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A catalog of rotational and radial velocities for evolved stars

III. Double-lined binary systems⋆,⋆⋆

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Abstract. Rotational velocity $v \sin i$ measurements are presented for a sample of 78 double-lined binary systems with an evolved component. This work is the third part of the large survey carried out with the CORAVEL spectrometer to establish the behavior the rotation for stars evolving off the main sequence (De Medeiros & Mayor 1999, A&AS, 139, 433; De Medeiros et al. 2002, A&A, 395, 97).

Key words. stars: evolution – stars: late-type – stars: fundamental parameters – stars: binaries: spectroscopic – techniques: radial velocities – catalogs

1. Introduction

This is the third part of the systematic survey carried out at the Geneva Observatory to determine precise rotational velocity $v \sin i$ for evolved stars of luminosity classes IV, III, II and Ib, in the spectral regions F, G and K. Although the major aim of such a survey is to obtain rotational velocities, the observational procedure has also produced about 4000 radial-velocity measurements. Consequently, this has revealed a number of new spectroscopic-binary stars, and additionally has confirmed the binary status for a large fraction of stars previously suspected to be radial-velocity variable. The results of this survey for single stars and single-lined binary systems of luminosity classes IV, III and II, namely subgiant, giant and bright giant stars, including the rotational velocity $v \sin i$, the individual and mean radial velocity, are presented by De Medeiros & Mayor (1999), and for the Ib supergiants by De Medeiros et al. (2002).

In the present work, we report the results of the survey for the double-lined binary systems with an evolved component. Section 2 presents the main characteristics of the sample and the observational procedure. The projected rotational velocity $v \sin i$ and the mean radial velocity values are given in Sect. 3. The analyses and interpretation of the present data will be presented in a forthcoming paper.

⋆ Based on observations collected at the Haute-Provence Observatory, Saint-Michel, France and at ESO, La Silla, Chile.

⋆⋆ Table 4 is only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/427/313

2. The observational program

For this observing program we have taken the stars from the main sample defined by De Medeiros & Mayor (1999) presenting characteristics of a double-lined binary system on the basis of one CORAVEL (Baranne et al. 1979) observation: Two well defined correlation dips or one correlation dip with a trend towards asymmetries. These criteria have produced a preliminary list of 70 SB2 or suspected SB2 stars as listed in Table 6 of De Medeiros & Mayor (1999). A second CORAVEL observation confirmed SB2 characteristics for 46 stars of the referred list, whereas 10 stars showed rather a single-lined (SB1) behavior. For 6 stars listed as SB2 candidates in Table 6 of De Medeiros & Mayor (1999), on the basis of a trend towards asymmetries in their correlation dips, a second CORAVEL measurement showed mostly a single behavior. For comparative propose, 23 SB2 systems listed by Strassmeier et al. (1993) have been added to the observing list. Thus, the present work brings observations for some 92 stars, including 57 SB2 systems with two clear CORAVEL dips, 3 SB3 systems with three clear CORAVEL dips, 18 SB2 systems presenting a blended CORAVEL dip, 11 single-lined SB systems and 7 single stars.

The observations reported here were obtained with the two CORAVEL spectrometers mounted on the 1-m Swiss telescope at the Haute-Provence Observatory, Saint Michel (France), and on the 1.54-m Danish telescope at the ESO, La Silla (Chile). The radial velocities are obtained by cross-correlations of the stellar spectra with a physical template, built from the spectrum of a K2 III star (Arcturus), and located in the focal plane of

Table 1. Rotational and radial velocity for double-lined (SB2) and triple-lined (SB3) binary systems with evolved components.

Name HD	Sp	$(B-V)$	RV km s^{-1}	ϵ km s^{-1}	N	ΔT days	$V \sin i$ km s^{-1}	$\epsilon_{\rm rot}$ km s^{-1}	Remark
5137 A	G5III	0.86	–13.31	0.33	2	304	<1.0		
B			18.32	9.18	2	304	<1.0		
5516 A	G8IIIb	0.94	–19.25	9.00	3	45	<1.5		
B			–1.56	8.99	3	45	<1.0		
8357 A	G8IV	0.87	17.49	4.87	19	3751	6.0	1.0	SB2O
B			19.24	5.77	19	3751	<1.9		
8435 A	G6-8IV-IIIe	0.70	–4.21	11.70	5	1796	28.8	3.9	
B			12.52	16.85	5	1796	24.1	2.4	
13480 A	G5III+F5V	0.78	–26.32	7.33	30	6237	35.6	3.6	SB2O
B			–10.82	7.27	27	6237	8.8	1.0	
C			–63.20	37.69	3	2983	28.0	2.8	
17904 A	FIV	0.41	59.48	26.46	2	636	30.5	3.5	
B			1.17	18.65	2	636	27.1	3.7	
18894 A	G0IV-V	0.60	28.55	1.59	64	3624	4.6	1.0	SB2O
B			–1.31	1.98	61	3624	3.1	1.0	
C			11.64	2.38	1	0	5.4	1.0	
21242 A	K0IV	0.91	37.35	4.72	110	5202	9.9	1.0	SB2O
B			43.21	5.92	38	5196	17.1	3.3	
24546 A	F5IV	0.41	40.04	0.85	1	0	12.8	1.3	SB2O
B			10.75	0.75	1	0	9.6	1.3	
26337 A	G5IV	0.67	13.64	5.03	26	5958	39.6	4.0	SB2O
B			36.19	5.94	23	5958	21.4	2.7	
29104 A	G5II-III+A	0.74	–20.84	8.80	3	474	<1.0		
B			–7.56	15.07	2	474	2.5	3.2	
31738 A	G5IV	0.71	6.63	1.18	21	3706	22.5	2.2	
B			9.84	4.86	21	3706	11.0	1.1	
34029 A	K0III	0.90	23.01	6.16	9	1460	3.0	1.0	SB2O
B	G1III	0.60	36.35	6.96	7	1212	34.5	3.4	
40084 A	G5III	1.23	13.40	14.06	4	2200	6.6	1.1	SB2O
B			–22.35	14.55	4	2200	8.3	1.0	
41116 A	G7III	0.82	24.83	0.46	125	5212	<1.0		SB2O
B			23.77	3.40	130	5212	5.5	1.0	
43358 A	F5IV:	0.46	4.25	0.50	2	331	5.3	1.0	SB2O
B			39.55	4.13	2	331	17.7	1.0	
C			–30.79	1.34	1	0	20.7	2.1	
44780 A	K1III	1.21	13.13	10.46	2	1871	2.7	1.2	SB2O
B			19.57	9.94	2	1871	<1.0		
46178 A	K0III	1.07	–24.81	6.19	2	254	3.2	1.5	
B			–14.16	8.43	2	254	<1.0		
47415 A	F8IV	0.53	31.67	6.90	24	4426	6.4	1.0	SB2O
B			37.29	7.36	23	122	4.5	1.0	
47703 A	F8III	0.49	86.58	4.25	6	3012	6.1	3.3	
B			84.20	11.49	6	3012	8.2	3.2	
56200 A	F4II	0.40	16.51	3.62	2	713	20.5	2.0	
B			32.62	0.66	2	713	2.3	1.0	
57364 A	G8III/K2-3III	1.08	5.39	7.03	2	454	20.4	3.5	SB2O
B			51.74	15.44	2	454	22.4	4.0	
58972 A	K3III	1.43	41.23	16.34	2	254	2.3	1.1	SB2O
B			51.41	15.69	2	254	<1.0		
59148 A	K2III	1.11	46.29	4.90	2	188	2.0	1.5	SB2O
B		1	22.24	5.36	2	188	2.0	1.6	
60318 A	K0III	1.01	1.78	0.26	3	959	<2.9		
B			–14.05	0.71	3	959	<1.0		
64235 A	F5IV	0.41	-8.50	1.72	2	1556	17.8	1.0	
B			24.36	1.84	2	1556	10.3	5.7	
65626 A	F9IV/G5IV	0.62	50.49	21.73	4	97	12.7	1.0	SB2O
B			0.62	19.84	4	97	14.8	1.0	
77137 A	G5IV	0.76	131.54	30.47	4	3464	26.6	2.7	SB2O
B		0.72	–31.21	13.09	4	3464	26.9	2.7	
78418 A	G5IV-V	0.66	3.89	5.23	18	3286	1.6	1.0	SB2O
B			13.71	6.18	17	3286	2.3	1.6	
81873 A	K0III	1.04	27.96	0.45	1	0	1.2	1.8	
B			8.65	0.49	1	0	<1.0		
82543 A	F7IV-V	0.62	24.64	0.80	6	2226	6.0	2.6	
B			23.99	12.05	6	2226	7.6	2.9	
92787 A	F5III	0.33	19.53	9.01	3	1526	12.6	1.5	
B			–10.83	4.57	1	0	35.4	7.0	
101309 A	K1IV/G5V	0.94	-7.18	20.97	2	1094	18.8	1.0	SB2O
B			19.14	22.43	2	1094	8.4	1.2	
106677 A	K0III	1.14	–56.82	9.59	6	3731	9.6	1.0	SB2O
B			–32.76	9.65	6	3731	9.3	1.0	
114519 A	F4IV	0.42	22.71	20.95	6	2922	18.2	1.5	SB2O
B	G9IV	0.91	19.70	2.20	1	0	9.1	7.6	
122703 A	F5III	0.45	–28.35	1.98	1	0	37.9	5.7	
B			22.12	1.59	1	0	22.4	3.2	
123999 A	F9IV	0.54	11.10	12.00	12	1818	12.5	1.0	SB2O
B			0.84	13.22	11	1818	9.5	1.0	
137164 A	K2IV	1.04	–32.04	0.50	1	0	6.8	1.6	SB2O
B			19.36	0.51	1	0	3.6	2.7	
139862 A	G8II	0.94	–30.26	5.28	2	65	9.6	2.6	

Table 1. continued.

Name HD	Sp	$(B-V)$	RV km s^{-1}	ϵ km s^{-1}	N	ΔT days	$V \sin i$ km s^{-1}	ϵ_{rot} km s^{-1}	Remark
139862 B			–3.76	3.72	2	65	9.1	3.4	
155555 A	G5IV/K0IV	0.83	13.68	40.33	3	1801	35.6	3.6	SB2O
B			28.24	59.17	2	1	32.9	9.0	
155638 A	F2IV	0.45	6.76	11.79	2	429	24.3	2.4	SB2O
B	K0III	1.07	26.16	12.97	6	429	1.5	3.0	
158614 A	G9IV-V	0.72	–79.87	0.36	15	3778	1.5	8.1	SB2O
B			–73.64	0.42	15	3778	1.5	8.1	
163930 A	K0IV/F4V-IV	0.59	–308.23	65.33	2	360	44.2	4.4	SB2O
B			–305.48	0.84	1	0	7.4	3.2	
169268 A	F6III-IV	0.34	–17.81	8.92	26	1856	10.1	1.0	
B			–16.90	8.41	25	1856	13.7	1.0	
171802 A	F9IV	0.55	–4.54	1.94	3	186	7.3	1.0	SB2O
B			–36.29	1.74	3	186	2.6	1.6	
172088 A	F9IV	0.55	–18.00	0.57	79	7643	9.7	1.0	
B			–15.82	0.81	79	7643	<1.0		
172865 A	G5III	1.00	13.77	0.39	30	2700	2.1	1.7	SB2O
B			20.57	0.78	30	2700	2.5	3.9	
174881 A	K1II-III	1.18	–22.08	2.90	36	3792	<1.0		SB2O
B			–17.19	2.76	36	3792	<1.0		
178619 A	F5IV-V	0.52	1.75	15.74	17	2914	12.0	1.0	SB2O
B			21.82	15.34	17	2561	11.4	1.0	
179094 A	K1IV	1.09	1.79	5.86	28	5124	14.9	1.0	SB2O
B			28.06	6.48	11	4820	1.8	2.9	
182549 A	G6II	0.90	–29.35	0.35	2	381	68.4	1.0	
B			–5.81	20.28	2	381	68.4	1.0	
185734 A	G8III-IV	0.97	15.65	1.56	3	2513	<1.0		SB2O
B			–6.66	1.33	3	2513	2.4	1.0	
198084 A	F8IV-V	0.54	–28.26	0.51	1	0	<1.0		SB2O
B			–36.24	0.60	1	0	5.4	1.0	
202447 A	G0III+A5V	0.53	–18.89	11.06	2	355	1.3	1.7	SB2O
B			–19.94	12.63	2	355	20.0	6.2	
206301 A	G2IV	0.65	–5.00	4.42	23	5787	5.8	1.0	SB2O
B			2.06	5.68	21	5787	4.6	1.3	
206901 A	F5IV	0.43	–1.93	4.82	29	2629	10.0	1.0	SB2O
B			–17.03	3.17	24	2629	24.5	3.0	
210334 A	G2IV+K0III	0.72	–17.55	12.28	5	3675	41.1	9.0	SB2O
B			–81.00	16.38	4	997	24.4	3.3	
212280 A	G0IV	0.70	0.96	4.26	48	1187	9.0	1.0	SB2O
B			–8.80	2.99	32	1075	22.8	2.3	
218527 A	G8III-IV	0.91	–11.95	0.43	1	0	3.7	1.3	
B			–33.04	1.06	1	0	4.7	1.0	
250810 A	K1IV/F5	1.00	31.90	65.28	2	6	56.7	12.4	SB2O
B			35.59	73.24	2	6	12.4	4.9	

the instruments. The radial-velocity system is the one defined by Udry et al. (1999). The typical integration time was 5 min and the data reduction was made by using standard procedures (Duquennoy 1987; Duquennoy et al. 1991; De Medeiros & Mayor 1999). The radial velocities are derived from a 2-Gaussian fit following the procedure described in Duquennoy (1987) or in Duquennoy et al. (1991).

In all cases, the radial-velocity uncertainty is derived from an instrumental error quadraticallly added to the photon noise and to the scintillation noise, which are estimated from the parameters of the observations (Baranne et al. 1979). Different studies in large data samples (e.g. Duquennoy et al. 1991; Udry et al. 1999; De Medeiros & Mayor 1999) show that the typical uncertainty for the CORAVEL radial velocities is about 0.3 km s^{-1} for low and moderate rotator stars, typically stars with $v \sin i < 10$ km s^{-1}. For stars with higher rotation rates, the uncertainty is somewhat larger. The rotational velocities $v \sin i$ were obtained through an appropriate calibration of the widths of the cross-correlation dips as described by Benz & Mayor (1984) and De Medeiros & Mayor (1999). For a complete discussion on the observational procedure, calibration and error analysis, the reader is referred to these authors. However, for giant and subgiant stars De Medeiros & Mayor (1999) have shown that CORAVEL $v \sin i$ values present an uncertainty of about 1.0 km s^{-1} for stars with $v \sin i$ lower than about 30 km s^{-1}. For higher rotators the estimations show a relative uncertainty of about 10% for all luminosity classes.

3. Contents

The main results of this part of the catalogue are listed in Tables 1 and 2, where stars appear in order of increasing HD number. Table 1 presents the CORAVEL rotational velocity measurements for the multi-lined systems with two or three well defined components. Table 2 lists the CORAVEL rotational velocity measurements for single-lined and blended double-lined systems. The columns are:

1. HD number.
2. Spectral type.
3. $(B-V)$ color index.
4–5. Mean radial velocity RV and its uncertainty ϵ, on the number N of CORAVEL observations. In this case the

Table 2. Rotational and radial velocity for single-lined and blended double-lined binary systems with evolved components.

Name HD		Sp	$(B-V)$	RV km s^{-1}	ϵ km s^{-1}	$P(\chi 2)$	N	ΔT days	$V \sin i$ km s^{-1}	$\epsilon_{\rm rot}$ km s^{-1}	Remark
2436		K5III	1.58	–11.53	9.54	0.000	2	372	<1.7		SB
5303		K4IV/G0V	0.73	32.02	16.70	0.000	15	5846	21.8	2.2	SB2
8949	A	K1III	1.12	2.75	0.89	0.000	32	6998	<1.1		SB
22468		G5IV/K1IV	0.92	–23.00	7.45	0.000	5	4820	17.4	2.1	SB2O
23838		G2III+F2:V	0.76	20.30	8.31	0.000	3	478	1.1	1.0	SB2O
37847		K2III	1.07	–4.29	15.09	0.000	4	1566	21.0	2.1	SB2
38751		G8IIIv	1.01	15.80	0.54	0.007	2	366	1.7	1.4	SB
59878	A	K0II-III+F	1.01	34.20	0.53	0.008	2	188	<1.0		SBO
68461		G8III	0.89	–23.60	4.29	0.000	4	468	2.0	1.1	SB
102509		G5III-IV+A7V	0.55	–7.88	7.23	0.000	12	5522	5.5	1.0	SB2O
112313		G5IV-III	0.78	2.53	1.58	0.000	2	5	30.7	3.1	SB2
112859		K0III/F	0.93	55.99	2.95	0.000	2	676	14.3	3.2	SB2
115781		K0III	1.14	28.45	0.74	0.014	4	430	38.9	3.9	SB2
118216		F2IV/K2IV	0.38	9.42	1.28	0.000	18	4384	13.8	1.0	SB2O
121909		F8IV-V/G2V	0.57	–24.80	4.18	0.000	1	0	31.3	10.9	SB2O
128171		G8IV/K3IV	1.04	–30.48	4.50	0.000	15	2921	30.9	3.1	SB2
150708		G2IV/K0IV	1.10	–36.32	79.19	0.000	2	11	66.6	7.6	SB2O
151237		F8II	0.49	–49.13	1.99	0.006	9	1156	69.2	6.9	SB
152830		F5II	0.34	–7.58	7.19	0.000	4	194	19.6	1.0	SBO
158393		G5III	1.06	17.39	2.11	0.000	2	1	23.3	2.4	SB2
163621		K1IV/G6V	0.90	–28.79	9.77	0.000	2	724	8.4	1.0	SB2
169689		G8III-IV+A	0.92	–34.55	15.00	0.000	2	299	7.0	1.0	SB
169985		G0III+A6V	0.50	–25.96	11.74	0.000	2	649	3.3	1.1	SBO
185151		K0III	1.25	–34.22	24.50	0.000	2	211	35.3	3.5	SB2O
192577		K2II+B3V	1.18	1.44	1.37	0.000	3	386	6.8	1.0	SBO
196753		K0II-III+A	0.98	19.84	0.95	0.000	2	386	4.6	1.0	SB
209318		G9IV/G5	1.14	–83.52	38.08	0.000	5	1193	49.5	11.8	SB2O
219113		F8IV/K1IV	1.00	–24.33	18.66	0.000	15	0	7.1	1.3	SB2O
283533		G0II	0.71	–11.34	0.43	0.000	2	322	4.2	2.2	SB2?

Table 3. Rotational and radial velocity for 6 apparently single evolved stars.

Name HD	Sp	$(B-V)$	RV km s^{-1}	ϵ km s^{-1}	$P(\chi 2)$	N	ΔT days	$V \sin i$ km s^{-1}	$\epsilon_{\rm rot}$ km s^{-1}
18925	G8III+A2V	0.70	–1.23	0.28	0.172	3	320	1.8	1.3
32453	G5III	0.88	6.05	0.19	0.958	2	241	2.0	1.4
63799	K1III	1.12	–47.08	0.20	0.617	2	188	<1.0	
73596	F5III	0.40	25.10	1.21	0.831	2	272	46.0	5.1
109511	K2III	1.15	3.06	0.11	0.979	6	3322	2.0	1.0
182549	G6II	0.90	–29.36	0.15	0.787	5	2582	1.4	1.0
201051	K0II-III	1.05	–8.47	0.19	0.590	2	370	<1.0	

uncertainty is given by max $(\epsilon_1/\sqrt{N}, \sigma/\sqrt{N})$, where ϵ_1 is the typical error for one single radial velocity measurement.

6. N, the number of observations for each star.
7. The time span ΔT of the observations.
8–9. Rotational velocity and its uncertainty.
10. Remarks: SB2O indicates binaries for which the orbital parameters are available in the literature.

The remarks SB and SB2 in Table 2 indicate stars presenting, respectively, a single-lined spectroscopic binary behavior and the double-lined systems with a blended behavior.

Table 3 lists the CORAVEL rotational velocities for 7 single stars with a previously suspected SB behavior.

– Columns 1–7 are defined as in Table 1 and 2, whereas Col. 8 gives $P(\chi^2)$, the probability that the radial velocity of the star is constant.
– Column 9. N, the number of observations for each star.
– Column 10. The time span ΔT of the observations.
– Columns 11–12. Rotational velocity and its uncertainty.

The individual radial-velocity measurements (Table 4) are available at the CDS "Centre de Données Stellaires of Strasbourg Observatory".

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