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A MISIDENTIFIED RR LYRAE VARIABLE STAR IN ω CENTAURI[†]

NAVARRETE, C.^{1,2}; CATELAN, M.^{1,2}; CONTRERAS RAMOS, R.^{1,2}; ALONSO-GARCÍA, J.^{1,2}; DÉKÁNY, I.^{1,2}; GRAN, F.^{1,2}; HEMPEL, M.^{1,2}; ANGELONI, R.^{1,2,3}

¹ Instituto de Astrofísica, Facultad de Física, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, 782-0436 Macul, Santiago, Chile; e-mail: (cnavarre;mcatlan)@astro.puc.cl

² The Milky Way Millennium Nucleus, Av. Vicuña Mackenna 4860, 782-0436 Macul, Santiago, Chile

³ Departamento de Ingeniería Eléctrica, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, 782-0436 Macul, Santiago, Chile

With a total population of variable stars now approaching 500, including nearly 200 RR Lyrae (Clement et al. 2001; Kaluzny et al. 2004; Weldrake et al. 2007), ω Centauri = NGC 5139 (RA 13^h26^m47^s.28, DEC $-47^{\circ}28'46.1''$, J2000) represents an excellent laboratory for studies of stellar variability, and indeed is one of the best known such laboratories to study RR Lyrae-type variables in particular.

Kaluzny et al. (2004) performed a detailed variability search in ω Cen, finding 117 new variables, in addition to the 275 previously known ones (Clement et al. 2001). More recently, Weldrake et al. (2007) performed a new wide-field variability survey of the cluster, covering 0.75 deg² – i.e., 4 times the Kaluzny et al. field of view. They recovered 106 variables from the Kaluzny et al. catalogue, and reported the discovery of 81 additional variable stars.

In this note, we report the identification, from near-IR photometry, of an ω Cen RR Lyrae variable star previously misidentified by Weldrake et al. (2007). Accurate coordinates, light curves and periods are presented for both this star and the one with which it was erroneously associated.

Our work is based on time-series J, K_s observations, obtained with the 4-m VISTA telescope at ESO’s Cerro Paranal Observatory, using the wide-field, near-IR VIRCAM camera (Dalton et al. 2006). The total (effective) FoV of the camera is 1.1×1.5 deg², which is larger than the field studied by Weldrake et al. (2007). We present the photometry for the so-called “pawprint” images (see, e.g., Minniti et al. 2010, for an explanation and additional references), hereafter referred to simply as images. The data set was obtained in service mode, between December 2011 and April 2012, comprising a total of 252 and 600 images in J and K_s , respectively, covering a time span of 352 days. However, due to the way these images are taken (see Minniti et al. 2010), they effectively represent 42 and 100 independent epochs in J and K_s , respectively. These observations were obtained mainly in an effort to obtain near-IR light curve templates, to assist in the automated classification of the light curves obtained in The Vista Variables in the Vía Láctea (VVV)

[†]Based on observations made with the ESO VISTA Telescope at Paranal Observatory under programme ID 087.D-0472(A).

ESO Public Survey (Minniti et al. 2010; Catelan et al. 2011, 2013). Nevertheless, a quick search for new variable stars was also carried out, using DAOPHOT II/ALLFRAME (Stetson 1987, 1994).

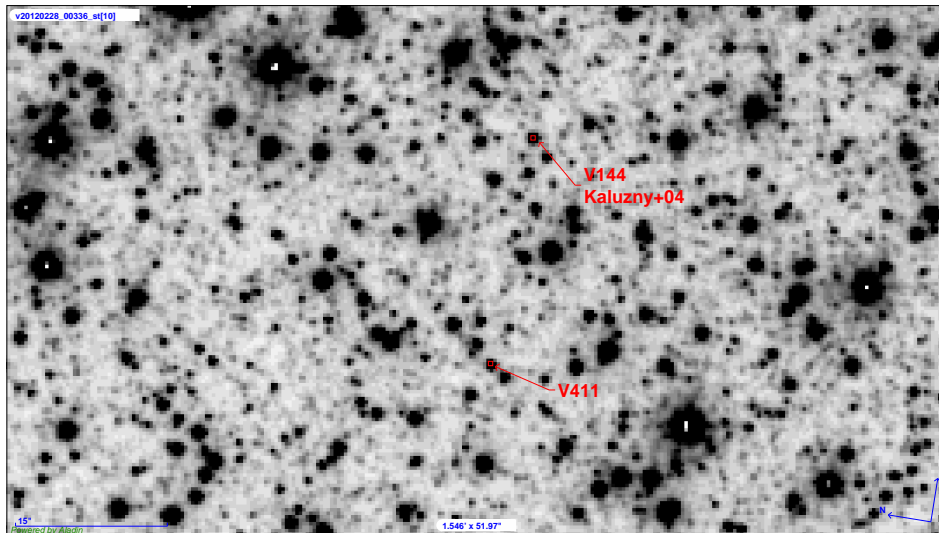


Figure 1. Finding chart for the two RR Lyrae variable stars, based on one of our K_s images. North is to the left and East is up. The scale is 0.34 arcsec/pixel. V411 is the new name proposed for ID-133 in Weldrake et al. (2007). The angular distance between V144 and V411 is 22.7 arcsec.

Thus, stars whose time series presented high standard deviation, compared to the non-variable stars, were selected as candidate variables. The analysis of variance (AoV) statistic (Schwarzenberg-Czerny 1989) was then used to determine the periods, if present, for these candidates. Periods were then refined using ANOVA (Schwarzenberg-Czerny 1996). Only stars brighter than 14th mag in K_s were considered, thus limiting our search mostly to RR Lyrae and type II Cepheids.

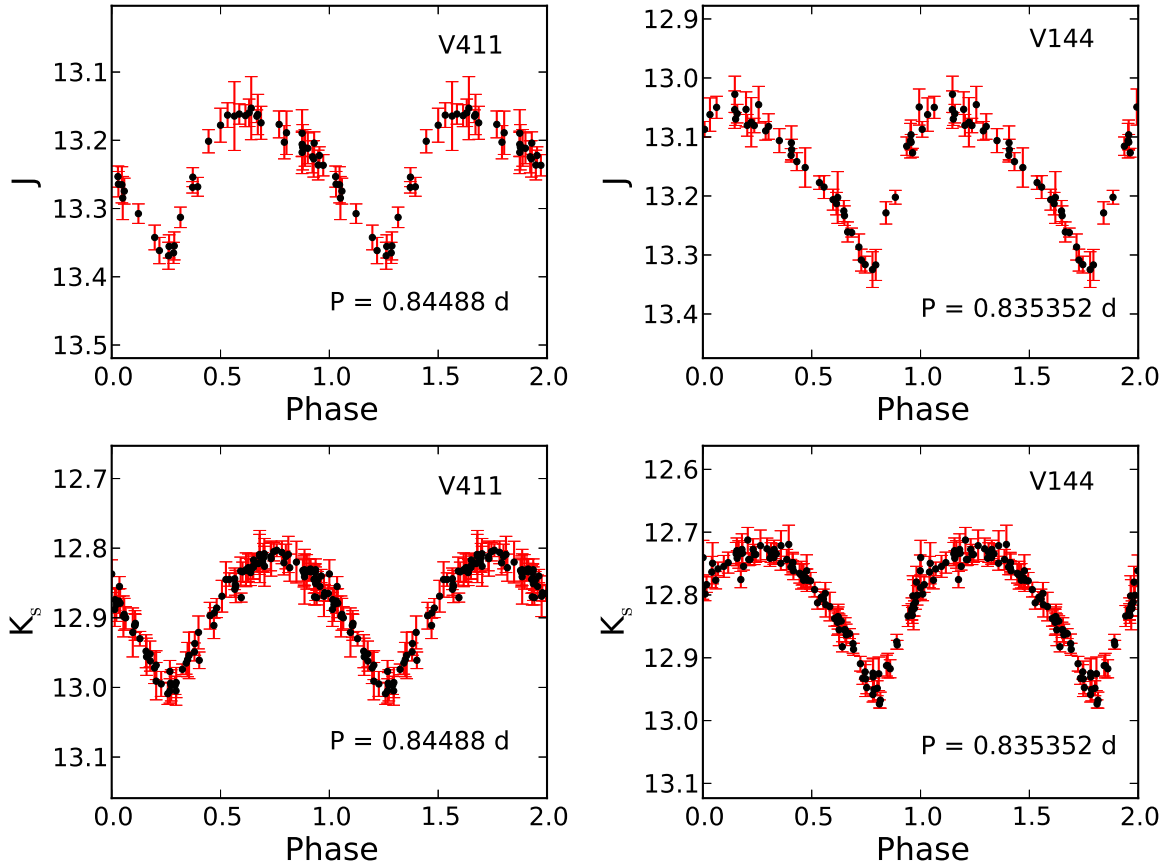
All the previously known variables in this magnitude range were recovered successfully. Among them, we recovered both V144 from Kaluzny et al. (2004) and ID-133 from Weldrake et al. (2007). This was initially surprising, since Weldrake et al. classified their ID-133 as being the same star as V144 in the Kaluzny et al. catalogue. Further analysis confirmed that these are indeed different stars. Figure 1 shows a finding chart, in one of our K_s images.

Coordinates, magnitude-weighted mean magnitudes, periods, and variability types are presented in Table 1. Despite the fact that the two variables have very similar periods and mean magnitudes, the differences are significant, and their respective light curve shapes present slight but noticeable differences as well (Fig. 2). For this reason, we propose to rename variable ID-133 in Weldrake et al. (2007) as V411, following the standard nomenclature and current entries in the latest edition of the Sawyer-Hogg/Clement catalogue of variable stars in globular clusters (Clement et al. 2001; Clement 2013, priv. comm.).

In order to check our results, we matched the positions of ID-133 (V411) and V144 with the Sollima et al. (2004) near-IR catalogue for stars in the ω Cen central region. Sollima et al. derived mean J and K_s magnitudes, in the 2MASS filter system, for 73,000 stars. Matching our coordinates with their catalogue, we find matches for both stars whose magnitudes are fully consistent with ours, to within the errors.

Table 1. Properties of V144 and V411, Based on VISTA Observations.

Name	Proposed ID ^b	LEID ^c	RA (J2000)	DEC (J2000)	$\langle J \rangle$	$\langle K_s \rangle$	Period (d)	Type
ID-133 ^a	V411	42208	13:26:40.77	-47:28:17.00	13.236	12.878	0.84488	RRab
V144	V144	42231	13:26:43.02	-47:28:18.01	13.148	12.808	0.83352	RRab

Notes:^a As given in Weldrake et al. (2007).^b Following the Sawyer-Hogg scheme (Clement et al. 2001).^c LEID Identification number from van Leeuwen et al. (2000).**Figure 2.** VISTA near-IR light curves for the two RR Lyrae stars, V411 = ID-133 in Weldrake et al. (2007, *left panels*) and V144 (*right panels*). The upper and lower panels show the light curves in J and K_s , respectively. All the light curves were folded considering MJD = 55693.965445 as zero point.

Based on this evidence, we conclude that ID-133 from Weldrake et al. (2007) is *not* the same star as V144 from Kaluzny et al. (2004), despite the fact that both variables have very similar magnitudes, colors, and periods. The total number of RR Lyrae stars known in ω Cen is accordingly revised to 198, including 192 from Kaluzny et al., 5 from Weldrake et al. (2007), and the misidentified one discussed in the present paper. We note, in closing, that the coordinates given by Weldrake et al. appear slightly offset (by 3.66 arcsec) from the ID-133 (V411) position in our images. However, no other misidentified star was found in our search.

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