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Variability Survey of ω Centauri in the Near-IR: Period-Luminosity Relations

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Abstract. ω Centauri is by far the most massive globular star cluster in the Milky Way, and possibly the remnant of a dwarf galaxy. As such, it contains a large number of variable stars of different classes. Here we report on an extensive, wide-field time-series study of ω Cen in the J and K_S bands, which has allowed us to study the near-IR period-luminosity relations for different variability classes, including the first such relations for the SX Phoenicis stars.

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ω Centauri (NGC 5139) is by far the most massive globular star cluster in the Milky Way, and has even been suggested to be the remnant of a dwarf galaxy. As such, it contains a large number of pulsating variable stars. Among them, RR Lyrae (RRL) and Type II Cepheids (T2Cs) are well-known for following tight period-luminosity (PL) relations in the near-IR (Catelan & Smith 2015). SX Phoenicis stars (SX Phe) are also expected to follow PL relations, but no such relations have heretofore been reported in the near-IR. ω Cen is one of the best targets for this purpose, as it has a rich variable star content, hosting at least 270 pulsating stars, including T2Cs, RRL, and SX Phe stars.

A deep, wide-field, near-IR variability survey of ω Cen was carried out by our team using ESO's 4.1m VISTA telescope. Our time-series data comprise 42 and 100 epochs in J and K_S, respectively. Figure 1 shows the K_S, $(J-K_S)$ color-magnitude diagram for the cluster (based on data for the innermost 10 arcmin), with the detected variable stars overplotted (based on our entire dataset, covering 1.1×1.5 deg^2 around the cluster center). This unique dataset has allowed us to derive complete K_S-band light curves for more than 200 variable stars in the cluster's field.

Using this dataset, Navarrete *et al.* (2015) reported an updated census on the number, variability type and membership of all but 4 of the known RRL stars in ω Cen's field, and also discovered four new RRL. Moreover, reference Oosterhoff I and II loci in the Bailey (period-amplitude) diagram were derived for the J and K_S bands, in addition to expressions relating the light-curve amplitudes in the V, J, and K_S bandpasses.

This unprecedented variable star catalogue also allow us to perform a detailed analysis of the near-IR PL relations for different variability classes, including T2Cs, SX Phe, and RRL stars (Navarrete et al., in prep.). Based on our intensity-averaged magnitudes, and using calibrated PL relations from the literature (Matsunaga *et al.* 2006 for T2Cs, Alonso-García *et al.* 2015 for RRLs), an updated distance modulus for the cluster was also

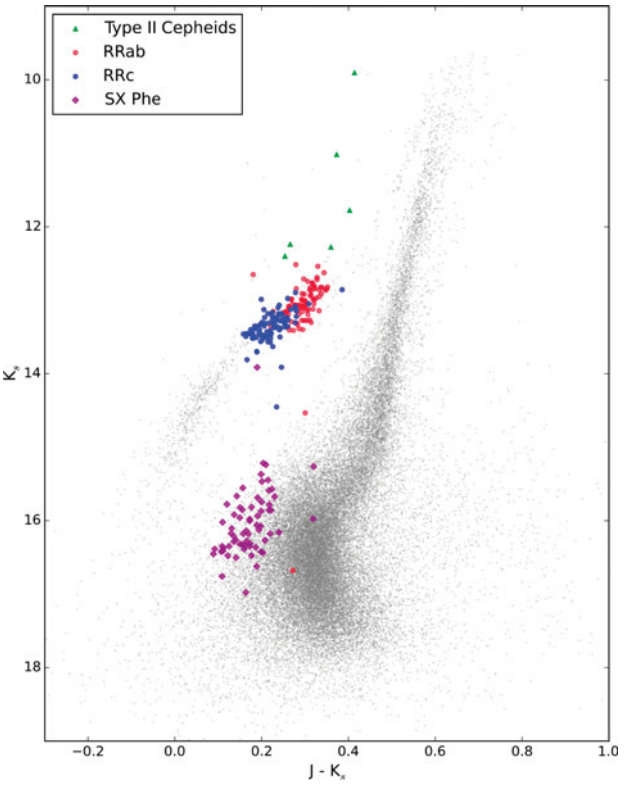

Figure 1. Near-IR CMD showing the non-variable ω Centauri stars in the cluster's innermost region (11 arcmin^2, *grey dots*). Variable stars over the entire cluster field (1.1×1.5 deg^2) are marked with *green triangles* (T2Cs), *red* and *blue circles* (RRab and RRc, respectively), and *purple diamonds* (SX Phe).

obtained. For SX Phe stars, fundamental-mode candidates (Olech *et al.* 2005; McNamara 2011) have been considered to derive, for the first time, calibrated near-IR PL relations.

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