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SEARCH FOR UNDETECTED STAR CLUSTERS IN OUR GALAXY IN THE 2MASS DATABASE

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Abstract. A simple and robust method, based on stellar surface density was proposed in order to search for undetected star clusters in our Galaxy on the base of the 2MASS catalogue. The zone of the sky of galactic latitude between -80 and -40 degree was choosen to test the method. As a result we identify approx. 30% of suspected cluster candidates. Careful check of the remaining objects show that most of them are asterisms.

1. Introduction and Motivation

The known Galactic globular clusters (GC) are less than 150 (Harris 1996). The majority of them were discovered through optical searches, biased against highly obscured objects. Since the Galaxy is estimated to have 160±20 GCs (Harris 1991), a certain number of them may still be hidden behind the Galactic disk. On the other hand, according to the latest numerical predictions approximately 50 star clusters are expected to be found towards the galactic center (Portegies et al, 2001).

The Two Micron All Sky Survey (2MASS) offers an opportunity to carry out a search for missed GCs because it covers the Galactic Plane in near-infrared wavelengths where the extinction is almost ten times smaller in comparison with the optical part of the spectrum (e.g. Rieke & Lebofski 1985). The abundant dust found throughout this region obscures both Galactic and extragalactic sources. The 2MASS provides the first views in three near-infrared bands (J, H and K_S) of the entire populations of sources–ranging from galaxies in the Zone of Avoidance to stars and clusters in the Milky Way–across a significant fraction of the sky.

The purpose of this paper is to present the searching criterion for undetected star clusters and the first results for the zone of the sky of galactic latitude between -80 and -40 degrees.

2. Search Algorithm

A simple and robust method, based on stellar surface density was chosen for this project. It was implemented as a set of C codes in order to carry out the process automatically – a necessity dictated by the vast amount of data that have to be processed.

The first step was to divide 2MASS point source catalog into spatial bins. We chose square bins, to minimize the computational demands. The bin size is a free parameter, to allow searches of structures of different angular sizes on the sky. For each bin we store the total number of stars, the K_S-band luminosity function, and the distribution of stars along $J - K_S$ color.

We also select and store the "red" objects in each bin, for further analysis. We use an adaptive definition for them: (i) a polinomial separating the stellar locus from non-stellar point sources on the $[K_S, (J - K_S)]$ CMD was determined based on a inspection of star-dominated fields; (ii) for each bin the polinomial is given an offset relative to the median K_S-band magnitude, and the median $J - K_S$ color of the bin.

The result from the first step is a 2-dimensional distribution of stars on the sky. Next, we search for peaks in this 2-D histogram. For each bin we calculate the background level and its standard deviation σ from the average number of stars in the neighbouring bins. Finally, we store for future inspection and identification the "peaks" of the 2-D distribution that deviate by more than 3σ from the background value.

3. Results and Discussion

To verify our search algorithm and to explore the parametric space of the search parameters – namely the bin size and overdensity – we selected a region of the sky with low concentration of globular clusters: $0 \leq$ R.A. ≤ 24 hr and Dec ≤ -40 degr, far from the Galactic center.

A map of the region is given in Fig. 1. The known CGs are indicated by open circles.

The field yielded 149 cluster candidates. A search in SIMBAD databases allowed us to identify only 42 of them. In Fig. 2 are shown histograms of standard deviation σ and number of stars in the selected bins. Solid lines are for cluster candidates, dotted lines indicate the "known" objects.

Analysis of Fig. 2 shows that 28% of cluster candidates are identified. Only 2% of them have $\sigma \leq 4$ and N_{star} (number of stars in the bin) more than 150. The careful check of these cluster candidates shows, that they are usually situated in very reach fields in Magelanic Clouds and Galaxy. We exclude them from future analysis and prepare list of so-called "most probable candidates". They are given in Table 1. The coordinates given in Columns 2 and 3 represent the center of the bins.

The above selected star cluster candidates were checked in Simbad on R plates. Ten of them which are situated in dense and crowded fields are examined on J,H,K Quick View images. Another 7 clusters are identified as LMC clusters. The remaining cluster candidates are probably asterisms, except 5 candidates which could be star clusters. The coordinates of their centers are given in Table 2.

Further analysis of the color-magnitude diagrams and follow-up observations are necessary to confirm the status of star cluster candidates given in Table 2.

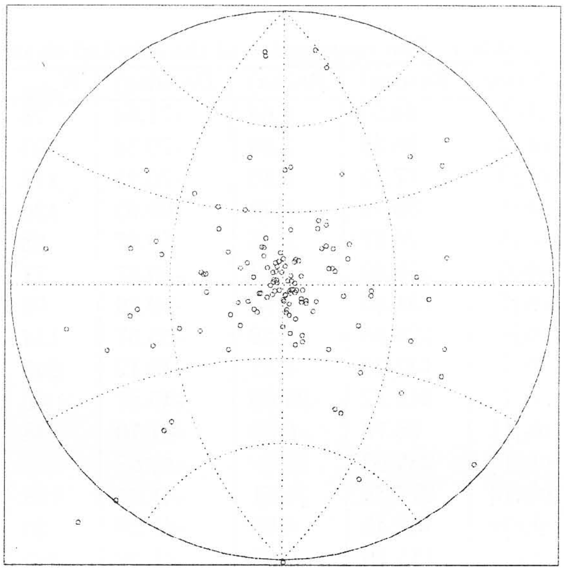

Fig. 1: Map of the test field. The known Galactic GCs are indicated as open circles.

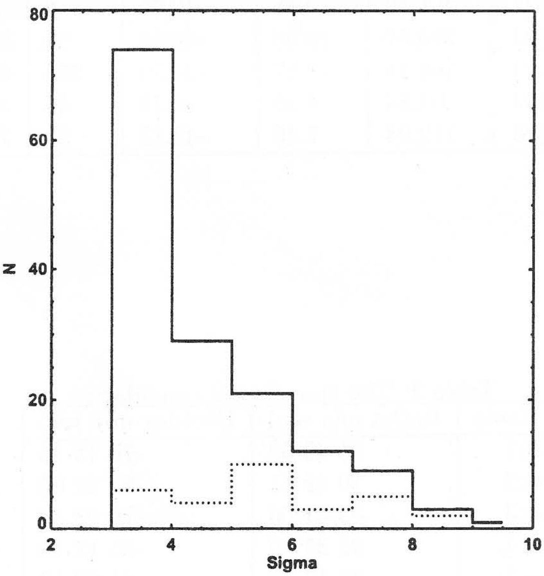

Fig. 2: Histograms of standard deviation σ and number of stars in the bins. Solid lines are for cluster candidates, dotted lines indicate the "known" objects.

Table 1: The coordinates of the selected objects

Name	Ra(deg)	Ra(ha)	Dec(deg)	N_{star}	σ
obj1	84.54	5.64	-71.54	78	3
obj2	85.38	5.69	-70.38	123	3
obj3	77.71	5.18	-70.21	113	3
obj4	85.79	5.72	-69.63	120	4
obj5	126.87	8.45	-59.87	58	6
obj6	129.62	8.64	-59.87	71	5
obj7	131.45	8.76	-59.29	95	6
obj8	128.95	8.59	-55.37	114	9
obj9	132.29	8.81	-48.12	245	5
obj10	342.12	22.80	-46.87	46	6
obj11	98.70	6.58	-41.70	48	5
obj12	289.62	19.30	-41.62	88	5
obj13	277.79	18.51	-41.37	158	5
obj14	102.45	6.83	-41.29	59	6
obj15	115.20	7.68	-41.29	109	6
obj16	104.79	6.98	-41.04	65	6
obj17	297.87	19.85	-41.04	46	5
obj18	119.29	7.95	-40.87	149	7
obj19	112.95	7.53	-40.79	99	7
obj20	105.62	7.04	-40.70	59	6
obj21	296.79	19.78	-40.70	54	5
obj22	299.37	19.95	-40.54	55	5
obj23	268.16	17.87	-40.29	358	6
obj24	103.54	6.90	-40.12	48	5
obj25	112.04	7.46	-40.12	89	7

Table 2: The star cluster candidates

Name	Ra(ha min sec)	Dec(deg min sec)
cc1	05 42 39	-70 14 18
cc2	10 42 41	-62 32 02
cc3	05 41 06	-70 23 33
cc4	08 35 30	-55 12 13
cc5	08 10 49	-41 20 12

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