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Multi-band photometry in Omega Centauri

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Abstract. We present new medium-band *uvby* Strömgren and broad-band *VI* photometry for the central regions of the globular cluster ω Cen. From this we have obtained differential reddening estimates relative to two other globulars (M 13 and NGC 288) using a metallicity-independent, reddening-free temperature index, $[c] \equiv (u-v)-(v-b)-0.2(b-y)$, for hot horizontal-branch (HB) stars ($T_e \geq 8,500$ K). We estimate color excesses of these hot HB stars using optical and near-infrared colors, and find clumpy extinction variations of almost a factor of two within the area of the cluster core. In particular, the greatest density of more highly reddened objects appears to be shifted along the right ascension axis by 1-1.5' when compared with less reddened ones. These findings complicate photometric efforts to investigate the star formation history of ω Cen.

Key words. globular clusters: general — globular clusters: Omega Centauri

1. Introduction

Reddening uncertinties hardly affects the comparison between theory and observations, in particular for globular clusters affected by differential reddening. Current reddening estimates toward ω Cen cluster around E(B-V)=0.11±0.02. However, the reddening map of Schlegel et al. (1998) indicates reddening variations of ~0.02 across the body of the cluster, while 2MASS data show a very clumpy reddening distribution outside 1° from the cluster center. In a recent investigation (Freyhammer et al. 2005), we presented *BRIJK* photometry for ω Cen stars and we show that in order to fit the anomalous giant branch (ω3) we need to adopt a 0.2 larger distance modulus, an increase of ~0.03 for the reddening, a metal-intermediate chemical composition and an age coeval with the bulk of the ω Cen stars. This suggests that the ω3 branch could be a clump of stars located ~500 pc beyond the main body of ω Cen , and that there may be a clumpy reddening distribution across the cluster. To further constrain the possibility of differential reddening toward ω Cen , we use hot HB stars ($T_e \geq 8,500$ K) and we adopt a reddening-free index based on Strömgren photometry, $[c] = c_1 - 0.2(b-y)$, where $c_1 = (u-v)-(v-b)$

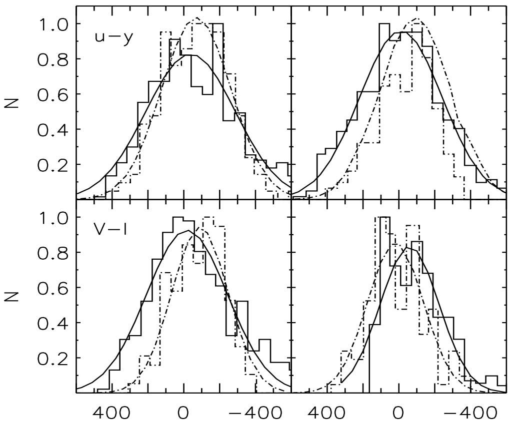

Fig. 1. Comparison between the spatial distribution along the right-ascension (X) and declination (Y) axis of more-reddened (dashed-dotted line) and average-reddened (solid line) hot HB stars in two different colors.

and $E(b-y) = 0.74E(B-V)$, to estimate the reddening of individual HB stars.

2. Reddening estimates

A set of 110 *uvby* Strömgren images of ω Cen were collected with the Danish Telescope, covering a field of 14'×14' on the cluster center. These have been supplemented with 30 *uvby* images of ω Cen collected by Grundhal and 210 *vby* by Hilker with the same telescope (see Hilker & Richtler 2000). Photometry was performed with DAOPHOT/ALLFRAME and the merged star catalog includes $\approx 2\times10^5$ stars. The typical photometric precision for faint HB stars is better than $\sim 0\overset{m}{.}03$ at $y \approx 19.5$ and better than $\sim 0\overset{m}{.}02$ at $u \approx 19$mag. Our broad-band star catalog has been obtained from a set of *UVI* images collected with FORS1@VLT (Calamida et al. 2005, Freyhammer et al. 2005).

To obtain differential reddening estimates for ω Cen we selected two GCs, M 13 ([Fe/H]=−1.54) and NGC 288 ([Fe/H]=−1.24), each marginally affected by reddening (E(B-V)=0.02, M 13; E(B-V)=0.03, NGC 288), and each possessing an extended blue HB for which both Strömgren and *VI* photometry exist. The comparison of ω Cen , M 13, and NGC 288 hot HB stars in the $u-y$ vs $[c]$ and $V-I$ vs $[c]$ planes shows that ω Cen stars are systematically redder and display, at fixed $[c]$, larger color dispersions (e.g., $\sigma_{u-y} = 0.085$) compared to M 13 ($\sigma_{u-y} = 0.037$) and NGC 288 ($\sigma_{u-y} = 0.016$). The spread in color might be due to variations in the reddening toward ω Cen since the $[c]$ index is reddening free. In Calamida et al. (2005) we show that HB stars with $T_e \geq 8,500$ are scarcely affected by metal abundance This means that only a reddening variation or a non stellar spectral energy distribution can move an object off the color-[c] relation. Supported by this evidence, we estimated the differential reddening for each hot HB star in ω Cen by fitting fiducial sequences to the hot HB stars in M 13 and in NGC 288 in the (color)vs$[c]$ planes, finding a mean reddening for ω Cen of E(B-V)=0.11±0.03. Although the new mean reddening value agrees well with literature, reddening estimates for individual HB stars present a star-to-star scatter larger than our error budget. This suggests variable reddening toward the cluster core with a dispersion $\sigma_{E(B-V)} \approx 0.04$ and supports the results of Cannon & Stobie (1973), who found reddening variations with $\sigma_{E(B-V)} \approx 0.03$-0.05. Finally, we investigated the spatial distribution of less-, more-, and average-reddened HB stars (selecting stars with color excess within $\pm 1\sigma$). The distribution of these objects is clumpy: more-reddened stars appear to be more concentrated in the N-W region of the cluster and their peak is shifted by 1-1.5' along the right ascension axis compared to the peaks of normal and less-reddened objects (see Fig. 1). Our results show that ω Cen is indeed subject to variable reddening, which should be taken into account in photometric investigations. For a more detailed discussion see Calamida et al. (2005).

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