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A WFCAM near-infrared survey of M31 dwarf elliptical satellites

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Abstract. We present preliminary results from a UKIRT/WFCAM wide-field, near-infrared survey of several dwarf galaxies in the Local Group. In particular, we focus on the four dwarf elliptical satellites of M31 (NGC147, NGC185, NGC205 and M32). The detailed understanding of nearby dEs is crucial for the studies of more distant objects. This is the first time these dEs are consistently imaged within such a wide field-of-view ($\sim$ 1 deg^2), thus enabling us to study luminous asymptotic giant branch (AGB) stars (indicative of an intermediate-age population, $\sim$ 1 − 8 Gyr) over their whole extent. In particular, we separate C- from O-rich AGB stars and look for radial gradients and global structures in these dEs, in order to constrain their past evolution and their interactions with M31/with each other.

Key words. Galaxies: dwarf – Galaxies: stellar content – Galaxies: photometry – Galaxies: Local Group – Galaxies: individual: NGC185, NGC147, NGC205, M32

1. Introduction

The understanding of the formation and evolution of elliptical galaxies remains poorly understood to date. Within our Local Group, the only examples of this galaxy type are the four dwarf ellipticals (dEs) NGC147, NGC185 and NGC205, and M32, all companions to the giant M31. The latter two lie at very close distances from M31, thus potentially prone to strong influences from their giant host, while the other two have long been believed to form a galaxy pair and are located further away from M31, at $\sim$ 160 kpc (McConnachie, 2012). NGC147 and NGC185 additionally show signs of rotation, thus supporting a scenario where they were born as rotationally supported, possibly gas-rich, objects that later turned into spheroids (Geha et al., 2010). These are thus important laboratories where to investigate the nature and effects of host-satellite interactions, and to test the predictions of cosmological models on the formation and possible associations of dwarf galaxies.

Despite the fact that several studies focused on their recent star formation, structural properties and past interaction history, so far the M31 dEs companions have been mostly targeted with small field-of-view pointings, thus invalidating any global conclusion on their nature. In this contribution, we present the first homogeneous wide-field survey of these galaxies, carried out with UKIRT/WFCAM at near-IR wavelengths (J, H and K bands; see also Cioni et al. 2008; Sibbons et al. 2012) and covering $\sim$ 1 deg^2 around each of the targets, thus

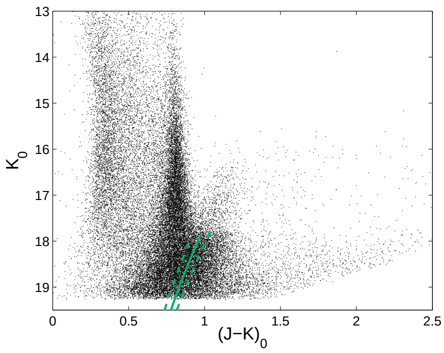

Fig. 1. Dereddened CMD for NGC185. Overplotted are Dartmouth isochrones shifted at the distance of this dE. The isochrones have a fixed age of 10 Gyr and varying metallicities ([Fe/H] = −1.5, −1.3, −1.1, from left to right), and indicate the uppermost ∼ 1 mag of the red giant branch. The two vertical sequences visible at $(J-K)_0 \lesssim 0.9$ consist of Galactic foreground stars. Luminous AGB stars are found above the TRGB, distinguished into O-rich ($(J-K)_0 \lesssim 1.3$) and C-rich ($(J-K)_0 \gtrsim 1.3$) stars.

allowing us to derive their physical properties over their whole spatial extent.

2. Results and conclusions

Aperture photometry was performed with a modified version of the WFC/INT pipeline (e.g. Irwin, 1985). The WFCAM data allow us to construct deep color-magnitude diagrams (CMDs) reaching ∼ 1 mag below the tip of the red giant branch (TRGB; an example is shown in Fig. 1). The analysis of luminous asymptotic giant branch (AGB) stars above the TRGB allows one to constrain the intermediate-age (∼ 1 − 8Gyr) star formation in a galaxy, where deep old main-sequence turnoff photometry over a large area would be observationally too demanding. In this context, near-IR bands are strategical for the separation between the targets' stellar content and Galactic foreground contaminants (Fig. 1; e.g. Gullieuszik et al., 2008), and are not heavily affected by dust. Additionally, near-IR colors provide a good separation between C- and O-rich AGB stars, in absence of spectroscopic data (Fig 1; e.g. Kang et al., 2006).

By comparing the luminosity of AGB stars to stellar evolutionary models, we are able to put constraints on the latest epoch of star formation for the target dEs. We further find that the dwarfs have been able to produce a second generation of intermediate-age stars which are more metal-rich and more centrally concentrated than the bulk of their old RGB populations. Spatial density maps reveal large-scale asymmetric substructures in the stellar distribution, pointing at possible tidal interactions whose origin remains to be clarified. Finally, we use the spatially resolved ratio of C- to O-rich AGB stars, which approximately traces [Fe/H] in a galaxy (e.g. Cioni, 2009), in order to investigate the presence of radial metallicity gradients in the dEs.

The results presented in this contribution are described in detail in Crnojević et al., in prep.

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