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Local Cosmology from Isolated Dwarfs: variable stars from the LCID project

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Abstract. During Cycle 14 a total of 113 HST orbits were secured to observe five isolated dwarf galaxies, namely Tucana, LGS3, LeoA, IC1613, and Cetus. The aim of the project is a full characterization of the stellar content of these galaxies, in terms of their SFH, radial distributions, halo populations and variable stars. Deep (V≈29) F475W, F814W data allowed us to fully sample all the evolutionary phases from the tip of the Red Giant Branch (RGB) to well below the old Main Sequence Turnoff (MSTO). Here we briefly summarize the latest results of the LCID project concerning the variable star content of our sample galaxies.

Key words. (galaxies:) Local Group – galaxies: photometry, techniques: photometric – galaxies: individual (Tucana, Cetus)

1. Introduction

Dwarf galaxies are the most numerous among the different types of galaxies in the Universe. During the last years, these inconspicuous objects became the cornerstone of many astrophysical projects because of their importance in the cosmological framework of cold dark matter models. Beside the high-z studies, a complementary approach it the analysis of nearby dwarfs. In particular, the Local Group (LG) is an excellent laboratory because nearby objects can be resolved into stars well below their old main sequence (MS) Turnoff (TO). Among these, isolated dwarfs are particularly interesting because their evolution has not been significantly influenced by the vicinity of giant galaxies. Therefore, it is possible to investigate the first episodes of star formation and the possible delay caused by reionization. In this context, we obtained 113 ACS@HST orbits to observe 5 isolated dwarf galaxies of the LG: Cetus and Tucana (dSph), IC1613 and LeoA (dIrr), and LGS3 (transition dIrr/dSph). The aim of the LCID project (Local Cosmology from Isolated Dwarfs, *http:/www.iac.es/project/LCID*) is a full characterization of the stellar content of these galaxies, in terms of their SFH, radial distributions, halo populations and variable stars.

Here we summarize latest results concerning variable stars in the galaxies of our sample.

2. Variable stars

Deep (V≈29) F475W, F814W images were collected at different epochs during Cycle 14. The number of orbits devoted to each galaxy depends on its distance (see Tab. 1). Two

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Table 1. Summary of the variable stars detected (RR Lyrae type ab, c, d), Cepheids (Anomalous, Classical), Binaries, other (including Long-Period variables, candidate δ-Scuti)

Galaxy	*# orbits*	*RRab*	*RRc*	*RRd*	*Cep*	*Bin*	*other*
Tucana	32	216	82	60	6	-	7
Cetus	25	146	8	17	3	2	-
LGS3	12	58	9	5	6	8	4
IC1613	24	60	24	5	44	58	69

F475W, F814W were collected during each visit to obtain a good time sampling for the short period variables. The search for variable stars has been carried out using the variability index defined in Welch & Stetson (1993). The period search was first performed on the suspected variables through Fourier analysis following the prescription of Horne & Baliunas (1986), then refined by hand upon visual inspection of the light curves.

Tab. 1 summarizes the variables detected in the four galaxies in which the search has already been performed. We found a sizeable population of RR Lyrae stars in all the galaxies, strongly supporting the presence of an old (>10 Gyr) population. Both Anomalous and Classical Cepheids candidates, which are representative of intermediate-age and young populations, have been detected in LGS3 and IC1613. Moreover, a sizable sample of other types of variables was detected, including binaries, long-period variables around the Red Giant Branch, and candidate δ-Scuti stars.

2.1. RR Lyrae stars in Tucana and Cetus

Fig. 1 shows a zoom-in on the HB of Cetus and Tucana. The HB morphology is quite different between the two galaxies, despite both being isolated dSph, with similar mean metallicity ([Fe/H]≈-1.8) and old MSTO morphology. The blue side of the HB is considerably more populated in Tucana than in Cetus. This is also verified in the small number of RRc detected: the ratio RRc/RRab is 0.38 and 0.05, for Tucana and Cetus respectively. The latter has a HB ratio ([HBR=(B-R)/(B+V+R)], Lee 1990) of -0.74, corresponding to a red HB. The only stellar systems similar to Cetus, in terms of HBR and metallicity, are the Galactic globular cluster (GC) Ruprecht 106 ([HBR=-0.82, [Fe/H]=-1.67], Clement et al. 2001) and the Fornax 4 GC ([HBR=-1.0, [Fe/H]=-2.0], Buonanno et al. 1999), which have a very red HB for their metallicity and are often thought to be slightly younger than the other GC.

Tucana, on the other hand, is unusual in its large fraction of double-mode pulsators (17% of the entire sample of RR Lyrae stars).

The period-amplitude (PA) diagram for the two galaxies is shown in Fig. 2, together with a linear fit relation (full line) and the 1.4-σ limits. The comparison of the two galaxies shows interesting features.

First, although the mean period of the RRab is similar for Tucana and Cetus (0.613d and 0.604d, respectively), Tucana presents a higher dispersion around the fit. We are investigating if a spread in the age and/or metallicity of the old population can explain this empirical finding. Second, the slope of the period-amplitude relations are different, even after rejecting the outliers through σ-clipping. In particular, the PA relation of Tucana is less steep. The reasons are currently not well understood, although it might be related to the presence of a sizable number of Blazhko variables (Catelan 2004).

3. Conclusions

We presented the latest results of the LCID project concerning the variable stars search in four isolated dwarf galaxies of the LG. Most of the 920 variables detected are new discoveries. In particular, the two dSphs of our sample show interesting differences, in the relative

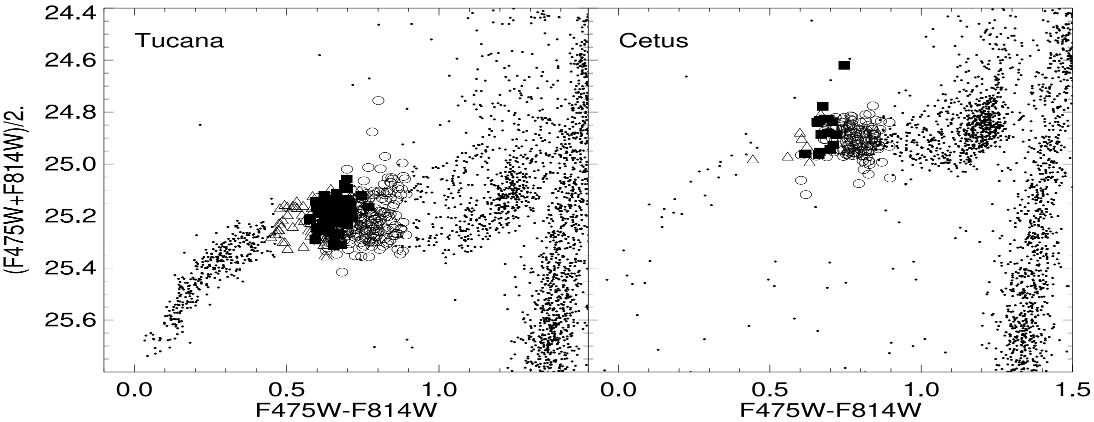

Fig. 1. CMD of the HB region of the two dSph galaxies of our sample, Tucana and Cetus. Different types of RR Lyrae stars are marked with different symbols: open circles (RRab), open triangles (RRc), filled squares (RRd). Note the different morphology of the HB, especially in the blue side of the CMD.

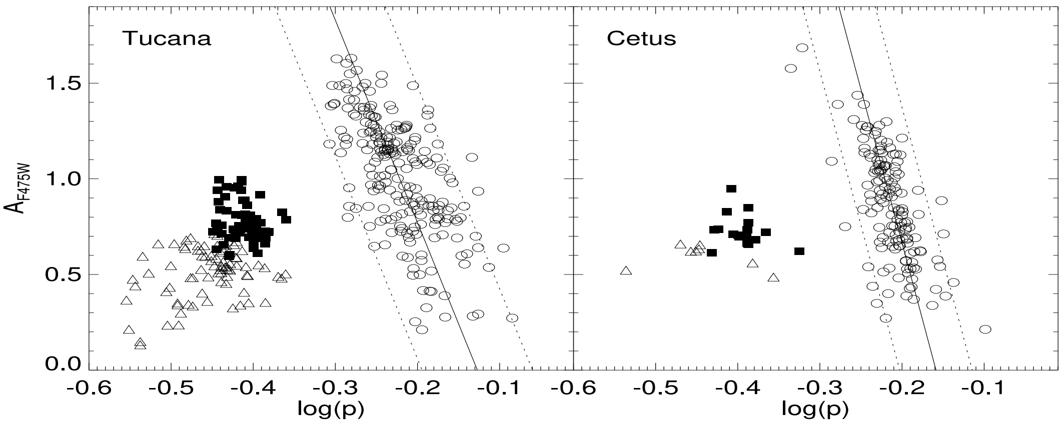

Fig. 2. Period-amplitude diagram for the RR Lyrae stars in the two galaxies.

numbers of RR Lyrae and in the morphology of the HB. We are investigating how different star formation histories at older epochs can explain our empirical finding.

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References

Catelan, M. 2004, ApJ, 600, 409
Clement, M., et al. 2001, AJ, 122, 2587
Horne, J. H., & Baliunas, S. L. 1986, ApJ, 302, 757
Lee, Y.W. 1990, ApJ, 363, 159
Stetson, P.B. 1994, PASP, 106, 250
Welch, D. & Stetson, P.B. 1993, AJ, 105, 1813