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Stellar populations in bulges The isolated galaxies

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Resumen / En una reciente serie de artículos se han presentado los resultados de la investigación sobre la población estelar y sus gradientes en las regiones de la galaxias donde la luz esta dominada por el bulbo.
En la presentación oral se han mostrado los resultados de estos trabajos y los últimos avances del proyecto, mostrando las propriedades de la población estelar en el bulbo de galaxias en ambiente aislado.

Abstract / In a recent series of papers we presented the results of the investigation on the stellar populations and their gradients of the bulge dominated region.
The results of these works have been presented in the talk along with the last progresses in this projects, showing the properties of the stellar populations in the bulge dominated regions of galaxies in isolated environment.

Keywords / galaxies: abundances — galaxies: bulges — galaxies: formation — galaxies: kinematics and dynamics — galaxies: spiral — galaxies: stellar content

1. Introducción

Most of the stars in the local universe reside in the bulges of disk galaxies. Their morphological classification is based on the relative prominence of the spheroidal and disk components and their structures reflects the different formation processes. Thus, it follows that understanding how bulges assembled is a crucial step in understanding galaxy formation.

Dissipative collapse (e.g., Gilmore & Wyse, 1998), major and minor merging events (e.g., Cole et al., 2000), and redistribution of disk material due to the presence of a bar or environmental effects (e.g., Kormendy & Kennicutt, 2004) drives to the variety of properties observed in bulges. Theoretical models give strong constraints on the resulting galaxy that need to be tested with observations. In particular, an invaluable piece of information to understand the processes of formation and evolution of galaxies is imprinted in their stellar populations (e.g., Seidel et al., 2015; McDermid et al., 2015; Corsini et al., 2018) and even more in their radial gradients (e.g., Gorgas et al., 2007; Morelli et al., 2008; González Delgado et al., 2014; Morelli et al., 2015b) since different formation scenarios predict different radial trends of age, metallicity, and alpha/Fe enhancement.

To take on this challenge we have started a campaign to investigate the stellar populations of bulges of galaxies residing in dense environments to compare their nature with the nature of bulges in isolated galaxies.

In Morelli et al. (2008, 2012, 2015a) the central value and radial gradient of age, metallicity, and [α/Fe] enhancement has been measured for a large number of high-surface brightness (HSB) and low-surface brightness (LSB) galaxies. The only common feature for these bulges (independently from their morphological type and environment) is the negative metallicity gradient along the galaxy radius. All these characteristics are supporting scenarios like violent relaxation due to a merging event, or dissipative collapse in monolithic scenario and discourage secular evolution. However, secular evolution could still be the main responsible for the formation of galaxies with small bulges (Costantin et al., 2017, 2018). The variety of the results testifies the complexity of the topic and could be due to the continuous interactions between the cluster galaxies and their dense environment (Corsini et al., 2017).

2. Isolated bulges

A way to make the observational picture simpler is studying the bulges of isolated galaxies, for which the interactions with the surrounding environment or with other galaxies are likely to be negligible (Hirschmann et al., 2013).

In Morelli et al. (2016) we analysed the stellar populations of the bulges of a carefully selected sample of HSB isolated disk galaxies to be compared with the complementary samples of bulges in HSB cluster galaxies and giant LSB galaxies. In Fig. 1 we reported the comparison of morphological type, central velocity disper-

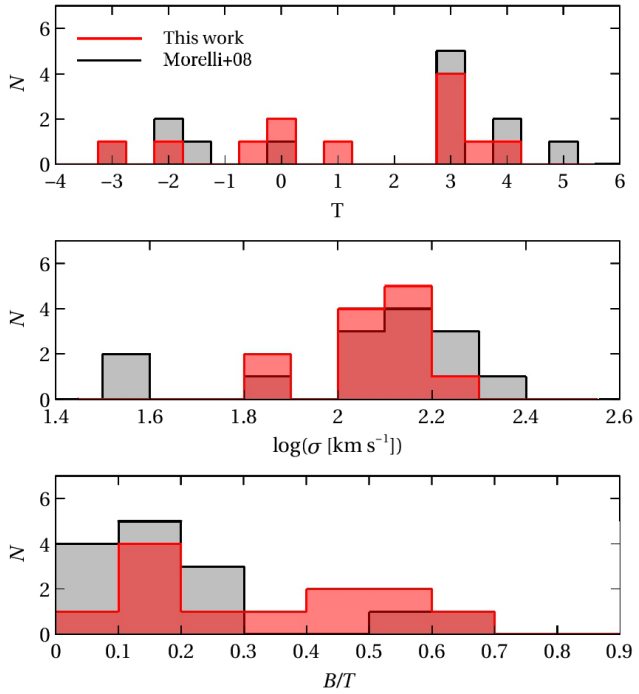

Figure 1: Distribution of the morphological type (upper panel), central velocity dispersion (middle panel), and B/D ratio (lower panel) for the sample galaxies (red histograms). The distribution of the same quantities for the group and cluster galaxies studied by Morelli et al. (2008) is plotted for a comparison (grey histograms).

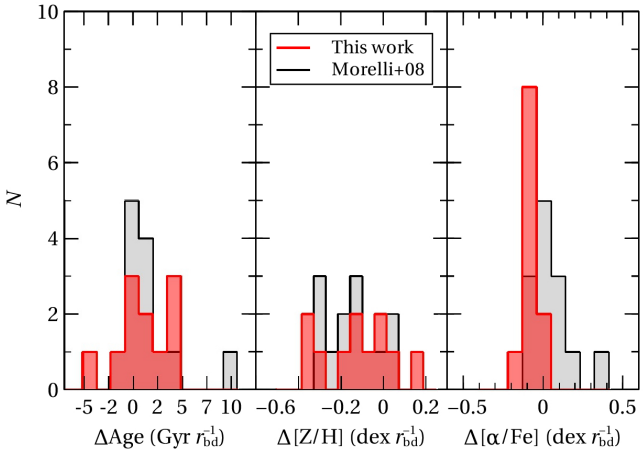

Figure 2: Distribution of the gradients of mean age (left-hand panel), total metallicity (central panel), and total α/Fe enhancement (right-hand panel) for the sample bulges (red histograms). The distribution of the same quantities for the bulges of group and cluster galaxies studied by Morelli et al. (2008) is plotted for a comparison (grey histograms).

sion, and B/D ratio between the two sample.

In order to measure the stellar populations gradients in the bulge we had to derive the relative importance of disc, bulge and bar along the radius. Their structural parameters were derived from the sky and mask-subtracted i-band images by applying the Galaxy Surface Photometry Two-Dimensional Decomposition (GASP2D) algorithm (Méndez-Abreu et al., 2008, 2014). Following the photometric decomposition we defined $r_{\rm bd}$, the radius where the surface brightness contribution of the bulge component is equal to the contribution from the other components.

The gradients of age, metallicity and α-enhancement were derived as the difference between the value derived at radius $r_{\rm bd}$, and the central value obtained within $0.1r_{\rm e}$. We confirm the negative radial trend in metallicity also for the isolated galaxy, but the main result is the negative gradient for the [α/Fe] enhancement (Fig. 2).

3. Conclusions

We analysed the surface-brightness distribution, stellar kinematics, and stellar population properties of a sample of isolated galaxies selected from the Catalogue of Isolated Galaxies (Karachentseva, 1973), to constrain the dominant mechanism of the assembly of their bulges. We give particular attention to the stellar populations gradient along the radius of the galaxy.

All the sample bulges show a negative gradient for the α/Fe enhancement. This is a prediction of the dissipative collapse model for bulge formation and it has never been observed before. We suggest that the gradients imprinted during the inside-out formation process are preserved in the bulges of isolated galaxies, which suffered a limited number of interactions and mergers, whereas the gradients are cancelled in the bulges of group and cluster galaxies as a consequence of phenomena driven by environment.

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References

Cole S., et al., 2000, MNRAS, 319, 168
Corsini E.M., et al., 2017, MNRAS, 466, 974
Corsini E.M., et al., 2018, A&A, 618, A172
Costantin L., et al., 2017, A&A, 601, A84
Costantin L., et al., 2018, MNRAS, 481, 3623
Gilmore G., Wyse R.F.G., 1998, AJ, 116, 748
González Delgado R.M., et al., 2014, A&A, 562, A47
Gorgas J., Jablonka P., Goudfrooij P., 2007, A&A, 474, 1081
Hirschmann M., et al., 2013, MNRAS, 433, 1479
Karachentseva V.E., 1973, Soobshch. Spets. Astrofiz. Obs., 8, 3
Kormendy J., Kennicutt R.C., 2004, ARA&A, 42, 603
McDermid R.M., et al., 2015, MNRAS, 448, 3484
Méndez-Abreu J., et al., 2008, A&A, 478, 353
Méndez-Abreu J., et al., 2014, A&A, 572, A25
Morelli L., et al., 2008, MNRAS, 389, 341
Morelli L., et al., 2012, MNRAS, 423, 962
Morelli L., et al., 2015a, Astron. Nachr., 336, 208
Morelli L., et al., 2015b, MNRAS, 452, 1128
Morelli L., et al., 2016, MNRAS, 463, 4396
Seidel M.K., et al., 2015, MNRAS, 451, 936