Asociación Argentina de Astronomía
BAAA, Vol. 55, 2012
A.C. Rovero, G.E. Romero, L. Pelliza & M. Lares, eds.

PRESENTACIóN MURAL

Astrophysical parameters of Small Magellanic Cloud star clusters

F. Maia[1], A.E. Piatti[2], J.F.C. Santos, Jr.[1]

(1) Departamento de Fíica - ICEx/UFMG - Brazil
(2) Instituto de Astronomía y Física del Espacio (IAFE-CONICET)

Abstract. We present results obtained from CCD CT1 photometry for a sample of star clusters located in crowded fields in the Small Magellanic Cloud (SMC). The targets were studied by using spatial density maps, center finding algorithms, radial density profiles and a decontamination procedure to clean their color-magnitude diagrams (CMDs) of field stars. The results show that out of 68 objects investigated, only 37 (54 %) present a spatial stellar overdensity. Furthermore, only 8 (12 %) of them show stellar density profiles to be fitted by a King function. Ages, metallicities and color excesses of these genuine clusters were also estimated from isochrone fitting on their field decontaminated CMDs.

Resumen. Presentamos resultados obtenidos a partir de fotometría CCD CT1 de una muestra de cúmulos estelares ubicados en regiones muy densas de la Nube Menor de Magallanes. Los objetos seleccionados fueron analizados utilizando mapas de densidad estelar, algoritmos de centrado, perfiles radiales de densidad y un procedimiento de decontaminación o para limpiar sus diagramas color-magnitud de las estrellas del campo. Los resultados muestran que de un total de 68 objetos estudiados, sólo 37 (54 %) presentan una sobredensidad espacial de estrellas. Más aún, sólo 8 de ellos tienen perfiles radiales de densidad ajustables por una función de King. Determinamos sus edades, metalicidades y excesos de color a partir del ajuste de isócronas teóricas en los diagramas color-magnitud de los cúmulos.

Density maps

A stellar density enhancement over the surrounding field is the most basic condition to identify a star cluster. However, such an enhancement can be difficult to recognize in star fields with density fluctuations. To address this issue we have built stellar density maps taking into account different magnitude levels. We proceeded as follows:

1. we selected stars brighter and fainter than a fixed T1 mag, distributed inside a 2'x2' box around the centers given by Bica et al. (2008);
2. a stellar density value was then calculated over a region of 5" around each selected star;

3. the stellar density values were interpolated into a uniform grid and plotted as a contour map.

The brightest magnitude limit was chosen in order to include at least 10% of the total number of stars in the region. Fixed T1 mags were set at increments of 0.5 mag, so that we were able to produce contour maps with different cluster/star field density contrast.

Center finding

For this purpose, we devised an algorithm to interactively search for the highest density peak inside a given area. Given the cluster initial (visual) radius and the centers of Bica et al. (2008), the algorithm performs the following tasks:

1. stars around the initial center value and inside the cluster radius are selected;
2. new center values are calculated as the average of the selected star positions, weighted by the calculated stellar density of each star;
3. the initial central coordinates are replaced by the new center values and the algorithm is iterated until the distance between the initial center and the new center value is less than 0.5" and the stellar density at the new center is 1-σ above the sky density fluctuations. The algorithm aborts whenever a maximum number of 5 iterations is reached. Fig. 1 (left panel) shows the results of the center finding algorithm for K 57.

Structural parameters

Structural parameters of the targets were determined according to the following steps:

1. cluster centers were calculated as the average of the central coordinates obtained from the center fiding algorithm over each density map;
2. we then built radial density profiles (RDPs) around the new central coordinates;
3. a mean sky density value was calculated in a region beyond the cluster radius;
4. the cluster limitting radius was calculated as the point where the cluster stellar density reaches the mean sky level in its RDP; and
5. the cluster central stellar density and its core radius are calculated by fitting a 2-parameter King function to the RDP (see Fig. 1, right panel).

Only 8 out of 37 selected clusters show converging King profiles. Although the remaining ones do present density stellar enhancements, they tend to present sub-clusterings or elongated forms that do not conform the analytical function applied. They must be subject to an individual, more detailed analysis in order to determine their real nature.

Decontamination and isochrone fitting

To account for the field stars present in the region of the 8 genuine clusters, we used a photometric decontamination procedure (Maia et al., 2010) that samples the field population outside the cluster region and statistically removes it from the cluster CMD. The resulting cleaned cluster CMDs were subject to manual isochrone fitting using the Padova models with metallicities Z=0.008 and Z=0.004. We also adopted a constant distance modulus of 18.90 ± 0.10 for all the clusters (Glatt et al., 2010). Fig. 2 show the observed cluster CMD, the reference field CMD and the decontaminated CMD for K 57, whereas Table 1 lists the resulting parameters for the 8 confirmed star clusters.

Results and conclusions

Although only 8 objects has converged thought the analysis employed, we cannot rule out the existence of other genuine clusters in our selected sample. **Complementary studies are also required.** Indeed, another 29 objects have been identified as possible clusters based on the convergence of our center finding algorithm over the magnitude limited density maps. We found, however, a remarkably large number of objects (31) that did not match our convergence criteria. These could be attributed to asterisms in the catalog of Bica et al. (2008) **(see, e.g., Piatti & Bica, 2012)**.

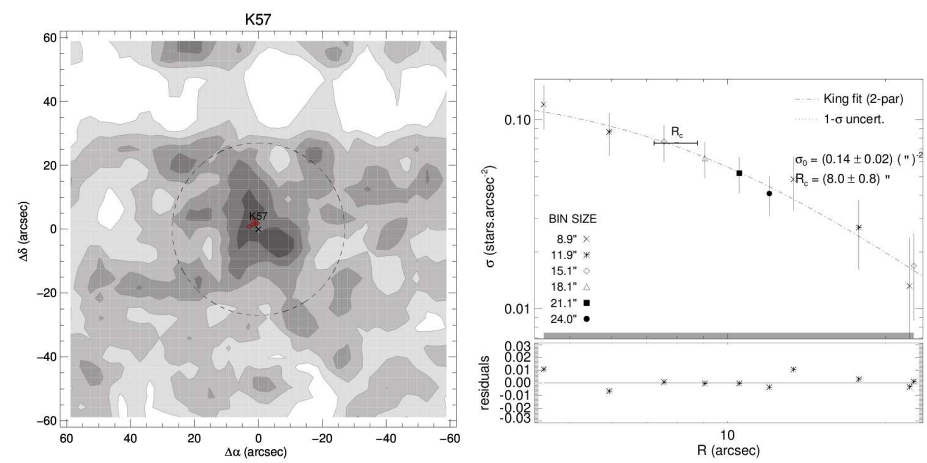

Figure 1. *Left:* Stellar density map in the field of K 57. *Right:* A King function fitted to its RDP.

1. Bibliografía

Bica E., Bonatto C., Dutra C. M., Santos J.F.C., 2008, MNRAS, 389, 678
Glatt K., Grebel E. K., Koch A., 2010, A&A, 517, A50
Maia F.F.S., Corradi W.J.B., Santos J.F.C., Jr., 2010, MNRAS, 407, 1875
Piatti A.E., Bica, E. 2012, MNRAS, 425, 3085

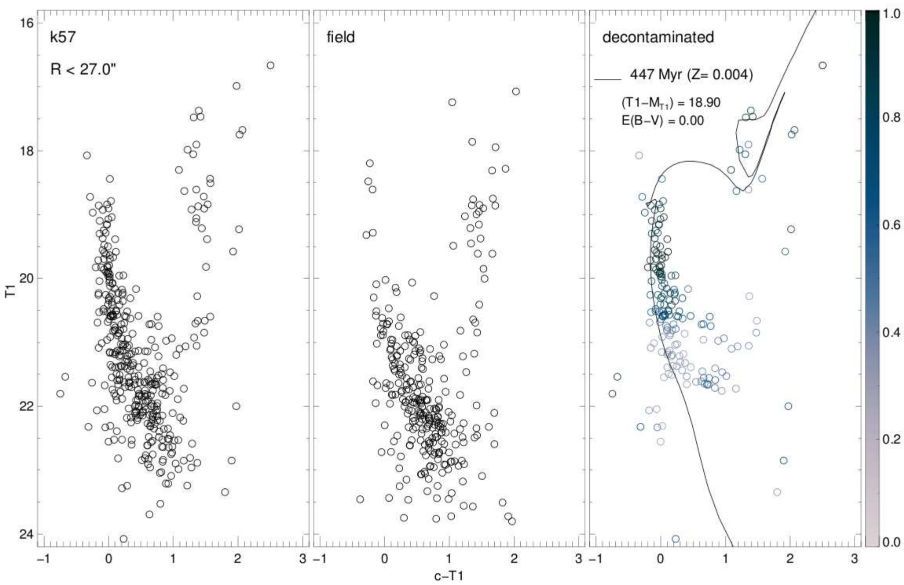

Figure 2. The observed cluster CMD, the field CMD and the cleaned cluster CMD for K 57 are shown.

Table 1. Estimated parameters for 8 SMC star clusters

ID	RA(J2000) (hh:mm:ss.s)	DEC(J2000) (dd:mm:ss)	R_{lim} ($'$)	σ_o stars/$'^{-2}$	R_{core} ($'$)	log$t$	E(B-V)
BS 80	00:56:14.5	-74:09:22	0.38	502±106	0.14±0.03	9.45	0.00
B 111	01:01:56.3	-71:01:13	0.41	356±74	0.14±0.02	9.15	0.00
K 57	01:08:15.9	-73:15:25	0.41	475±81	0.18±0.03	8.75	0.00
OGLE 53	00:49:16.9	-73:12:36	0.18	147±60	0.22±0.10	8.90	0.00
K 55	01:07:31.2	-73:07:11	0.72	506±64	0.21±0.02	8.70	0.00
K 63	01:10:46.4	-72:47:31	0.69	315±60	0.20±0.04	8.70	0.00
HW 52	01:06:56.5	-73:14:06	0.52	277±134	0.13±0.05	8.10	0.05
HW 32	00:57:23.2	-71:10:13	0.63	114±41	0.19±0.06	8.00	0.00