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Structural decomposition of galaxies in the CALIFA survey

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Abstract. Several clues for understanding the nature and evolution of galaxies can be gained by studying galactic structures and their evolution with time and environment. However, even for nearby galaxies, detailed structural decomposition is not a straightforward task. Choosing the number of structural components and the limits placed on their parameters can have a large effect on the derived characteristics of galaxies. For distant galaxies, structural analysis is further hampered by the spatial resolution limits of the imaging. However, by using a relatively robust two-component bulge+disk modelling, galaxies in the nearby Universe can be compared to distant galaxies for tracing signs of evolution in the extracted structures. We start such a study by analysing first a well observed nearby sample of galaxies, using ∼600 targets from the CALIFA survey. We show that even in this small sample of nearby galaxies, the effects of environmental density are already well apparent.

Keywords. galaxies: photometry, galaxies: structure, galaxies: spiral, galaxies: elliptical

1. Data and methodology

We use the Sloan Digital Sky Survey (SDSS; York *et al.* 2000) Data Release 10 images of galaxies, which are selected based on the Calar Alto Legacy Integral Field Area Survey (CALIFA) sample, described by Sanchez *et al.* (2012). For the CALIFA survey, targets have been selected to have an apparent diameter which fits within the FoV of the integral field spectrophotometer on the Calar Alto 3.5 m telescope. An additional selection criterion in redshift range of 0.005 to 0.03 is made. Thus the CALIFA selection criteria create a comprehensive sample of nearby Universe galaxies. The available kinematical data can later be used to verify the meaningfulness of the decomposition.

Structural decomposition was performed on post-stamp cutouts from the corrected SDSS DR10 frames. Galfit (Peng *et al.* 2010) was used to fit galaxy models with two Sersic components. Initial guess parameters for the fitting were derived with Source-Extractor (Bertin & Arnouts 1996).

2. Results

The galaxy sample is characterised with the g-i colour-magnitude diagramme on Fig. 1. Spiral and elliptical morphologies, as determined within the Galaxy Zoo project (Lintott *et al.* 2008), are shown. As expected, elliptical galaxies are generally redder, while spirals have a much broader colour span.

The mean values of the main structural parameters of the extracted bulges and discs are given in Table 1. In the table, we compare two subsamples: isolated galaxies vs rich groups (with 10 or more members); the group membership has been taken from the galaxy group catalogue Tempel *et al.* (2014). Both bins contain 44 galaxies. Even for these small subsamples, several expected differences between sparser and denser environments are

	Isolated	**Rich groups**
B/T_i	0.34(±24)	0.43(±26)
N_{Bulge}	2.5(±1.3)	3.2(±1.2)
r_{bulge} (kpc)	1.4(±1.0)	1.9(±1.3)
N_{disk}	0.6(±0.4)	0.7(±0.4)
r_{disk} (kpc)	4.5(±2.0)	6.0(±3.2)
$L_r/L_{r,Sol}$ (10^{10})	1.0(±0.7)	2.2(±1.7)
g-*i*	1.0	1.2

Table 1. Mean values of some structural characteristics of galaxies in different environments; the uncertainties are shown in brackets. From top to bottom: ratio of bulge to total luminosity in the *i* band, bulge Sersic index, bulge effective radius in kpc, disk Sersic index, disk effective radius in kpc, total *r* band luminosity in 10^{10} Solar values, the median of *g*-*i* colours.

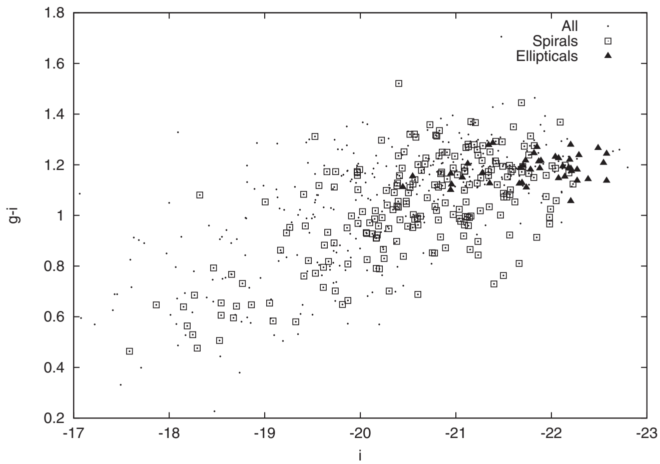

Figure 1. Color-magnitude diagramme of the galaxy sample. The complete sample is shown with dots, morphological determination from Galaxy Zoo is given with an empty box around a dot for spirals and filled triangles for ellipticals.

apparent: galaxies tend to become more luminous, redder, and with higher bulge-to-total ratios in denser environments. Interestingly, the Sersic indices and effective radii increase simultaneously with environmental density, indicating that stellar matter in galaxies becomes less concentrated in cluster environments. This effect is more prominent for bulges; we speculate that it is a natural result of galaxy-galaxy interactions.

The presented results show that even a simple bulge+disc decomposition can be a powerful tool for analysing the structure and evolution of galaxies.

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