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PRESENTACIóN MURAL

CCD CT_1 photometry of small angular size candidate star clusters projected on to crowded Small Magellanic Cloud star fields

A.E. Piatti[1], E. Bica[2]

(1) Instituto de Astronomía y Física del Espacio (IAFE-CONICET)
(2) Departamento de Astronomía, UFRGS, Brazil

Abstract. We present for the first time CCD CT_1 photometry for 11 unstudied or poorly studied candidate star clusters. The selected objects are of small angular size, contain a handful of stars, and are projected towards the innermost regions of the Small Magellanic Cloud (SMC). To clean their Colour-Magnitude Diagrams (CMDs) from the unavoidable star field contamination, we use a method which has shown to be able to eliminate stochastic effects in the cluster CMDs caused by the presence of isolated bright stars, as well as, to make a finer cleaning in the most populous CMD regions. The resulting cleaned cluster CMDs suggest that most of the studied candidate star clusters would not appear to be genuine physical systems. Furthermore, we confirm that the ages previously derived for some of them mostly reflect those of the composite stellar populations of the SMC field. On the other hand, if we use the spatial distribution of possible non-clusters to statiscically decontaminate that of the cataloged clusters, we find that there is no clear difference between the expected and the observed cluster spatial distributions. However, if we double the amount of possible non-clusters the difference becomes bigger than 2σ between $a \approx 0.3°$ and $1.2°$ (a = the semi-major axis of an ellipse parallel to the SMC bar and with $b/a = 1/2$).

Resumen. Presentamos por vez primera fotometría CCD CT_1 de 11 objetos no estudiados o poco estudiados, catalogados como cúmulos estelares de la Nube Menor de Magallanes (NMM). Los objetos seleccionados son de pequeño tamaño angular, contienen un puñado de estrellas, y se encuentran proyectados en dirección a las regiones interiores de la NMM. Para limpiar sus diagramas color-magnitud (DCM), utilizamos un método que ha mostrado ser capaz de eliminar efectos estocásticos en los DCM, como así también realizar una limpieza más fina en las regiones más pobladas del DCM. Los DCM de estos objetos, previamente limpiados de la contaminación de estrellas del campo, muestran que no se trata en la mayoría de genuinos sistemas físicos. Encontramos que las edades estimadas previamente para algunos objetos corresponden más bien a la composición de poblaciones estelares del campo. Finalmente, teniendo en cuenta la distribución espacial de los objetos que no resultaron ser cúmulos y la de los cúmulos catalogados, encontramos que no existen diferencias claras entre la distribución observada y la derivada de sustraer

los objetos que no son cúmulos. Sin embargo, si duplicamos la cantidad de objetos que posiblemente no son cúmulos, la diferencia resulta mayor que 2σ entre $a \approx 0.3^\circ$ and 1.2° (a= semi eje mayor de una elipse paralela a la barra de la NMM y con b/a=1/2)

1. Cleaning cluster CMDs

We collected CCD CT_1 images obtained at the CTIO 4m telescope and the MOSAIC II camera attached ($36' \times 36'$ field onto a 8K×8K CCD detector array) for 11 objects cataloged as star clusters (Bica et al. 2008, hereafter B08), namely: B 119, BS 20, BS 25, BS 35, BS 251, BS 265, H86-70, H86-78s, H86-86, H86-88, and H86-197. Once the photometric data were standardized, we built Colour-Magnitude Diagrams (CMDs) for the selected objects. They are available from the authors upon request. Since the objects are relatively small and are projected towards dense SMC fields, cleaning procedures of field stars in the CMDs result critical for any further analysis.

When applying a field star cleaning procedure to decontaminate the cluster, a compromise between minimizing the residuals left after the subtractions of field stars from the cluster CMDs and maximizing the cleaning of field stars is always desiderable. Since the size of the (mag,colour) bins used to count field stars in the CMDs should also reflect the photometric errors involved, which are bigger at fainter magnitudes, previous procedures have tried with different bin sizes as a general budget which, in turn, depends on the sizes of the spatial regions used to build the extracted CMDs. Sometimes the radial density profile of a star cluster is taken into account to assign statistical membership probabilities. This constrains the star field cleaning procedure to those clusters for which it is possible to satisfactorily trace their stellar radial distributions.

In our case, we have used of a method which employs variable cells in the field CMDs. We selected four different regions per object with the same area as for the candidate clusters as reference star fields. These circular field areas were placed towards the north, the east, the west and the south of the candidate cluster at a distance of four times the radii. This was done in order to take into account variations in the spatial density, magnitudes, and colours of field stars. Note that the candidate star clusters are of small angular sizes, typically $\sim 0.1'$-$0.3'$. Whenever an excess of stars remains in the cleaned CMDs, we assume that we are dealing with an enhancement of stars caused by the presence of a possible star cluster or by a stellar fluctuation in the SMC field or by a chance grouping of stars. When applying the cleaning procedure to the CMDs of the 11 selected candidate star clusters, we found that nearly 1/3 of them would not appear to be genuine physical systems (i.e. B119, BS251, H86-78s, H86-88).

Figs. 1 and 2 illustrate as example the results for BS 25 and H86-78s. The top-left panels depict schematic finding charts for all the measured stars. The size of the plotting symbol is proportional to the star brightness. We have plotted the stars with different symbols in order to show the different membership probabilities provided from the cleaning procedure employed, as follows: filled circles correspond to stars with a probability of being a feature of the cluster field higher than 75% (black), equals to 50% (drak-grey), and lower than 25% (cleargrey), respectively. North is up and East is to the left. The top-right panels shows field CMDs. They were built from an equal cluster area extraction. Each open box is centred on a measured field star, and its size was fixed by the respective computed free-path, i.e., the boxes are variables. These boxes were used to count the number of stars to subtract in the respective cluster CMD boxes. The bottom panels show three different CMDs, distinguishing those stars that have chances of being a candidate cluster field feature $< 25\%$, equal to 50%, and $> 75\%$, respectively. The ZAMS and the isochrones from Girardi et al. (2002) for the age derived by Glatt et al. (2010) are superimposed with solid and dashed lines, respectively.

Finally, we used the spatial distribution in the SMC of possible non-clusters to statiscically decontaminate that of the SMC cluster system. By assuming that the area covered by 11 studied fields (36'×36' each) represents an unbiased subsample of the SMC as a whole and by using an elliptical framework centred on the SMC centre ($b/a = 1/2$), we found that there is no significant difference between the expected and the observed cluster spatial distributions (see Fig. 3). However, a difference at a 2σ level would become visible between $a \approx 0.3^o$ and 1.2^o, if we doubled the amount of possible non-clusters.

2. Bibliografía

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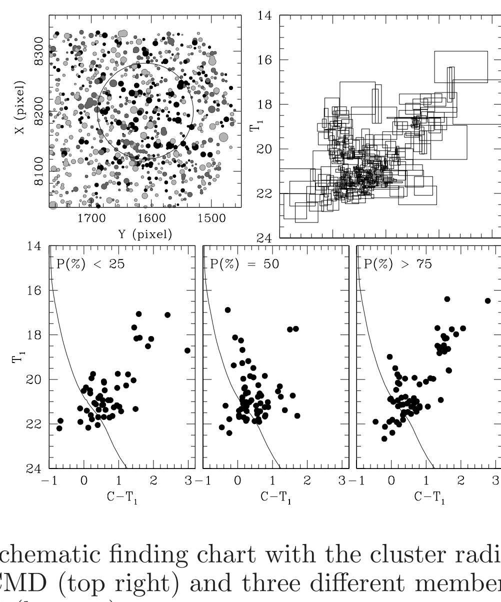

Figure 1. A schematic finding chart with the cluster radius from B08 (top-left), the field CMD (top right) and three different membership probabilities CMDs for BS 25 (bottom).

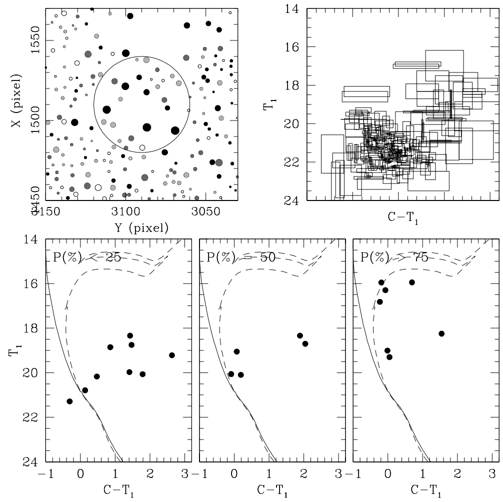

Figure 2. A schematic finding chart with the cluster radius from B08 (top-left), the field CMD (top right) and three different membership probabilities CMDs for H86-78s (bottom).

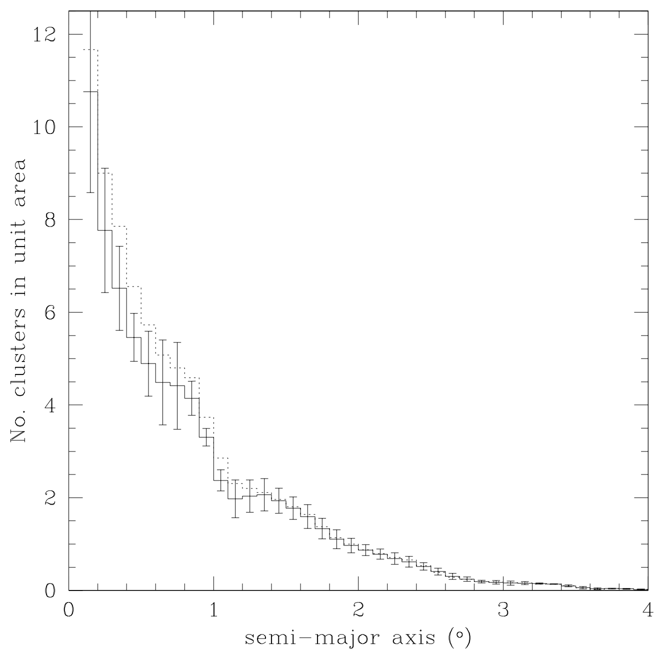

Figure 3. Spatial distribution of SMC clusters: observed (dotted line) and expected (solid line) curves are shown.