Search of RR Lyrae stars around Omega Centauri (NGC5139)

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ABSTRACT

The well known naked-eye globular cluster Omega Centauri (ωCen) may be part of the residues of a dwarf galaxy destroyed by tidal forces of Milky Way (MW). We recently conducted a survey of RR Lyrae stars (RRLS) in an area of 50 sq deg around Omega Centauri (ωCen) which is significantly larger than the area studied by previous works. We will present the discovery an overdensity of stars formed by 13 new RRLS (10 RRab and 3 RRc) at distances similar to ωCen (5.2 kpc) and located outside its tidal radius (r_t > 57 arcmin), extending up to 9 degrees from the center of the cluster. Very few halo stars (4) are expected in the survey area at the narrow range of magnitudes found for this group of RRLS. Thus, the region contains an overdensity of RRLS which may constitute evidence for the remains of the progenitor galaxy of ωCen.

Introduction

ωCen has several unusual properties that led to the proposal that the cluster is the remaining core of a destroyed dwarf galaxy (Bekki & Freeman 2003). Some of these unusual properties are: (*i*) a retrograde, low inclination orbit around the MW (Dinescu et al. 1999), (*ii*) an overall rapid rotation (Merrit et al. 1997), making it one of the more flattened galactic globular cluster (White & Shawl 1987), (*iii*) a color-magnitude diagram showing a complex stellar population, with a wide range of metallicities and two main sequences (Bedin et al. 2004), (*iv*) a complex chemical pattern (King et al. 2012), (Gratton et al. 2011), (Marino et al. 2012) and (*v*) a high velocity dispersion measure toward the center which may be indication of it having an intermediate mass black hole (Noyola et al. 2010). It has been proposed that ωCen may be the equivalent to the M54+Sagitarius dwarf system but, in the case of ωCen, the progenitor galaxy must have been already completely destroyed by now (Carreta et al. 2010).

ωCen has a rich population of RRLS (Weldrake et al. 2007), as all satellite galaxies of the MW do (e.g. Vivas & Zinn 2006). It is expected that if there really was a galaxy associated with ωCen, it must has been rich in this type of star. Although the progenitor galaxy has been completely destroyed by now, debris material should be expected along its orbit. We decided to use this type of stars as tracers of debris around the cluster. Since these stars have almost the same luminosity (they are standard candles), any RRLS in the region having the same magnitude as the horizontal branch of the cluster (V=14.5 mag) may share a common origin with the cluster.

Observations around ωCen

The techniques used for this survey are similar to the ones used extensively by our group in the galactic halo and the Canis Major overdensity with the QUEST camera (Vivas & Zinn 2006, Mateu et al. 2009, Mateu et al. 2012). The survey was carried out during 2010-2011, with multi-epoch V, I, observations obtained with 1.0/1.5m Jürgen Stock Schmidt telescope and QUEST mosaic camera, at the National Astronomical Observatory of Venezuela. We analysed time series for a total of 659,036 stars, whose distribution in the sky is shown in Figure 1. The candidate RRLS were selected from variable stars in the color-magnitude diagrams (Fig. 2) for periodicity analysis.

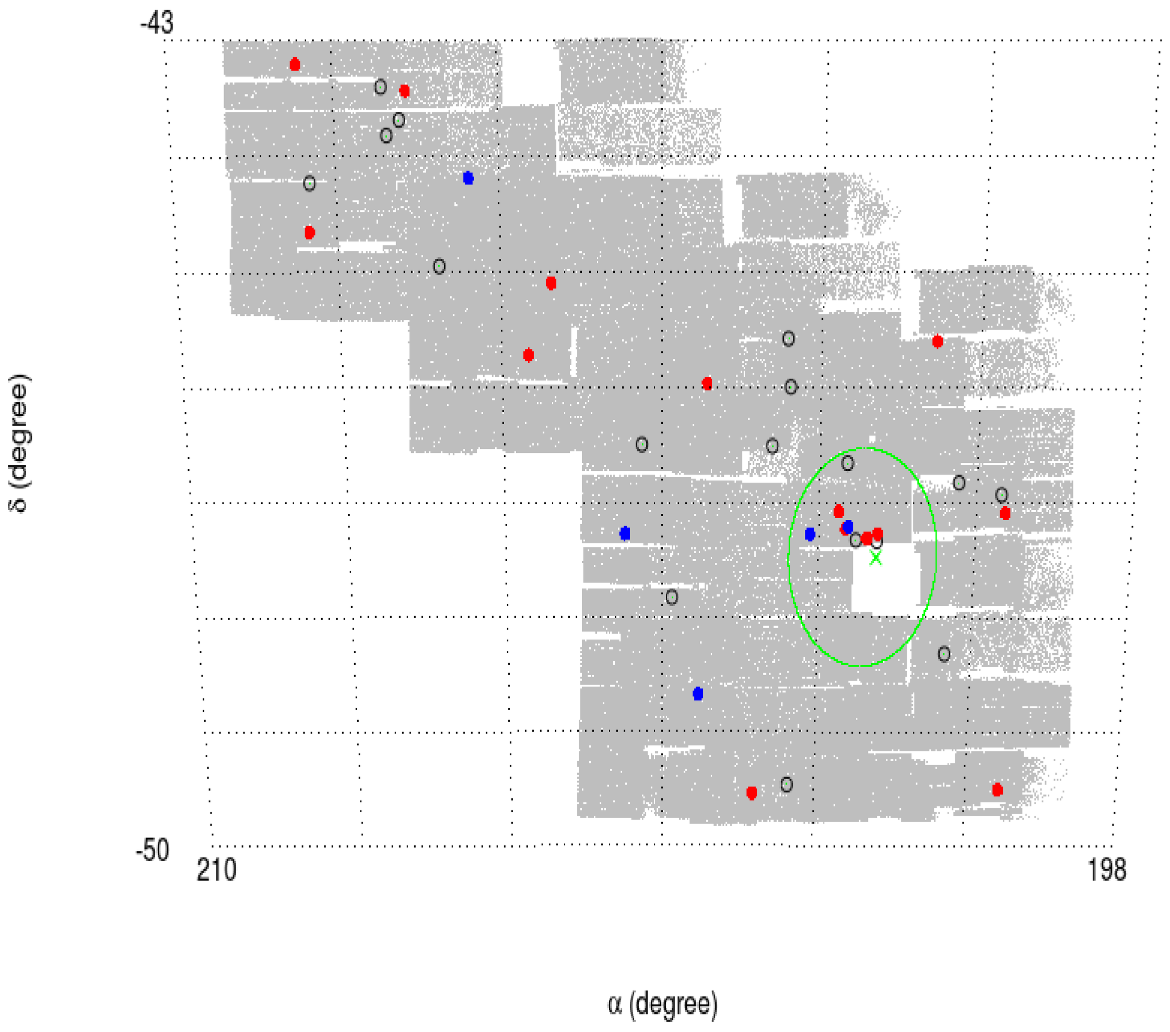

Fig. 1. Spatial distribution of the survey area in the vicinity of ωCen. The center of the cluster and its tidal radius are indicated by a green cross and a circle, respectively. RRLS discovered in this work are indicated with small circles, and the ones having mean magnitudes close to the horizontal branch of the cluster are marked with solid circles (red for RRab and blue for RRc).

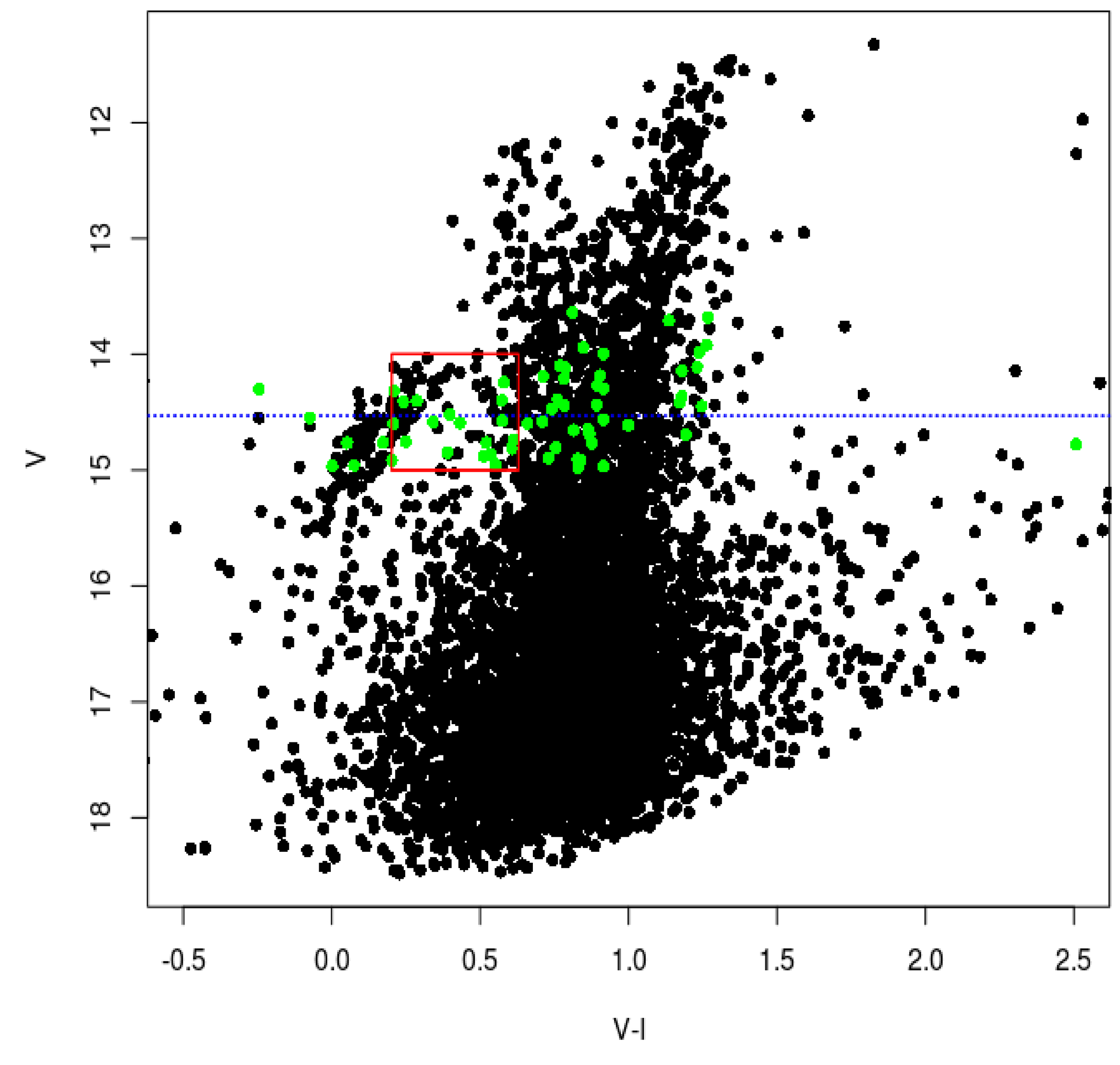

Fig. 2. Color-magnitude diagram of one field observed in this work. Variable stars with 14 < V < 15 are indicated with green points. Only the variable stars within the red box were selected for further analysis. The dashed blue line indicates the brightness of the horizontal branch of ωCen (V=14.53 mag).

Results and Conclusions

We detected a total of 36 RRLS in our survey, 29 of which are new discoveries since they were not found in any database in the literature. Examples of light curves are shown in Figure 3. We calculated the distance to these stars assuming an absolute magnitude of M_v= 0.55 mag and reddening values from Schlegel et al. (1998), and found that 13 RRLS are at distances similar to the distance of ωCen. These RRLS are spread over the entire survey area, up to ≈ 9 deg from the cluster center. Using the number density profile of RRLS in the halo (e.g. Vivas & Zinn 2006), we can calculate the expected number of such stars in the halo in this area of the sky, as a function of distance. For the range of distances between 4.7 kpc and 6.6 kpc, we would expect to find only 4 RRLS. Having found 13 stars in this range of distances is a significant excess and its presence can not be explained as the normal population of the halo.

This excess of RRLS is presumably associated with remnants of a destroyed dwarf galaxy. Final confirmation requires however the measurement of their radial velocities. The confirmation of these RRLS as part of the ωCen system will allow us to put constraints on its orbit and on its origin.

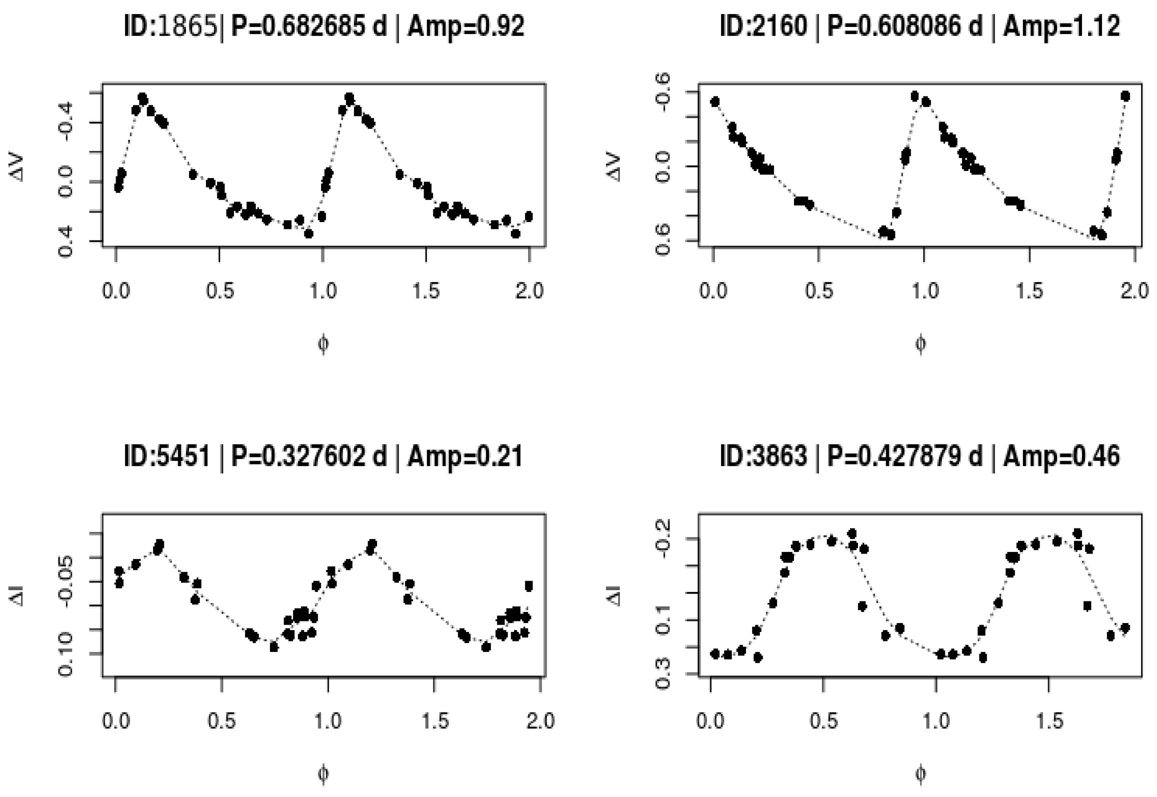

Fig. 3. Sample of lightcurves of RRLS discovered in this work with the QUEST camera at the Venezuelan 1 m Schmidt telescope.

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