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The Nature of some doubtful Open Clusters as revealed by Hipparcos

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Abstract. We discuss the nature of some galactic open clusters by using proper motions and parallaxes from the Hipparcos and ACT catalogues. We show that the clusters Collinder 399, Upgren 1, NGC 1252 and Melotte 227 do not exist. Collinder 132 is found to be mainly composed out of members of an OB association, but there may be a star cluster present in this area too. Röser & Bastian (1994) proposed that NGC 2451 consists of two star clusters. We show that NGC 2451 A definitively does exist, NGC 2451 B may exist. A star cluster may also be present in the area of Roslund 5. The Hipparcos data finally confirm the reality of Collinder 135.

Key words: Galaxy: open clusters and associations: general – Astrometry

1. Introduction

The publication of the Hipparcos Catalogue (ESA 1997) allows us to take a new look on the nature of some controversial galactic open clusters. The accurate proper motions and parallaxes of Hipparcos allow to distinguish between true star clusters and chance alignments of stars. In addition, the Hipparcos Catalogue provides new information to separate members from non-members for the confirmed clusters.

However, the catalogue also has some limitations. For example, the motions of the stars were followed only for a few years. The measured proper motions therefore reflect only the mean motion of the stars during this time interval and may differ from the longterm motion if the star is a member of a multiple system (for a full discussion of this effect see Wielen 1997). Hence if there are indications that a star is double, the astrometric solutions of Hipparcos should be treated with caution. Furthermore, even apparently single stars may have undetected companions, which perturb their motion. This possible deviation is particularly important if one tries to disprove the existence of a cluster, since discrepant proper motions in the Hipparcos Catalogue may not necessarily be a sign of real (longterm) differences in the space motion of the studied stars. Another drawback is the increasing incompleteness at fainter magnitudes.

We have therefore combined the Hipparcos Catalogue with proper motions from the ACT Reference Catalogue (Urban et al. 1997). The ACT contains 988,758 positions and proper motions of stars and was obtained by combining new reductions of the Astrographic Catalogue (AC 2000, Urban et al. 1998) with the Tycho Catalogue (ESA 1997). It is well suited for our purposes, since the mean epoch of an AC plate is as early as 1907, so that the proper motions were derived with a time difference of more than 80 years and reflect, unlike the Hipparcos proper motions, the longterm motion of the stars. In addition, the proper motions of the ACT have a mean error of only 3 mas/yr and were reduced to the Hipparcos system, which allows for a direct comparison.

Throughout this work we will neglect perspective effects and assume that all cluster stars have similar proper motions. This is justified by the relative large distances and resulting small angular diameters of the clusters studied. For the same reason we did not try to employ convergent point methods (like e.g. De Bruijne et al. 1997).

2. Collinder 399

Collinder 399 is a concentration of bright stars, located in a one square degree big field around $l = 54\overset{\circ}{.}68, b = 1\overset{\circ}{.}96$ ($\alpha_{2000} = 19^h25^m, \delta_{2000} = 20°11'$). It was first mentioned by Meyer (1903, 1905) and then briefly discussed by Doig (1926) and Collinder (1931). The most extensive membership study so far was done by Hall and van Landingham (1970). They concluded on the basis of UBV magnitudes, spectral classifications, radial velocities and proper mo-

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Table 1. Suspected members of Collinder 399

No.	HIP No.	HD No.	Magnitude V	Parallax [mas] π	σ_π	PM Hipparcos [mas/yr] $\mu_{\alpha *}$	$\sigma_{\mu_{\alpha *}}$	μ_δ	σ_{μ_δ}	PM ACT [mas/yr] $\mu_{\alpha *}$	$\sigma_{\mu_{\alpha *}}$	μ_δ	σ_{μ_δ}
1	95340	182422	6.40	2.88	0.69	3.07	0.55	0.42	0.65	3.52	1.78	1.1	1.70
2	95432	182620	7.16	5.98	0.83	19.30	0.64	9.35	0.82	21.01	1.76	4.8	1.50
3	95487	182761	6.31	8.16	0.74	-5.87	0.54	-17.08	0.66	-0.28	0.85	-16.3	1.05
4	95560	182919	5.60	14.94	0.71	3.36	0.54	-36.13	0.65	2.11	1.68	-33.6	2.25
5	95582	182955	5.84	7.17	0.75	0.64	0.60	-48.14	0.73	1.41	3.26	-45.8	2.75
6	95584	182972	6.64	5.77	0.79	-1.31	0.61	-11.27	0.73	0.56	1.05	-6.6	1.65

Notes to the table: Column 2: Hipparcos, 3: HD numbers, 4: Visual magnitudes from Hipparcos, 5 to 10: Parallaxes and proper motions together with their errors from Hipparcos, 11 to 14: Proper motions from the ACT. Note that the ACT proper motions in right ascension were multiplied by $\cos\delta$ to match Hipparcos.

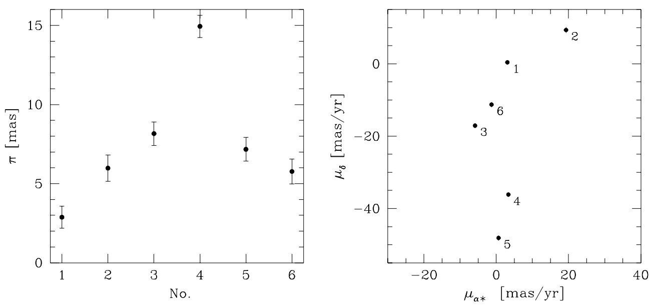

Fig. 1. Parallaxes (left) and proper motions (right) of the suspected members of Collinder 399.

tions, that Collinder 399 is a cluster, but that it consists of only 5 early-type stars (HD 182422, 182620, 182761, 182919 and HD 182972) and one red giant (HD 182955).

All suspected members could be found in the Hipparcos and ACT catalogues and we have collected the relevant data in Table 1. Figure 1 shows the Hipparcos parallaxes and proper motions of the suspected members. On the basis of their parallaxes two of the six stars cannot belong to the cluster: Star 1 (HIP 95340) seems to be a background star, while star 4 (HIP 95560) is clearly foreground. Only four stars may share a common parallax of $\pi \approx 6.85$ mas, corresponding to $d_{Clus} = 145$ pc, consistent with the distance modulus of m-M = 5.5 derived by Hall & Van Landingham (1970).

We have also plotted the proper motions of the suspected members in Fig. 1. The proper motions differ by about 20 mas/yr from each other, with a typical 1 mas/yr uncertainty of a single proper motion. The differences are therefore real and not due to errors. They correspond to roughly 15 km/sec with the adopted distance of 145 pc, which is about a factor of 100 higher than the value one would expect if the stars form a bound system. Since the Hipparcos and ACT proper motions are in general agreement (see Table 1), it is impossible that the Hipparcos proper motions are perturbed by short period binaries ($P \lesssim 200$ years). We cannot rule out the possibility that the stars are members of long period binary systems ($P \gtrsim 200$ years), since then both the Hipparcos and ACT proper motions would deviate in the same way from the true motion of the star. However, to explain deviations of 20 mas/yr by binary effects would require much too high masses for the companions to be a reasonable alternative. The proper motion differences must therefore reflect a real difference in the space motion of the studied stars. They cannot form a bound system. In addition, the density of fainter stars is not raised in the cluster area (Hall & Van Landingham 1970). We therefore conclude that Collinder 399 is not a cluster, but only a chance alignment of some stars of magnitudes 5 to 7.

3. Upgren 1

Upgren 1 was first noted by Upgren (1963). It is a group of seven F-type stars scattered over an area of 0.1 square degrees. It is located in Canes Venatici at $l = 142^\circ\!.68, b = 80^\circ\!.18$ ($\alpha_{2000} = 12^h35^m, \delta_{2000} = 36^\circ 22'$). Anderson (1966) and Osborn (1967) published proper motions for these stars and noted that not all of them belong to a physical group. Later Upgren et al. (1982) presented narrow-band photometry and radial velocities for the cluster stars. They concluded that five stars form a physical group, while the membership of the remaining two stars is less likely. Stefanik et al. (1997) confirmed these results, but noted that the velocity dispersion of the five stars is larger than one would expect if they form a bound system. Based on parallaxes and proper motions obtained with the multichannel astrometric photometer (MAP) Gatewood et al. (1988) also concluded that Upgren 1 consists of two dynamically different groups.

We have collected the parallaxes and proper motions of the 7 stars in Table 2. Star 2 could not be found in either Hipparcos or ACT, star 3 is not included in the Hipparcos Catalogue.

Table 2. Suspected members of Upgren 1

No. Upg.	HIP No.	HD/BD No.	Magnitude V	Parallax π	σ_π	PM Hipparcos [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	PM ACT [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	r_v [km/sec]	σ_{r_v}
1	61383	109462	9.10	7.32	1.51	23.92	1.24	-26.92	0.99	25.14	2.12	-30.7	1.44	4.30	0.11
2		+37 2296	9.86											1.45	0.11
3		109509	8.13							-98.02	2.42	-49.3	1.36	-18.71	0.43
4	61424	109530	7.30	8.24	0.97	-18.77	0.89	-6.40	0.64	-23.81	2.47	-0.6	1.80	-19.36	0.44
5	61435	109542	8.22	9.01	1.07	-96.89	1.03	-50.06	0.75	-95.46	3.10	-48.2	2.69	-17.90	0.10
6	61497	109648	8.76	4.41	1.14	-10.41	1.04	-33.56	0.87	-8.47	1.39	-29.8	2.43	-18.94	0.07
7	61430	+36 2284	9.37	6.28	1.47	-58.59	1.29	-18.04	1.05	-57.68	1.43	-17.0	1.94	-17.23	0.12

Notes to the table: Column 1: Star numbers from Upgren et al. (1982), 2-14: same as Table 1, 15 - 16: Radial velocities and errors from Stefanik et al. (1997)

Figure 2 shows parallaxes and proper motions. With the exception of stars 3 and 5 the proposed members share no common motion. Since the ACT and Hipparcos proper motions are in general agreement, short period binaries again cannot play a significant role. As in the case of Collinder 399 binaries with longer periods would require too massive companions to be a reasonable alternative. We therefore conclude that Upgren 1 is not a cluster.

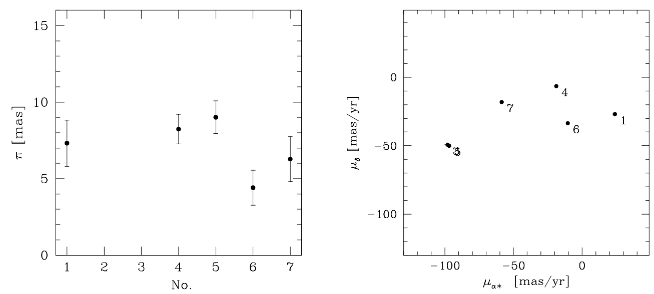

Fig. 2. Parallaxes (left) and proper motions (right) of the suspected members of Upgren 1.

Stars 3 and 5 are of special interest. The proper motions from the ACT suggest a common space motion. The radial velocities of the two stars differ by 1.8 times their standard errors and are not incompatible with such an assumption. In addition star 3 is known to be a long period binary which may complicate the determination of its radial velocity. The parallax of star 5 corresponds to a distance of about 110 pc. With such a distance the separation of stars 3 and 5 would be $d = 0.13$ pc. Such systems are expected to survive for about 10 Gyrs before they are disrupted by encounters with passing disk stars (Bahcall et al. 1985). Hence, it is not unlikely to observe such systems.

4. NGC 1252

NGC 1252 is located in Horologium at $l = 274\overset{\circ}{.}6$, $b = -58\overset{\circ}{.}1$ ($\alpha_{2000} = 3^h 11^m, \delta_{2000} = -58°08'$). The New General Catalogue describes it as a group of 18 or 20 stars, but it is not included in the Catalogue of Star Clusters and Associations by Ruprecht et al. (1981). If it exists, it would be one of the few clusters located at a high galactic latitude. The cluster is of general interest because the carbon star TW Horologii could be a member of it. Eggen (1972) found a distance modulus of $m - M = 5.85$ to this star, corresponding to a distance of $r = 150$ pc. Bouchet & Thé (1983) performed $UBVRI$ photometry for 38 stars in a region of radius $0\overset{\circ}{.}5$ around TW Hor. They found 16 probable cluster members, and a cluster distance of approximately 470 pc. TW Hor was found to be a likely cluster member. In a later investigation Eggen (1984) searched the Cape Zone Catalogue for proper motions of the suspected members. He found six stars of which only three could share a common motion, casting doubt on the reality of NGC 1252.

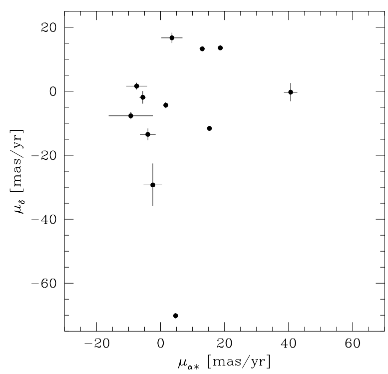

Fig. 3. Proper motions of the stars, that Bouchet & Thé (1983) considered as members of NGC 1252.

Table 3. Suspected members of NGC 1252

BT	HIP	HD	V	B-V	Parallax [mas]		Proper Motion [mas/yr]				Source
					π	σ_π	$\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	of PM
1	14779	20059	8.67	1.02	10.24	0.78	4.67	0.68	-70.17	0.80	1
3			9.71	0.85			40.63	2.07	-0.30	2.89	2
4	14975	20286	9.17	.00	1.59	0.80	1.61	0.72	-4.35	0.87	1
5			10.44	0.46			3.53	3.31	16.70	1.59	2
10			9.23	1.05			-7.49	3.29	1.60	1.03	2
23			10.74	0.55			-5.58	1.05	-1.90	1.98	2
30		20093	9.62	0.54			-2.44	2.89	-29.30	6.58	2
32		20145	9.40	1.03			-9.32	6.89	-7.70	1.03	2
34	14691	19949	8.69	1.53	0.37	0.89	13.00	0.78	13.25	0.80	1
35	14588	19780	8.99	1.22	1.91	0.89	15.25	0.79	-11.61	0.78	1
36			10.63	0.73			-3.99	2.47	-13.50	1.86	2
38[1]	14930	20234	5.71	2.42	2.48	0.56	18.65	0.46	13.55	0.50	1

Notes: 1: TW Hor, Column 1 gives the star numbers from Bouchet and Thé. The proper motions in columns 8 to 11 are taken from the Hipparcos (1) or ACT catalogues (2).

Due to the relatively big errors of the Cape Zone Catalogue and the limited number of stars no definite conclusion can be drawn from Eggen's investigation. We therefore searched the Hipparcos and ACT catalogues for the probable cluster members of Bouchet & Thé. 12 stars could be found, including all stars brighter than 11th magnitude. They are listed in Table 3. Figure 3 shows their proper motions. It is obvious that they do not form a cluster, since at most only two stars can share a common motion. In particular the proper motion of TW Hor, $\mu_{\alpha*} = 18.65 \pm 0.46$ mas/yr, $\mu_\delta = 13.55 \pm 0.50$ mas/yr, is not shared by any other star.

There might be a slight chance that Bouchet & Thé have missed the real cluster members. We therefore searched the Hipparcos and ACT catalogues for stars which lie in a one square-degree field centered on the position of NGC 1252. Figure 4 shows their proper motions and magnitudes (a few high velocity stars have already been omitted). It seems possible that some stars have the same motion, but their magnitudes and colours are incompatible with the assumption of membership to a cluster. On the other hand, those stars which may form a main sequence have very discrepant proper motions. Combining this with the result of the previous paragraph, we therefore conclude that NGC 1252 is no cluster.

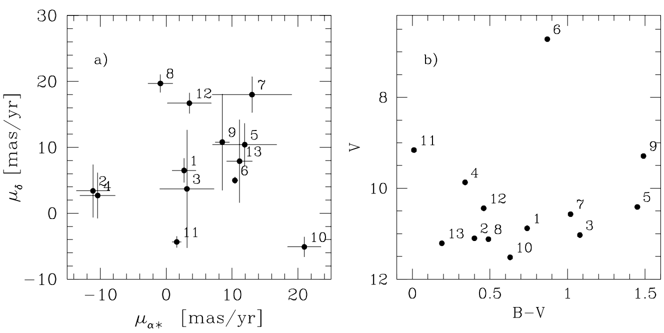

Fig. 4. Proper motions (left) and colour-magnitudes (right) of all Hipparcos stars in the direction of NGC 1252

5. Melotte 227

Melotte 227 is a loose concentration of stars located around the 6.7 mag star HD 192074. Like NGC 1252 it is located at a high galactic latitude, its coordinates are $l = 314\overset{\circ}{.}54$, $b = -30\overset{\circ}{.}43$ ($\alpha_{2000} = 20^h12^m, \delta_{2000} = -79°03'$). It was discovered by Melotte (1915) on the basis of its appearance on Franklin-Adams chart plates. Melotte described the cluster as a few bright stars forming a coarse cluster scattered over an area of one square degree.

The cluster is only rarely mentioned in the literature. Collinder (1931) gave its diameter as somewhat over 1° and its membership as some 15 or 20 stars. Epstein (1968) published photoelectric photometry for 25 stars in the ($uvby$) system. He noted that the studied stars do not define a sharp main sequence and found a considerable dispersion in the derived distance moduli.

In order to reveal the nature of Melotte 227 we selected all stars within a 2° by 2° field centered on HD 192074 from the Hipparcos Catalogue. They can be found in Table 4. Column 3 gives the number used by Epstein for the stars in common. No radial velocities could be found for the stars of Table 4.

Figure 5 shows the parallaxes and proper motions of the possible members. Although there seems to be a concentration of parallaxes around $\pi = 5$ mas, the proper motions scatter randomly and show no clustering. For a star

Table 4. Hipparcos stars in the field of Melotte 227

No.	HIP	HD	No. EP	Magnitude V	Parallax [mas] π	σ_π	PM Hipparcos [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	PM ACT [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}
1	98592	187874		9.61	5.91	1.19	8.77	.96	-22.75	1.05	8.81	1.86	-20.0	0.98
2	98757	188136	17	8.01	5.29	.87	2.17	.73	-7.82	.76	2.24	1.62	-11.8	1.43
3	98789	188304		8.35	3.63	.93	30.02	.72	7.53	.81	31.70	4.46	10.8	3.14
4	98806	188230	16	8.22	5.30	.97	3.15	.83	-16.66	.84	3.42	1.91	-19.7	3.23
5	98820			9.62	4.39	1.57	3.80	1.36	-17.55	1.40	1.02	2.73	-17.1	3.78
6	99013	188520	14	8.01	7.76	.78	26.52	.65	-32.03	.66	18.61	1.43	-30.1	3.26
7	99144	188990	15	8.97	3.92	1.02	10.13	.91	13.31	.89	6.81	1.53	11.7	0.90
8	99379	189487	13	7.26	5.43	.72	-39.56	.62	36.10	.57	-35.96	3.90	37.9	6.61
9	99931	190808	11	7.88	12.50	.75	4.41	.65	35.77	.61	4.55	2.08	34.0	3.25
10	100303	191631	21	8.47	10.02	.85	3.70	.72	-73.28	.65	2.39	3.39	-72.8	0.82
11	100416	191735	10	7.61	6.78	.66	13.71	.57	-9.24	.55	12.16	1.15	-10.9	1.21
12	100491	192074	9	6.64	8.80	.57	31.04	.48	-44.74	.43	30.04	0.82	-44.8	2.68
13	100594	192316	8	7.56	8.18	.66	46.93	.57	-47.35	.51				
14	100844	193005		8.52	5.79	.91	23.89	.77	-48.02	.58	20.53	0.83	-45.4	0.83
15	100891	193049	6	7.93	15.31	.74	19.09	.69	-9.29	.55	12.23	4.73	-8.9	1.89
16	100913	192966	7	8.32	2.61	.78	.36	.63	-39.48	.64	0.72	2.32	-38.8	0.82
17	101137	193549	5	8.24	11.18	.78	-.36	.68	3.33	.60	1.41	0.82	3.8	0.82
18	101631	194717		9.10	19.84	1.01	2.11	.97	88.89	.80				

Notes to the table: Column 4: Star numbers from Epstein (1968), Other columns: Same as Table 1

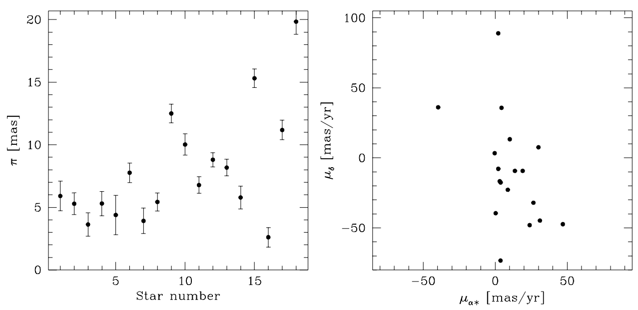

Fig. 5. Parallaxes (left) and proper motions (right) of Hipparcos stars in the field of Melotte 227

cluster at a distance of 200 pc, the differences in the proper motions that are due to the internal motion of the stars are of the order of 1 mas/yr. Since the observed differences are of the order of 10 to 20 mas/yr, the stars cannot form a bound system. Only two stars share the same proper motion. These are stars 4 and 5 of Table 4, which are the components of the double star system CCDM 20041-784. Since in addition Epstein could not identify a proper main sequence among the stars we are forced to conclude that Melotte 227 is not a cluster.

We find only a random concentration of stars of magnitude 7 to 10 in this field. Epstein found 25 stars brighter than 11th magnitude per square degree in the field of Melotte 227 and noted that this is about twice the normal star density for such a galactic latitude. This means that the density of bright stars is raised by 3σ above average, still small enough to be explained by a statistical fluctuation.

6. Collinder 132

Collinder 132 is a loose concentration of stars located in Canis Major at $l = 243\overset{\circ}{.}3$, $b = -9\overset{\circ}{.}2$ ($\alpha_{2000} = 7^h 14^m$, $\delta_{2000} = -31^\circ 10'$). Collinder (1931) gave its membership as 18 stars spread out over a region of about 85 arcmin. He estimated a distance of 270 pc to the cluster. During the last 20 years a debate arose about the nature of this cluster. Claria (1977) performed photoelectric UBV measurements for 35 stars, as well as Hβ measurements for 18 stars in the cluster area. He interpreted the data as demonstrating the existence of two clusters, which he called Collinder 132A and 132B. For the two clusters, he determined distances of 560 and 330 pc respectively. Eggen (1983) performed intermediate-band and Hβ photometry for 14 stars in the cluster region. He found evidence for the existence of two unbound groups of stars in the cluster area. He interpreted the first group as being connected to the nearby cluster Collinder 140 and supposed that the stars in the second group were members of the CMa OB2 association. The distances and assigned members of both groups differ significantly from Claria's groups.

This controversial situation calls for a re-examination of Collinder 132. In a first step we selected all stars within a 3° by 3° field around the cluster centre from the Hippar-

Table 5. Stars in the field of Collinder 132

No. Cl.	HIP	HD/CD	V	B-V	Parallax [mas] π	σ_π	Proper Motion [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	$V_0 - M_V$ Claria	$V_0 - M_V$ Eggen	Designation Cl.	Eg.	Final
4	34954	55985	6.32	-0.18	2.25	.61	-4.15	.45	4.33	.57	8.97	9.1	132A	II	CL
5	34937	55958	6.57	-0.17	2.71	.62	-5.41	.49	4.23	.58	9.16	8.6	132A	I	CL
7	35391	57120	7.01	-0.19	2.50	1.53	-2.51	1.29	4.63	1.65	8.72		132A		AS
8	35168	56554	7.15	-0.18	1.44	.70	-2.57	.50	3.41	.62	8.86	9.55	132A	II	AS
9	34646	55173	7.58	-0.17	-1.34	.91	-2.18	.73	4.29	1.00	8.92		132A		BG
10	34964	56046	7.66	-0.09	-.36	.72	-1.25	.55	2.71	.70	7.83	9.8	132B	II	AS?
11	34898	55817	7.72	-0.08	1.25	.92	-3.69	.71	3.65	.89	7.44		132B		CL
13	35342	56998	7.97	-0.08	3.04	.79	-3.50	.60	3.62	.86	7.44	7.9	132B	BG	BG
17	35348	56997	8.28	-0.06	.98	.92	.92	.63	.16	.90	7.52	8.3	132B	I	BG
19		56638	8.50	-0.04			-2.95	1.02	6.8	2.06	7.78	8.9	132B	BG	CL
20		−30°4133	8.55	-0.10			-6.17	1.02	5.2	1.34	8.47		132A		AS
22	35174	56582	8.85	-0.03	2.15	.90	-5.94	.69	9.00	.98	7.68	8.35	132B	I	BG
25		56657	9.08								7.51		132B		
27	120047	56343	9.24	-0.06	.66	1.09	-3.85	.88	3.85	1.09	8.75	9.6	132A	II	AS
28		55215	9.27	0.16			-11.55	4.53	1.2	2.61	6.81		132B		BG
29		−30°4132	9.44								8.74		132A		
30		56374	9.53	0.05			-5.54	1.93	6.8	2.08	8.47	8.5	132A	I	CL
31		−30°4269	9.76	-0.04			0.52	1.04	7.5	1.04	8.73		132A		AS
34		56555	10.12								8.93	9.5	132A	II	
35			10.63								8.95	9.65	132A	II	

Notes to the table: Column 1: Star numbers from Claria (1977), Column 12: $V_0 - M_V$ from Claria (1977), Column 13: $V_0 - M_V$ from Eggen (1983), Columns 14 - 16: Designations from Claria, Eggen and this work

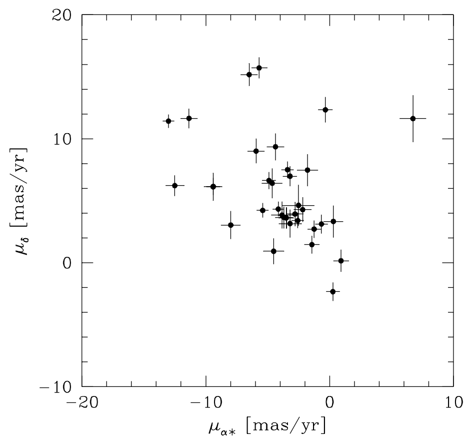

Fig. 6. Proper motions of all Hipparcos stars in the field of Collinder 132. Note the concentration of proper motions near $\mu_{\alpha*} = -3$ mas/yr, $\mu_\delta = 4$ mas/yr.

cos Catalogue. Figure 6 shows a proper motion diagram of the stars found. There is a concentration of proper motions around $\mu_{\alpha*} = -3$ mas/yr, $\mu_\delta = 4$ mas/yr, which indicates the presence of a star cluster or association in this field.

In order to reveal the nature of this concentration, a larger field of 6° by 6° was searched for stars having proper motions close to $\mu_{\alpha*} = -3$ mas/yr, $\mu_\delta = 4$ mas/yr. We proceeded in the following way: For every star, we first calculated a χ^2-value according to

$$\chi^2 = z'\Sigma^{-1}z \;, \qquad (1)$$

where z is the (two dimensional) difference vector between observed and expected proper motion and Σ is the covariance matrix from the Hipparcos Catalogue. Stars with χ^2-values higher than a certain threshold χ^2_{Max} were rejected as members. We chose $\chi^2_{Max} = 11.83$, which corresponds to the 3σ confidence level for a system with two degrees of freedom. We next removed stars with incompatible parallaxes. Finally, we removed stars that were clearly above the main-sequences of Fig. 7 but were too faint to be giant members, so that they are non-members without doubt.

Figure 7 shows a colour-magnitude diagram of the remaining stars. There seem to be two groups of stars present in this field.

Stars which belong to the lower of the two main sequences are shown as filled dots in Fig. 7. They show no clear concentration on the sky, instead they are distributed throughout the upper half of the right diagram in a more or less random way. The natural explanation is that they are members of an unbound association, not of a cluster. From the Hipparcos parallaxes of the suspected members, we derive a mean parallax of $\pi = 0.53 \pm 0.44$. Eggen derived a distance modulus of $V - M_V = 9.6 \pm 0.1$ for his second group. This corresponds to a distance of $d = 830 \pm 40$

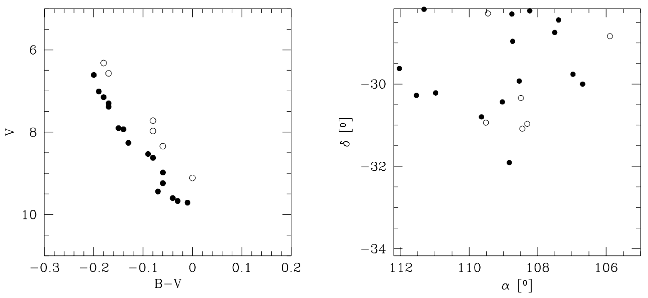

Fig. 7. Photometry (left) and positions on the sky (right) of the stars which may belong to star clusters. Stars of the first group are shown as filled dots, stars of the second group as open circles.

pc, which is in rough agreement with our value. In addition, most stars of Eggen's second group belong to the lower main-sequence. The stars of the lower sequence in Fig. 7 may therefore be members of the CMa OB2 association. We have marked them by 'AS' in Table 5. We note that the stars of Collinder 121, which is about 8 degrees north-east of Collinder 132, have magnitudes and colours comparable to the stars of this association. In addition, Collinder 121 has a similar proper motion (Baumgardt et al. 1998). Hence, there may be a connection between this association and Collinder 121.

The stars of the upper sequence (open circles) show a noticeable concentration around $\alpha = 109°$, $\delta = -31°$, which may indicate the presence of a cluster. Claria measured distance moduli for the four central stars in Fig. 7 and obtained $V_0 - M_V = 7.44$ (HIP 34898), 7.44 (35342), 8.97 (34954) and 9.16 (34937). Eggen has determined distances for 3 of the 6 stars. His distance moduli differ considerably from Claria, he found $V_0 - M_V = 7.9$ (HIP 35342), 9.1 (34954) and 8.6 (34937). He noticed that HIP 34898 is an eclipsing binary and derived distance moduli between 8.1 and 8.8, depending on the nature of the variable. From these stars only HIP 35342 seems to be a foreground star, since both Claria and Eggen derived significantly shorter distances to this star than to the others. The other stars may form a cluster with a distance modulus of $V_0 - M_V \approx 8.8$, corresponding to a distance of $d = 575$ pc. With such a distance, their angular separation corresponds to a displacement of about 5 pc. Hence they may be members of a star cluster. In addition, the Hipparcos parallaxes of all three stars are compatible with this distance.

Based on their colours and proper motions two additional stars from the ACT may belong to this group: HD 56374 and HD 56638. Claria derived distance moduli of 8.47 and 7.78 for them, Eggen derived 8.5 and 8.9. At least the distances of Eggen are compatible with a cluster membership of the two stars. We have marked the possible members of this cluster by a CL in Table 5. Precise radial velocities would help to establish the reality of this group.

Eggen speculated that HIP 34937 and HD 56374 together with HIP 35174 and HIP 35348 form a group of stars which is connected to the star cluster Collinder 140. This group is likely not to exist, since the proper motion of HIP 35348 differs clearly from the other stars. Furthermore the proper motions of HIP 34937 and HIP 35174 differ by about 4 mas/yr from each other.

Claria suspected the presence of two clusters, Collinder 132 A and B. Some stars of Collinder 132 A belong to our hypothetical cluster. Furthermore the distances of both agree with each other. Figure 8 shows the proper motions of the suspected members of Collinder 132 B. The reality of this cluster is doubtful, since most stars do not share a common motion. In addition one of the stars (HIP 34898) with a proper motion close to $\mu_{\alpha*} = -3.5$ mas/yr, $\mu_\delta = 3$ mas/yr seems to be located at a much larger distance than the 330 pc that Claria determined for Collinder 132 B. Moreover the photometric distances of Eggen argue against a cluster.

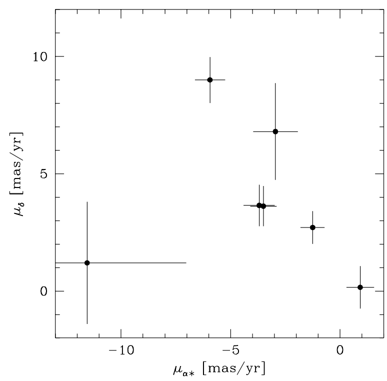

Fig. 8. Proper motions of the suspected members of Collinder 132 B. They seem to share no common motion.

7. NGC 2451

NGC 2451 is located in Puppis at $l = 252\overset{\circ}{.}4, b = -6\overset{\circ}{.}7$ ($\alpha_{2000} = 7^h45^m, \delta_{2000} = -38°0'$). During the last 30 years a debate has arisen about its existence and physical parameters. Williams (1967a,b) measured three-colour photometry for 213 stars in a 1 square degree field centered on HD 63032 and determined a distance of $d = 330 \pm 20$ pc to the cluster. Eggen (1983) however re-investigated this region and found a wide range of distance moduli between $m - M = 6.0$ and 9.0 with no prominent concentration. Lyngå & Wramdemark (1984) argued on the basis of Eggen's photometry that there is a clustering of stars brighter than 9th magnitude at a distance of $d = 220$

pc. In a later investigation Eggen (1986) found a concentration of stars of spectral types between B8 and A0 at distances less than 250 pc, too.

Röser & Bastian (1994) investigated a 6° by 6° area centered on HD 63032. On the basis of proper motions from the PPM Catalogue they argued for a star cluster in this region, which they called Puppis Moving Group. They derived a distance of $d = 220$ pc to this cluster, in accordance with Lyngå & Wramdemark (1984) and Eggen (1986). Furthermore, they found evidence for a second cluster at a distance of approximately 400 pc. Platais et al. (1996), using proper motions and CCD BV photometry confirmed the reality of the first cluster, which they called NGC 2451 A. They also found evidence for a second cluster, NGC 2451 B, at a distance of about 400 pc.

The Hipparcos data offer the opportunity to reinvestigate the nature of NGC 2451. In a first step we selected all stars in a 4° by 4° area centered on $\alpha_{2000} = 115\overset{\circ}{.}5$, $\delta_{2000} = -38\overset{\circ}{.}4$ from the Hipparcos Catalogue. Their proper motions are shown in Fig. 9, where some stars with high proper motions have already been omitted. Two conspicuous concentrations appear, located at approximately $(\mu_{\alpha*}, \mu_\delta) = (-23, 15)$ mas/yr and $(-8, 5)$ mas/yr. The first group is the cluster NGC 2451 A, while the second concentration is mainly due to the background of Milky Way stars. We will first discuss NGC 2451 A.

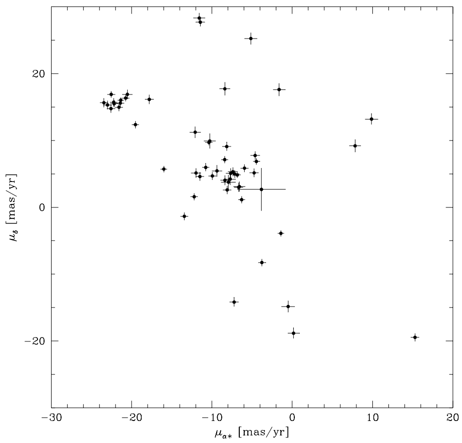

Fig. 9. Proper motions of all Hipparcos stars in the direction of NGC 2451.

7.1. NGC 2451 A

Figure 10a shows the proper motions of the possible members in greater detail. It is possible that all stars share a common proper motion. Looking at the spatial distribution of the stars (Fig. 10b) one notices a clear concentration of the hypothetical members. This is a strong argument in favour of a star cluster. A cluster of 100 $M_\odot$ would have a tidal radius of roughly 6 pc. At a distance of 220 pc this corresponds to an angular diameter of 3°. Hence, with the exception of the star at the right edge (HIP 36653), all stars may be bound to the same cluster. We note, that HIP 36653 has also the most discrepant proper motion in Fig. 10a, so that its membership is doubtful. Figure 10c shows the parallaxes of the probable cluster members. It is possible that all stars are at the same distance. Excluding HIP 36653, we obtain a mean parallax of $\pi = 5.25 \pm 0.19$ mas for the cluster. This is in perfect agreement with the photometric distance of $d = 190$ pc (corresponding to a parallax of $\pi = 5.26$ mas) that Platais et al. determined for NGC 2451 A.

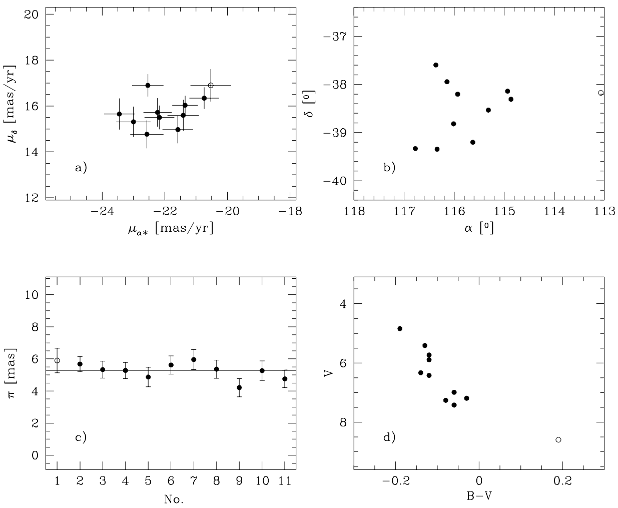

Fig. 10. Proper motions (a), spatial distribution (b), parallaxes (c) and colours and magnitudes (d) of the suspected members of NGC 2451 A. The star shown with an open circle is HIP 36653.

Figure 10d finally shows a colour-magnitude diagram of NGC 2451 A. Although there is some scatter, the possible members form a well-defined main-sequence. NGC 2451 A therefore beyond doubt is a true star cluster. We have listed the possible members in Table 6. Based on their magnitudes, colours and parallaxes, two additional Hipparcos stars may be members of NGC 2451 A: HIP 37514 and HIP 37915. Their proper motions differ significantly from the rest of the cluster stars, but this may be due to binary effects. There are some hints that HIP 37514 is a binary, since it has a G-type solution in the Hipparcos catalogue. In addition, the radial velocity of HIP 37915 is very close to that of HIP 37297. Furthermore, both stars are located in the central part of the cluster, adding further evidence for their membership.

The radial velocities seem to exclude two stars as possible cluster members: Star 7 (HIP 37666) has a very dis-

Table 6. Members and possible members of NGC 2451 A

No.	HIP No.	HD No.	Magnitude V	Parallax [mas] π	σ_π	Proper Motion [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	Radial velocity r_v [km/s]	Q	Final Desig.
1	36653	60330	8.59	5.90	0.76	-20.53	0.65	16.90	0.71			PNM
2	37297	61831	4.84	5.68	0.46	-21.35	0.41	16.03	0.42	+26.4	B	M
3	37322	61878	5.73	5.33	0.53	-22.54	0.50	16.90	0.49	+30	C	M
4	37450	62226	5.41	5.28	0.50	-20.74	0.47	16.34	0.47	+40	D	M
5	37514	62376	6.54	5.01	0.56	-17.80	0.53	16.15	0.70			PM
6	37557	62503	7.26	4.87	0.61	-22.57	0.53	14.77	0.61			M
7	37666	62712	6.42	5.62	0.57	-21.41	0.50	15.59	0.67	-6	C	PM
8	37697	62803	7.42	5.96	0.63	-23.00	0.55	15.31	0.66			M
9	37752	62893	5.89	5.36	0.57	-22.23	0.45	15.72	0.62	+37.0	B	PM
10	37829	63080	7.19	4.21	0.57	-21.58	0.49	14.97	0.60			M
11	37838	63079	6.99	5.27	0.61	-23.45	0.49	15.65	0.68			M
12	37915	63215	5.87	5.16	0.53	-19.53	0.45	12.37	0.54	+27.9	B	PM
13	37982	63401	6.33	4.76	0.55	-22.17	0.48	15.50	0.52			M

Notes to the table: Columns 1 - 10: Same as Table 1. Columns 11 and 12 are taken from the WEB Catalogue (Duflot et al. 1995) of radial velocities. Column 13 gives our decision upon membership

crepant velocity, and the velocities of stars 1 (37297) and 9 (37752) differ also significantly from each other. However, we note that HIP 37666 is a double star and its radial velocity is based on only three measurements, which weakens the discrepancy of its radial velocity.

7.2. NGC 2451 B

Röser & Bastian (1994) found evidence for a second cluster among the stars in a one-square-degree field centered on the K4 giant HD 63032. Based on its distance modulus they found that the star itself could be a member of this cluster.

In contrast to NGC 2451 A it is difficult to identify a second cluster in the proper motion diagram of Fig. 9. If it exists, its proper motion must be either un-distinguishable from the bulk of Milky Way stars or it contains only a few Hipparcos stars. In order to examine the reality of NGC 2451 B, we proceeded in the following way: We first searched the list of Williams (1967a) for stars which are close to the lower of the two main-sequences in Fig. 5 of Röser & Bastian (1994) and are therefore possible cluster members. These stars were then identified in the Hipparcos and ACT catalogues. Figure 11 shows the proper motions of the stars found.

There is a clear concentration of proper motions around $\mu_{\alpha*} = -14$ mas/yr, $\mu_\delta = 4$ mas/yr. Assuming a Milky Way model with the 1985 IAU recommended values of galactic rotation (A = -14 km/sec/kpc, B = -12 km/sec/kpc, R_0 = 8.5 kpc, V_0 = 220 km/sec) and assuming a local solar motion of $(U/V/W)$ = (9/12/7) km/sec, we predict proper motions between $(\mu_{\alpha*}/\mu_\delta) = (-9.7/6.2)$ mas/yr (for d = 200 pc) and $(\mu_{\alpha*}/\mu_\delta) = (-3.6/4.5)$ mas/yr (for d = 1000 pc) for the NGC 2451 field. The concentration in the proper motions is somewhat offset

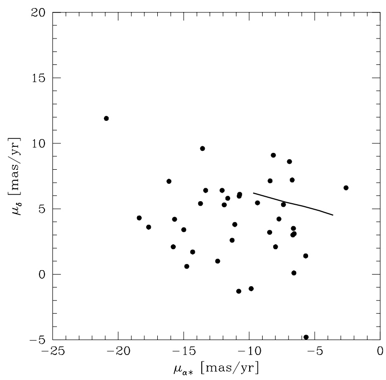

Fig. 11. Proper motions of stars from the list of Williams that may be members of NGC 2451 B. The solid line shows the expected proper motions of stars in the direction of NGC 2451 and with distances between 200 and 1000 pc, assuming that the space motions consist of solar motion and galactic rotation only.

from this line and probably not due to the Milky Way background. It may be a hint of a star cluster.

To check the cluster hypothesis further, we next searched the ACT Catalogue for stars with proper motions within 3σ to $\mu_{\alpha*} = -14$ mas/yr, $\mu_\delta = 4$ mas/yr. Figure 12 shows the positions on the sky of the stars found. The possible cluster members show a concentration near $\alpha = 116°$, $\delta = -37.°8$, which supports the cluster hypothesis. NGC 2451 B may therefore be a true star cluster.

We assume that all stars from Williams list with proper motions within 3σ to $\mu_{\alpha*} = -14$ mas/yr, $\mu_\delta = 4$ mas/yr are possible cluster members and have collected them in

Table 7. Possible members of NGC 2451 B

No. Williams	HD/CD No.	V [mag]	B-V [mag]	RA 2000	DEC 2000	Proper Motion [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}
254	63032	3.60	1.70	07 45 15.30	-37 58 06.95	-10.77	0.45	5.97	0.58
266	63216	8.51	-0.01	07 46 10.22	-38 06 05.68	-15.70	2.98	4.20	3.83
148	61374	9.03	-0.03	07 37 22.23	-37 41 14.84	-9.85	3.05	-1.10	1.83
179	61830	9.10	0.03	07 39 33.91	-37 21 31.88	-10.73	2.52	6.10	2.66
261	63133	9.14	0.02	07 45 48.62	-37 32 48.04	-8.44	2.09	3.20	1.25
022	62802	9.35	0.06	07 44 08.60	-37 59 00.68	-12.41	1.03	1.00	1.29
200	62210	9.39	0.15	07 41 09.33	-39 18 41.00	-16.13	3.31	7.10	0.94
140	61288	9.55	0.09	07 36 50.96	-39 11 11.14	-15.00	1.59	3.40	1.35
276	63375	9.65	0.12	07 47 02.98	-38 31 10.42	-10.80	2.65	-1.30	2.42
298	63706	9.60	0.16	07 48 43.66	-37 27 35.27	-13.57	1.64	9.60	2.65
287	63529	9.92	0.07	07 47 45.68	-37 27 40.75	-11.31	1.32	2.60	1.03
024	-37 3833	9.86	0.11	07 44 13.91	-37 38 52.22	-11.64	1.03	5.80	1.03
016	-37 3825	9.92	0.13	07 43 49.70	-37 58 00.77	-13.72	2.48	5.40	2.38
005	-37 3812	10.27	0.09	07 43 05.09	-38 07 57.00	-13.33	3.21	6.40	1.49
023	-37 3831	10.54	0.20	07 44 08.10	-38 08 51.55	-11.91	3.56	5.30	6.54
059	-37 3864	10.51	0.31	07 45 18.19	-38 02 49.21	-14.77	1.69	0.60	1.08
108	-38 3609	10.59	0.28	07 44 48.95	-38 23 27.86	-7.99	3.93	2.10	3.81
021	-37 3828	10.60	0.27	07 44 05.68	-37 53 36.05	-14.32	2.82	1.70	1.10
041	-37 3850	10.70	0.30	07 44 51.03	-37 40 07.33	-18.40	2.38	4.30	1.09
034	-37 3842	10.82	0.34	07 44 39.85	-37 38 33.42	-15.80	3.14	2.10	3.44
010	-37 3819	11.00	0.46	07 43 38.77	-38 14 06.79	-5.66	5.91	-4.80	4.08
045	-37 3852	11.09	0.40	07 44 55.26	-38 04 46.56	-11.10	1.23	3.80	1.68
027		11.41	0.43	07 44 23.24	-37 55 28.30	-12.07	3.23	6.40	2.45

Notes: Columns 1, 3 and 4 are taken from Williams (1967a). Columns 5 to 10 are taken from the ACT Catalogue, except for HD 63032 where they are taken from Hipparcos

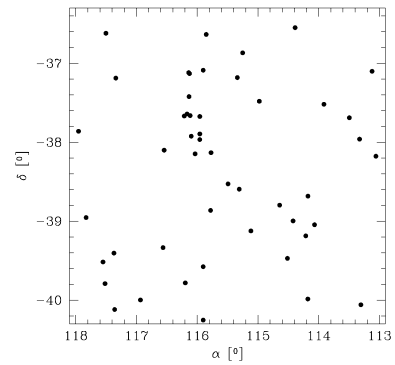

Fig. 12. Positions of all ACT stars with proper motions close to $\mu_{\alpha*} = -14$ mas/yr, $\mu_\delta = 4$ mas/yr.

Table 7. It is unclear, whether HD 63032 belongs to this cluster. Its proper motion ($\mu_{\alpha*} = -10.77 \pm 0.45$ mas/yr, $\mu_\delta = 5.97 \pm 0.58$ mas/yr) differs clearly from the mean of the ACT stars. In addition, as a cluster member, it would be about five magnitudes brighter than the brightest main-sequence star.

8. Collinder 135

Collinder 135 is located in Puppis at $l = 248.^\circ 8, b = -11.^\circ 2$ ($\alpha_{2000} = 7^h 17^m, \delta_{2000} = -36°40'$). The discussion about the nature of Collinder 135 has been going on for 30 years. Williams (1967b) proposed that the cluster does not exist, an opinion which was shared by Claria & Kepler (1980), who only found evidence for a concentration of stars at a much larger distance. On the contrary, Eggen (1983) argued that 8 stars around π Pup could form a cluster at a distance of approximately 300 pc. Amieux (1993) has measured radial velocities for 63 stars in a 2° by 2° field. She found a peak in the radial velocity diagram at +20 km/sec, but noted that most of the stars in this peak are field stars. Amieux & Röser (1995) have combined the radial velocities with proper motions from the PPM Catalogue. The proper motions favoured the hypothesis of a cluster, but were not accurate enough to definitely separate the cluster from the field stars.

Figure 13 shows the proper motions of all Hipparcos stars in a 4° by 4° field centered on the position of the cluster. There is a clear concentration of stars around $\mu_{\alpha*} = -10.5$ mas/yr, $\mu_\delta = 6$ mas/yr, which becomes even more pronounced if one considers only the central 2° by 2° area. This is a first sign for the presence of a cluster.

Table 8. Members and possible members of Collinder 135

No.	HIP No.	HD No.	Magnitude V	Parallax [mas] π	σ_π	Proper Motion [mas/yr] $\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	Radial velocity r_v [km/s]	σ/Q	Src	Final Desig.
1	34461	54773	9.44	4.40	0.94	-12.26	0.79	7.54	0.99				M
2	34817	55718	5.94	3.61	0.63	-9.76	0.54	7.48	0.65	17	C	2	M
3	35030	56237	8.68	4.15	0.81	-9.85	0.68	8.28	0.94				M
4	35075	56376	7.39	3.42	0.64	-11.37	0.53	6.26	0.68	20	1.8	1	M
5	35202	56733	5.81	4.80	0.54	-7.91	0.55	4.93	0.55				PM
6	35226	56779	5.03	3.40	0.56	-10.39	0.46	6.21	0.59	9	D	2	M
7	35264	56885	2.71	2.98	0.55	-10.57	0.44	7.00	0.60	15.8	A	2	M
8	35363	57150	4.65	3.85	0.72	-11.29	1.57	1.85	1.97	18.6	B	2	M
9	35386	57194	8.10	4.70	1.47	-7.57	1.24	9.83	1.79	18	2.3	1	M
10	35406	57219	5.11	3.90	0.55	-10.15	0.45	5.90	0.59	18	E	2	M
11	35460	57331	8.16	2.42	0.72	-11.13	0.58	5.89	0.87	21	1.5	1	M
12	35483	57411	7.82	3.77	0.64	-10.58	0.53	5.42	0.66	12	2.4	1	PM

Notes: Columns 1 - 12: Same as Table 5. Column 13: Sources of radial velocities: 1. Amieux (1993), 2. WEB Catalogue

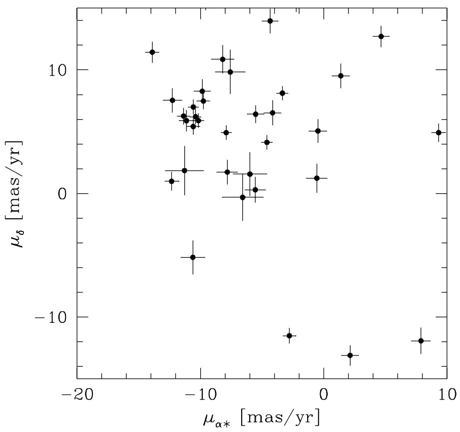

Fig. 13. Proper motions of all Hipparcos stars in the direction of Collinder 135. Note the concentration of proper motions near $\mu_{\alpha*} = -10.5$ mas/yr, $\mu_\delta = 6$ mas/yr.

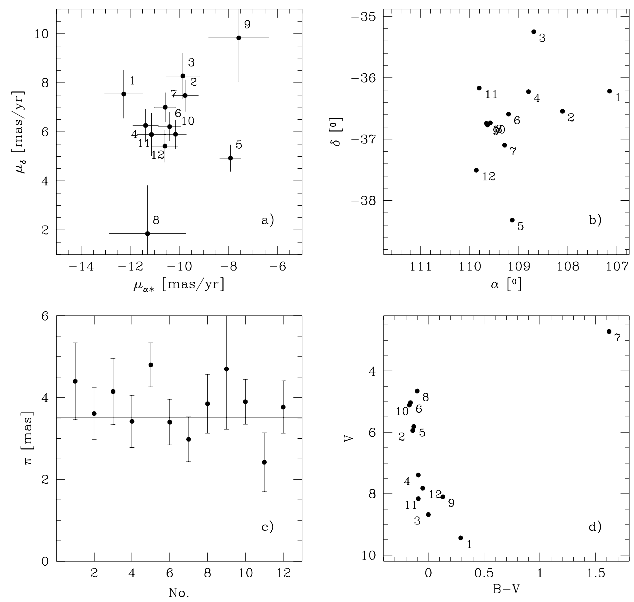

Fig. 14. Proper motions (a), positions (b), parallaxes (c) and colour-magnitudes (d) of the suspected members of Collinder 135. The straight line in panel c) shows the mean parallax of $\pi = 3.52$.

All stars with proper motions between -14 mas/yr < $\mu_{\alpha*}$ < -6 mas/yr and 2 mas/yr < μ_δ < 10 mas/yr were considered as members of a hypothetical cluster. Figure 14 shows (clockwise from top left) their proper motions, positions, colour-magnitudes and parallaxes. The presence of a cluster becomes even more likely, since the suspected members may have a common parallax and proper motion, form a well defined main-sequence and show a clear spatial concentration. In addition, it seems possible that most stars share a common radial velocity (see Table 8). All aspects studied so far favour the hypothesis of a bound group of stars, and we therefore conclude that Collinder 135 is a cluster.

Table 8 lists the basic parameters of the candidate members. The red giant π Puppis (HIP 35264) is found to be a member of Collinder 135. Stars 8 and 9 are members of double systems. This may explain their large proper motion deviations in Fig. 14a. Star 5 (HIP 35202) is an uncertain member, since it has the largest separation from the others and shows quite large proper motion and parallax differences too. Membership of HIP 35483 is also uncertain, since its radial velocity differs significantly from the cluster mean. The other stars seem to have similar radial velocities, which supports their membership. Omitting the two uncertain members, we obtain a mean parallax of $\pi = 3.52 \pm 0.22$ mas for the cluster, which is in good agreement with the 300 pc (corresponding to a parallax of $\pi = 3.33$ mas), that Eggen (1983) determined as the cluster distance.

9. Roslund 5

Roslund 5 was among the seven possible galactic clusters discovered by Roslund (1960) on objective-prism plates. It is located in Cygnus at $l = 71.^\circ4, b = 0.^\circ25$ ($\alpha_{2000} = 20^h10^m, \delta_{2000} = 33°46'$). It was studied photographically by Nelson (1969), who found a relatively well-populated main sequence for this cluster. Lee & Perry (1971) obtained UBV magnitudes for 46 stars in the cluster area. They found a considerable scatter in the colour magnitude diagram of these stars. They therefore concluded that Roslund 5 is not an open cluster, but only a slightly obscured area with a background of relatively early-type stars.

Looking at Fig. 2 of Lee & Perry, it seems possible that at least some of their stars are located at a common distance. A cluster may therefore still be present in this area. We have selected all stars in a 2° by 2° field centered on the cluster position from the Hipparcos Catalogue. Figure 15 shows their proper motions. There is a conspicuous group of stars with proper motions close to $\mu_{\alpha*} = 3$ mas/yr, $\mu_\delta = -1$ mas/yr. This may be a hint for a star cluster.

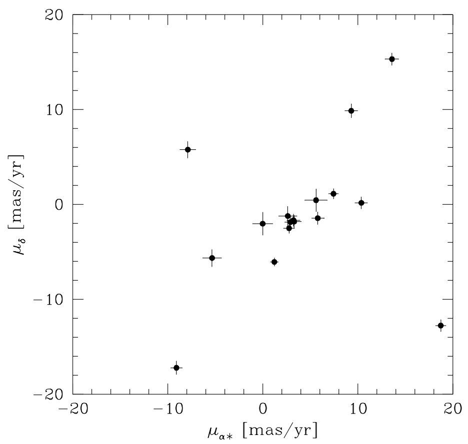

Fig. 15. Proper motions of Hipparcos stars in the field of Roslund 5.

Figure 16 shows proper motions, positions, parallaxes, and colour-magnitudes of the stars which may form a cluster. They show a concentration around $\alpha = 302.^\circ5, \delta = 33.^\circ7$. In addition, our hypothetical members may be at a common distance (Fig. 16c) and their magnitudes are sufficiently close to each other to be consistent with a common distance (Fig. 16d). Their colours show some scatter, but this may be due to the fact that the extinction is varying over the region studied (Lee & Perry 1971). We obtain a mean parallax of $\pi = 1.95 \pm 0.4$ mas, corresponding to a distance of about 500 pc. If we assume a mass of $M_{Cl} = 50$ $M_\odot$ for Roslund 5, we obtain a tidal radius of 5 pc, which corresponds to an angular diameter of roughly one degree. At least three, possibly even four of the Hipparcos stars may therefore be physically connected to each other.

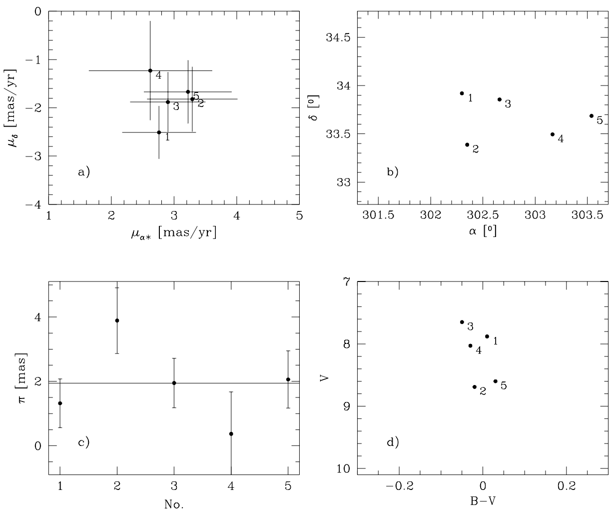

Fig. 16. Proper motions (a), positions (b), parallaxes (c) and colour-magnitudes (d) of the possible members of Roslund 5.

We next searched the ACT Catalogue for possible members. If Roslund 5 is a real cluster, one would expect to see a density enhancement of ACT stars around the cluster position. However, we do not see such an enhancement if we consider all ACT stars in the field (see the left panel of Fig. 17). But Roslund 5 may be sparsely populated, so this does not necessarily exclude a cluster. We therefore apply some criteria to the ACT stars, to pre-select members from non-members. Within the magnitude limits of the ACT, a main-sequence star surely has $B - V < 0.4$ if it is a cluster member. In addition, we require that the proper motion of a star must be sufficiently close to $\mu_{\alpha*} = 3$ mas/yr, $\mu_\delta = -2$ mas/yr, so that the χ^2-value of its proper motion deviation

$$\chi^2 = \frac{(\mu_{\alpha*} - 3)^2}{\sigma^2_{\mu_{\alpha*}}} + \frac{(\mu_\delta + 2)^2}{\sigma^2_{\mu_\delta}} \qquad (2)$$

is lower than a certain threshold $\chi^2 < \chi^2_{max}$. We found that $\chi^2_{max} = 3.0$ is a good compromise between bad statistics due to a low number of stars and no signal due to too many stars considered. The distribution of the remaining stars is shown in the right picture of Fig. 17. Again, there

Table 9. Possible members of Roslund 5

No.	HIP	HD/BD	RA 2000	DEC 2000	V	B-V	π	σ_π	Proper motion [mas/yr]				r_v	
							[mas]		$\mu_{\alpha*}$	$\sigma_{\mu_{\alpha*}}$	μ_δ	σ_{μ_δ}	[km/s]	Q
1	99279	191530	20 09 11.77	+33 55 11.82	7.88	0.01	1.32	0.76	2.76	0.59	-2.51	0.55	-25	E
2	99299	191568	20 09 23.85	+33 23 15.71	8.69	-0.02	3.89	1.02	3.29	0.72	-1.82	0.67	-37	C
3	99415	191811	20 10 38.23	+33 51 20.55	7.65	-0.05	1.95	0.77	2.90	0.60	-1.88	0.62	-14	C
4	99590	192225	20 12 39.82	+33 29 44.21	8.03	-0.03	0.37	1.30	2.62	0.98	-1.23	1.03	-12	C
5	99728	192516	20 14 09.31	+33 41 10.57	8.60	0.03	2.06	0.89	3.22	0.70	-1.67	0.65	-17	C
6		227885	20 08 35.62	+33 39 43.47	9.44	0.11			3.62	2.03	-0.30	1.26	-20	D
7			20 08 54.38	+33 34 54.47	11.26	0.27			2.12	1.68	-4.50	1.99		
8		227935	20 08 57.62	+33 48 56.49	10.16	0.14			2.74	2.50	-3.80	1.97		
9		228033	20 09 55.93	+33 54 12.59	9.96	0.11			-1.99	4.21	-3.50	1.97		
10		228035	20 10 00.40	+33 30 23.55	11.24	0.21			6.25	2.07	-1.60	1.39		
11		228034	20 10 00.60	+33 39 37.24	9.68	0.23			6.24	2.06	-2.60	2.45		
12		228058	20 10 07.91	+33 46 30.48	10.86	0.23			0.25	3.42	-3.80	1.54		
13		191743	20 10 17.63	+33 33 19.30	8.89	-0.03			4.50	1.25	-1.60	2.80	-25	D
14		228073	20 10 24.94	+33 48 08.03	9.23	0.06			1.00	4.83	-6.20	3.55	-28	D
15		+33 3779	20 10 35.72	+33 53 26.57	9.17	-0.01			3.74	3.17	-3.50	2.32	-06	E
16		228110	20 10 48.10	+33 43 05.13	9.25	-0.02			1.37	1.25	-3.50	2.71	-10	E
17		228167	20 11 15.15	+33 34 05.83	9.26	0.02			4.00	2.52	-3.90	1.25		

Notes: Column 1: Running, 2: HIP, 3: HD/BD number, 4-6, 7-9: Right ascension and Declination (J2000), 10+11: V and B-V, 12-13: Parallax, 14-17: Proper motion from Hipparcos or ACT, 18+19: Radial velocity and error from the WEB Catalogue

appears to be a slight clustering near $\alpha = 302\overset{\circ}{.}5, \delta = 33\overset{\circ}{.}7$.

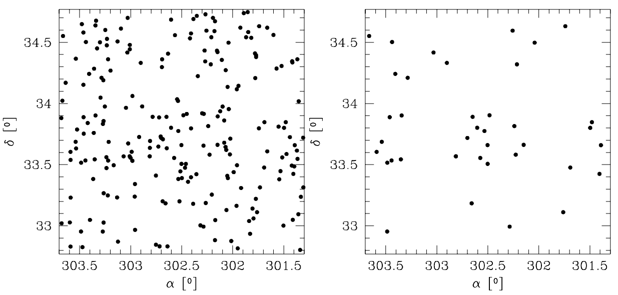

Fig. 17. Distribution of all ACT stars (left) and those stars fulfilling the membership criteria (right) in the field of Roslund 5.

We consider all stars that fulfill the membership criteria and lie within a circle of 0.5 degree radius around $\alpha = 302\overset{\circ}{.}5, \delta = 33\overset{\circ}{.}7$ as possible cluster members. They can be found in Table 9 together with the possible members from Hipparcos. Table 9 surely does not include all members of Roslund 5 and it may contain several nonmembers also.

The last two columns give the radial velocity and a quality flag for the stars which could be found in the WEB Catalogue (Duflot et al. 1995). We note that the quality flag of the WEB Catalogue is on the system of the GCRV (Wilson 1953), which means that the error of the radial velocity rises from A to E. For example a C corresponds to a mean error of less than 2.5 km/sec, while a D corresponds to a mean error of less than 5 km/sec. Keeping this in mind, it seems possible that most stars of Table 9 have the same radial velocity. The exception may be HIP 99299 with a velocity of -37 km/sec, which seems to be too different from the mean cluster velocity of about -18 km/sec.

The data presented so far is compatible with the assumption that Roslund 5 is a cluster, although we cannot rule out the possibility that our stars are part of an unbound association. Precise radial velocities for the stars of Table 9 would help to decide whether they form a bound system or not.

10. Summary

Eight controversial clusters were studied with the help of the Hipparcos and ACT catalogues. We confirm the reality of Collinder 135 and NGC 2451 A. It seems possible that star clusters are present in the areas of NGC 2451 B, Collinder 132 and Roslund 5. Collinder 399, Upgren 1, NGC 1252 and Melotte 227 are found to be chance alignments of stars.

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