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Catalogues of radial and rotational velocities of 1253 F–K dwarfs in 13 nearby open clusters[⋆,⋆⋆]

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ABSTRACT

Context. We conducted a long-term monitoring of solar-type dwarfs in 13 nearby open clusters, $d < 500$ pc, over 19 years, but most individual radial velocities were never published, apart from a small number of spectroscopic binaries.

Aims. Our program was designed to study membership and duplicity, and to search for new cluster members.

Methods. We obtained 6070 radial velocities during 19 years of observations at the Haute-Provence Observatory (France) and 1130 during 13 years at ESO La Silla (Chile) for 1253 stars in the field of 13 open clusters. The zeropoint of the CORAVEL radial velocity system was improved and the new values supersede those published previously.

Results. The membership and binarity of solar-type stars in NGC 1976 (Orion), IC 2602, NGC 7092, and NGC 2682 are briefly discussed. For the entire sample, we confirmed the membership of 894 stars and discovered 150 new spectroscopic binaries among them. Added to those already known in the Hyades and Coma Berenices, the number of member spectroscopic binaries is 188. The overall binary frequency is 30% (188/618) for stars with at least 2 measurements. Since no spectroscopic binaries were found among its 26 members, IC 2602 may however represent an exception. New orbital elements were computed with the updated values of the radial velocities for 66 systems, representing 55 members and 11 non-members.

Conclusions. This paper is the final report from our team of CORAVEL radial velocities of solar-type dwarfs in nearby open clusters. All CORAVEL observations for dwarfs and red giants in open clusters are now available in electronic form.

Key words. galaxy: open clusters and associations: general – stars: late-type – stars: binaries: spectroscopic – techniques: radial velocities

1. Introduction

Open clusters are unique astrophysical laboratories. To exploit their full potential, one requires at least reliable information about membership. Because of their small internal velocity dispersion, usually less than, or about, 0.5 km s^{-1}, radial velocities can provide an efficient criterion. However, the acquisition of a few radial velocities is often insufficient in determining membership reliably, because a significant fraction of the member stars are binaries or belong to multiple systems. Their mean velocity may differ from the cluster mean velocity by an amount that depends on the phase distribution of the measurements, which is unknown until an orbit can be computed. Consequently, it is often necessary for an orbit to be completed before membership can be ascertained, even if the star is found to be a non-member.

The study of the duplicity or multiplicity of the cluster members provides direct and detailed information about the final products of cluster and star-formation processes, and more precisely, the frequency of binaries and distribution of orbital periods. With earlier telescopes and instruments, nearby open clusters were the most suitable targets for studying membership, duplicity, and rotation of solar-type stars in the spectral domain F5 to K0, or even later in the Hyades.

The installation of the CORAVEL spectrovelocimeters at the Haute-Provence Observatory (France) in 1977 and at La Silla (Chile) in 1983 permitted us to undertake a systematic survey of several nearby clusters, namely those closer than 500 pc. At that time, much less information was available, and the sample selection was often based on *UBV* photometry and proper motions. Results from the ROSAT satellite came later and the observing lists were extended when possible to include new candidates in the observing list.

The search for new members was also an initial goal, either to extend spatially the investigated areas, and mainly the outer part (corona) of clusters such as the Pleiades and Praesepe, or to extend the main sequence toward fainter magnitudes, as for example the Coma Berenices and NGC 7092 clusters. The rate of success in the discovery of new members was satisfying for the corona of the Pleiades and Praesepe, while it was poor for the main sequence of Coma Berenices. The analysis produced

⋆ Based on observations collected at the Haute-Provence Observatory (France) and with the Danish 1.54-m at the European Southern Observatory, La Silla, Chile. This reaserch has made use of the WEBDA database, operated at the Institute for Astronomy of the University of Vienna, and of the SIMBAD database, operated at CDS, Strasbourg, France This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

⋆⋆ Full Tables 8, 10, and 11 are 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/498/949

sometimes unexpected results, for example for Alpha Persei, in which membership was difficult to assess.

Altough extensive, long-term programs are underway at CfA and Wisconsin, no comprehensive studies of other nearby clusters ave been published so far, except for the Hyades, extensively observed by Griffin et al. (1988) and Latham and collaborators (Latham 1992), IC 2391, analysed by Platais et al. (2007), and NGC 2682 (M 67), the only cluster in our sample located beyond 500 pc, observed by Mathieu et al. (1986, 1990). The numerous individual radial velocities obtained with the CORAVELs have not been published before, mainly because of the necessity to correct first the zeropoint of the radial-velocity system to agree more closely with the other radial-velocity absolute systems.

Although several papers have already been published describing CORAVEL observations, the analysis of a few clusters have not been completed. We present here the results about membership and binarity for three open clusters, Orion Ic (NGC 1976), IC 2602, NGC 7092, and of rotation in NGC 2682. This paper primarily provides full catalogues of individual and mean radial velocities, including rotational velocities.

For nearby clusters, the number of stars with rotational velocities available in the literature is certainly higher than that with radial velocities. However, the resolution has often been insufficient to resolve the line width of the lowest rotators. Only upper limits could be derived, usually equal to 10 or 6 km s^{-1}. Using CORAVEL observations we can measure rotation to velocities of about 1 km s^{-1} with a precision of about 1 km s^{-1}.

This paper presents briefly the instrumentation, and discusses the studied clusters, recalling results already published and presenting more details for the remaining clusters. For 1253 stars in 13 nearby open clusters, we then present the catalogues of individual and mean radial velocities and $V \sin i$ values, and a redetermination of most orbits in the new radial-velocity system.

2. Observations

The radial velocity observations were acquired during a systematic observing program covering both hemispheres. The decommissioning of the instruments in 1997 abruptly ended our observing campaigns.

The observations in the northern hemisphere were made with the photoelectric scanner CORAVEL (Baranne et al. 1979; Mayor 1985) installed on the Swiss 1-m telescope at the Haute-Provence Observatory (OHP), France, over 19 years from January 1978 to October 1997. The clusters observed at OHP were the Hyades, the Pleiades, the Alpha Persei cluster, Praesepe, Coma Berenices, NGC 752, and NGC 7092. The adopted limiting magnitude of selected dwarfs at OHP was $B = 12.5$.

The radial velocity observations in the southern hemisphere were completed with the second photoelectric scanner CORAVEL mounted on the Danish 1.54-m telescope at ESO, La Silla (Chile), over 13 years from March 1983 to July 1996. The observations were allocated in both ESO and Danish time, generously attributed to this long-term program. The clusters observed from La Silla are NGC 6475, IC 2391, IC 2602, Blanco 1, and evolved stars in NGC 2682 (M 67). The limiting magnitude of the selected dwarfs was $B = 14.5$. The larger size of the telescope at La Silla and the lower photon noise of the photomultiplier permitted us to measure stars with fainter magnitudes than at the OHP.

The integration time was usually between 600 and 1200 s, depending on the star luminosity and quality of both weather and seeing, to reach the required radial-velocity precision. Longer integration times were also needed to minimize the noise in the correlation function and derive rotational velocities.

The radial velocities were placed on the system defined by Udry et al. (1999), calibrated with high precision data from the ELODIE spectrograph (Baranne et al. 1996). This new calibration introduced a small change in zeropoint, which varied by about 0.3–0.5 km s^{-1} the individual and mean velocities that have been previously published. Accordingly, the present data supersede those published before 2000. The data were not corrected for either the effect of gravitational redshift or convective blueshift.

Following the method of Benz & Mayor (1984), the projected rotational velocities ($V \sin i$) were derived from the width of the correlation functions.

The stars were observed as frequently as possible to detect binaries, at least once a year during the first years at the OHP. The observation rate then depended on whether the star was a member or non-member, and single or binary. Suspected single stars were observed over longer intervals, while binaries were monitored more frequently to obtain a sufficient number of measurements for determining an orbit.

The observations were made by a large number of observers, mostly from the Geneva Observatory. Mermilliod (5271 meas., 68%), Mayor, Duquennoy, and Burki contributed together to about 89% of the total amount of observations.

3. Individual clusters

The clusters are presented in an order of decreasing age, from the oldest to the youngest.

3.1. NGC 2682 (M 67)

A number of evolved single stars were selected to measure the rotational velocities across the Hertzsprung gap, from the turn-off to the base of the red-giant branch. Two observations, separated by about 2 years, were secured. No star was found to be variable. The resulting data, mean radial velocities, and rotation are given in Table 1. The star designation corresponds to that used in WEBDA[1].

Figure 1 presents the distribution of the $V \sin i$ as a function of $B - V$ in the lower part of the figure, and the corresponding colour-magnitude diagram in the upper part. The rotation of the stars can thus be easily compared with their location in the Hertzsprung gap. If the rotation seems to decline from $B - V = 0.50$ to $B - V = 0.65$, there is no clear relation for $B - V > 0.70$, where scatter dominates. It is unclear whether this is merely an effect of the viewing angle, $\sin i$, or an intrinsic property of the star rotation and evolution. The lower part of Fig. 1 can be compared with Fig. 5 of Melo et al. (2001), who analysed the rotation on the upper main sequence of M 67 and studied the angular momentum evolution of 1.2 $M_\odot$ stars.

3.2. NGC 752

The sample selected on the basis of the data available in 1979 contains 78 stars from the catalogue of Heinemann (1926), 22 fainter stars from the *UBV* photographic photometry of Rohlfs & Vanysek (1961), and 3 stars from Rebeirot (1970). For most

[1] WEBDA: http://www.univie.ac.at/webda/

Table 1. Radial and rotational velocities for stars in NGC 2682.

No.	ID	V_r	ϵ	N	$V \sin i$	Err	ΔT	$P(\chi^2)$
0003	F 3	32.51	0.63	2	9.3	1.7	736	0.128
0006	F 6	33.77	0.38	2	6.0	2.0	736	0.814
0018	F 18	32.81	0.40	2	11.2	1.4	736	0.775
0020	F 20	33.45	0.31	2	0.9	0.0	734	0.249
0037	F 37	33.11	0.34	2	2.6	2.0	697	0.251
0048	F 48	32.56	0.30	2	0.4	4.4	697	0.688
0054	F 54	34.72	0.36	2	4.6	2.5	734	0.258
0072	F 72	33.17	0.26	2	1.2	2.2	735	0.985
0094	F 94	33.17	0.32	3	8.1	1.4	734	0.796
0096	F 96	33.75	0.34	2	7.3	1.5	695	0.490
0115	F 115	34.24	0.25	3	3.4	2.3	734	0.801
0127	F 127	33.99	0.35	3	5.3	1.6	734	0.193
0157	F 157	32.86	0.36	2	7.3	1.7	694	0.708
0163	F 163	33.06	0.67	2	5.2	1.9	694	0.045
0166	F 166	32.60	0.28	2	2.9	0.0	694	0.944
0193	F 193	33.94	0.26	2	2.6	1.7	694	0.383
0215	F 215	33.08	0.43	2	10.6	1.6	694	0.641
0226	F 226	33.00	0.27	2	2.0	2.0	694	0.860
0227	F 227	33.03	0.31	2	5.0	1.8	694	0.465
0237	F 237	33.52	0.69	2	0.0	0.0	695	0.015
0241	F 241	32.53	0.36	2	5.2	2.1	696	0.409
0243	F 243	33.09	0.36	2	6.4	1.9	696	0.572
0256	F 256	33.24	0.35	2	6.0	3.1	696	0.739
0271	F 271	34.00	0.33	2	4.5	2.2	696	0.976
0272	F 272	30.16	0.56	2	5.5	1.9	696	0.102
0281	F 281	32.74	0.32	2	5.1	1.8	696	0.322
0287	F 287	32.46	0.40	2	8.3	1.7	696	0.424
0289	F 289	33.18	0.50	2	7.3	2.1	697	0.198
0303	F 303	35.12	0.35	2	4.2	2.4	697	0.365
0317	F 317	33.18	0.33	2	2.2	0.0	697	0.744
4018	S 1060	33.58	0.50	1				
7368	S 368	33.82	0.35	2	0.5	3.4	698	0.902
7489	S 489	33.42	0.51	2	8.8	2.2	699	0.829
7657	S 657	32.57	0.32	2	5.7	1.7	699	0.707
7859	S 859	32.07	0.45	2	0.9	3.1	699	0.191
7871	S 871	32.75	0.38	2	5.7	2.2	699	0.580
8524	S 1524	33.04	0.57	1	1.5	4.3		
8639	S 1639	32.90	0.37	2	3.8	0.0	698	0.777
8713	S 1713	32.87	0.64	2	4.2	1.9	698	0.031
8792	S 1792	33.67	0.36	2	3.5	2.2	698	0.436

Note: the star designation corresponds to that used in WEBDA. In the column ID, F refers to Fagerholm (1906) and S to Sanders (1977). The successive columns give: the radial velocity (V_r) and error on the mean (ϵ), the number of measurements (N), the rotation ($V \sin i$) and its error (Err), the time interval covered by the observations (ΔT) and the probability that the scatter is due to random noise ($P(\chi^2)$).

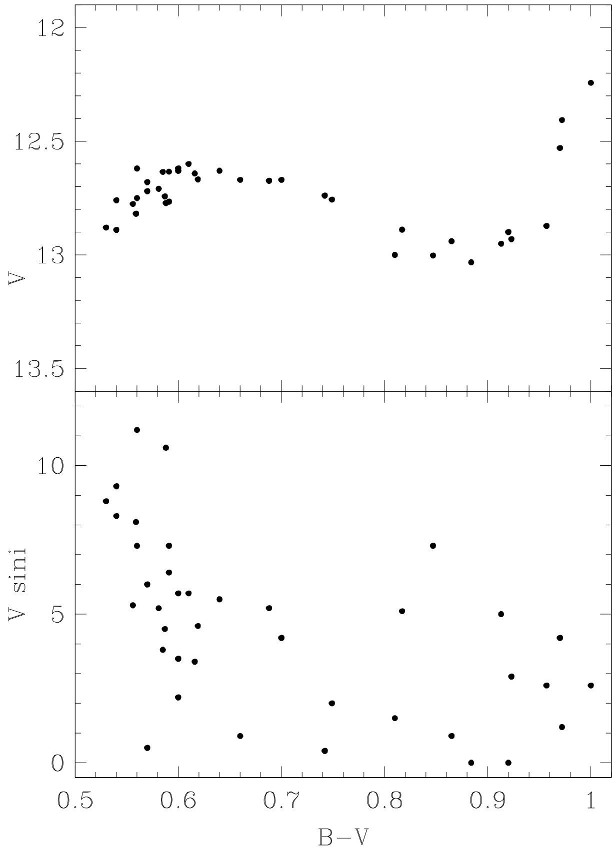

Fig. 1. Subgiants in M 67. *Upper diagram*: V vs. $B-V$, *lower diagram* $V \sin i$ versus $B-V$.

stars, between 3 and 7 observations were completed. Seven non-members were identified and 20 spectroscopic binaries discovered. We observed NGC 752 in collaboration with Dave Latham at CfA and mean radial velocities obtained at CfA were published by Daniel et al. (1994). The CfA observers have continued their long-term monitoring and many orbits have been determined. The final analysis of CORAVEL and CfA observations will be published later by Dave Latham.

3.3. Hyades (Melotte 25)

Two observations were obtained for 101 stars from the list of van Bueren's (1952), 23 stars from van Altena (1966), and 33 from Pels (1975), principally to determine rotational velocities. With a few exceptions, we did not plan to monitor binaries, because Griffin et al. (1988) had published a major survey of the Hyades. Their work was continued at CfA (Stefanik & Latham 1985, 1992). Most CORAVEL observations in the Hyades have not been published before.

An orbit was nevertheless determined for star vB 119. The radial velocity curve is displayed in Fig. 2 and the orbital elements are given in Table 8. Surprisingly, no elements have been published for this system. We have also enough observations to compute an orbit for vA 677.

Radial velocities for components A and Ba of vB 75, a visual double star (ADS 3248) in which B is a spectroscopic binary, were obtained by Smekhov (1995), who determined a period $P = 21\overset{d}{.}253$ and showed that the systemic velocity of B was changing due to its motion during the visual orbit. This system was also observed with CORAVEL, and 45 (A) and 57 (Ba) observations were obtained in three distinct periods in 1979, 1982, and 1985. Orbital elements were computed for each year separately and the resulting systemic velocities are recorded in Table 2, which indicates the year, the phase in the visual orbit with respect to $T = 1917.74$ (Smekhov 1995), the mean velocities of A and probable error, the systemic velocities of Ba and probable errors, in km s^{-1}, and the number of measurements used. These data points are well reproduced by the curve drawn in Fig. 2 of Smekhov (1995).

In their study of the Hyades, CORAVEL radial velocities were also used by Perryman et al. (1998). Spectroscopic orbits of three double-lined binaries in the Hyades field, BD +22° 669, vA 771, and vB 166, were published by Griffin et al. (1982). The orbital elements of the double-lined binaries vB 22 and vB 34 were discussed by Mayor & Mazeh (1987). The observations

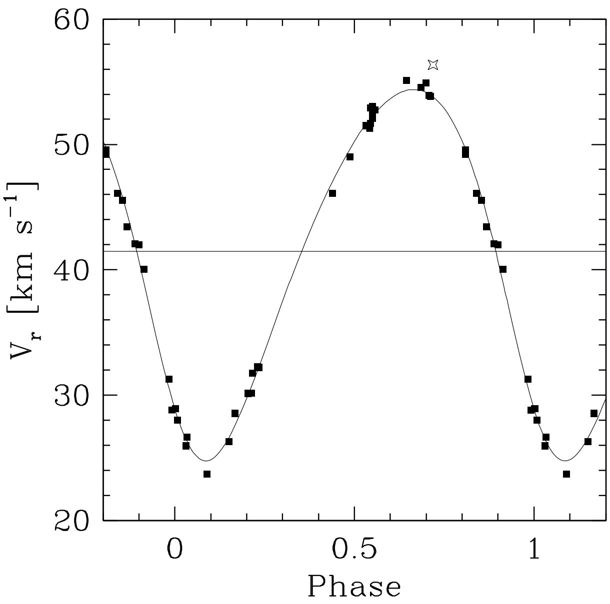

Fig. 2. Radial-velocity curve for vB 119 in the Hyades.

Table 2. Mean radial velocities for vB 75 A and Ba.

Date	Phase	V_A	ϵ_A	V_{Ba}	ϵ_B	N
1979.00	0.517	+42.73	0.45	+38.21	0.18	20
1982.08	0.593	+44.49	0.63	+37.33	0.27	7
1985.16	0.670	+45.55	0.48	+36.46	0.42	14

and orbits of Hyades Am stars were analysed by Debernardi et al. (2000).

3.4. Praesepe, NGC 2632

The observations of 220 stars in Praesepe have been completely published. Mermilliod et al. (1990) first examined the membership of 117 stars to the corona of the cluster and confirmed the membership of 48 stars. Mermilliod & Mayor (1999) published the mean radial velocities of 103 stars in the central part of Praesepe from the list of Klein-Wassink (1927) and the orbital elements of 20 spectroscopic binaries among the 24 detected. Additional observations were completed for several binaries and all orbits were recomputed in the new radial-velocity system. The updated orbital elements are listed in Table 8. A new orbit was computed for star KW 536 by combining the 34 CORAVEL observations with the 13 radial velocities by Bolte (1991), who published 211 individual radial velocities for 17 stars in this cluster.

Three triple systems, KW 365, 367, and 495 were studied in more detail by Mermilliod et al. (1994). Each system consists of a wide pair, and one component is in addition a spectroscopic binary for which an orbit was determined. Observations and orbits of Praesepe Am stars were analysed by Debernardi et al. (2000).

3.5. Coma Berenices (Melotte 111)

The radial velocities of 74 stars in the field of the Coma Berenices cluster (Melotte 111) were analysed by Mermilliod et al. (2008c). The membership of 31 stars was confirmed. An orbit was determined for the first time for the six spectroscopic-binary members. The binary rate obtained was 22% (7/32). Significant effort was made to find new members and for this purpose, 40 stars were observed. However, only 8 turned out to be members according to their radial velocity and location in the (V, $B-V$) colour-magnitude diagram.

3.6. NGC 7092

Solar-type stars on the main sequence of NGC 7092 were observed to ascertain their membership. Twenty-four stars were bright enough to be observed with the OHP 1m-telescope and 20 were found to be members. Two double-lined binaries and one single-lined system were discovered.

McNamara & Sanders (1977) did not find any member fainter than $V = 10.5$ and claimed that NGC 7092 possesses few if any faint members. Stars fainter than $V = 10.5$ were selected according to their proper motions in the list of McNamara & Sanders (1977). In the first step, they were observed on the Geneva photometric system. We used the B and V filters only for the faintest stars. The colour-magnitude diagram showed that most selected stars were indeed members and that the lack of faint members was due to a small difference in the μ_δ component of the proper motion between the bright and faint cluster members, i.e., $\mu_\delta = -0.169\,V + 0.475$. The radial velocity observations ascertained without any doubt the membership of these faint stars (Table 3).

The mean radial velocity of NGC 7092 is -5.26 ± 0.30 km s^{-1} (17 stars). It agrees with the value derived by Abt & Sanders (1973) for eight bright members, -8.0 ± 1.0 km s^{-1}. A few years later, *UBV* photoelectric photometry (Platais 1984) and new proper motions (Platais 1993) confirmed the existence of faint main-sequence stars.

3.7. NGC 6475 (M 7)

Seventy-five stars were observed in the field of the open cluster NGC 6475: 23 stars brighter than $V = 11.60$ from the list of Koelbloed (1959); 18 stars, $11.45 < V < 12.95$, from the list of Constantine et al. (1969), i.e., numbers from 1018 to 1939 in the radial velocity catalogue, and 34 stars in the magnitude interval $11.45 < V < 13.70$ from the catalogue of X-ray sources detected by Prosser et al. (1995), of number > 3300. Table 4 provides the coordinates of stars appearing only in the unpublished catalogue of Constantine et al. (1969). The other stars are those in common with the list of Prosser et al. (1995). The V and $B-V$ photometric data are taken from the photographic catalogue of Constantine et al. (1969). Most CORAVEL observations of stars from the latter two lists were obtained in July 1996. Nine spectroscopic binaries (1 SB2 and 8 SB1) were discovered among the cluster members. Only stars observed at least twice were considered in computing the binary rate given in Table 9.

CORAVEL mean radial velocities for stars in NGC 6475 were published by Sestito et al. (2003) in their study of the lithium abundances. The individual observations of stars in NGC 6475 (M 7) were used by James et al. (2009) in a comprehensive study of the cluster based on new CCD photometric data, spectral classifications, and radial velocities from several instruments.

3.8. Pleiades (Melotte 22)

The results of the observations of 276 stars in the Pleiades were completely published. Rosvick et al. (1992) first studied the membership of 83 stars selected from the lists of candidates by

Table 3. Radial and rotational velocities for stars in NGC 7092.

No.	ID	V	$[B-V]$	V_r	ϵ	N	$V \sin i$	Err	ΔT	$P(\chi^2)$	Notes
0039	M 39	10.32	–0.49	–6.91	0.76	9	23.7	2.5	4753	0.288	
0042	M 42	11.25	–0.40	–5.14	0.90	8	40.0	4.0	4753	0.851	
0054	M 54	10.93	–0.35	–5.90	0.73	8	21.9	5.1	4342	0.261	
0077	M 77	8.89	–0.74	–2.87	6.58	26	27.4	2.7	4771	0.000	SB2
0091	M 91			–6.45	0.22	6	4.9	2.0	4755	0.585	
0146	MS 31	11.72	–0.42	+0.41	3.77	7	28.7	4.4	3666	0.000	
0147	MS 72	12.51	0.00	–4.04	0.28	4	7.9	1.8	3644	0.652	
0150	MS 306	11.65	–0.36	–36.50	1.05	7	23.6	2.4	4351	0.003	NM
0151	MS 329	11.27	–0.23	–14.99	5.82	7	9.9	1.3	4810	0.000	SB2
0155	MS 560	11.96	–0.08	–2.48	1.42	4	10.1	3.2	3644	0.000	
0158	MS 697			–45.28	0.71	3	13.7	2.6	2899	0.212	NM
0159	MS 731	12.82	–0.09	–3.54	0.25	5	4.3	1.6	3633	0.369	
0160	MS 748	12.68	–0.04	–5.76	0.40	4	5.8	2.1	3644	0.096	
0162	MS 765	12.78	–0.01	+4.66	3.59	6	15.6	1.5	3666	0.000	SB
0166	L 464	12.90	–0.08	–5.50	0.62	4	4.6	2.9	3644	0.000	
0171	MS 986	10.69	–0.52	–20.70	10.12	8	41.0	4.1	4756	0.000	SB
0172	MS 1260	10.06	–0.42	+11.74	0.99	8	30.6	3.2	4351	0.063	NM
0174	MS 1394	10.54	–0.34	–6.37	0.52	7	17.1	1.3	4349	0.274	
0182	MS 1716			–53.99	0.27	4	3.8	2.1	4035	0.994	NM
0183	MS 1728	11.19	–0.38	–5.97	0.72	6	22.4	2.2	4349	0.222	
0201	Pl 194			–8.06	2.50	8	12.7	2.4	4142	0.000	SB
0202	Pl 305			–5.01	0.27	4	6.3	2.8	2942	0.406	
0203	Pl 4469			–6.23	0.29	4	6.8	1.8	2942	0.903	
0239	MS 697	13.05	–0.05	–5.42	1.74	1	25.1	3.9			

Note: identification sources: M: Mävers (1940); MS: McNamara & Sanders (1977); Pl: Platais (1984); L: Lavdovski (1961).

Table 4. J2000 coordinates for C-labelled stars in NGC 6475.

No.	V	$B-V$	RA	Dec
1018	11.59	0.66	17 53 33.74	–35 02 30.7
1197	12.30	0.79	17 52 37.60	–34 55 09.0
1223	11.43	0.60	17 54 53.42	–34 53 26.2
1442	12.63	0.83	17 54 05.83	–34 42 38.1
1534	12.58	0.84	17 53 20.86	–34 36 52.0
1539	12.26	0.78	17 53 58.15	–34 37 45.4
1629	11.70	0.71	17 53 30.99	–34 35 35.0
1642	12.01	0.78	17 54 14.72	–34 34 57.7
1738	12.65	0.81	17 54 33.36	–34 31 20.2
1886	11.93	0.98	17 54 27.57	–34 21 17.9

van Leeuwen et al. (1986). Mermilliod et al. (1997) reported the observations of 93 candidates taken from Artjukhina & Kalinina (1970). They identified a total of 81 new members in the corona of the Pleiades.

Mermilliod et al. (1992) analysed the observations of 100 F5-K0 stars from the catalogue of Hertzsprung (1947). They discovered 13 spectroscopic binaries and determined orbits for 11. One object, HII 2027, was found to be a triple system.

Raboud & Mermilliod (1998) studied the structure of the Pleiades cluster. They observed a clear segregation between the spectroscopic binaries and single stars. They also found that the shape of the outer part was elliptical, while the central part was nearly circular.

The distribution of the rotational velocities was studied by Queloz et al. (1998). Half of the 235 low-mass stars in the Pleiades of mass between 0.6 and 1.0 $M_\odot$ have rotation rates lower than 10 km s^{-1}.

3.9. Alpha Persei (Melotte 20)

The radial velocities of 60 stars in the field of the Alpha Persei cluster (Melotte 20) were analysed by Mermilliod et al. (2008b). The membership of 37 stars was confirmed and 12 spectroscopic binaries were discovered. An orbit for the double-lined binary He 848 was determined. The binary rate obtained was 32% (12/37).

3.10. Blanco 1

In this cluster, 148 stars were observed with the southern CORAVEL. Supplemented by new proper motions and *UBVI* CCD photometry, these data were analysed by Mermilliod et al. (2008a). The membership of 68 stars was confirmed and 14 spectroscopic and suspected binaries were discovered. The rate of spectroscopic binaries equalled 20% (14/68)

3.11. IC 2391

Our sample contains 33 stars. Twelve were selected on the basis of their photometry and spectral types in WEBDA, five (SHJM 6, 7, 8, 9, 10) come from the survey of Stauffer et al. (1989), and thirteen were selected from the X-ray sources detected by Patten & Simon (1996). CORAVEL observations are included in the study of IC 2391 by Platais et al. (2007).

3.12. IC 2602

Few radial velocity data for the solar-type stars in IC 2602 exist in the literature. Only candidates from the list of ROSAT X-ray sources received one radial velocity per star (Stauffer et al. 1997; Randich et al. 2001). We selected members known in 1983 to have rotational velocities lower than ~50 km s^{-1} from the lists of Braes (1962) and Whiteoak (1961). Twelve stars of the

Table 5. Coordinates for SR stars in IC 2602.

SR	RA	Dec	V	$B-V$	$V-I_c$
1	10 43 02.424	–64 19 03.16	12.39	0.85	1.06
2	10 47 47.104	–64 34 11.34	11.68	0.73	0.87
3	10 43 15.712	–64 23 54.16	10.75	0.64	0.73
4	10 38 46.337	–64 00 48.85	11.5		0.99
5	10 51 39.408	–64 41 07.52	11.09		0.75

14 targets observed turned out to be members (Table 6), but no spectroscopic binaries were detected in this small sample.

In April 1996, we obtained one observation of 17 stars selected in the list of X-ray sources. They were identified by the suffix "R", according to the designation of Randich et al. (1995). The comparison with the data obtained by Stauffer et al. (1997) and Randich et al. (2001) in 1994 and 1995 (reproduced in the column V_r (lit) in Table 6) shows that the radial velocity of most stars did not vary over the interval of one or two years. Several non-members (Br 59, 113, R12a) and probable non-members (SR 1, SR 2, SR 4, SR 5, R42a, R42c R46, R100) were identified, although some of them (R42a, R42c, R100) may be binaries. Further observations are needed to ascertain their membership and binary status.

Five stars with designations between SR 1 and SR 5, were observed at the request of Dr. Randich, to check their membership. Table 5 provides their J2000 coordinates from the UCAC2.0 catalogue (Zacharias et al. 2004). Only one, SR 3, seems to be a member.

These observations allowed us us to confirm the membership of 25 stars. The binary rate in this cluster should be unusually low because none of the confirmed members clearly appear to be a spectroscopic binary.

3.13. Orion nebula cluster (NGC 1976)

Thirty-nine stars were selected from the paper of Smith et al. (1983), under the condition that $V \sin i < 50$ km s^{-1}, and were observed between 3 and 7 times. Most stars had no precise radial velocities in WEBDA. A few have RVs from Walker (1983) obtained with a dispersion of 115 Å/mm. Our RVs are in good agreement with those of the 10 stars observed by King (1993). These values are reproduced in column ($V_{r\rm lit}$) in Table 7.

According to the proper-motion membership probabilities recorded in WEBDA, only six stars have membership probabilities higher than 0.50: P1404, 1414, 2404, 2441, 2445, and 2494. Three are spectroscopic binaries (P1404, 2445 and 2494) and an orbit was published for two of them, namely P2445 and 2494, by Reipurth et al. (2002). The three constant-velocity stars infer a mean radial velocity of 28.5 ± 1.3 km s^{-1}. Fours stars, P1284, 1429, 2552, and 2737, have a mean radial velocity within 3.5 km s^{-1}of the mean value, but have astrometric membership probabilities equal to zero (McNamara & Huels 1983; Tian et al. 1996).

The determination of membership is not obvious, because the scatter in the radial velocities is large, and the proper-motion membership probabilities indicate that many candidates are non-members. It is impossible to rely on the photometric colour-magnitude diagram to refine the member selection because of the width of the pre-main-sequence band. It is however necessary to know both the membership and the binary character to derive reliable individual masses and ages for the pre-main-sequence stars. Too large a mass would be attributed to binaries if their duplicity is not taken into account.

The $V \sin i$ distribution of stars that have both zero membership probabilities and radial velocities that differ from the cluster mean reaches its maximum at $V \sin i$ less than 5 km s^{-1} and all stars but one have $V \sin i < 20$ km s^{-1}. The stars with membership probabilities $P > 0.50$ and radial velocities in agreement with membership have a uniform distribution of $V \sin i$ covering the complete interval from 10 to 200 km s^{-1}. This means both that most slow rotators are non-members and that fast rotators in the paper of Smith et al. (1983), which could obviously not be observed with CORAVEL, are more likely to be members of the Orion cluster, as expected for a sample of very young stars.

4. Global results

4.1. Membership

The catalogue of mean radial velocities for the 1253 red dwarfs contains information about the membership derived from the radial velocities. In many cases, the non-membership is evident, because the radial velocity is constant over many years and differ significantly from the cluster mean velocity. However, because of the presence of binaries, the strict application of the 3σ criterion is unreliable. For values of σ equal to about 1 km s^{-1} or less, this criterion means selecting stars within an interval of ±3 km s^{-1} about the cluster mean radial velocity. In total, we identified 894 members in these 13 nearby open clusters and detected 359 non-members.

4.2. Spectroscopic binaries

The $P(\chi^2)$ probability was used to select spectroscopic binaries (cf. Sect. 5.1), such that stars with $P(\chi^2) < 0.001$ were considered to be binaries. In Table 10, 232 stars of the 1253 stars observed fulfill this criterion, and $P(\chi^2)$ is inferred to equal 0.000. However, fourty-four binaries are considered to be non-members because of their discrepant systemic velocities with respect to the mean value of their parent cluster. We discovered about 150 spectroscopic binaries, not including those already known in the Hyades and in Coma Berenices. The overal binary frequency computed for stars with at least 3 observations is 32% (153/475). The frequency is similar when one considers stars with at least 2 observations: 30% (188/618). However, there may be differences in the binary frequency of individual clusters, as shown by the example of IC 2602 described above. Detailed counts and statistics are given in Table 9.

New orbital elements were determined for 66 systems (Table 8) with updated radial velocities and, sometimes, additional observations obtained after the first publication of the orbital elements. Eleven systems were found to be non-members. Only the beginning of Table 8 is shown here, the full table can be found at the CDS.

The (e, log P) diagram (Fig. 3) contains the spectroscopic-binary members from Table 8. The limiting period marking the transition between circular and elliptical orbits is distinctive. Mayor & Mermilliod (1984) suggested that most of the orbital circularization could be determined by stellar evolution prior to arrival on the main sequence. The theory developed by Zahn & Bouchet (1989) showed indeed that most of the circularization occurs during the pre-main-sequence phase and predicted a value for the cut-off period of between 7 and 8.5 days. This limit is therefore nearly independent of the cluster ages and corresponds well to the observations. It also corresponds to

Table 6. Radial and rotational velocities for stars in IC 2602.

No.	ID	V_r	ϵ	N	$V \sin i$	Err	ΔT	$P(\chi^2)$	$V_{r(\mathrm{lit})}$	Src.	Notes
0006	Br 6	+16.07	0.74	4	26.6	2.8	2553	0.839			
0056	Br 56	+18.57	0.19	5	2.0	1.5	4411	0.408	+19.1	a	
0057	Br 57	+19.15	0.19	5	2.9	1.5	4411	0.447	+19.2	a	
0059	Br 59	–1.58	0.29	4	13.6	0.8	2554	0.917			NM
0113	Br 113	–6.85	0.64	4	9.4	4.2	2550	0.057			NM
0116	Br 116	+20.33	2.68	3	38.3	3.8	2550	0.013			
0120	Br 120	+15.80	1.10	4	51.2	12.6	2550	0.967			
0131	Br 131	+13.94	1.92	3	51.8	8.4	2550	0.150			
0132	Br 132	+17.89	0.29	5	14.7	1.1	3707	0.365			
0134	Br 134	+20.81	0.38	1	8.4	1.4					
0149	Whit 71	+15.29	0.94	1	23.1	3.5					
0154	Whit 79	+17.04	0.23	5	4.8	1.5	3671	0.691	+17.4	a	
0156	Whit 84	+16.46	2.14	4	66.5	9.9	2513	0.002			
0157	Whit 85	+17.39	0.26	5	11.8	0.9	4407	0.809			
0501	SR 1	+2.20	2.48	1	30.1	8.0					
0502	SR 2	–3.46	0.55	1	7.1	2.7					
0503	SR 3	+15.34	0.56	1	14.7	1.9					
0504	SR 4	–18.83	1.12	1	24.2	4.4					
0505	SR 5	–4.57	0.43	1	2.8	2.7					
1010	R1	+17.81	0.40	1	6.3	1.9			+16.	d	
1031	R3a	+17.62	0.65	1	27.5	2.8			+21.	b	
1080	R8	+17.12	0.82	1	26.9	2.7					
1121	R12a	–14.29	0.36	1	8.0	1.3			-13.	b	NM
1140	R14	+16.26	0.48	1	13.8	1.5			+18.	b	
1151	R15a	+17.75	0.39	1	6.4	1.8			+17.4	c	
1180	R18	+13.97	1.86	1	12.6	6.9			+13.	b	
1290	R29	+18.67	0.76	1	19.2	2.6			+17.	b	
1421	R42a	–12.38	1.62	1	19.1	6.8					
1422	R42b	+18.10	0.46	1	9.7	1.9					
1423	R42c	+7.12	1.52	1	8.0	7.1			-40.	d	SB?
1451	R45a	+17.75	0.49	1	13.1	1.5			+12.	b	
1460	R46	+66.62	0.90	1	18.7	2.3			+74.	d	NM, SB?
1590	R59	+15.92	1.05	1	29.1	2.9			+16.	b	
1660	R66	+16.41	0.51	1	12.6	1.9			+17.3	a	
1951	R95a	+16.84	0.48	1	10.9	1.6			+16.	b	
2000	R100	–0.36	0.70	1	14.4	2.3					

Note: reference of the sources: a: Stauffer et al. (1997), CTIO, January 1995; b: Stauffer et al. (1997), ESO, April 1994; c: Randich et al. (2001), CTIO, January 1994; d: Randich et al. (2001), ESO, April 1995.

the limit observed for field dwarfs in the solar neighbourhood (Duquennoy & Mayor 1991).

The absence of points with $e < 0.10$ and $P > 10$ days is clearly apparent. This means that binary systems are created with primarily elliptical orbits, and that circular orbits are produced by tidal evolution.

4.3. Rotation

The $V \sin i$ values collected in the catalogue correspond to stars in the spectral interval F5-K0, except for the Hyades for which we could cover a wider temperature domain. They were derived from the width of the correlation functions, following the outline by Benz & Mayor (1984). The distribution of the rotational velocities, ($B-V$, $V \sin i$), is shown only for the Hyades (Fig. 4). The different symbols refer to single and binary stars. No difference in the distribution is visible, except for 3 stars.

The short period binary vA 677 ($B-V = 1.21$, $V \sin i = 22.9$), has had no orbital parameters published. The referee, Dave Latham, kindly informed us that, based on 79 CfA velocities spanning 5291 days, vA 677 is a single-lined spectroscopic binary with a circularized orbit of period $P = 1\overset{\mathrm{d}}{.}484698$ and $V \sin i = 25.3$ km s^{-1}. He adds that the observed rotation is consistent with what might be expected if the rotation has been synchronized with the orbital period.

According to the Dave Latham, the high rotation of Pels 81 (($B-V = 1.45$, $V \sin i = 21.4$) determined by CORAVEL may be due to blending of the two sets of lines at phases when the velocities of the two components differ. Based on 135 CfA observations spanning 9186 days, Pels 81 is a double-lined spectroscopic binary with $P = 367\overset{\mathrm{d}}{.}84$. The CfA spectra show no significant rotation in either of its components.

The data point at $B-V = 0.58$ and $V \sin i = 32.4$ represents vB 49. The present value differs from that recorded in WEBDA, 2.8 ± 0.7 km s^{-1}, published by Paulson et al. (2003). The four CORAVEL measurements are in good internal agreement. The depth of the correlation functions is shallower than that of stars of similar colours and the width is about twice as large, which justifies the higher rotation derived. Is vB 49 a long-period binary with unresolved components? To date, we have no explanation for the difference. However, the value of $V \sin i = 2.8$ km s^{-1} would reproduce the sequence in Fig. 4 more accurately than $V \sin i = 32.4$. Dave Latham comments that, based on 12 CfA spectra spanning 8450 days, the Hyades member Hanson 307 at RA = 4:24:12.8 and Dec = +16:22:44 and $V = 8.23$ mag shows no significant velocity variation and

Table 7. Radial and rotational velocities for stars in the Orion nebula cluster (NGC 1976).

No.	ID	V	$B-V$	V_r	ϵ	N	$V \sin i$	Err	ΔT	$P(\chi^2)$	$V_{r(\mathrm{lit})}$	Notes
1037	P 1037	10.32	0.72	+45.57	0.23	3	1.6	1.7	1040	0.507		NM
1147	P 1147	10.45		+21.60	0.31	3	6.7	1.9	1479	0.420		
1158	P 1158	10.95	0.59	–56.09	3.84	6	0.2	2.7	744	0.000		NM,SB
1199	P 1199	10.67	0.66	–11.08	0.25	3	3.3	1.7	1480	0.960		NM
1284	P 1284	10.74	0.99	+29.86	0.23	3	1.1	0.0	1480	0.328		
1361	P 1361	11.36	0.56	–17.31	0.35	3	7.3	3.0	896	0.734		NM
1404	P 1404	11.49	0.84	+25.61	1.11	5	24.3	2.4	1481	0.000	+26.6	SB
1414	P 1414	11.45	0.63	+27.12	0.61	7	30.9	3.1	1863	0.887	+24.6	
1429	P 1429	11.13	1.03	+28.00	1.06	3	1.9	2.3	1480	0.000		SB
1467	P 1467	10.55	0.60	+23.65	0.27	3	7.0	1.1	1040	0.834		
1474	P 1474	10.97	0.63	–13.18	0.27	3	1.0	2.3	1040	0.976		NM
1590	P 1590	10.26	0.54	+21.41	0.19	6	4.6	1.1	1864	0.524	+18.3	
1662	P 1662	10.73	0.66	+77.17	3.03	3	2.4	0.0	1480	0.000		NM,SB
2125	P 2125	10.53	0.55	+73.28	0.43	3	1.5	2.1	1479	0.073		NM
2158	P 2158	10.76		+34.61	0.19	4	3.6	1.4	1863	0.520	+36.4	
2164	P 2164	11.24	0.95	+113.01	0.30	3	5.3	1.5	1480	0.311		NM
2292	P 2292	11.45	1.06	+107.30	0.24	3	1.9	0.0	1481	0.679		NM
2339	P 2339	9.96	0.53	19.19	0.55	7	14.6	0.9	1863	0.000	+19.8	SB
2345	P 2345	11.37	0.69	–8.83	0.35	3	3.9	2.9	1480	0.428		NM
2374	P 2374	10.92	0.58	+18.97	0.20	6	4.5	1.3	1863	0.472	+21.8	
2404	P 2404	11.27	0.69	+26.02	0.54	10	29.4	2.9	2168	0.025	+23.1	
2423	P 2423	11.04	0.62	+68.07	0.36	3	6.7	1.9	1479	0.290		NM
2433	P 2433	11.38	0.55	+32.19	0.46	3	9.2	1.6	1482	0.231	+26.8	
2441	P 2441	10.76	0.69	+30.13	0.37	5	10.2	1.3	1501	0.134	+20.3	
2442	P 2442	11.12	0.81	+54.74	0.25	3	1.7	1.9	1480	0.614		NM
2445	P 2445	11.13	0.63	+25.90	5.35	6	5.8	2.3	2168	0.000		NM,SB2O
2474	P 2474	11.35	0.57	+137.73	1.12	3	7.7	2.1	832	0.002		NM
2494	P 2494	10.74	0.88	+24.54	4.00	29	22.0	2.2	2166	0.000		SB2O
2534	P 2534	11.39	0.92	–34.31	0.24	3	0.6	2.2	1480	0.635		NM
2552	P 2552	11.69	0.55	+29.41	0.61	3	6.9	2.4	1482	0.120		
2566	P 2566	11.01	0.53	–3.20	0.31	3	6.6	1.4	1480	0.584		NM
2571	P 2571	11.29	0.57	+55.23	0.42	3	9.3	1.9	1479	0.794		NM
2575	P 2575	9.94	0.64	–10.08	0.25	3	4.4	1.5	1482	0.711		NM
2737	P 2737	10.98	0.82	+25.34	0.27	3	2.6	0.0	1472	0.428	+24.1	
2752	P 2752	10.88	0.67	+23.43	0.29	3	2.7	0.0	1479	0.266		
2909	P 2909	11.01	0.94	+13.70	0.54	3	5.2	2.7	1472	0.047		NM

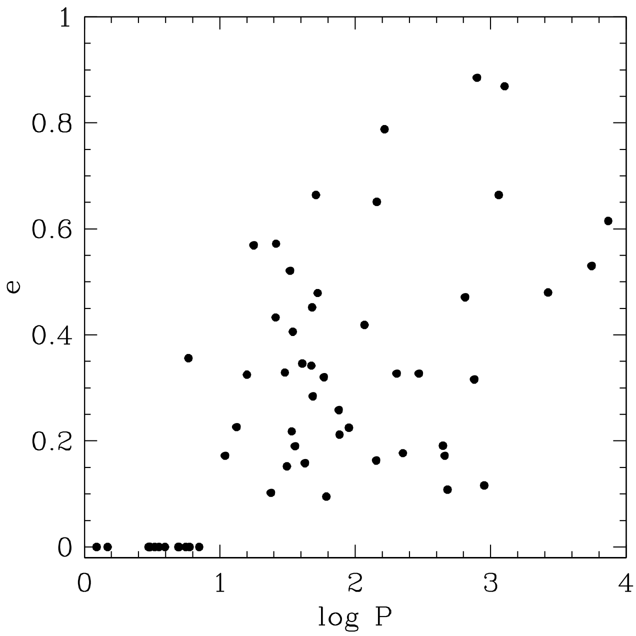

Fig. 3. Distribution of the eccentricity in function of the periods in log. The point at ($\log P = 0.768$, $e = 0.356$) is KW 181 in Praesepe. Note the absence of stars with $e < 0.10$ and $\log P > 1.0$.

has $V \sin i = 3.4$ km s^{-1}. According to the CfA concordance for the Hyades, this is the same star as vB 49. Perhaps a different star was observed with the Coravels, but the star is rather bright, even for a 1m-telescope!

4.4. Summary data

The mean radial velocities of the 13 open clusters and general information on membership are collected in Table 9. The values were computed after excluding the definite and suspected binaries from the samples. If necessary, several (usually 2) iterations were made to account for the most deviant radial velocities (suspected long period binaries). The successive columns contain: the cluster designation (Cluster), the mean radial velocity (Vr), the uncertainty in the mean (ϵ), the dispersion (σ, rms), and the number of stars used in the computation of the mean velocity, the total number of observations (N_{mes}), the number of stars observed (N_{obs}), the number of members (N_{mem}), the number of binary members (N_{SB}), the number of orbits determined (N_{orb}), and the binary frequency (Freq.).

The binary frequency was computed by dividing the number of spectroscopic binaries by the number of members with at least two measurements. In computing the mean velocity, we considered both single stars and binaries with an orbit. However, we did not apply any correction to account for the variation in the

Table 8. New and updated orbital elements of the spectroscopic binaries.

Cluster	No.	P	T	γ	e	ω	K_1	K_2	$f(m)$	$a \sin i$	σ	n_{obs}
Alpha Per	143	61.1458	45 994.781	+5.26	0.095	133.4	31.56		0.0196	2.64	0.56	18
		0.0011	0.063	0.14	0.006	4.2	0.20		0.0004	0.19		
Alpha Per	457	202.38	45 868.7	–3.29	0.327	328.1	11.21		0.0250	29.5	1.1	25
		0.14	3.2	0.23	0.026	5.5	0.30		0.0027	1.1		
Alpha Per	848	89.812	48 452.2	– 0.64	0.225	26.8	28.87		0.399	186.7	0.50	30
		0.19	1.4	0.34	0.018	5.0	0.82		0.016	2.6		
Pleiades	173	480.82	44 550.6	+5.33	0.108	214.2	15.88	16.87	0.1964	104.4	0.98	48
		0.38	6.7	0.10	0.009	4.9	0.17	0.20	0.0069	1.3		
Pleiades	320	756.4	44 488.1	+5.94	0.316	289.1	10.93		0.0876	107.8	0.81	28
		1.3	7.2	0.16	0.019	4.5	0.24		0.0077	3.3		
Pleiades	522	23.8353	44 993.1	+6.67	0.102	19.76	4.86		0.000279	1.583	0.56	22
		0.0034	1.7	0.13	0.032	27.94	0.17		0.000032	0.060		

Units: P: [days], T: Julian period, γ, K1, K2 and σ(O−C): [km s^{-1}], $f(m)$: solar mass, $a \sin i$: Gm. The full table is also available in electronic form at the CDS.

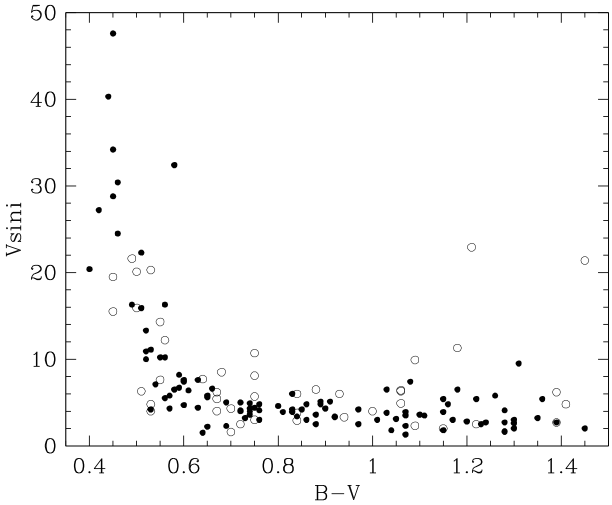

Fig. 4. Distribution of the rotational velocities for the Hyades. Black dots: single stars, open circles: spectroscopic binaries.

radial velocity, i.e., the projection of the space velocity, across the cluster fields. This explains the large dispersion obtained for the Hyades.

5. Catalogues

This section presents the radial-velocity catalogues for the CORAVEL observations. As mentioned above, few individual observations have been published, apart from several spectroscopic binaries. Furthermore, the zeropoint of the radial velocity system has been improved and the mean values published before 2000 should therefore be replaced by the new radial velocities.

5.1. Individual radial velocities of red dwarfs

The first catalogue contains 7200 individual measurements derived from observations obtained with the CORAVEL scanners. Observations of the components of a double-lined binary are regarded as a single observation when they have the same Julian date, which means that they were derived from a single, composite signal. At the head of Table 10, we present the content of its individual columns. The full table is available in electronic form at the CDS.

The internal errors are $\epsilon_1 = (\epsilon_{\rm ph}^2 + \epsilon_{\rm scint}^2 + \epsilon_{\rm inst}^2)^{1/2}$, where the subscripts denote photon, scintillation, and instrumental noise respectively. The instrumental unavoidable error is given by $\epsilon_{\rm inst}$, even in absence of photon or scintillation noise:

Coravel – OHP	JD < 2 444 700	$\epsilon_{\rm inst} = 0.4$ km s^{-1}
	JD > 2 444 700	$\epsilon_{\rm inst} = 0.3$ km s^{-1}
Coravel – La Silla		$\epsilon_{\rm inst} = 0.2$ km s^{-1}.

Denoting by $\bar{\epsilon}_1$ the mean uncertainty in the different measurements of a given star, we can deduce an estimate of the variability by comparing the rms with $\bar{\epsilon}_1$, where $E/I = \sigma_{\rm vr}/\bar{\epsilon}_1$. We can also derive the quantity $\chi^2 = \sum_i (v_i - v)^2/\epsilon_{1i}^2$ and obtain a quantitative estimate of the probability $P(\chi^2)$ that the observed rms is due to random errors.

The star identifications were chosen to match those used in WEBDA and facilitate their inclusion in the database. It is then easier to search the database for any object in the present survey.

5.2. Mean radial velocities of 1253 red dwarfs

We computed the mean radial velocities for the 1253 stars. The individual errors in the measurements were used to compute relative weights as $1/\epsilon_1^2$. The estimated internal uncertainty in the mean radial velocity was denoted by $\epsilon = \max(\sigma, \bar{\epsilon}_1)/\sqrt{n}$.

The results are collected in Table 11. Only the beginning is displayed to provide an example of its layout and content, and the full Table is available in electronic form only at the CDS or through WEBDA. J2000 coordinates have been taken from the database for stars in open clusters WEBDA[2] described by Mermilliod & Paunzen (2003), from SIMBAD, or extracted from the UCAC2.0 catalogue (Zacharias et al. 2004) through the VizieR facility offered by the CDS when the coordinates in WEBDA or in SIMBAD were not given in the format used here (2 decimals for the second in RA). Finally, coordinates for a few stars were taken from the Two Micron All Sky Survey (2MASS) (Skrutskie, et al. 2006).

The absence of a $V \sin i$ value indicated that no data value could be computed, as occured for example when the correlation function width was too small. Values equal to 0.0 for the error of $V \sin i$ indicate that the $V \sin i$ are only upper limits.

Stars in northern clusters were observed 2–7 times, while 1 to 5 observations of southern stars were completed (Fig. 5). This

[2] http://www.univie.ac.at/webda/webda.html

Table 9. Cluster mean radial velocities and statistics.

Cluster	V_r	ϵ	σ	N	$N_{\rm mes}$	$N^*_{\rm obs}$	$N_{\rm mem}$	$N_{\rm SB}$	$N_{\rm orb}$	Freq.	Notes
Hyades	+39.29	0.25	2.85	133	649	157	152	33	5	22	Mel 25
Praesepe	+34.76	0.07	0.79	130	1977	218	148	38	25	28	NGC 2632
Coma Ber	+0.01	0.08	0.44	28	819	64	28	6	6	21	Mel 111
Pleiades	+5.94	0.08	1.02	149	1652	272	180	37	12	20	Mel 22
Alpha Persei	–1.39	0.17	1.08	23	363	60	34	11	1	32	Mel 20
NGC 752	+5.54	0.14	1.05	54	452	90	76	23	4	31	
NGC 1976	+28.50	1.30		3	159	36	18	5	1	28	Orion nebula
NGC 2682	+33.26	0.11	0.71	40	81	40	40	0			M 67
NGC 6475	–14.78	0.23	1.33	33	174	75	67	9		21	M 7
NGC 7092	–5.26	0.30	1.20	17	158	24	20	3		15	M 39
IC 2391	+14.49	0.14	0.55	16	121	30	26	10	1	55	*o* Vel
IC 2602	+18.12	0.30	0.90	10	74	37	26	0			θ Car
Blanco 1	+5.53	0.11	0.82	49	521	150	79	11		17	Zeta Scl
Total					7200	1253	894	73	55	52	

Table 10. Catalogue of individual radial velocities.

Cluster	No.	HJD	Comp	RV	ϵ_1	Date	Integ.	Counts	Obs.
Pleiades	0164	2 444 584.483		14.10	1.96	24 10 78	385	12 590	OHP
Pleiades	0164	2 444 636.258		–2.30	2.22	10 12 80	545	8829	OHP
Pleiades	0164	2 444 880.553		6.89	2.31	02 10 81	547	7911	OHP
Pleiades	0164	2 446 708.630		16.33	2.31	04 10 86	443	4788	OHP
Pleiades	0173	2 443 806.506	A	17.55	0.95	31 10 78	327	1020	OHP
Pleiades	0173	2 443 813.502	A	17.29	0.82	31 10 78	267	759	OHP
Pleiades	0173	2 443 813.502	B	–8.23	1.06	31 10 78	267	759	OHP
Pleiades	0173	2 443 813.507	A	20.13	0.94	31 10 78	940	721	OHP
Pleiades	0173	2 443 813.507	B	–7.87	1.29	31 10 78	940	721	OHP

Note: the columns contain the cluster names, the star identification according to the numbering system used in WEBDA, the Julian Date, the component of the double-lined binaries (A or B), the radial velocity and their error in km s^{-1}, the UT date, the exposure length, the counts, and the observatory. The full table is available in electronic form at the CDS.

Table 11. Catalogue of mean radial and rotational velocities.

Cluster	No.	ID	RA(J2000)	Dec(J2000)	$\bar{RV}$	ϵ	σ	E/I	N	$V \sin i$	Error	ΔT	$P(\chi^2)$	Notes
Blanco 1	0008	SA140 66	23 59 26.73	–28 51 13.9	4.74	0.25	0.48	0.80	6	14.9	0.7	4737	0.675	NM
Blanco 1	0015	ZS 3	0 00 11.33	–29 50 42.5	–8.32	1.66	3.71	7.65	5	4.1	1.5	350	0.000	NM, SB
Blanco 1	0016	ZS 9	0 00 12.04	–30 20 50.4	–6.08	0.20	0.20	0.47	5	6.0	1.0	3989	0.930	NM
Blanco 1	0018	SA140 91	0 00 35.38	–29 15 48.3	11.42	0.56	0.56		1	6.2	2.9			NM
Blanco 1	0019	W 19	0 00 45.02	–29 06 30.2	6.31	0.36	0.81	1.88	5	0.0	0.0	3971	0.008	SB2?
Blanco 1	0020	SA140 97	0 00 46.60	–29 08 05.6	6.63	0.16	0.34	0.85	6	4.8	0.9	3985	0.613	

Note: the columns contain the cluster name, the star identification according to the numbering system used in WEBDA, the original identification (ID), the mean radial velocity ($\bar{RV}$), the uncertainty on the mean (ϵ), the formal standard deviation, (σ), of radial velocities, all three in km s^{-1}, the external to internal error ratio, $E/I = \sigma/\epsilon$, the number of observations used in the computation of the mean velocity (N), the rotational velocity ($V \sin i$) and its error, the time span in [days] covered by observations, (ΔT), the probability that the scatter is due to random noise ($P(\chi^2)$), and notes on membership (NM for non members), binarity (SB1: spectroscopic binary, SB1O: binary with an orbit, SB2 and SB2O: double-lined binary. The full table is available in electronic form at the CDS.

difference arises because the telescope at OHP was dedicated full-time to CORAVEL observations. In contrast, observing runs at La Silla were completed as discrete, short runs of typically 5–6 nights per observing period and the priority was often given to the red-giant program. The difference in the number of stars with more than 15 observations reflects the difference in the number of binary orbits determined at OHP and at La Silla.

The distribution of $P(\chi^2)$ (Fig. 6) is flat, as expected outside the peak for variable stars. This proves that the values of ϵ_1 were correctly estimated. The significant peak for $P(\chi^2) < 0.001$ corresponds to the 232 spectroscopic binaries discovered. Only the stars with a value $P(\chi^2)$ less than 0.001 were considered to be binaries. Stars with values less than 0.003 are considered as candidate binaries (noted SB?).

6. Discussion and conclusion

This paper has presented the final set of results for radial velocity observations of red dwarfs in nearby open clusters obtained with the CORAVEL spectrovelocimeters during 20 and 13 years in the northern and southern hemispheres, respectively. It provides a catalogue of both individual and mean radial velocities,

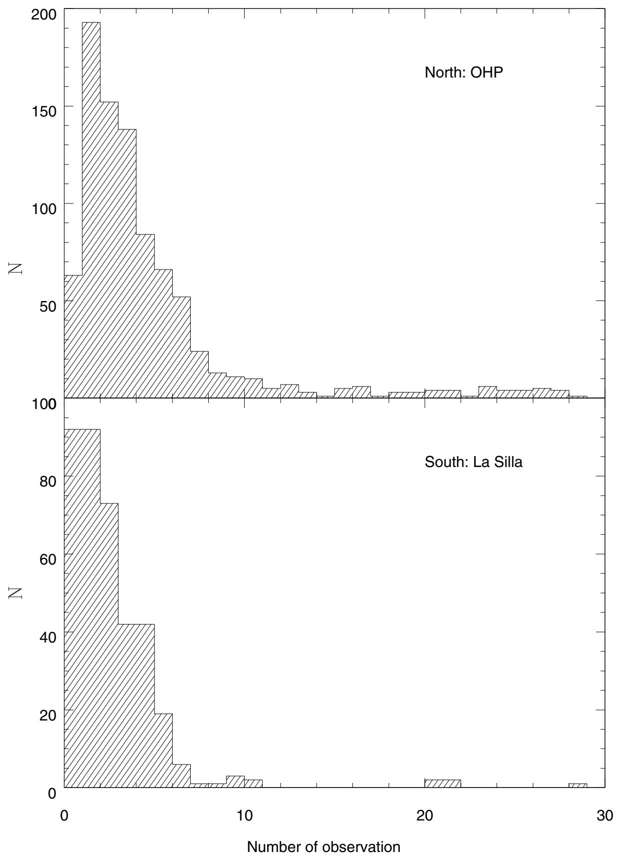

Fig. 5. Distribution of the number of observations per star. *Upper diagram*: North (OHP), *lower diagram*: South (LS).

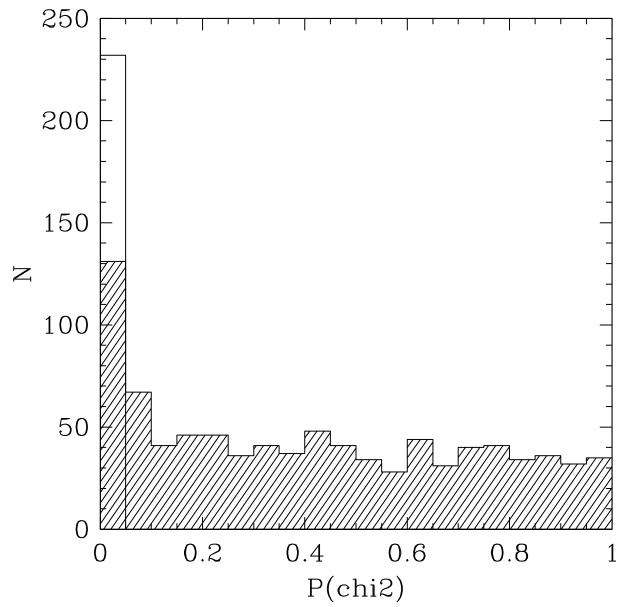

Fig. 6. Distribution of the probability $P(\chi^2)$ by bins of 0.05. This distribution is flat as expected for single stars (hatched part). It presents a maximum in the bin $0.000 < P < 0.05$ (open histogram) corresponding to the 232 spectroscopic binaries.

most of them being previously unpublished. Only one or two observations could be secured for a number of stars, but they will be useful as a first epoch for future work searching for spectroscopic binaries. The development of radial-velocity determination with multi-fiber spectrographs such as GIRAFFE and HYDRA promise to reduce the gap that has existed between the amount of available photometric and astrometric data and spectroscopic radial velocity data. When one considers the extent of the main sequence in most nearby open clusters and the capabilities of large telescopes and modern instruments, the magnitude domain covered by our surveys, for example in Praesepe, may appear to be small. This magnitude interval simply corresponds to what was achievable with 1m-class telescopes and a extremely reliable instrument allowing observation of stars one-by-one only.

Together with the publication of the CORAVEL observations of red giants (Mermilliod et al. 2008d), 17 717 radial velocity observations for stars in open clusters are now public. The two initiators of this long-term program are now retired (JCM and MM) and will not undertake any further research based on these data. Feel free to use them!

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