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GEMINI/GeMS observations of globular clusters in the Galactic bulge

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Abstract. By exploiting the exceptional high-resolution capabilities of the near-infrared camera GSAOI, combined with the Multi-Conjugate Adaptive Optics (MCAO) system GeMS, at the GEMINI South Telescope, we are investigating the structural and physical properties of a sample of globular clusters in the Galactic bulge. In this contribution we present the science cases of Liller 1 and NGC 6624.

Key words. globular clusters – individual: (Liller 1, NGC 6624) – Instrumentation: adaptive optics – Technique: photometric

1. Introduction

Galactic globular clusters (GCs) are known to be crucial benchmarks for stellar evolution, stellar dynamics and as fossil records of the Milky Way formation history. To investigate those orbiting the bulge, high-quality NIR observations able to peer through the thick dust clouds obscuring the Galaxy central regions, are needed. The Gemini South Telescope (Chile), equipped with the MCAO system GeMS is the best facility to study GCs in the Galactic bulge. GeMS uses multiple deformable mirrors and natural and/or laser guide stars (Neichel et al. 2014). The NIR camera GSAOI has a resolution of 0.02″/pix and a field of view of 85” × 85”. Here we present the results that we obtained for Liller 1 (Saracino et al. 2015) and NGC 6624 (Saracino et al. 2016), thanks to GeMS-GSAOI observations in the J and K_s band, performed under program GS-2013-Q-23 (PI: D. Geisler). For the data analysis we followed a standard pre-reduction procedure within the IRAF environment and Point Spread Function fitting by using the DAOPHOT package (Stetson 1987).

2. Liller 1 and NGC 6224

Liller 1 is a bulge GC, at just 1 kpc from the Galactic center (Harris 1996), where the foreground extinction is very high, $E(B-V) = 3.09$ (Valenti et al. 2010). Fig. 1 shows the deep NIR color-magnitude diagram (CMD) of the cluster, reaching $K_s \sim 19$ below the main-sequence (MS) turnoff, that we obtained with

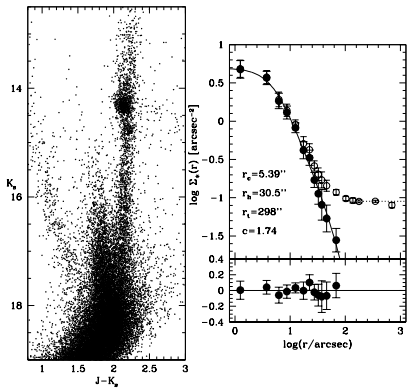

Fig. 1. *Left*: NIR CMD of Liller 1 obtained from GEMINI observations. *Right*: Resolved count star density profile of Liller 1: observed (empty circles) and background-subtracted (solid circles). The best-fit King model is also shown (see labels for the values of the King parameters).

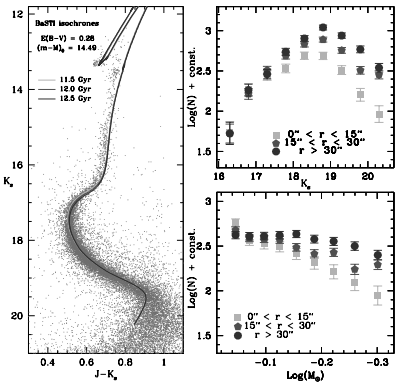

Fig. 2. *Left*: GEMINI CMD of NGC 6624. Isochrones (Pietrinferni et al. 2004) aged from 11.5 to 12.5 Gyr, in steps of 0.5 Gyr are superimposed as solid lines. *Right*: Luminosity and mass functions of MS stars in different radial bins (see labels).

our GEMINI observations. We re-determined the center of gravity of Liller 1, finding that it is located $\sim 2.2''$ south-east from the literature value. By using direct star counts we built the density profile of the cluster (Fig. 1) and re-derived its main structural and physical parameters. We found that Liller 1 is significantly less concentrated and less extended than previously thought. Its mass is $M_{\rm tot} \sim 2.3 \times 10^6 M_\odot$, comparable to that of the most massive clusters in the Galaxy (ω Centauri and Terzan 5). Finally, Liller 1 has one of the largest collision rates (the 2$^{\rm nd}$ after Terzan 5) among all star clusters in the Galaxy.

NGC 6624 is located at the edge of the inner bulge, at a distance of $\sim$ 7.9 kpc from Earth (Harris 1996). Given its moderate extinction, $E(B-V) = 0.28$ (Valenti et al. 2004a), it was already observed in the optical bands. Thanks to GEMINI observations, instead, we built the deepest and highest-quality NIR CMD ever obtained from the ground for this cluster (Fig. 2), and probably for any GC. It reaches $K_s \sim 21.5$ ($\sim$ 8 mag below the horizontal branch level), thus sampling the entire MS extension and also revealing the so-called "MS knee" at $K_s \sim 20$

(Fig. 2). By taking advantage of the exquisite quality of the data, we estimated the absolute age of NGC 6624 from the isochrone fitting method, finding $t = 12.0 \pm 0.5$ Gyr (in good agreement with previous estimates). We also studied the completeness-corrected and background-subtracted luminosity and mass functions of MS stars, down to $M \sim 0.45 M_\odot$, finding evidence of a significant increase of low-mass stars at increasing distances from the center (Fig. 2). This is a clear signature of mass segregation, confirming that NGC 6624 is in an advanced stage of dynamical evolution (Goldsbury et al. 2013).

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References

Goldsbury, R., Heyl, J., & Richer, H. 2013, ApJ, 778, 57
Harris, W. E. 1996, AJ, 112, 1487
Neichel, B., et al. 2014, MNRAS, 440, 1002
Pietrinferni, A., et al. 2004, ApJ, 612, 168
Saracino, S., et al. 2015, ApJ, 806, 152
Saracino, S., et al. 2016, ApJ in press, arXiv:1609.02152
Stetson, P. B. 1987, PASP, 99, 191
Valenti, E., Ferraro, F. R., & Origlia, L. 2004a, MNRAS, 351, 1204
Valenti, E., Ferraro, F. R., & Origlia, L. 2010, MNRAS, 402, 1729