Search and investigation of new stellar clusters using the data from huge stellar catalogues

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In this brief note we want to show several new methods which allow to involve the data from existing huge stellar catalogues into the search and analyze of stellar clusters. We also show some preliminary but very promising results of those methods.

Currently there are several compiled catalogues of stellar clusters, but they all have several significant disadvantages

1. There is a big percentage (tens of percents) of clusters in the catalogues which actually do not have any parameters measured, do not have a Color-Magnitude diagram (CMD), and are therefore just non-verified groups of stars.
2. A significant part even of well known big clusters do not have confident measurement of parameters (radius, distance, color excess).
3. All the clusters in catalogues came from very different sources, and nobody ever performed a really homogeneous search of clusters.

But now the existing data in huge stellar catalogues really allow to overcome most of the problems mentioned above, and we can apply a really serious and uniform approach to the search and investigation of stellar clusters.

Our work:

1. We have designed the method to search/find effectively stellar clusters of different radii in the star catalogues (like USNO, 2MASS etc.). This task is not so simple, and has not been performed by anybody before, because of highly variable mean stellar density. For this task we used a somehow modified method based on the convolution with density functions (fig. 4)
2. Also, we have designed a rather robust method which can be used to determine whether this density peak is just occasional overdensity of field stars or this is a real group of evolutionary related (lying on one isochrone) stars. In that method simultaneously we also find the position of the isochrone of the cluster. (This last steps are mainly based on the fact that in real clusters only stars lying on the isochrone show a density peak, but the field stars should demonstrate flat distribution (fig. 3). This fact allows to find the position of the isochrone of the cluster even when the CMD is "polluted" by field stars)

So, briefly, we can find clusters, confirm them, and determine the main parameters (radius, distance and color excess) of those clusters.

Our algorithms are mainly realized and programmed (we almost finished the automation of them). And surely we have performed some tests of them. The testing was based on several fields from 2MASS (2MASS is our primary target catalogue). And the results of the tests are quite promising. From the very preliminary analysis of the 250 sq. degrees in the Galaxy Anticenter region we have found several ($>\approx 10$) NEW clusters, and have determined the parameters for them (fig. 2). In that region also we were able to determine the parameters for several clusters without such measurements. Also, a set of new clusters was found when we just looked in the region of Perseus arm. (I should notice also, that the clusters, which we have found are not just infrared clusters, most of them are clearly visible in the optical wavelength range).

Conclusion: As a result of our work we plan to obtain the new catalogue of confirmed stellar clusters, containing several percents of new clusters, and with homogeneously measured parameters. It would be interesting also to try to apply these methods to several other catalogues (DENIS, SDSS ...).

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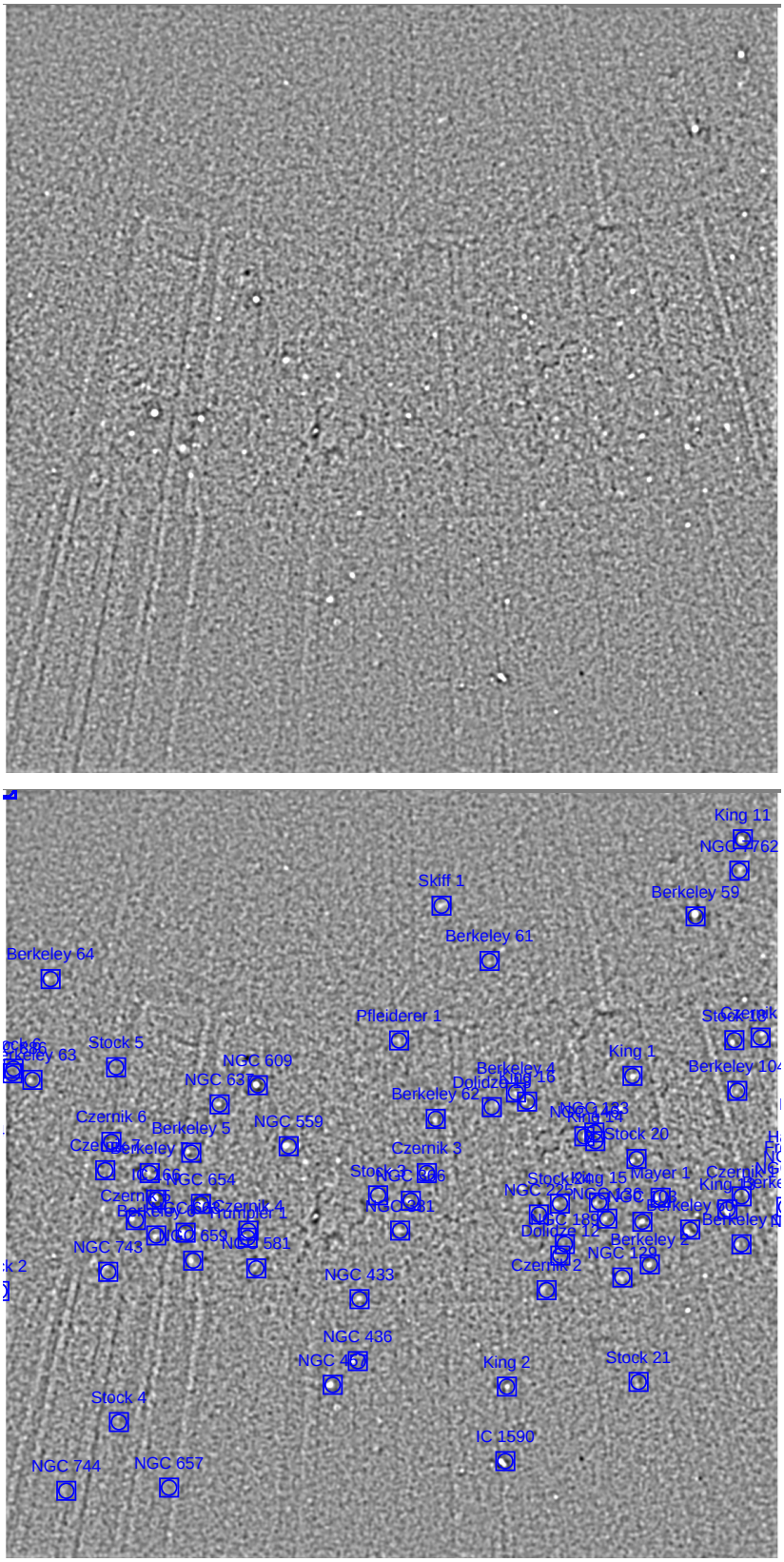

Figure 1: The Region of Perseus arm (16^0 x 16^0).
The top panel is the overdensity map obtained by our methods, the bottom panel is the same map but with overplot of known clusters. It can be seen that most of the known clusters correspond to the peaks on our map, so they can be easily detected by our method. But also, there are several peaks not corresponded to known clusters. These are new clusters.

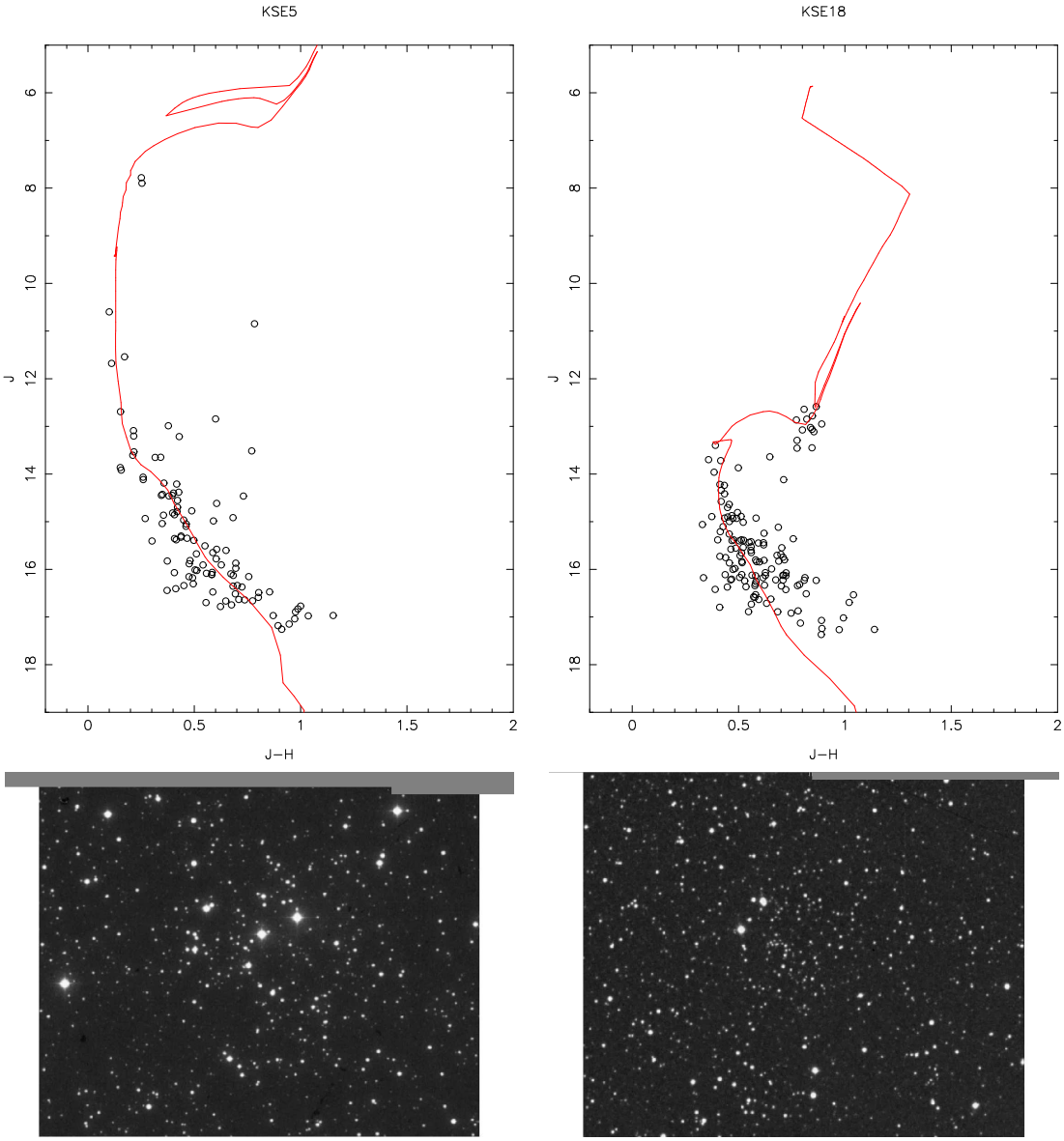

Figure 2: Just two examples of NEW open clusters. Panels on the top – Color-Magnitude diagrams of clusters KSE5 and KSE18 with overplotted isochrones. Panels on the bottom – corresponding DSS images.

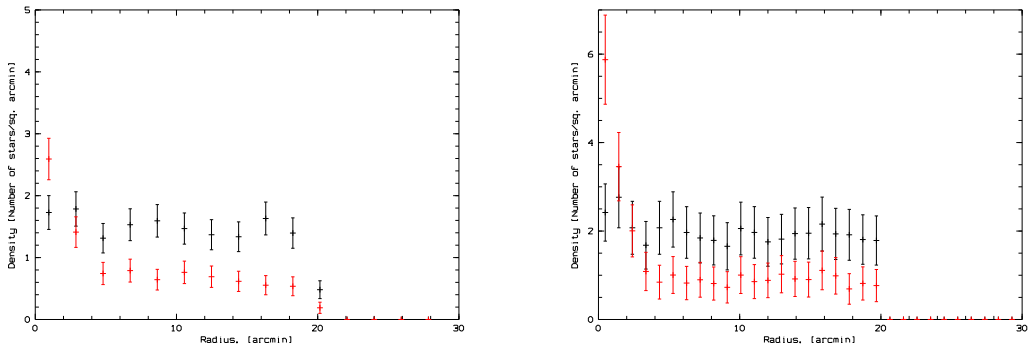

Figure 3: The density plots for two clusters from previous plots (the red points are the density of points lying on the isochrone, the black ones are the density of stars lying "far" from isochrone on CMD). This plots allows us to determine the right isochrone position of the cluster, only when the isochrone is rightly positioned we will obtain the peak of red points (cluster), and the constant level of black points (field).

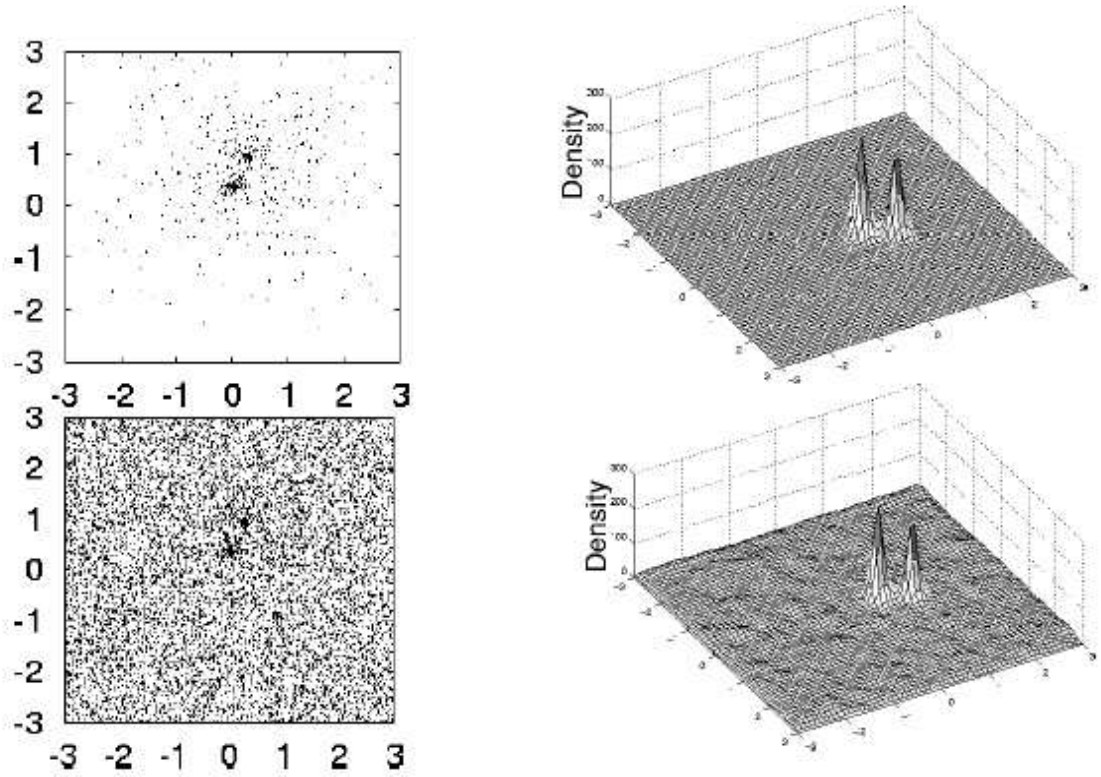

Figure 4: The illustration of the method based on density functions. Each object from the catalogue is "transformed" to some predefined function and the summary image is computed.