MAD@VLT: Deep into the Madding Crowd of Omega Centauri

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Abstract

We present deep and accurate Near-Infrared (NIR) photometry of the Galactic Globular Cluster (GC) $\omega$ Cen. Data were collected using the Multi-Conjugate Adaptive Optics Demonstrator (MAD) on VLT (ESO). The unprecedented quality of the images provided the opportunity to perform accurate photometry in the central crowded regions. Preliminary results indicate that the spread in age among the different crowded stellar populations in $\omega$ Cen is limited.

1 Introduction

Quantitative constraints concerning the evolutionary properties of low-mass stars mainly rely on the comparison between predicted and observed Color-Magnitude Diagrams (CMDs) of GCs. The GCs present several key advantages when compared with field stars: (i) cluster stars typically present the same age and the same chemical composition; (ii) cluster stars are located at the same distance, since the depth effects are negligible, and present the same reddening; (iii) cluster stars in a CMD are distributed according to their evolutionary status, (consecutio), therefore, they are redundant systems; (iv) cluster cores host a zoo of compact objects: Cataclysmic Variables [6], Millisecond pulsars, Low-Mass X-ray Binaries [7] and low/intermediate-mass black hole [1].

The main drawback of GCs is that quite often more than half of the cluster stars are located in the innermost regions, and indeed the half mass radius of massive clusters is at most a few arcminutes. This is the reason why accurate and deep photometry of the innermost regions of GCs became chore only with the superb spatial resolution and image quality of the Hubble Space Telescope (HST) optical images. Accurate photometry in the crowded central regions of GCs is not a trivial effort even by using HST images.

The GC $\omega$ Cen seems to be a peculiar system. It is the only one to show a well defined spread in the abundance of iron and $\alpha$-elements, thus suggesting that it

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might be a possible link between GCs and dwarf galaxies. It is also the most massive GC. This means that ω Cen is a perfect laboratory to investigate fast evolutionary phases [3]. The use of optical and NIR photometry of cluster stars presents several advantages when compared with either optical or NIR photometry. The optical-NIR colors can be adopted to pinpoint peculiar stellar populations that present either different ages or different chemical compositions [9].

2 Observations and Data Reduction

Optical data were collected with the Advanced Camera for Surveys (ACS) on board the HST and the reduction strategy was already discussed by Castellani et al. [4] and by Calamida et al. [3].

MAD is a prototype instrument performing wide Field of View (FoV) real-time correction for atmospheric turbulence. The reader interested in more details concerning the MCAO techniques and MAD characteristics is referred to Gilmozzi and Spyromilio [8] and Marchetti et al. [10]. During the first on-sky demonstration run of MAD two 1 x 1 arcminute fields were observed in the region across the center of ω Cen. Five images of 5 x 24 s each were collected in Ks-band and three images of 5 x 24 s each in J-band, while four images of 10 x 24 s were collected in Ks-band and three images of 10 x 24 s in J-band. The seeing during the observations of the first night changed from 0.7 to 0.9", while during the second it changed from 0.9 to 1.2".

The photometry was performed using DAOPHOTIV/ALLSTAR and ALLFRAME. We selected ≈ 100 isolated stars to estimate an analytical point-spread