INVESTIGATION OF STAR CLUSTERS DETECTED AUTOMATICALLY IN 2MASS POINT SOURCE CATALOGUE

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INTRODUCTION

Some attempts to search for star clusters in huge catalogues (2MASS, USNO-A2, DENIS etc.) have been reported elsewhere: Bica et al. (2003a, b) , Drake (2005), Kronberger et al. (2006), Ivanov et al. (2002) etc. For the first time, we have developed a method of an AUTOMATIC search for star clusters in stellar catalogues and applied it to 2MASS catalogue. The detailed description of this method is given in the poster by Sergey Koposov (JD13-43).
At the first stage, we investigated the field of 16 by 16 degrees in the region of the Galactic anticenter, and detected 88 density peaks there. We compared all these peaks with those on the list of open clusters by Dias et al. (2002) and matched 27 of our peaks to known optically visible clusters. Besides, 9 density peaks were matched to infrared clusters embedded in the nebulae from the list by Bica et al. (2003a, b). Dias catalogue contains additional 15 open clusters in this region, but our method does not detect them. However, only two clusters of 15 are reliable open clusters: NGC 1912 and NGC 2168, both having their diameters greater than 20 arcmin. But in the first turn, we are interested in detecting more distant clusters which have diameters from few to ten arcmin. Because more than a half of known clusters which are on our list of detected density peaks, have unreliable or no parameter measurements, we fulfilled the detailed analysis of all 88 peaks.

13 star clusters discovered and confirmed
4 infrared clusters discovered
5 new clusters suspected

METHOD OF ANALYSIS

We built the Hess-diagramme in (J,J-H) coordinates: we plotted CMD within radius *r* equal to 2, 3, or 4 arcmin (depending of the cluster size) around the overdensity center, then we subtracted the CMD for field stars built in the ring between two radii: 3*r and 4*r. Each CMD was previously normalized to the number of stars and smoothed using a 3-pixel Gaussian. (Fig.1)

If a cluster-suspect was found at the Hess-diagramme, then we fitted its CMD with the isochrone by Girardi et al.(2002) of solar metallicity (Fig.2) and simultaneously verified whether the detected stellar group is a real star cluster. For the verification, we employed the fact that the members of a cluster lying on the same isochrone on the CMD exhibit a peak on the radial density distribution (Fig.3). By fitting the position of the isochrone to obtain the maximum contrast on the density plot, we simultaneously determined main physical parameters of a cluster: age, distance, and colour excess.

We performed isochrone fitting on (J, J-H) diagramme, because there is a higher magnitude limit for J-band in 2MASS, and used a 15-arcmin region around stellar overdensity. We independently performed the same fitting procedure on a (K,J-K) CMD and compared the distances obtained from two fittings with each other and the relation $E(J-H)/E(J-K)$ with the normal extinction law given by Cardelli et al. (1989), which equals to 0.55. Also we used the relations $A_{Ks}=0.670*E(J-K_s)$, $A_J=0.276*A_V$, and $E(J-H)=0.33*E(B-V)$ from the paper by Dutra et al.(2002).

Finally, we compared the isochrone fitting on colour-magnitude diagrammes built for regions 2 and 4 arcmin.
The cluster is considered to be a real cluster, if all plots (Hess-diagramme, CMD, radial density distribution) verify the reality of the

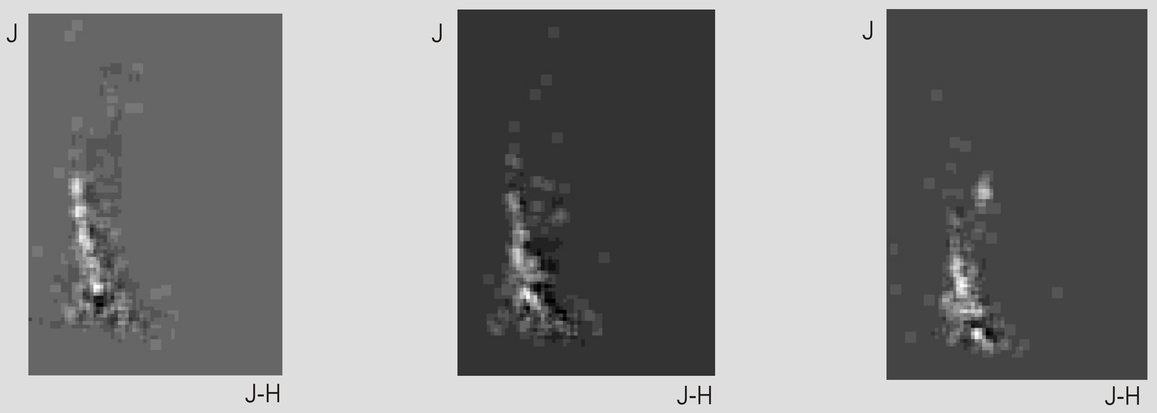

Figure 1. Hess-diagrammes for overdensity peaks Koposov 12, Koposov 49 and Koposov 52 verified to be new clusters.

RESULTS

8 of 88 density peaks are well-studied clusters. The physical parameters we determined using our technique are in a good accordance with published ones.

9 stellar overdensities are known clusters with unreliable or no parameter measurements. We found the distances, ages and reddenings for these objects: Basel 4, Be 19, Be 71, Be 72, Cz 21, Cz 23, Cz 24, King 8, Pis 27. In some cases, we obtained more precise coordinates of the center of cluster.

2 peaks are listed in the Dias catalogue of open clusters (2002): IC 2157 and DC 8, but our analysis shows they are not real clusters based on our verification procedure.

9 density peaks turn out to be infrared clusters detected by Bica et al. (2003a, b). Because of a high value of differential reddening, it was impossible to fit isochrones and found parameters for such clusters.

4 peaks are also known clusters from the Dias list (2002): Dolidze 16, NGC 1893, NGC 1931, NGC 2175, but on Hess-diagrammes, they behave like IR clusters. One of them, NGC 2175, is the infrared cluster from Bica et al. (2003a) - [BDB 2003] G189.85+00.50.

We found 4 new infrared clusters, but could not evaluate their parameters. In Table 1, we list their coordinates.

13 STELLAR OVERDENSITIES APPEARED TO BE NEW CLUSTERS. ONE OF THEM, KOPOSOV 52, HAS BEEN PUBLISHED EARLIER AS KSE18 (ZOLOTUKHIN, KOPOSOV, GLUSHKOVA 2005) AND THEN INDEPENDENTLY FOUND BY KRONBERGER ET AL. (2006). THE PARAMETERS FOR ALL THESE CLUSTERS ARE LISTED IN TABLE 2.

Table 1. New infrared clusters.

Name	RA	DEC
Koposov 7	05 40 44.13	+35 55 25.0
Koposov 41	06 03 57.98	+30 15 40.7
Koposov 58	05 51 11.01	+25 46 41.3
Koposov 82	06 11 55.79	+20 40 14.0

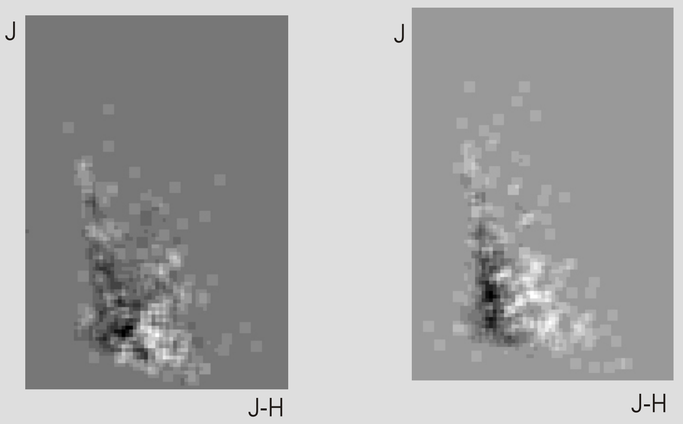

Figure 4. Hess-diagrammes for two new infrared clusters: Koposov 58 and Koposov 7.

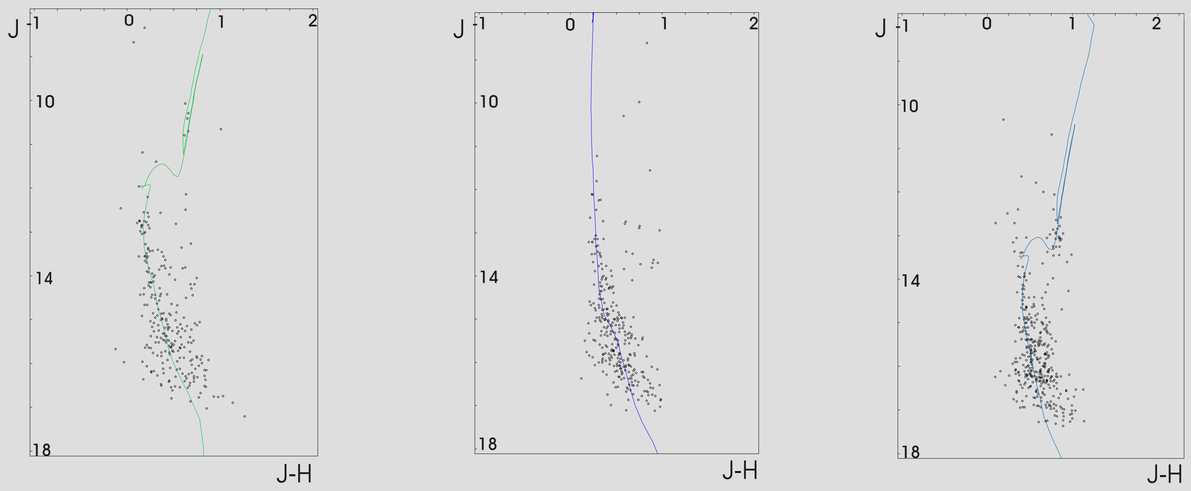

Figure 2. Colour-magnitude diagrammes of new clusters Koposov 12, Koposov 49, and Koposov 52 with the fitted isochrones.

For 5 peaks, Hess-diagrammes show some features as for real clusters, and we could fit the isochrones on CMD. However, these isochrones differ from those of reliable clusters, so we put them in the group of suspected clusters. One of them, Koposov 15, was described by Kronberger et al. (2005) but their isochrone fitting differs from ours.

34 density peaks showed no signs of a real cluster, and are considered as occasional groups of stars.

CONCLUSIONS

In the field of 16 by 16 degrees in the region of Galactic anticenter, we have found and verified 17 new open clusters and 5 suspected clusters. For 18 of them, we obtained main physical parameters.

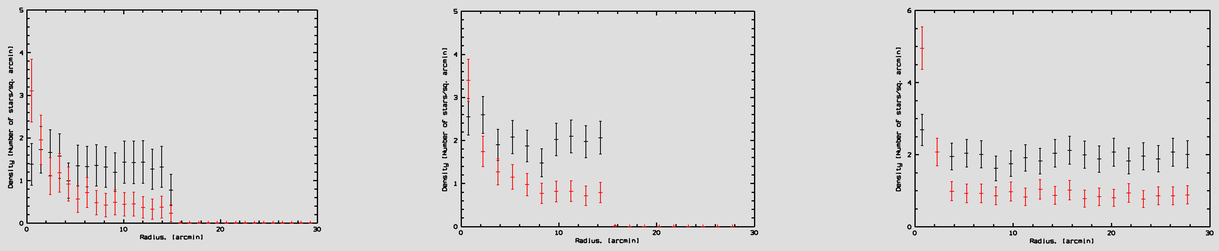

Figure 3. Radial density distribution of stars lying on fitted isochrone (red points) and that of field stars (black points) for the clusters Koposov 12, Koposov 49 and Koposov 52.

REFERENCES
Bica E., Dutra C.H., Soares J. and Barbuy B., 2003a, A&A 404, 223
Bica E., Dutra C.M., Barbuy B., 2003b, A&A 397, 177
Cardelli J.A., Clayton G.C., Mathis J.S., 1989, ApJ 345, 245
Dias W.S., Alessi B.S., Moitinho A. and Lepine J.R.D., 2002, A&A 389, 871
Drake A.J., 2005, A&A 435, 545
Dutra C.M., Santiago B.X., Bica E., 2002, A&A 381, 219
Ivanov V.D., Borissova J, Pessev P. et al., 2002, A&A 394L, 1
Girardi L., Bertelli G., Bressa A. Et al., 2002, A&A 391, 195
Kronberger M., Teutsch P., Alessi B. et al., 2006, A&A 447, 921
Zolotukhin I., Koposov S., Glushkova E., 2005, ASP Conference Ser. 30, 147

Table 2. Parameters of new open clusters.

NAME	RA	DEC	Diameter, arcmin	E(B-V)	Distance, pc	Age, log(t)
Koposov 5	05h 19m 39.21s	+36°30´16.5"	4	0.83 ± 0.05	2400 ± 200	9.90 ± 0.05
Koposov 10	05 47 28.61	+35 25 56.1	4	0.89 0.05	2000 100	< 7.5
Koposov 12	06 00 56.17	+35 16 36.2	9	0.30 0.05	2000 100	8.90 0.05
Koposov 27	05 39 30.05	+33 21 00.5	3	0.60 0.05	2300 200	< 7.5
Koposov 43	05 52 14.61	+29 55 09.3	8	0.38 0.05	2800 200	9.30 0.05
Koposov 49	05 44 22.18	+28 49 13.4	10	1.00 0.05	2600 400	< 7.5
Koposov 50	05 36 10.01	+28 44 32.6	4	1.72 0.10	3500 600	< 7.0
Koposov 52	05 53 48.92	+26 50 25.1	5	1.03 0.05	2900 200	8.95 0.05
Koposov 53	06 08 56.22	+26 15 49.1	5	0.38 0.05	3500 600	< 7.5
Koposov 62	06 18 02.03	+24 42 38.5	6	0.34 0.05	2800 200	9.40 0.05
Koposov 63	06 10 01.69	+24 33 38.1	5	0.15 0.05	2700 600	9.50 0.10
Koposov 71	06 14 15.39	+22 29 32.2	6	0.44 0.05	4900 200	9.15 0.05
Koposov 77	05 43 52.32	+21 42 37.1	5	0.57 0.05	1800 100	9.65 0.05