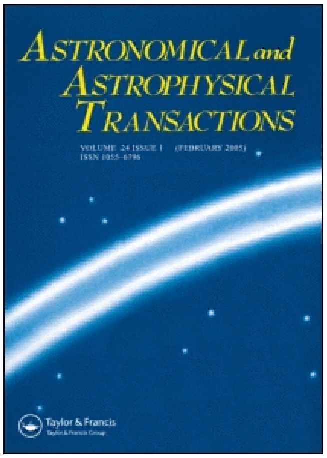

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G. V. Beshenov [a]; A. V. Loktin [a]
[a] Astronomical Observatory of Ural State University, Ekaterinburg, Russia

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PROPER MOTIONS OF OPEN STAR CLUSTERS FROM TYCHO-2 CATALOGUE DATA

G. V. BESHENOV and A. V. LOKTIN*

Astronomical Observatory of Ural State University, 51 Lenin Avenue, 620083 Ekaterinburg, Russia

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The results of determinating the proper motions of open clusters on the basis of the Tycho-2 catalogue data are presented here. The resulting catalogue contains mean proper motions for 390 open clusters.

Keywords: Open clusters; Proper motions; Catalogue

1 INTRODUCTION

Proper motions of open star clusters (OCLs) are important and informative parameters for these objects. Cluster proper motions can be used for the investigating the kinematic properties of the Galactic disc and for estimating the membership of particular stars in clusters. The usefulness of proper motions for these purposes is determined by their accuracy. The publication of results of observations from the Hipparcos satellite and of catalogues based on these observations, especially the Tycho-2 catalogue, provide the possibility of estimating accurate proper motions for their use in kinematic investigations together with radial velocities.

The target of our present work is to provide most OCLs in our 'Homogeneous catalogue of OCL parameters' (Loktin *et al*., 2001) with proper motions. Nearly simultaneously other groups of investigators have begun such work. In particular, we should mention the papers by Baumgardt *et al*. (2000) and Dias *et al*. (2001, 2002). However, the results of Baumgardt *et al*. are based on the data from the Hipparcos catalogue and not the Tycho-2 catalogue; the limiting magnitude and accuracy of proper motions in the Hipparcos catalogue are appreciably lower than these in the Tycho-2 catalogue, and the proper motions of some clusters in that paper were determined using only one to three stars. Dias *et al*. determined the proper motions of clusters from Tycho-2 data, but in our opinion these results suffers from slight defects. Firstly, Dias *et al*. determined proper motions for only 206 clusters whereas in the 'Homogeneous catalogue', the photometric parameters of 428 clusters were determined. Secondly, there is some doubt about the adequacy of their method. Dias *et al*. determined the components of the proper motions of clusters as corresponding parameters of the sum of two-dimensional normal distributions, which approximate the distributions of points on proper motion vector diagram in cluster fields. However, the normal distribution fits the distribution of the proper

* E-mail: alexhander.loktin@usu.ru

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motions of field stars poorly (Loktin, 2003) because of pronounced asymmetry and excess. In these circumstances the maximum point of the fit to the normal distribution may be biased. All this forced us to continue our determination of the proper motions of clusters for a maximum number of objects on the base of Tycho-2 data.

2 EXTRACTION OF CLUSTER MEMBERS

To extract cluster members we use both the kinematic (proper motions) and photometric criteria, using only stars belonging to main sequence (MS) and red giant branch (RGB) areas of the colour–magnitude diagram (CMD). For this purpose we use only Tycho-2 photometric data. For a particular cluster the data were read for stars belonging to rectangular area centred on the cluster, the size of the area being so large that the cluster corona was easily included in order to obtain as many cluster members as possible. This size varies from 4° for the cluster closest to the Sun to 2° for the most distant clusters. For most clusters we rejected from the sample the stars with proper motions that exceeded 50 marcsec year^{-1}, which is recommended for the application of the Sanders (1971) method for estimating the membership probabilities. From the remaining list, we rejected stars apparently deviating from the MS or RGB of the cluster CMD, which helps to reduce the number of background stars, the positions of MS and RGB being determined with the help of CMDs previously published in the literature. Usually after this 'cleaning' procedure has been carried out, we could see the condensation of cluster stars on the chart drawn for the remaining sample, and then the stars most distant from cluster centre are rejected from the sample in order to eliminate possible members of nearby clusters. For the final membership determination we use the Sanders method without turning the coordinate axes and, in most cases, the modified Sanders method (Loktin, 2003). All stars in the sample with membership probabilities exceeding 65% are used for calculating the mean values of proper motion components which are considered as the proper motion of the cluster. For the poorest clusters, which cannot be detected on the chart and vector diagram of proper motions, we consecutively rejected stars with the least membership probabilities and those most distant from the cluster centre (with previously known coordinates); this procedure may be repeated, and we choose the sample giving the most pronounced MS on CMD.

For some clusters from the 'Homogeneous catalogue' we did not managed to obtain satisfactory results, and, in the new catalogue of proper motions of clusters, 390 objects are included. Most of the remaining clusters are very distant or old where luminous stars are absent.

3 THE CATALOGUE

Our catalogue of the proper motions of OCLs from the 'Homogeneous catalogue' is shown in Table I. The columns of the table consecutively given the following: the first column gives the cluster name, the clusters being arranged in the order accepted for the 'Homogeneous catalogue', that is first NGC, then IC and finally the rest in alphabetical order; the second and third columns list the new mean proper motions in right ascension and their rms errors respectively; the fourth and fifth columns list the mean proper motions in declination and their rms errors respectively; the sixth column gives the number of stars used to calculate the mean proper motion and the last column contains notes where a question mark denotes clusters–poorly visible on the chart and proper motion vector diagram (two question marks indicate the worst cases).

TABLE I Catalogue of the proper motions of open clusters.

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
NGC103	−2.18	0.86	−0.33	0.76	10	
NGC129	−0.51	0.22	0.10	0.21	76	
NGC146	−4.68	0.60	2.64	0.64	20	
NGC188	−0.94	1.61	1.13	0.28	63	
NGC225	−5.54	0.37	0.66	0.33	27	
NGC366	1.19	0.64	−0.41	0.55	15	
NGC381	−0.18	0.23	−2.47	0.26	28	
NGC436	0.95	0.24	−4.11	0.22	17	
NGC457	−2.69	0.17	−1.89	0.18	13	
NGC559	−1.59	0.41	−0.52	0.46	24	
NGC581	−1.20	0.19	0.65	0.22	23	
NGC637	−0.37	0.40	−0.61	0.36	20	
NGC654	−0.97	0.28	−1.04	0.25	69	
NGC659	1.13	0.30	2.00	0.40	7	
NGC663	−1.94	0.15	0.06	0.14	41	
NGC744	−1.38	0.37	−2.96	0.33	40	
NGC752	8.02	0.20	−11.68	0.19	81	
NGC869	−0.41	0.24	−1.03	0.24	66	
NGC884	−0.73	0.13	−0.88	0.14	20	
NGC957	−0.88	0.28	−0.32	0.30	15	
NGC1027	−2.05	0.28	1.69	0.25	20	
NGC1039	0.03	0.18	−7.43	0.17	40	
NGC1245	−2.98	0.41	−3.05	0.36	25	?
NGC1252	7.98	0.45	5.95	0.60	6	
NGC1342	−0.12	0.27	−3.10	0.37	25	
NGC1444	−2.47	0.53	−3.85	0.50	9	
NGC1502	0.78	0.31	−0.15	0.33	20	
NGC1528	0.51	0.18	−3.63	0.16	50	
NGC1545	−0.04	0.28	0.79	0.37	20	
NGC1647	−1.87	0.18	−2.23	0.15	68	
NGC1662	−1.71	0.19	−2.14	0.20	36	
NGC1664	−3.32	0.20	−4.04	0.20	144	
NGC1778	−0.98	0.16	−4.28	0.15	190	
NGC1817	0.14	0.21	−4.20	0.24	48	
NGC1893	−0.05	0.14	−3.17	0.13	20	
NGC1907	−0.88	0.18	−3.57	0.20	10	
NGC1912	0.36	0.13	−5.51	0.12	20	
NGC1931	1.58	0.16	−7.55	0.16	10	
NGC1960	0.99	0.17	−3.96	0.15	114	
NGC2099	3.29	0.18	−6.84	0.17	21	
NGC2129	−0.71	0.28	−1.53	0.19	10	
NGC2141	0.62	0.52	−0.59	0.47	21	
NGC2158	1.43	0.29	−3.28	0.20	20	??
NGC2168	2.69	0.09	−3.44	0.08	56	
NGC2169	−3.47	0.28	−1.88	0.30	20	
NGC2175	−0.21	0.20	−4.95	0.26	20	
NGC2186	2.11	0.21	−1.95	0.27	11	
NGC2194	−1.28	0.27	−4.03	0.28	27	

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
NGC2204	−0.22	0.48	1.78	0.44	19	
NGC2215	0.87	0.80	−4.85	0.60	10	
NGC2232	−3.52	0.16	−3.25	0.16	20	
NGC2236	−3.48	0.27	−6.66	0.37	16	
NGC2243	2.53	0.54	2.90	1.30	4	??
NGC2244	−1.45	0.23	0.54	0.22	17	
NGC2251	−1.37	0.22	−3.73	0.21	32	
NGC2264	−0.63	0.14	−3.88	0.18	14	
NGC2269	−6.97	0.50	−4.78	0.50	7	?
NGC2281	−3.69	0.22	−7.40	0.18	44	
NGC2286	−1.81	0.36	−1.02	0.40	8	
NGC2287	−3.99	0.18	−1.16	0.19	105	
NGC2301	−2.13	0.13	−3.74	0.10	16	
NGC2302	−1.91	0.14	−2.46	0.16	14	
NGC2323	−0.27	0.07	−1.18	0.07	12	
NGC2324	0.79	0.25	−4.40	0.31	27	
NGC2335	0.54	0.33	−3.80	0.32	13	
NGC2343	−1.46	0.22	1.83	0.21	23	
NGC2345	−1.57	0.27	−2.15	0.21	20	
NGC2353	−2.89	0.21	1.53	0.21	30	
NGC2354	−6.55	0.26	0.22	0.27	9	
NGC2360	−4.30	0.27	6.68	0.29	14	
NGC2362	−2.10	0.33	3.27	0.38	51	
NGC2367	−7.34	0.36	3.20	0.27	25	
NGC2374	−3.52	0.27	−3.07	0.26	20	
NGC2383	−1.90	0.30	1.50	0.30	10	
NGC2384	−3.99	0.13	2.28	0.09	9	
NGC2395	−0.08	0.29	−6.12	0.42	10	
NGC2414	−3.66	0.27	−0.20	0.27	39	
NGC2420	−1.32	0.42	−4.18	0.26	76	
NGC2421	−5.71	0.32	2.64	0.33	15	
NGC2422	−3.64	0.06	1.78	0.06	92	
NGC2423	0.85	0.29	−2.83	0.32	44	
NGC2437	−5.66	0.15	−0.08	0.13	20	
NGC2439	−1.75	0.20	−1.67	0.21	50	
NGC2447	−3.64	0.08	2.60	0.08	100	
NGC2451	−22.05	0.14	14.37	0.23	20	
NGC2453	−3.68	0.30	3.07	0.21	18	
NGC2467	−6.22	1.08	2.04	0.76	20	
NGC2477	2.63	0.26	3.60	0.29	10	
NGC2482	−6.16	0.55	2.20	0.81	20	
NGC2483	−2.84	0.17	0.16	0.24	20	
NGC2489	−2.92	0.44	0.32	0.49	20	
NGC2506	−2.55	0.20	0.37	0.14	20	
NGC2516	−3.78	0.13	10.46	0.12	29	
NGC2527	−4.95	0.36	7.21	0.32	50	
NGC2533	−4.78	0.33	4.72	0.35	15	
NGC2539	−3.60	0.15	−1.53	0.14	213	
NGC2546	−5.35	0.11	3.92	0.11	20	

(*continued*)

TABLE I Continued

Cluster	Mean right ascension	Rms error of mean right ascension	Mean declination	Rms error of mean declination	N	Note
NGC2547	−6.27	0.20	9.53	0.17	155	
NGC2548	−1.14	0.18	2.48	0.19	27	
NGC2567	−1.59	0.17	1.56	0.18	10	
NGC2571	−5.14	0.23	3.46	0.28	12	
NGC2627	−5.03	0.30	0.18	0.42	10	
NGC2658	−1.73	0.59	−0.87	0.52	18	
NGC2660	−5.82	0.81	7.40	0.83	10	
NGC2669	−6.54	0.32	6.20	0.36	11	
NGC2670	−6.51	1.38	2.52	0.64	10	
NGC2682	−6.51	0.30	−4.54	0.28	90	
NGC2818	−3.32	1.37	1.22	1.21	10	
NGC2910	−5.26	0.30	3.81	0.45	20	
NGC2972	−5.51	1.87	4.92	2.67	7	?
NGC3033	−4.73	0.30	2.13	0.31	9	
NGC3114	−7.09	0.09	4.03	0.09	50	
NGC3228	−14.34	0.35	−0.37	0.31	12	
NGC3293	−5.55	0.16	2.27	0.17	145	
NGC3324	−8.03	0.42	3.54	0.30	15	
NGC3330	−8.08	0.49	2.95	0.43	20	
NGC3496	−3.82	0.36	3.71	0.33	12	
NGC3532	−9.25	0.26	3.88	0.19	14	
NGC3572	−4.67	0.09	1.78	0.08	35	
NGC3590	−7.54	0.12	1.42	0.12	20	
NGC3603	−5.76	1.78	0.28	1.24	12	??
NGC3680	−6.00	0.30	0.90	0.28	48	
NGC3766	−7.08	0.12	1.00	0.13	14	
NGC3960	−7.01	0.24	−0.45	0.33	20	
NGC4052	−6.82	0.48	−2.06	0.38	37	
NGC4103	−7.18	0.24	−0.57	0.31	27	
NGC4337	−3.03	0.41	−1.25	0.56	10	
NGC4349	−7.02	0.37	3.68	0.42	21	
NGC4439	−10.35	0.30	−4.36	0.28	30	
NGC4463	−4.41	0.28	−0.46	0.34	182	
NGC4609	−8.83	0.43	−0.74	0.39	20	
NGC4755	−4.44	0.15	−0.67	0.13	20	
NGC4815	−7.30	2.15	−6.01	0.97	6	?
NGC5138	−3.30	0.30	−0.27	0.25	15	?
NGC5168	−4.60	0.27	−2.19	0.24	28	
NGC5281	−4.27	0.20	−3.47	0.25	22	
NGC5316	−5.28	0.55	1.82	0.57	12	?
NGC5460	−5.96	0.30	−2.35	0.36	44	
NGC5606	−3.04	0.25	−3.08	0.22	50	
NGC5617	−2.96	0.34	−2.46	0.18	12	
NGC5662	−4.17	0.19	−7.27	0.16	20	
NGC5749	−0.02	0.38	−4.30	0.42	20	
NGC5822	−6.50	0.12	−5.85	0.11	42	
NGC5823	−5.77	0.16	−4.61	0.17	10	
NGC6025	−3.71	0.23	−2.77	0.25	33	
NGC6031	−4.20	0.31	−8.49	0.40	17	?

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
NGC6067	−0.98	0.11	−4.86	0.13	26	
NGC6087	−1.25	0.14	−2.12	0.14	50	
NGC6124	−1.80	0.56	−3.63	0.65	10	
NGC6134	0.48	0.14	−3.13	0.16	20	
NGC6167	−2.33	0.22	−4.21	0.20	20	
NGC6178	0.18	0.22	−2.15	0.19	22	
NGC6192	0.64	0.30	−3.39	0.41	20	
NGC6193	0.28	0.15	−4.79	0.15	20	
NGC6200	−0.33	0.09	−5.81	0.17	11	
NGC6204	−2.77	0.88	−2.89	0.89	11	?
NGC6208	−0.23	0.32	−3.40	0.29	20	
NGC6231	−0.92	0.11	−1.28	0.11	100	
NGC6242	0.33	0.26	0.10	0.21	20	
NGC6249	−0.84	0.24	−4.62	0.28	20	
NGC6250	−0.06	0.18	−3.65	0.19	30	
NGC6259	−2.64	0.33	−6.32	0.29	20	
NGC6268	0.13	0.24	−0.85	0.24	20	
NGC6281	−3.25	0.15	−5.03	0.14	12	
NGC6322	0.01	0.20	−2.33	0.20	20	
NGC6383	0.45	0.23	−6.90	0.21	34	
NGC6396	−2.94	0.77	−6.29	1.22	17	
NGC6405	−2.38	0.15	−7.19	0.16	20	
NGC6416	−0.31	0.34	0.26	0.37	66	
NGC6425	5.27	0.53	−0.02	1.11	12	
NGC6475	2.58	0.08	−4.54	0.07	20	
NGC6494	1.18	0.16	−1.39	0.14	50	?
NGC6514	−0.38	0.10	−2.57	0.10	141	
NGC6520	1.33	0.25	−3.15	0.35	20	
NGC6530	0.91	0.10	−3.22	0.12	108	
NGC6531	−0.24	0.10	−2.20	0.09	66	
NGC6546	1.08	0.22	−2.50	0.33	10	
NGC6604	−0.66	0.19	−0.88	0.17	97	
NGC6611	0.62	0.09	−0.32	0.10	20	
NGC6613	−0.66	0.07	−1.31	0.08	16	
NGC6633	0.23	0.11	−1.54	0.13	153	
NGC6649	0.93	1.77	−3.84	1.13	7	
NGC6664	−0.03	0.32	−3.42	0.31	16	
NGC6694	−3.04	0.26	−2.07	0.30	20	
NGC6704	−1.30	0.40	−4.36	0.32	9	?
NGC6705	−6.55	0.25	−0.04	0.38	9	
NGC6709	1.17	0.16	−3.13	0.21	11	
NGC6716	−0.80	0.24	−4.94	0.25	25	
NGC6755	−0.98	0.22	−4.46	0.27	12	
NGC6791	4.07	0.64	0.58	0.55	9	
NGC6802	2.79	1.15	−2.83	1.40	12	??
NGC6811	−4.95	0.22	−7.78	0.21	44	
NGC6819	−2.66	0.67	−3.93	0.78	14	
NGC6823	−2.05	0.26	−5.47	0.20	37	

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
NGC6830	0.12	0.26	−3.36	0.28	20	
NGC6834	−2.23	0.23	−3.03	0.26	15	
NGC6866	−3.54	0.35	−7.47	0.33	20	
NGC6871	−2.90	0.24	−6.95	0.29	20	
NGC6910	−3.37	0.25	−6.18	0.25	20	
NGC6913	−1.47	0.37	−4.69	0.34	20	
NGC6939	0.86	0.46	−2.16	0.53	13	
NGC6940	−2.28	0.18	−9.14	0.20	83	
NGC7031	−5.15	0.43	−3.90	0.45	13	
NGC7039	−2.04	0.21	−2.53	0.22	50	?
NGC7044	2.04	2.35	−3.12	1.37	10	??
NGC7062	−0.25	0.37	−2.86	0.31	18	?
NGC7063	0.86	0.37	−2.35	0.31	12	
NGC7067	2.47	0.36	−2.52	0.35	11	
NGC7082	−1.89	0.22	−3.20	0.25	12	
NGC7086	−0.69	0.20	−0.88	0.28	15	
NGC7092	−8.14	0.25	−19.66	0.27	39	
NGC7128	−2.55	2.03	−3.81	1.01	10	??
NGC7142	1.06	0.51	−4.43	0.34	20	
NGC7160	−1.54	0.12	−2.62	0.21	20	
NGC7209	2.30	0.19	2.36	0.22	17	?
NGC7226	−0.77	1.28	−4.41	0.83	20	?
NGC7235	−3.24	0.54	−3.53	0.62	24	
NGC7243	−1.00	0.18	−1.67	0.15	50	
NGC7245	−1.70	1.13	−4.02	1.59	10	??
NGC7261	−2.74	0.68	1.01	0.52	15	
NGC7380	−2.77	0.50	−3.55	0.58	20	
NGC7419	−2.30	1.40	1.40	0.96	10	
NGC7510	−1.16	0.29	−1.74	0.31	20	
NGC7654	−2.77	0.27	−1.18	0.29	83	
NGC7762	5.29	1.56	2.51	1.53	5	??
NGC7788	−1.20	0.42	0.58	0.53	20	
NGC7789	−2.20	0.22	−1.11	0.18	13	
NGC7790	−0.95	0.69	−1.50	0.44	24	
IC166	−2.11	0.24	0.00	0.23	14	
IC348	6.87	0.56	−9.15	0.49	11	
IC361	1.86	1.11	−2.25	1.85	20	??
IC1369	−6.59	0.43	−3.14	0.47	15	
IC1805	−1.89	0.28	−2.01	0.24	75	
IC1848	0.56	0.38	−0.91	0.46	20	
IC2391	−25.05	0.34	22.65	0.28	32	
IC2395	−4.86	0.33	3.48	0.23	33	
IC2488	−8.25	0.22	6.09	0.27	21	
IC2581	−9.54	0.15	3.17	0.13	120	
IC2602	−22.33	0.71	9.93	0.68	49	
IC2714	−8.04	0.12	0.56	0.13	90	
IC2944	−5.29	0.12	−0.16	0.12	96	
IC4651	0.64	0.13	−1.11	0.12	50	

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
IC4665	−0.85	0.20	−10.10	0.22	38	
IC4725	−3.02	0.17	−6.45	0.16	50	
IC4756	−0.14	0.09	−3.86	0.09	91	
IC4996	−3.18	0.10	−5.45	0.10	12	
IC5416	2.31	0.13	−0.93	0.12	20	
Abt 1	−2.67	0.45	−1.63	0.57	12	
Alpha Per	22.41	0.21	−25.87	0.25	60	
Ba 3	−0.96	0.28	−6.43	0.19	21	
Ba 10	1.47	0.12	0.35	0.29	13	
Ba 11	0.40	0.55	−1.05	0.56	5	
Be 11	−0.94	0.51	−7.15	0.59	22	
Be 28	−2.41	0.77	−3.43	0.68	9	?
Be 29	−0.14	0.80	−4.75	0.58	20	?
Be 31	−0.57	0.12	−3.29	0.12	5	
Be 42	1.41	0.70	−2.75	0.50	6	?
Be 62	−3.55	0.72	−1.82	1.41	11	?
Be 65	0.13	0.66	−3.61	0.52	10	
Be 82	−0.06	0.99	−4.38	1.78	3	?
Be 86	−3.06	0.32	−4.15	0.18	25	
Be 87	−1.60	0.67	−4.23	0.47	20	
Be 94	1.87	2.00	−2.02	0.91	45	
Be 96	−2.73	0.39	−2.20	0.47	30	
Bjur 2	−2.31	0.30	−3.78	0.35	40	
Bo 1	0.41	0.53	−5.04	0.61	30	
Bo 2	1.00	0.69	−2.80	0.80	20	
Bo 4	−2.60	0.20	0.38	0.26	75	
Bo 8	−1.47	0.96	4.86	0.78	20	
Bo 10	−5.09	0.33	3.48	0.36	25	
Bo 11	−8.27	0.45	2.29	0.45	25	
Bo 13	−2.17	0.67	−2.84	1.13	15	
Bo 14	−1.75	1.21	−1.63	0.49	5	?
Bo 15	−1.95	0.39	2.54	0.39	20	
Coma	−12.38	0.31	−9.39	0.33	32	
Cr 69	0.81	0.21	−3.15	0.21	175	
Cr 70	0.24	0.13	0.21	0.12	166	
Cr 96	−1.04	0.44	−3.77	0.31	25	
Cr 121	−5.11	0.20	4.58	0.20	50	
Cr 135	−10.72	0.21	6.11	0.19	77	
Cr 140	−8.01	0.16	4.36	0.21	133	
Cr 197	−10.01	0.25	7.08	0.25	200	
Cr 223	−7.95	0.48	2.47	0.38	30	
Cr 228	−6.66	0.29	2.45	0.27	39	
Cr 232	−4.79	0.23	4.14	0.19	20	
Cr 240	−8.60	0.55	1.90	0.28	10	
Cr 258	−7.10	0.70	−2.45	0.72	20	
Cr 268	−3.13	1.39	−2.34	0.62	10	
Cr 271	−6.66	0.82	−2.88	0.79	10	
Cr 272	−3.75	0.28	−1.23	0.37	20	
Cr 359	0.52	0.23	−9.20	0.36	10	

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
Cr 394	−1.54	0.22	−6.45	0.28	40	
Cr 463	−1.13	0.51	−1.67	0.32	10	
CV Mon	−2.27	1.16	−3.21	0.91	10	?
Cz 8	4.92	0.46	0.70	0.62	10	
Cz 13	3.45	1.83	2.18	1.90	4	??
Cz 20	−1.69	0.45	−3.77	0.49	20	
Delta Lyr	−0.70	0.58	−3.63	0.54	40	
Dzeta Scl	19.33	0.26	3.66	0.33	25	
Do 25	0.81	0.14	−2.07	0.16	181	
Do 42	−0.91	0.37	−3.73	0.43	40	
Haff 15	−1.97	1.70	0.36	1.55	5	?
Haff 16	−4.46	0.43	1.51	0.55	20	
Haff 18	−3.19	0.25	1.05	0.23	20	
Haff 19	−2.02	0.17	1.55	0.14	110	
Haff 21	−3.68	0.51	1.27	0.69	20	
Harv. 20	−0.63	0.51	−5.05	0.61	20	
Hogg 10	−6.94	0.64	1.76	0.57	20	
Hogg 14	−11.04	0.60	−3.68	0.62	20	
Hogg 15	−9.15	1.19	−1.73	0.43	10	
Hogg 16	−4.75	0.24	−2.35	0.18	27	
Hogg 17	−3.47	0.40	−3.66	0.51	40	
Hogg 18	−4.62	1.67	−3.52	0.82	10	?
Hogg 22	−1.46	0.22	−4.55	0.16	20	
King 4	0.73	1.81	−0.28	2.38	4	??
King 8	1.93	0.28	−4.95	0.29	20	
King 11	−4.72	0.73	−1.58	0.76	10	
King 12	−2.30	0.50	−1.07	0.46	20	
King 14	−3.77	0.71	0.71	0.48	20	
King 21	2.36	1.15	1.87	1.23	8	
Lynga 1	−9.95	0.53	−2.13	0.59	10	
Lynga 2	−4.79	0.51	−4.57	0.96	9	
Lynga 6	−1.54	0.34	−3.17	0.43	22	
Lynga 7	−1.15	0.11	−4.07	0.11	50	
Lynga 14	−3.04	1.13	−3.93	0.49	10	
Mark 6	−2.65	0.24	−1.45	0.21	50	
Mark 38	0.03	0.09	−0.88	0.08	100	
Mel 66	−4.18	0.61	7.67	1.56	10	
Mel 71	−0.90	0.11	1.14	0.11	5	
Mel 105	−4.37	0.82	−4.07	0.96	10	
Pis 1	−6.77	0.76	3.76	0.79	10	
Pis 3	−5.72	0.44	3.85	0.28	10	
Pis 4	−6.31	0.44	5.57	0.41	20	
Pis 5	−8.65	0.81	5.48	0.92	20	
Pis 6	−5.71	0.20	5.18	0.20	62	
Pis 8	−8.08	3.11	7.97	2.15	4	??
Pis 13	−8.28	1.28	5.20	1.31	10	??
Pis 16	−6.88	0.44	2.69	0.38	16	
Pis 17	−4.64	0.73	2.43	0.50	20	
Pis 20	−2.28	0.29	−4.87	0.39	20	

(*continued*)

TABLE I Continued

Cluster	*Mean right ascension*	*Rms error of mean right ascension*	*Mean declination*	*Rms error of mean declination*	*N*	*Note*
Platais 1	−2.88	0.48	−1.95	0.40	20	
Pleiades	19.71	0.10	−44.82	0.11	100	
Praesepe	−35.99	0.14	−12.92	0.14	100	
Ros 3	−2.18	0.25	−6.28	0.32	29	
Ros 4	−0.63	1.09	−2.97	1.20	10	
Ros 5	2.56	0.37	−1.73	0.28	40	
Ru 18	−0.06	0.78	−1.87	0.98	10	
Ru 36	−1.45	1.02	1.77	0.51	10	
Ru 44	−3.33	0.32	−0.05	0.39	40	
Ru 49	−4.74	0.92	1.01	0.76	20	
Ru 55	−5.23	1.00	0.59	1.41	10	
Ru 59	−3.44	0.49	2.70	0.64	20	
Ru 67	−7.93	0.76	3.59	0.74	10	
Ru 76	−4.32	0.50	4.98	0.47	10	
Ru 79	−3.75	3.00	0.79	1.65	10	
Ru 93	−3.84	0.47	1.50	0.48	20	?
Ru 97	−3.41	1.04	−0.60	0.64	10	
Ru 98	−6.54	0.70	−4.69	0.88	20	
Ru 107	−5.29	1.29	−1.30	0.85	12	?
Ru 108	−5.26	0.33	−1.30	0.41	40	
Ru 119	0.02	0.67	−2.70	0.58	20	
Ru 127	−0.44	0.50	−1.46	0.41	10	
S Vul	−1.27	0.49	−4.37	0.40	40	
Sher 1	−4.85	0.90	3.33	1.08	6	?
Stock 2	17.28	0.18	−14.18	0.20	80	
Stock 8	−0.59	0.38	−5.38	0.41	20	
Stock 13	−8.33	0.95	1.73	0.75	10	
Stock 14	−6.22	0.15	−1.03	0.21	16	
Stock 16	−3.08	0.19	−0.70	0.23	16	
Stock 17	−0.69	0.70	−3.62	0.83	20	?
Tr 1	−2.58	0.28	0.65	0.17	12	
Tr 2	−0.48	0.57	−2.71	0.98	10	
Tr 7	−1.70	0.39	5.53	0.23	12	
Tr 9	−4.78	0.58	2.23	0.45	20	
Tr 10	−11.96	0.24	6.80	0.24	55	
Tr 14	−3.05	0.25	3.28	0.27	29	
Tr 15	−4.22	0.44	3.44	0.29	20	
Tr 16	−5.38	0.22	4.02	0.29	10	
Tr 17	−1.67	0.67	4.98	0.63	10	
Tr 18	−7.83	0.37	1.08	0.37	20	
Tr 21	−5.50	0.48	−3.36	0.49	40	
Tr 22	−4.98	0.67	−3.35	0.71	20	
Tr 24	−0.45	0.23	−0.82	0.20	56	
Tr 27	−0.13	0.60	−2.67	0.58	20	
Tr 28	−0.98	0.46	−2.77	0.66	20	
Tr 35	−1.24	0.62	−2.80	0.67	20	?
Tr 37	−2.30	0.83	−3.81	0.91	18	
VdB 99	−11.15	0.53	1.50	0.38	20	
Waterl 6	−6.24	0.94	6.06	0.87	10	?
WZ Sgr	0.99	0.38	−1.11	0.29	20	

4 COMPARISONS AND ERRORS

In Figures 1 and 2 the dependences of the rms errors of proper motions on cluster distances from the Sun are shown, the rms errors being expressed in millarcseconds per year. It is evident from the figures that most rms errors are less than 0.5 marcsec year^{-1} which corresponds to a linear velocity of less than 2.5 km s^{-1} for 1 kpc distance. This value is comparable with the common errors of radial velocities of clusters at such distances. It is interesting to see the decrease in the number of clusters with large rms values with increasing distance from the Sun. This strange effect may have two explanations. Firstly, the determination of proper motions of distant clusters demand stricter usage of membership criteria, which may lead to a false decrease in errors. Secondly, for distant clusters, usually young members of surrounding associations are included in the sample, thereby increasing number of stars used. However, on the whole there is an increase on errors with increasing distance, which is shown by straight lines with parameters estimated by application of the least-squares method.

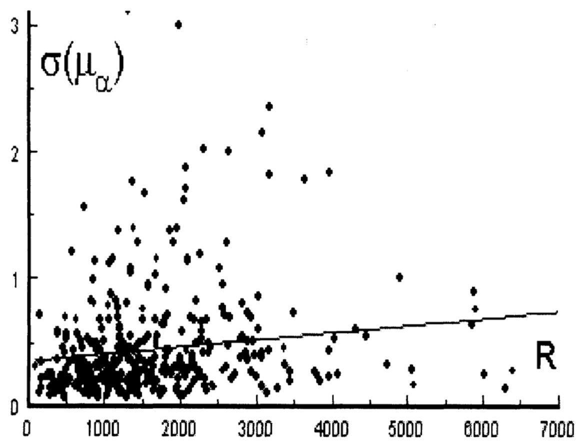

FIGURE 1 The dependence of errors in proper motions on distance from the Sun for right ascension.

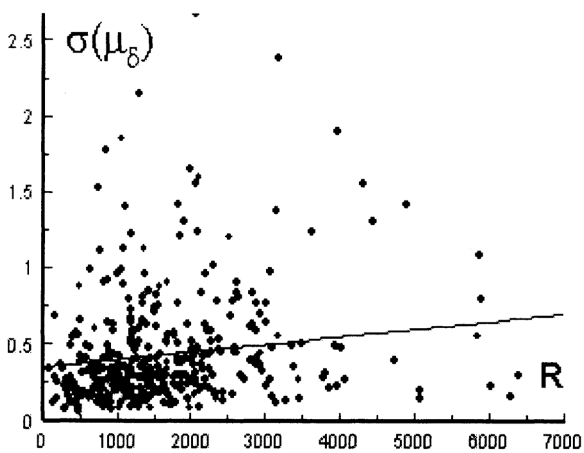

FIGURE 2 The dependence of errors in proper motions on distance from the Sun for declination.

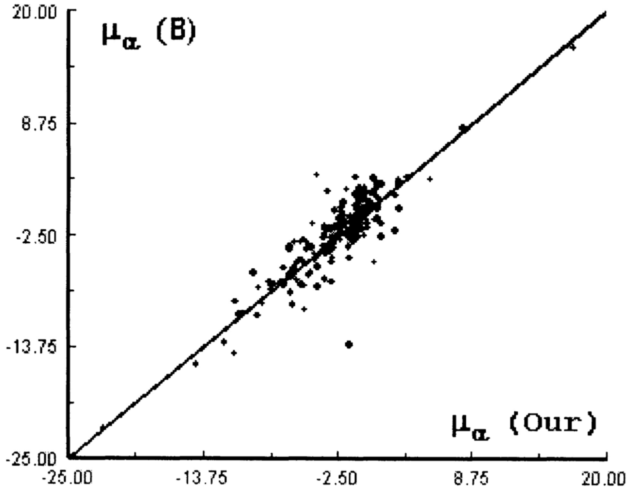

FIGURE 3 Comparison of our estimates of cluster proper motions with the results of Baumgardt *et al.* (2000) for right ascension.

The comparison of the proper motions determined by us with those found by Baumgardt *et al.* (2000) is shown in Figures 3 and 4 for all clusters in common, and that for our data and the results of Dias *et al.* (2001, 2002) is shown in Figures 5 and 6. One can see from the figures that the proper motions of clusters from various sources are reproduced well and not dominated by errors.

The apparently smaller dispersion of points around the line 45° in Figures 5 and 6 in comparison with that in Figures 3 and 4 shows the better quality of the Tycho-2 catalogue for mean proper motion determinations than the Hipparcos catalogue.

The proper motions of 166 open clusters from the 'Homogneous catalogue' which have radial velocities published in literature have already been used by the present authors for estimating the Galaxy rotation frequency from the Sun's distance (Loktin and Beshenov, 2003) and it was shown that, even for the most distant clusters, proper motions contain sufficient

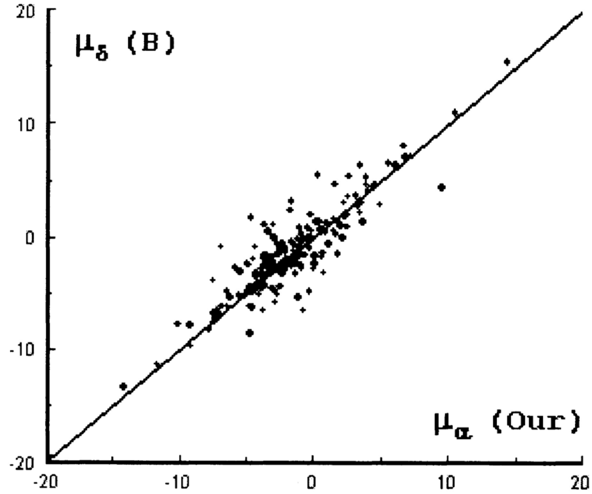

FIGURE 4 Comparison of our estimates of cluster proper motions with the results of Baumgardt *et al.* (2000) for declination.

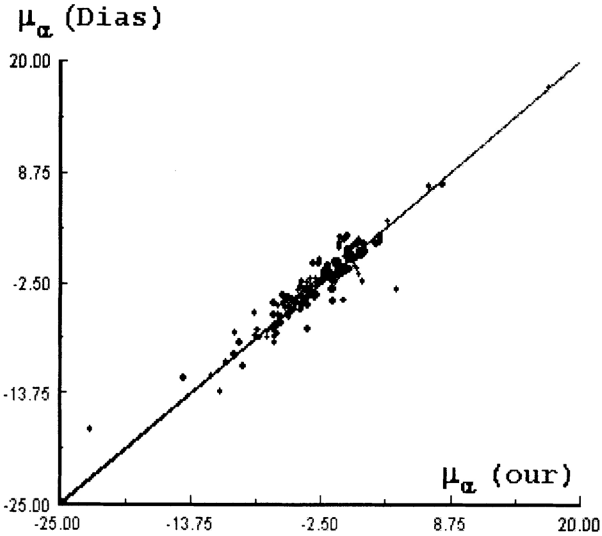

FIGURE 5 Comparison of our estimates of cluster proper motions with the results of Dias *et al.* (2001, 2002) for right ascension.

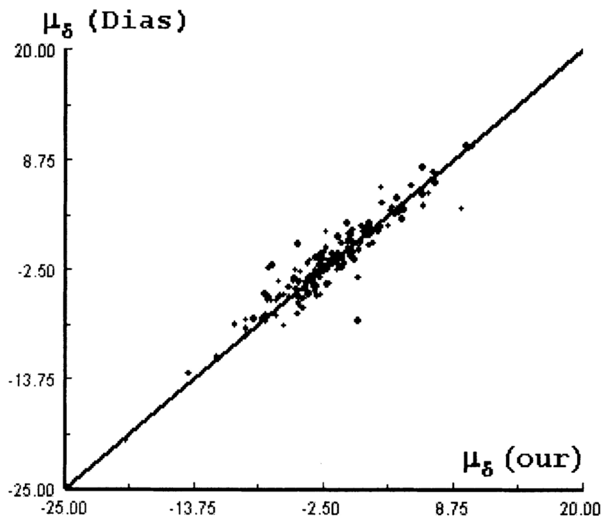

FIGURE 6 Comparison of our estimates of cluster proper motions with the results of Dias *et al.* (2001, 2002) for declination.

information about the kinematics of the Galaxy. At present we are attempting to determine the rotation curve of the Galaxy using the proper motions of all the clusters that we determined here.

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