



Membership Identification of Globular Clusters

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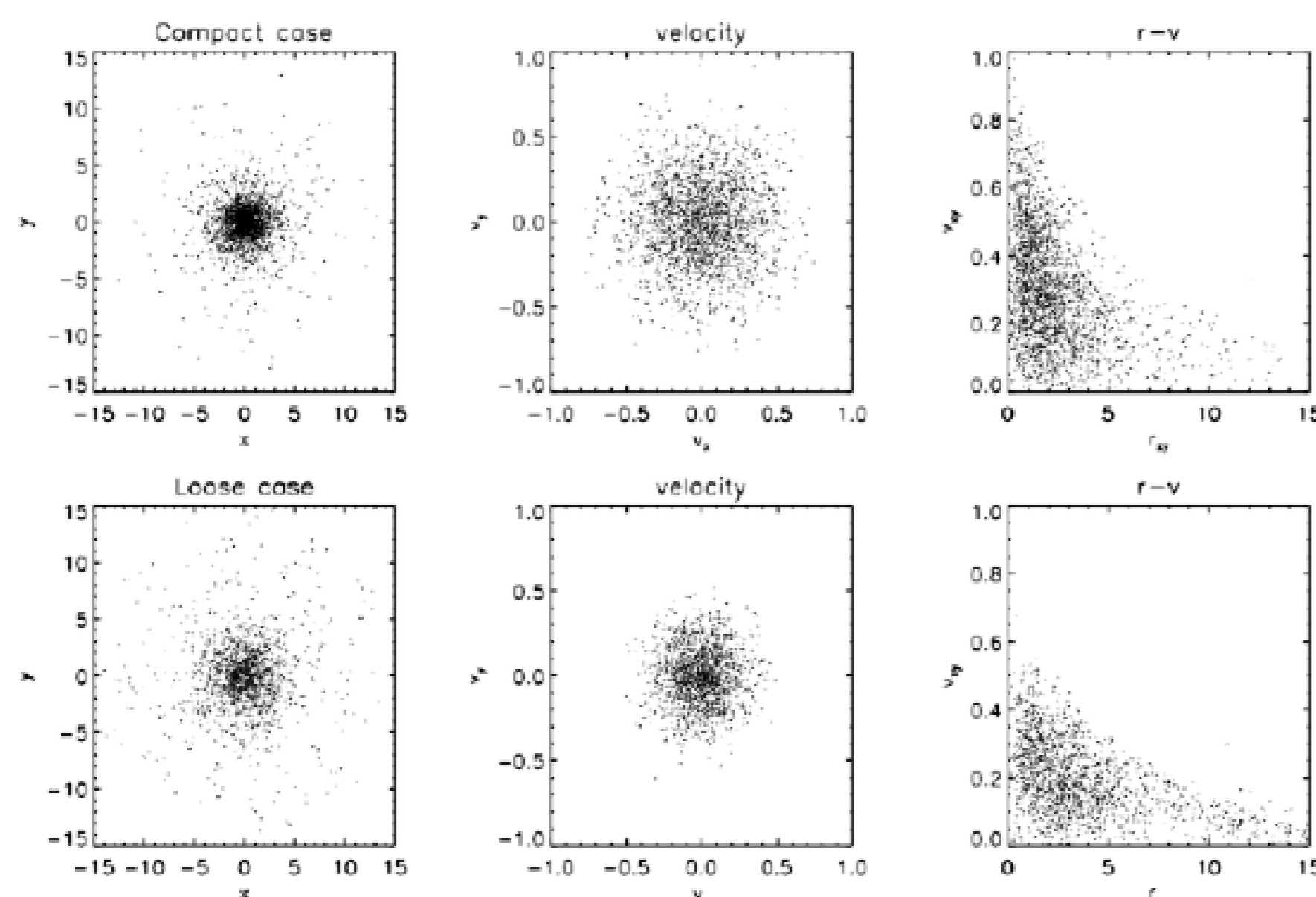
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Summary

We have developed a method for obtaining membership probabilities by determining the 2-D radius-velocity profile based on our simulations. The spatial distribution and the proper motion data are taken from the UCAC3 catalog. The color-magnitude diagram for clusters is also derived from the UCAC3, which includes the 2MASS data. We have identified the members of some globular clusters simply by separating the cluster members and the field stars in the radius-velocity profile. Previous works usually identified the membership of globular clusters by the spatial distribution (radius), velocity distribution (proper motion), or isochrone fitting on color-magnitude diagram. Field star contamination might be severe and many high speed stars near the central region might be neglected. Our method provides a more complete high velocity members and thus a better estimate of the mass of the cluster might be obtained.

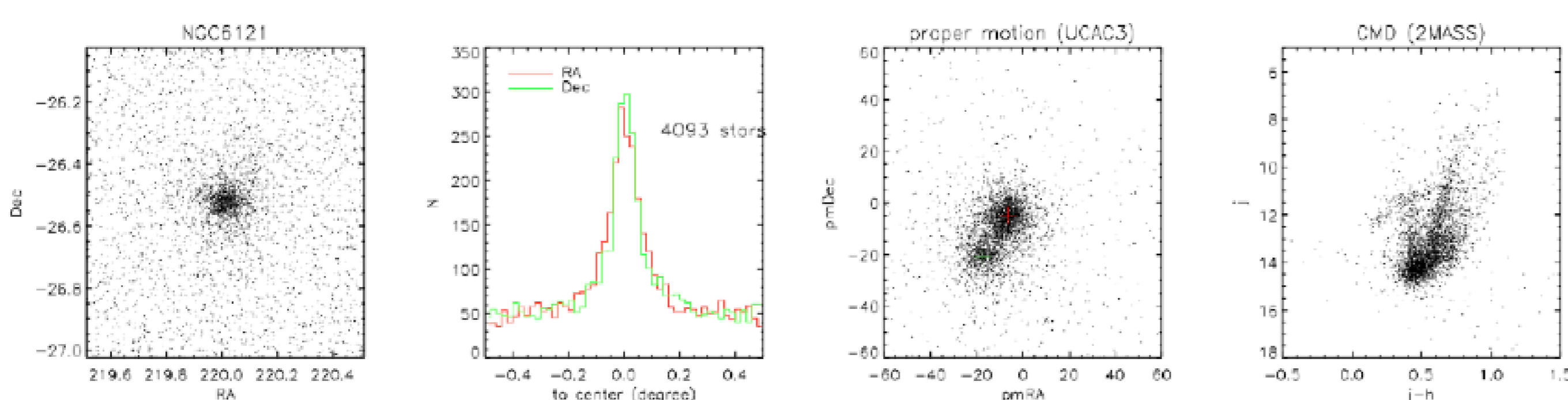
Radius-velocity profile of clusters



The distributions are taken from our simulations for stellar clusters with dispersing molecular clouds. Typical survival cases are classified as 'Compact' and 'Loose'. Stars near the center region could have higher velocity and distribute broader in $v_x - v_y$ space.

Globular cluster NGC 6121

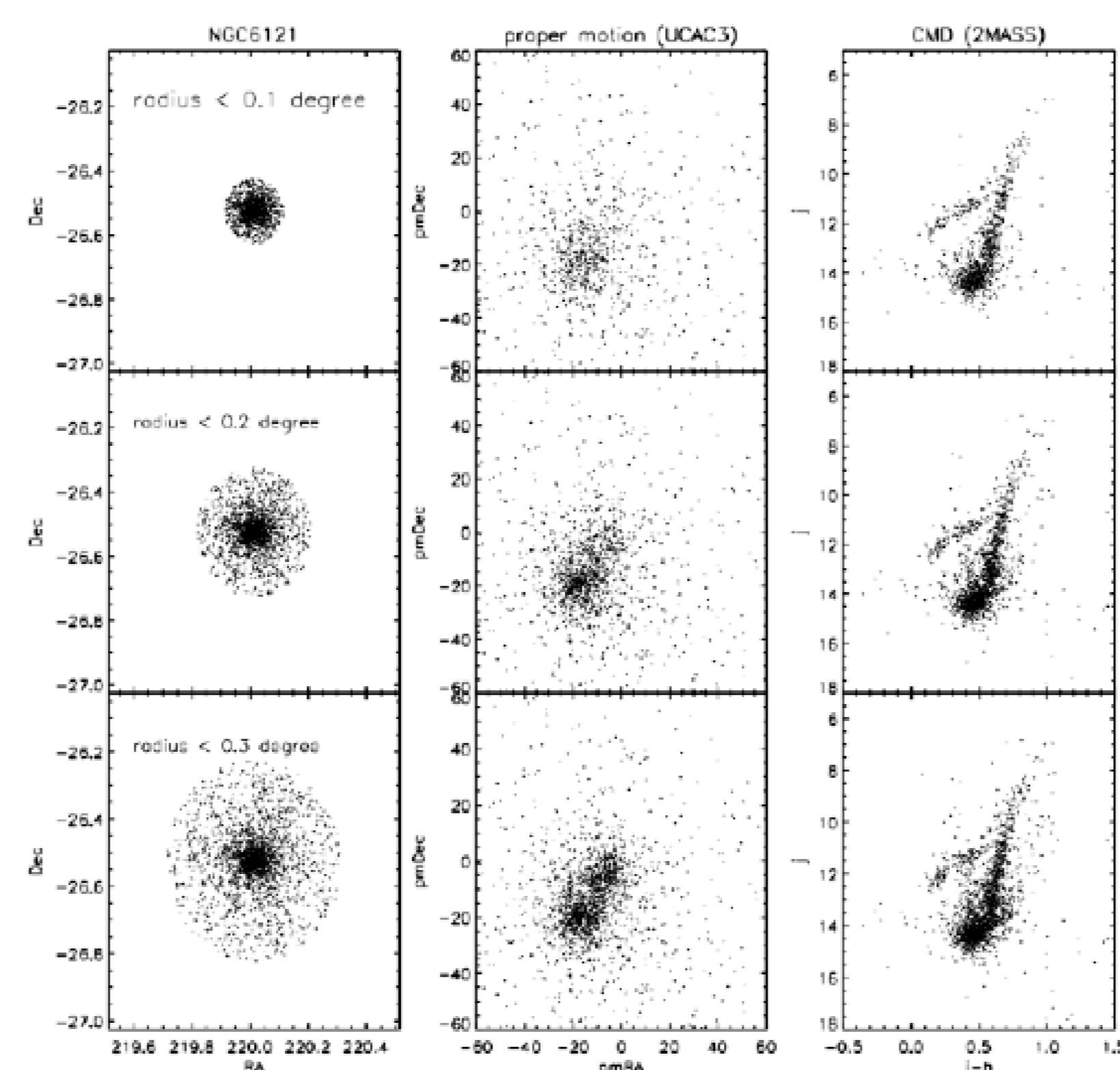
NGC 6121 (M4) is a nearby globular cluster (~ 2.2 kpc). The radius is about 0.2 degree from the histogram of RA and Dec directions. The proper motion (by UCAC3 data) shows that there are two groups, cluster members (green cross shows the center) and the field stars (red cross shows the center). But their distributions are overlap and so is the distribution in the infrared CMD (color-magnitude diagram) by 2MASS data.



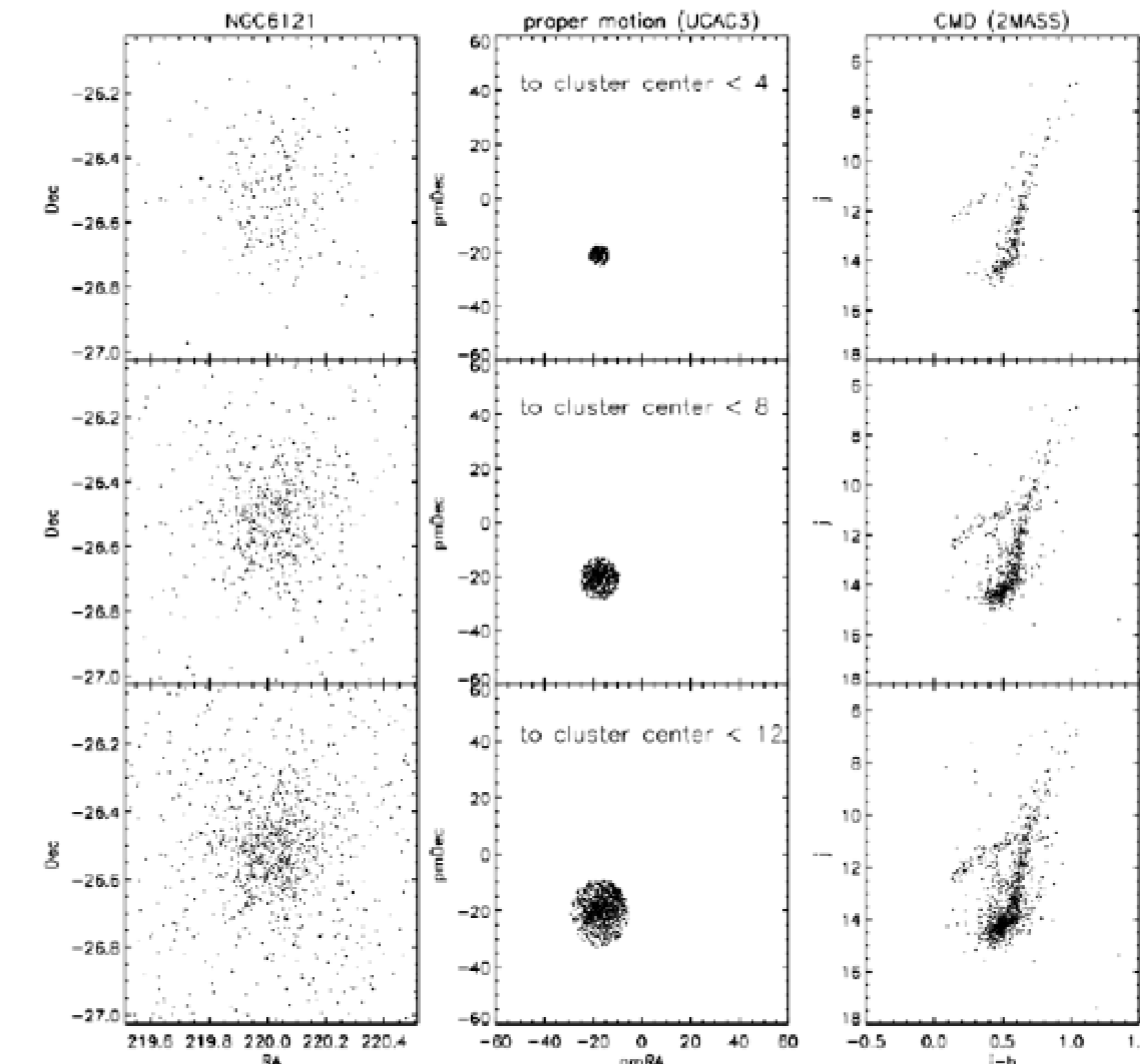
Membership identification

By radius restriction

The radius of NGC 6121 seems a little larger than 0.2 degree by the histogram. Here is stars chosen by the radius of 0.1, 0.2, and 0.3 degree, respectively. For 0.1 degree case, the contamination of field stars is not obvious in both proper motion and CMD. For 0.2 degree case, the contamination is not ignorable. It becomes even much worse for 0.3 degree case.



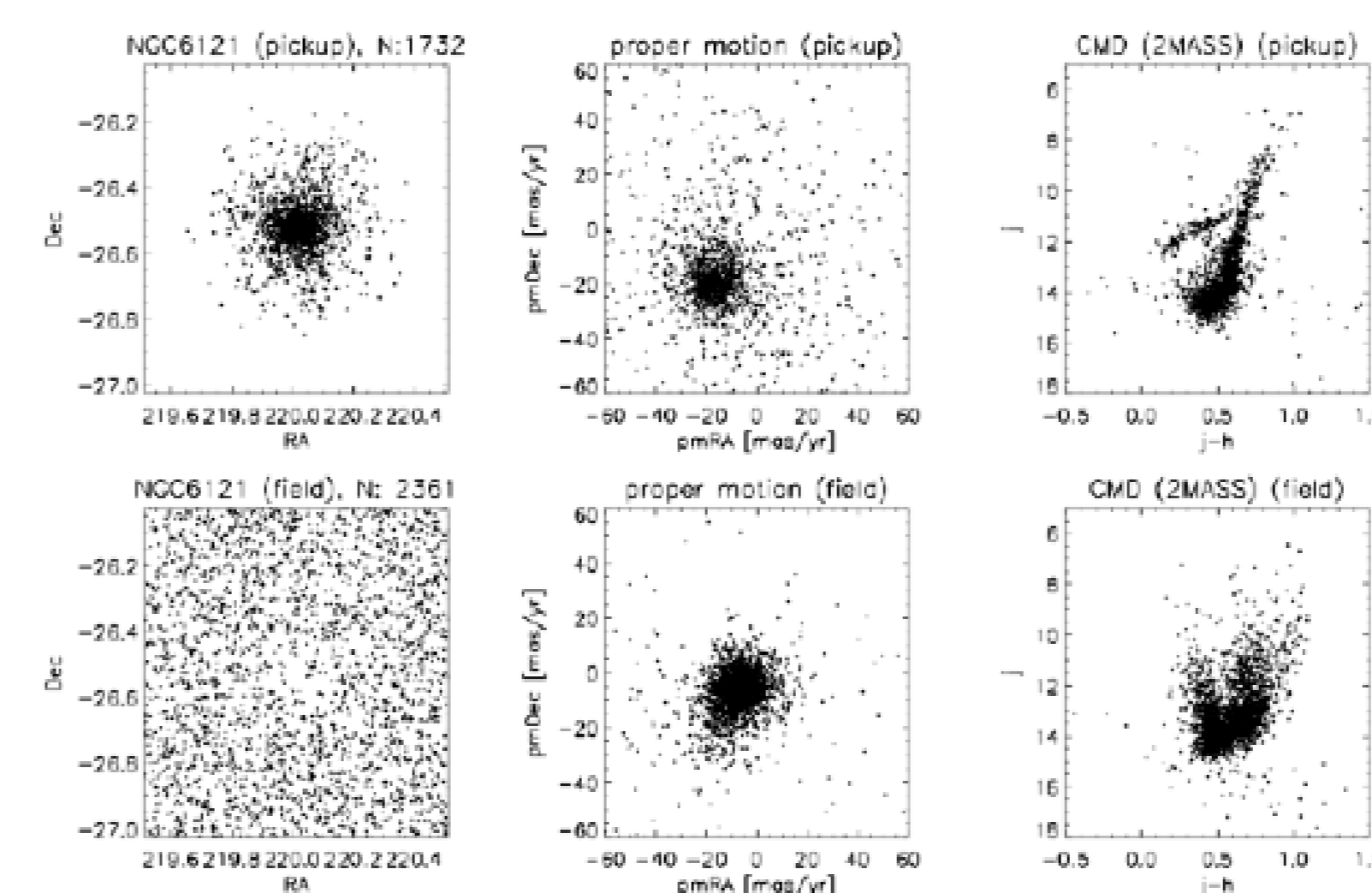
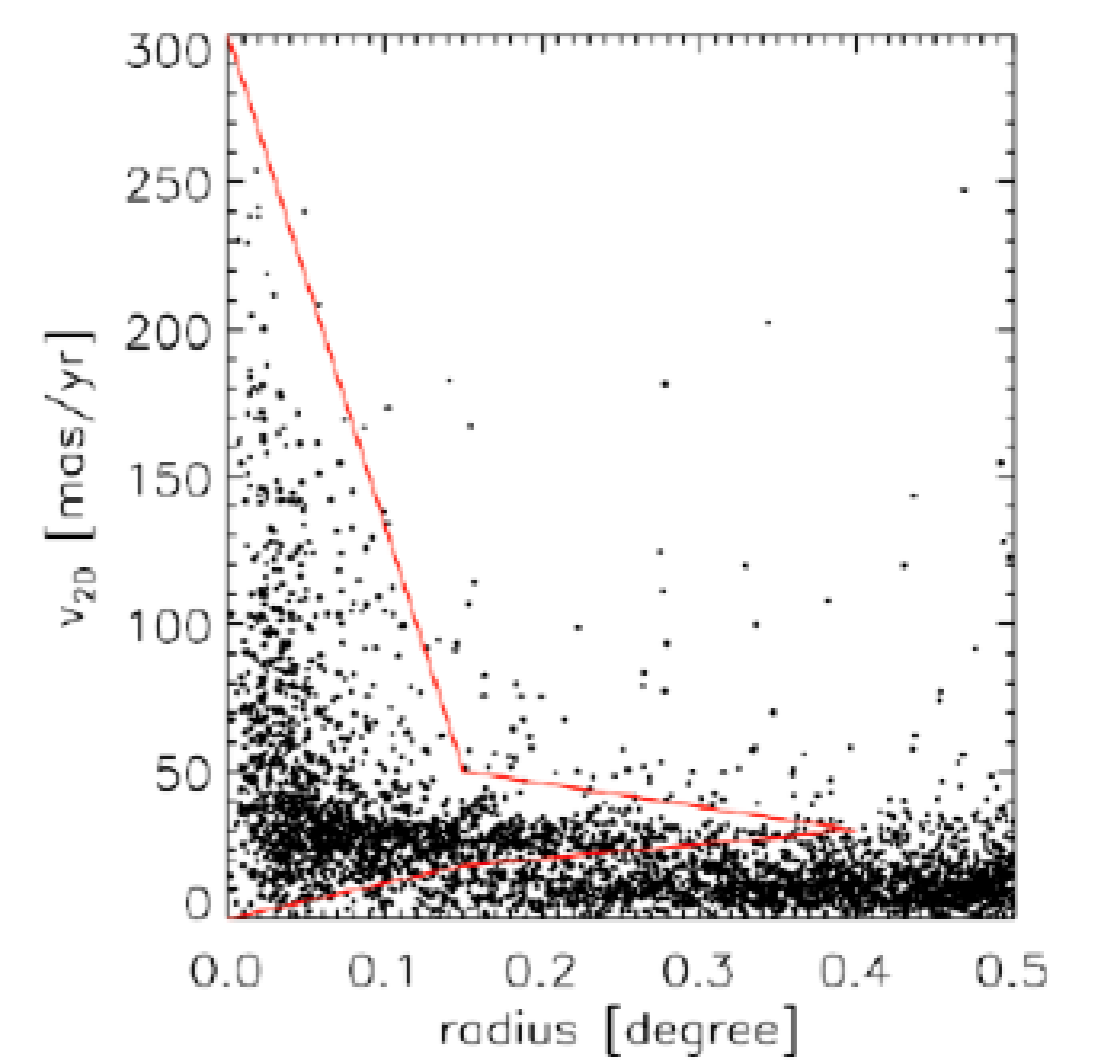
By proper motion restriction



The center of proper motion for member stars is at about $(-20, -20)$ [mas/yr]. Stars with proper motion less than 4, 8, and 12 mas/yr to the center are chosen. For proper motion < 4 mas/yr, more stars are within 0.2 degree and the CMD is quite clean. For proper motion < 8 mas/yr, field stars appear and the CMD is contaminated. For proper motion < 12 mas/yr, more field stars could be seen and less stars near the central region comparing with the plot of radius < 0.1 degree.

By r-v relation

By the $r - v$ relation derived from our simulations, the different distributions between the member stars and the field stars are expected. The $r - v$ relation for NGC 6121 shows the two groups and we can simply draw a few lines to separate them. As seen in the plot, most field stars spread widely and have lower velocities. The pickup stars present the internal motion of star clusters. The distortion of the internal motion is due to that the center of the proper motion of member stars is not at zero point.



Plots for 'the pickup stars' and 'the field stars' show the distinct properties in spatial distribution, proper motion, and CMD. Although there are still some contamination between each other.

Some other clusters

