5 14					3267.6832 1.0		53.7 0.4 14			
5720	2375.6066 1.0		-11.3 0.4 15				108110	2881.6503 0.5		5.9 0.8 13			
	2384.6014 1.0		-52.2 0.4 15					3261.6285 1.0		4.7 0.7 13			
	2670.8496 1.0		-18.8 0.3 14					3267.7045 1.0		6.8 0.4 14			
6037	2372.7055 1.0		-27.1 0.5 13				122250	2678.5360 1.0		10.2 0.8 11			
	2376.6173 1.0		-23.5 0.7 14					2881.7033 1.0		10.5 0.9 11			
	2670.8739 1.0		-27.3 0.3 14					3263.7005 1.0		8.7 0.5 10			
6559	2372.7207 1.0		28.1 0.5 15				131476	2876.8195 1.0		-23.7 0.5 14			
	2377.6334 1.0		30.8 0.3 15					3267.7178 1.0		-25.5 0.4 14			
	2670.8624 1.0		27.7 0.3 15					3270.7060 1.0		-24.8 0.3 14			
8599	2373.6404 1.0		-27.8 0.4 15				136703	2676.5101 1.0		-8.0 0.3 14			
	2377.6445 1.0		-26.6 0.3 15					3264.7614 1.0		-9.7 0.3 14			
	2672.8426 1.0		-27.4 0.3 15					3271.9989 1.0		-9.0 0.4 14			
14247	2373.6508 1.0		25.4 0.2 13				152260	2670.6007 1.0		-14.3 0.4 15			
	2383.6405 1.0		27.2 0.5 15					3263.6036 1.0		-17.6 0.4 15			
	2671.7776 0.5		27.0 0.4 14					3270.7982 1.0		-15.5 0.4 15			
17134A	2373.6957 1.0		0.9 0.4 15				156513	2670.6141 1.0		-17.8 0.4 14			
	2378.6823 1.0		-1.6 0.6 15					3263.6832 1.0		-19.0 0.4 13			
	2672.9012 1.0		-6.0 0.5 14					3270.7821 1.0		-19.9 0.6 14			
17134B	2679.7369 1.0		-12.7 0.5 14				162319	2671.5472 1.0		-16.0 0.4 14			
19589	2670.7109 1.0		-6.3 0.2 15					3261.8479 1.0		-19.1 0.4 14			
	2675.7209 1.0		-8.6 0.3 15					3266.8409 1.0		-13.8 0.5 14			
	2876.7418 1.0		-5.3 0.4 15				163153	2680.5080 1.0		-73.3 0.4 14			
20301	2373.7341 1.0		-10.8 1.4 11		54.8 3.8 11			3261.8610 1.0		-75.1 0.4 14			
	2384.6170 0.5		23.1 1.1 15					3264.9134 1.0		-74.3 0.4 15			
	2671.8900 1.0		-22.2 1.2 13		57.1 3.9 7		170010	2316.5292 0.5		-51.0 1.0 13			
	2674.9102 1.0		-14.9 1.0 14		51.1 3.3 11			2674.5440 1.0		-34.6 0.5 15			
	2681.6833 1.0		7.7 0.8 13				172103	2674.6205 1.0		-23.0 0.6 15			
21563	2378.7147 1.0		17.1 0.8 14					2681.5495 0.5		-26.5 1.1 15			
	2671.8719 1.0		18.8 0.6 15					3261.9063 1.0		-25.9 0.7 15			
	2676.8509 1.0		16.4 0.5 15					3270.8626 1.0		-24.9 0.4 14			
24497	2379.6093 1.0		16.6 0.6 12				184499	2668.5742 1.0		-165.6 0.6 15			
	2668.9178 1.0		20.7 0.5 13					2681.5135 1.0		-166.0 0.3 15			
	2675.7917 1.0		22.2 0.6 14				186154	2670.6400 1.0		-5.4 0.5 14			
	2679.7744 1.0		21.3 0.3 14					2680.6946 1.0		-6.2 0.2 13			
35877	2876.5385 0.5		4.8 0.5 14					3271.6635 1.0		-6.7 0.5 14			
37530	2374.7148 1.0		23.7 0.5 14				187420	2675.6747 1.0		-19.5 0.2 15			
	2381.6929 1.0		24.2 0.6 13					2679.6773 1.0		-15.7 0.2 14			
	2675.8812 1.0		23.4 0.5 13					3270.9320 1.0		-18.5 0.3 15			
42556	2670.7698 1.0		9.8 0.3 14				192827	2379.5245 1.0		-41.6 0.6 14			
	2869.5243 0.5		8.0 0.5 13					2672.7151 1.0		-44.1 0.3 13			
	2876.5553 1.0		11.5 0.3 14					2675.6953 1.0		-47.2 0.4 13			
52619	2384.6896 1.0		10.2 0.6 12				193302	2378.5241 1.0		-14.1 0.6 12			
	2678.8141 1.0		7.8 0.4 14					2678.7483 1.0		-13.8 0.4 13			
	2681.8275 1.0		11.0 0.5 13					2681.6040 1.0		-16.2 0.5 14			
57853	2868.5127 0.5		40.4 0.6 13				195909	2380.5168 1.0		-30.2 0.3 14			
	3263.5094 1.0		34.1 0.7 14					2679.5499 1.0		-26.1 0.4 14			
	3266.4976 1.0		32.5 0.5 14					2681.5952 1.0		-23.0 0.4 14			
66242	2379.8625 1.0		-16.6 0.5 15				198272	2384.5157 1.0		9.5 0.8 9			
	3262.5396 1.0		-19.2 0.7 12					2679.5605 1.0		9.4 0.7 11			
	3266.5026 1.0		-16.0 0.4 15					2681.5843 1.0		10.9 0.6 12			
70003A	2868.5632 1.0		15.5 1.4 14				200932	2677.6879 1.0		-38.9 0.5 13			
	3265.4678 1.0		12.5 2.1 11					2680.5783 1.0		-39.4 0.4 14			
	3267.4692 1.0		15.0 1.1 13					3264.9011 1.0		-32.8 0.6 13			
73072	2879.5211 1.0		-5.4 0.8 12				202501	2376.5417 0.5		8.6 0.5 13			
	2888.5791 1.0		-6.4 0.7 12		24.1 4.5 3			2675.6369 0.5		12.3 0.2 11			
	3265.5641 1.0		51.4 0.6 6		-27.5 10.6 3			2679.6889 1.0		11.6 0.2 14			
73451	2869.6488 1.0		45.5 0.7 15				209278B	2380.5591 1.0		16.8 0.5 15			
	3262.5498 1.0		21.2 1.0 12					2671.7078 1.0		13.9 0.3 14			
	3266.5440 1.0		21.3 1.3 13					2677.7520 1.0		16.5 0.5 15			
76376A	2384.7823 1.0		39.1 0.3 14				215749	2378.5594 1.0		19.4 0.6 14			
	3262.5900 1.0		37.1 0.4 13					2677.7150 0.5		17.6 0.6 13			
	3265.5810 1.0		36.0 0.6 14					2680.6622 1.0		18.6 0.6 14			
83095	2384.7982 1.0		16.2 0.5 14					2681.6509 1.0		18.4 0.5 14			
	3263.5702 1.0		12.9 0.5 14				223429	2373.5965 1.0		33.6 0.3 15			
	3266.4711 1.0		13.9 0.4 13					2383.5702 1.0		36.3 0.5 15			
83380	2384.8389 1.0		-1.9 0.4 15					2669.7804 1.0		30.0 0.5 15			
	3264.6012 1.0		-3.0 0.4 14										
	3268.5839 1.0		-3.2 0.5 15										