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A photometric study of poorly-populated stellar concentrations

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Abstract. Recent cluster candidate catalogues include a number of interesting poorly populated stellar concentrations. However, these objects have been little studied when compared to classical ones like open clusters, globular clusters and, the recently explored, embedded clusters. We investigate the nature of poorly-populated stellar concentrations by applying two independent approaches developed by our group, one previously applied mostly to open and embedded clusters (Method 1), and the other specifically to poorly-populated stellar concentrations themselves (Method 2).They are designated possible open cluster remnants (POCR). Method 1 was built to treat open clusters or candidates projected against crowded bulge and/or disc fields. We detect over densities against the background field. The Method 2 consists in a diagnostic tool to analyse 2MASS CMD distributions of the poorly populated systems and surrounding fields to disentangle them. We use automated tools to (i) derive the limiting radius, (ii) decontaminate the field and assign membership probabilities, (iii) fit isochrones. Finally, we compare POCR and field CMDs considering the isochrone solution. Our main goal is to photometrically identify stellar systems and candidate objects for future studies including kinematical analyses. In the present work we study 4 POCRs.

Key words. Galaxy: open clusters and associations: general

1. Introduction

Poorly-populated stellar concentrations are relatively common in classical open cluster catalogues (Mermilliod & Paunzen 2003;Dias et al. 2002). They are little studied in comparison to objects like open, globular and, the recently explored, embedded clusters (Camargo et al. 2010; Camargo et al. 2011). They are designated possible open cluster remnants (POCR)(Pavani et al. 2001).

2. The Sample

In this work we present the results for 4 POCRs. The complete sample includes 31 objects to be studied in a forthcoming paper (Fig. 1). They are underpopulated with respect to usual open clusters. We focus on the more concentrated ones (cPOCRs). Photometry is the main information source available for POCRs. The 2MASS database (Skrutskie et al. 2006) probes objects and fields homogeneously, gives photometric errors and completeness estimates.

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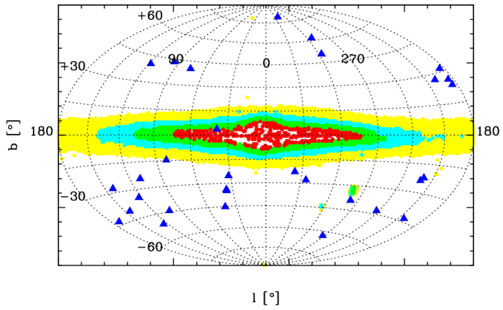

Fig. 1. Whole sky Aitoff projection showing in Galactic coordinates the positions of the 31 cPOCRs (triangles). 2MASS background stellar densities are shown in five levels, corresponding to the 20*th*, 40*th*, 60*th* and 80*th* percentiles in the $log(\rho_{field})$ distribution, considering star counts with $K_s < 14$ mag per square degree.

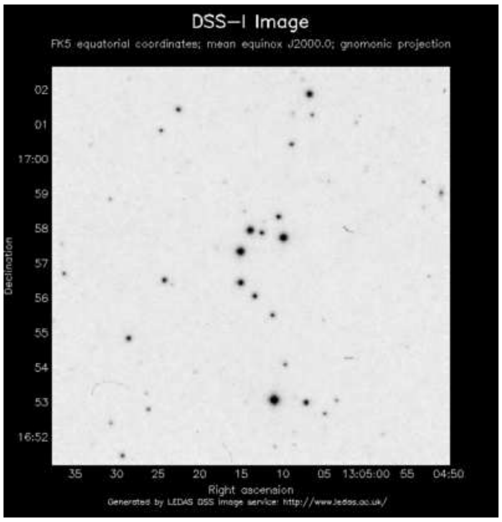

Fig. 2. Example of Digitised Sky Survey (DSS) *I* image. Renou 38 (8.0×8.0 arcmin^2).

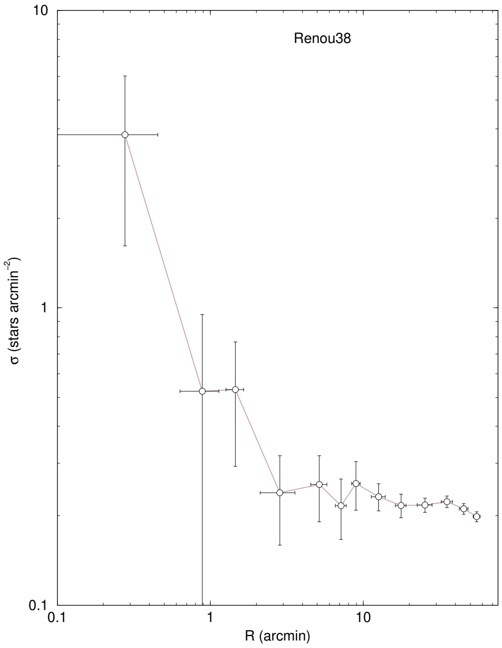

Fig. 3. Renou 38 stellar RDP provide a general view of POCR structure. Poisson errors are also shown.

3. The Method

We investigate the nature of the cPOCRs by applying two independent approaches developed by our group, one previously applied mostly to open and embedded clusters - Method 1 (Bonatto & Bica 2007;Bica & Bonatto 2011), and the other specifically to test if POCRs can be distinguished from field fluctuations - Method 2 (Pavani et al. 2011).

The methods (i) build stellar radial density profiles (RDP) - Fig. 3; (ii) analyse object and field CMD distributions to decontaminate and assign membership probabilities - Fig. 4 and 6. The statistical comparison with the field and the final characterization are also illustrated in Figs. 5. From isochrone fitting both methods give age, reddening values and distance modulus. We used the recent Padova isochrone models[1] (Girardi et al. 2010).

We also studied by means of Methods 1 and 2 the POCRs NGC 5385 and NGC 7134. The first appears to be an open cluster remnant (OCR), while the second appears to be plain field. For the OCRs we estimated the fundamental parameters. Renou 38: $\tau_{age} \approx 2.5$ Gyr, E(B V) ≈ 0.12 and $d_\odot \approx 0.7$ kpc. NGC 5385: $\tau_{age} \approx 2.3$ Gyr, E(B V) ≈ 0.13 and $d_\odot \approx 0.9$ kpc.

[1] `http://stev.oapd.inaf.it/cmd`

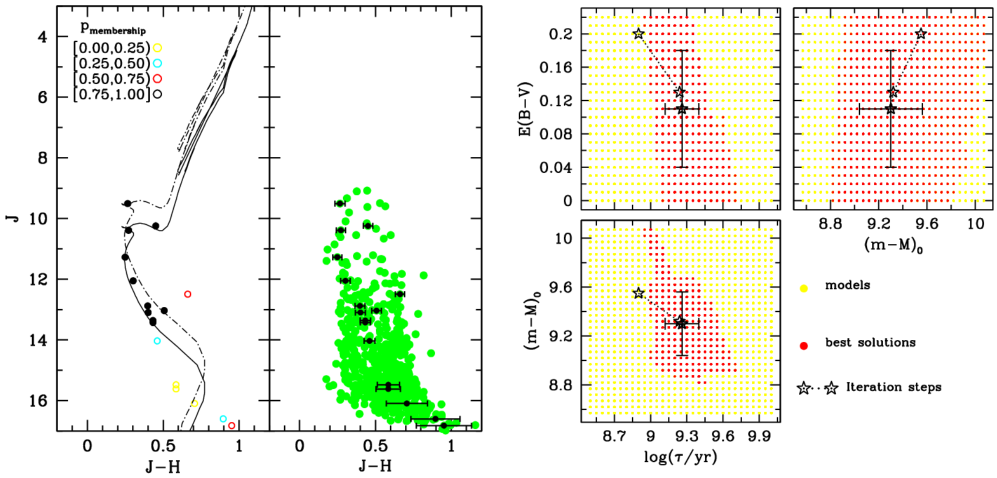

Fig. 4. Left Panel: Renou 38 J × (J-H) CMD where membership probabilities are shown in colour code. Solar metallicity isochrone, together with shifted one due to binaries of equal masses (dashed line). The POCR stars (R=4′) are plotted over the control field in green (R=30′). Right Panel: Parameter space where the evolution of the output solution (open star) is shown.

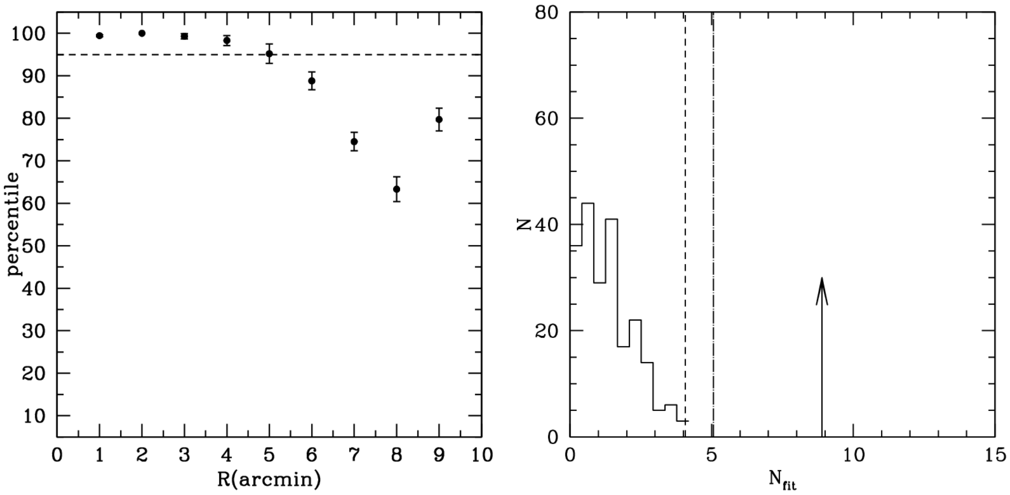

Fig. 5. Left Panel: Search of the optimal object radius. The horizontal dashed line indicates the 95th percentile locus. Right Panel: Field samplings of stars that fit an isochrone weighted by membership probability; the POCR counterpart is indicated by the arrow. We conclude that Renou 38 is very distinct from the surrounding fields.

4. Conclusions

It is important to systematically analyse POCRs trying to understand their nature as dynamically evolved open clusters, cluster remnants or asterisms. The open and embedded cluster analysis tool (Method 1) is capable to infer the nature of the POCRs. However, Method 2 deals better with poorly-populated

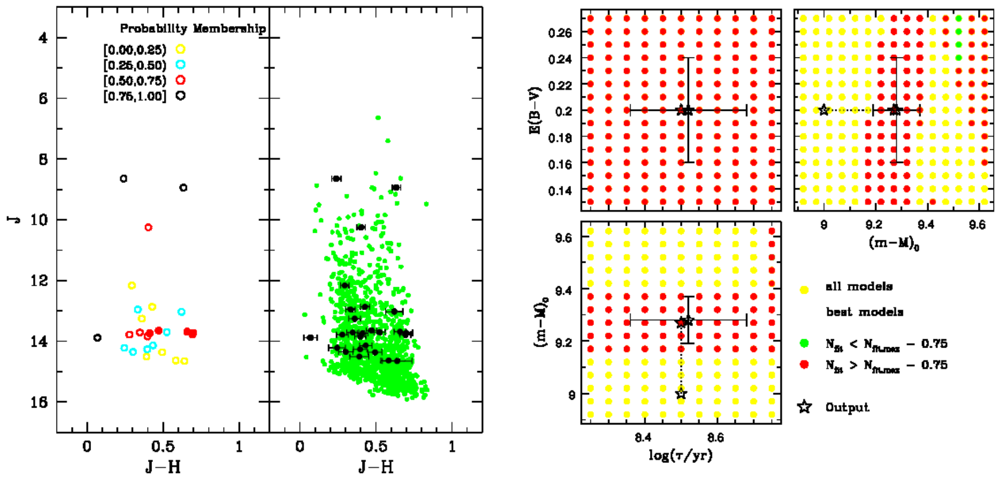

Fig. 6. Same as Fig. 4 but for NGC 843 (R=5′). The NGC 843 is indistinguishable from the surrounding fields.

objects, especially for membership probability and comparing in detail field variations.

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