Photometry of binary star clusters in the Small Magellanic Cloud

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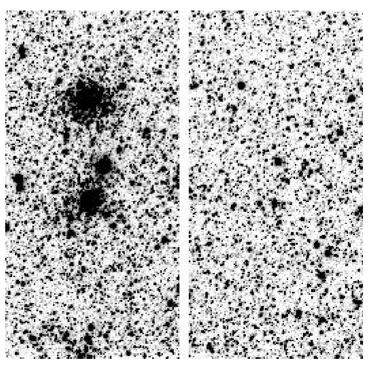
Introduction

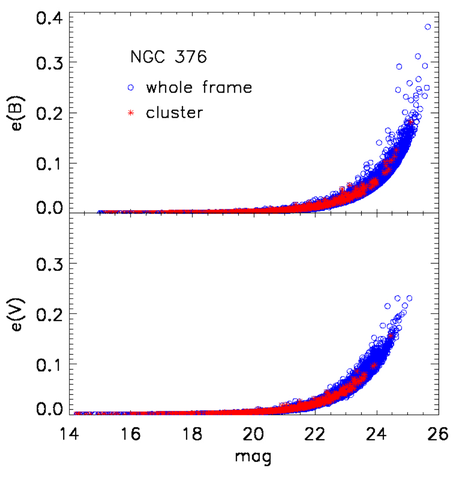
- True (physical) cluster pairs/multiplets occur in great numbers in both Clouds (Bhatia & Hatzidimitriou 1988; Bhatia 1990)
- About 13% of all SMC clusters catalogued in a recent census (Bica et al. 2008) take part in multiple groupings, which may include merging systems
- The aim of the present project is to determine fundamental properties as well as structural characteristics of a sample of SMC cluster binary/merger candidates

Data



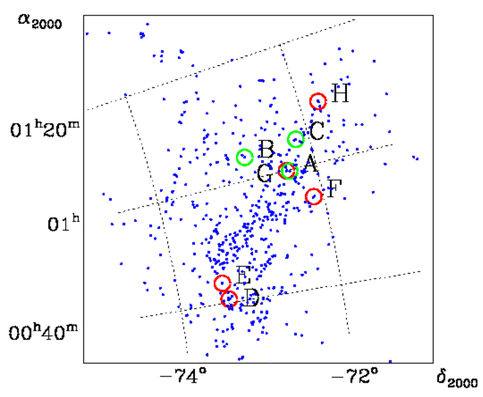
NGC220 / NGC222 V image

- SOAR 4.1m tel.
- Optical Imager (SOI) E2V 2x4k CCDs
- 1 pixel = 15μm
- FOV: 5.2'x5.2'
- Scale: 0.154 "/pixel (binned)
- Exposure times: 2x480s (B), 2x195s (V)
- Average seeing: 0.95" (B), 0.8" (V)



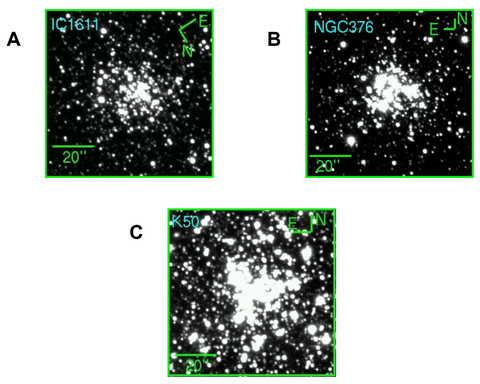
Sample: 8 pairs/merger candidates

SMC image for chart orientation

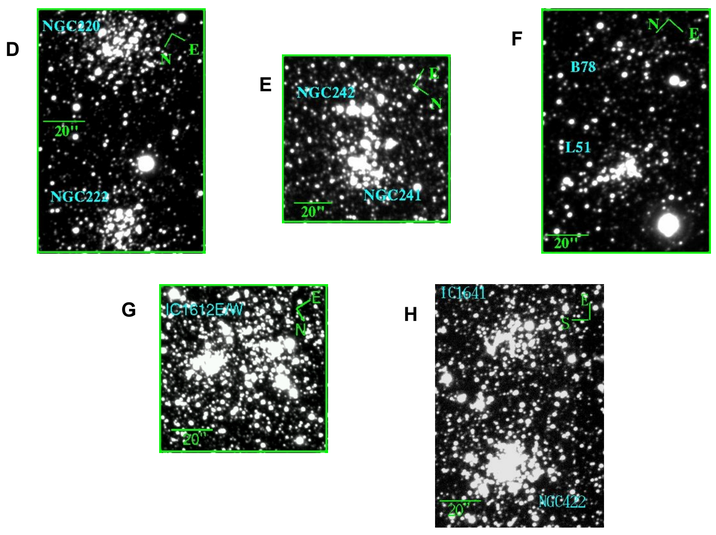


Blue dots: clusters from Bica et al. (2008)

Merger candidates

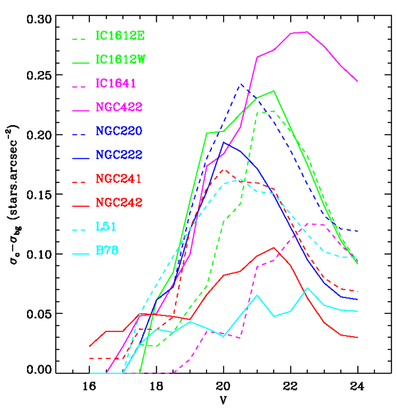


Binary candidates

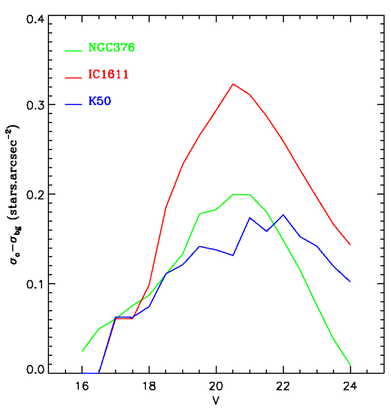


Cluster / field contrast

binary candidates

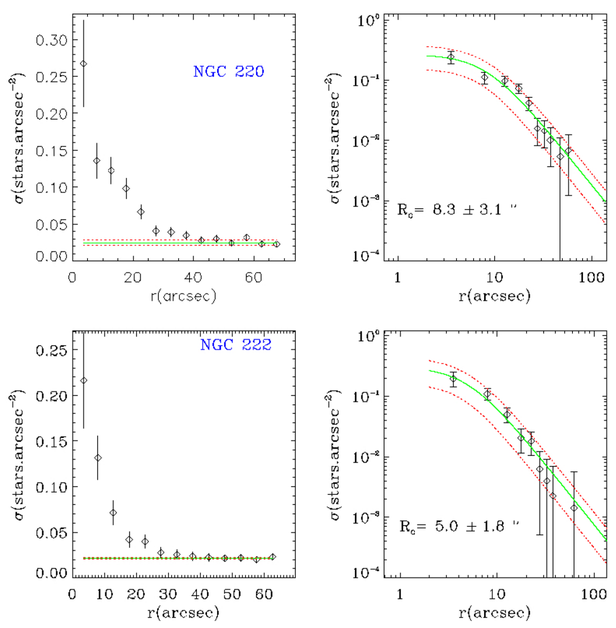


merger candidates

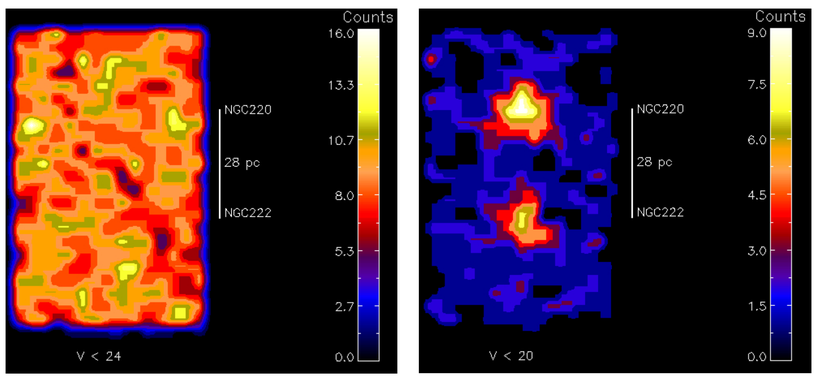


Radial density profile

- Star counts in rings 5” wide
- Data limited in V for maximum contrast field/cluster
- Constant background fitted to the 4 outermost rings
- 2-parameter King function fitted to the background corrected radial profile



Star Density Map (Isopleth)



(m-M)$_o$ = 19 → 3.3 " ~ 1 pc

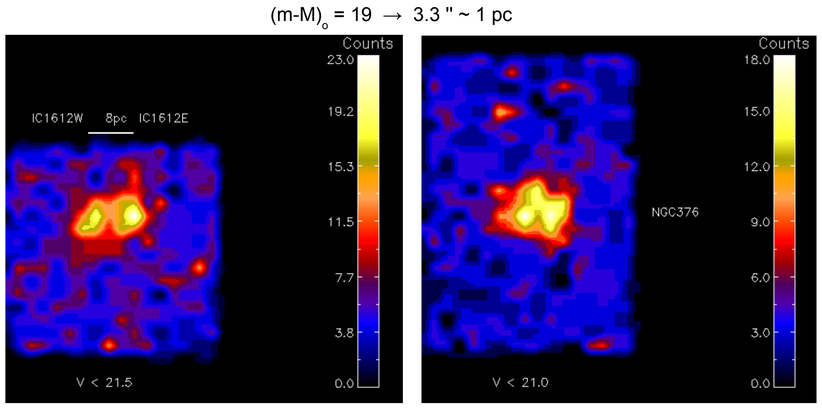


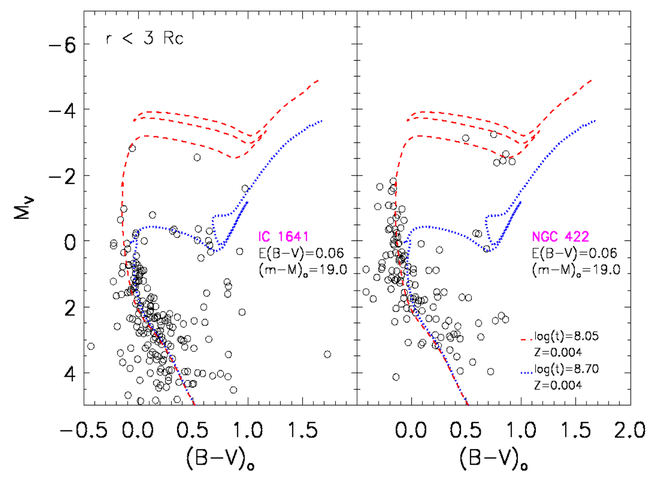
Table 1: Cluster sample and derived parameters.

Cluster	E(B-V)	age (Myr)	Z	R_c (pc)	Δage (Myr)	separation (pc)
NGC 220 (D)	0.10 ± 0.03	80 ± 10	0.008	2.5 ± 1.0	–	–
NGC 222 (D)	0.10 ± 0.03	80 ± 10	0.008	1.5 ± 0.5	0	28
NGC 241 (E)	0.05 ± 0.01	80 ± 10	0.008	2.0 ± 1.0	–	–
NGC 242 (E)	0.05 ± 0.01	60 ± 10	0.008	–	20	9
B 78 (F)	0.08 ± 0.02	55 ± 10	0.008	–	–	–
L 51 (F)	0.08 ± 0.02	35 ± 10	0.008	1.5 ± 0.3	20	17
IC 1612W (G)	0.07 ± 0.01	120 ± 30	0.008	2.3 ± 0.5	–	–
IC 1612E (G)	0.07 ± 0.01	60 ± 10	0.008	1.9 ± 1.0	60	8
NGC 422 (H)	0.06 ± 0.01	110 ± 30	0.004	1.7 ± 0.5	–	–
IC 1641 (H)	0.06 ± 0.01	500 ± 30	0.004	2.2 ± 1.0	390	20
NGC 376 (B)	0.09 ± 0.02	50 ± 10	0.008	3.2 ± 1.3	–	–
K 50 (C)	0.03 ± 0.01	50 ± 10	0.004	3.0 ± 1.2	–	–
IC 1611 (A)	0.07 ± 0.01	140 ± 30	0.002	2.4 ± 1.1	–	–

Colour-magnitude diagrams

- The CMD was built from data of a central circular area of radius < 3R_c in most cases
- Smaller radius (=R_c) was used whenever the two components were too close (IC1612E/W)
- Two isochrones indicate the age difference between the components
- The best matching isochrone was chosen by fixing (m-M)$_o$=19.0. E(B-V), age and Z were free parameters

Non-coeval case



- Components far apart than these limits may not merge, being disrupted by the galactic tidal field.

Conclusions

- NGC376 and K50 (but not IC1611) show merger signs: *bumps in the RDP*, *isopleth distortions* and have ages (50 Myr) consistent with formation time scales (e.g. Sugimoto & Makino 1989)
- Their core radius are the largest among the sample and their limiting radius are above the mean for SMC clusters at that age
- The mass of the sample clusters range between ~10^3 to $10^4 M_{sun}$. According to dynamical models subject to LMC tidal field, clusters with $10^4 M_{sun}$ and 6 pc apart would merge in 10 Myr. The same occurs for $10^4 M_{sun}$ clusters 14 pc apart (Bhatia 1990).

References

- Bhatia R. K. 1990, PASJ, 42, 757
- Bhatia R. K., Hatzidimitriou D., 1988, A&A, 230, 215
- Bica E., Bonatto C., Dutra C. M., Santos Jr. J. F. C., 2008, MNRAS, 389, 678
- Sugimoto D., Makino J., 1989, PASJ, 41, 1117

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