Formation and Evolution of Galaxy Bulges
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Stellar population in bulge of spiral galaxies

L. Morelli[1], E. Pompei[2], A. Pizzella[1], L. Coccato[3], E. M.Corsini[1], J. Méndez Abreu[1,5], R. P. Saglia[3], M. Sarzi[4] and F. Bertola[1]

[1]Dip. Astronomia, Universita' di Padova, Italy; [2]European Southern Observatory, Chile; [3]Max-Planck Institut für Extraterrestrische Physik, Germany; [4]University of Hertfordshire, U.K.; [5]INAF-Osservatorio Astronomico di Padova, Italy

Abstract. We present extensive photometric and spectroscopic study to give a new insight in the bulge stellar population. Super-solar α/Fe and its constant value along the radial profile, in most of the galaxies, suggest that the star formation in these objects has been fast and occurred at the same time in the whole bulge.

1. Introduction

Bulge of spiral galaxies, due to their privileged position in the center of galaxies, are very promising to reveal the mechanisms of their formation and evolution. Dynamical and kinematical studies have revealed their complexity suggesting they could have completely different nature through the Hubble sequence. Chemical evolution studies on bulges of spirals are few and so far mainly based on field galaxies. They show that bulges of early-type spiral galaxies (Sa to Sb) have similar behavior to field elliptical galaxies, while bulges hosted in late type spiral galaxies (Sc onward) host a younger stellar population. In this work we attack questions like the following:

- How do bulges form? Are the dissipative collapse, secular evolution, bar instability, merging events responsible for the bulge formation?
- How do galaxies form? Do the galaxy disks give rise to their bulges or is the bulge a small elliptical that acquired a disk in the merging framework of galaxy formation?

Any good theory explaining the galaxy evolution has to be able to reproduce the constraints given by the observation of stellar populations such as age, metallicity and α-enhancement. The lack of tight observational constraints prevented so far to reach conclusive answers for the above questions. To this aim we derived metal abundances, age and α-enhancement of the stellar population of a large sample of galaxies, with a morphological type ranging from S0 to Sc.

2. Sample and observations

The sample is composed by bright and nearby disk galaxies. All of them have been identified as member of either the Fornax or Pegasus cluster and chosen to be unbarred with a low-to-intermediate inclination. We obtained long-slit spectra at the ESO 3.6-m telescope using EFOSC2 spectrograph in the range between 4700Å and 6700Å, with a instrumental FWHM=6.5Å. For each galaxies we measured the stellar kinematics and the major axis radial profiles of the Lick indexes.

3. Results and conclusions

The highest values of Mg_2 and $\langle Fe \rangle$ (and therefore of metallicity) are always measured in the center of the galaxies. Furthermore we found a well defined relation between

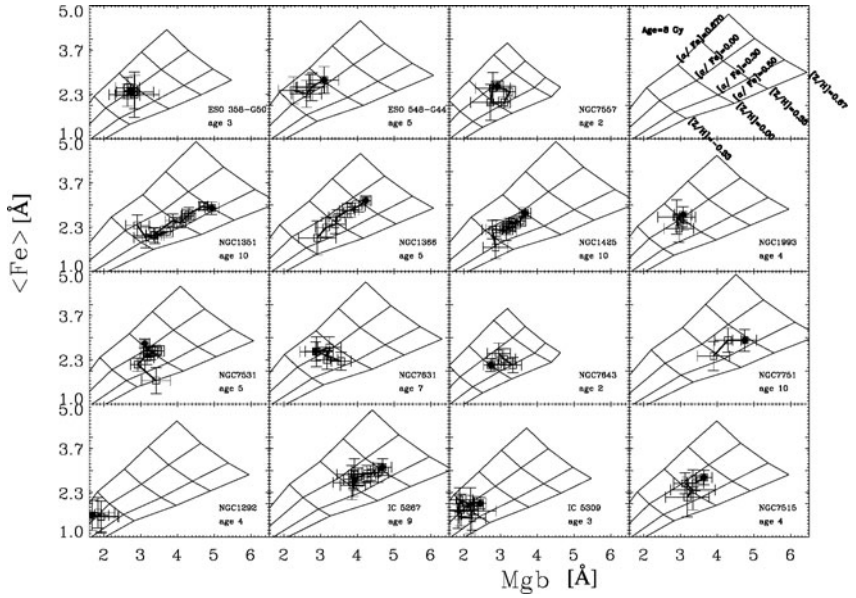

Figure 1. Measurements of Mg_b and $\langle Fe \rangle$ along the major axis of the sample galaxies. The filled dot correspond to the value measured in the galaxy center. The model grid refers to the age of the galaxy. In the upper left panel the values for α/Fe and metallicity (Thomas *et al.* 2003) are displayed in a grid corresponding to the fixed age of $8Gyr$. The galaxy name and age in Myr are given in the lower right corner of each pane.

the central velocity dispersion and the corresponding values of $\langle Fe \rangle$, Mg_b and H_β. This correlation is expected if the formation process of the spheroids occurred via dissipative collapse. Similar results have been found also for the Galactic bulge (Zoccali et al. 2006). The constant and super-solar values of the α-enhancement ratio (α/Fe=0.3) along radius suggests that the formation of the bulk of stars in spiral bulges, occurred with the same short ($< 1\ Gyr$) timescale as in elliptical and S0 galaxies. Therefore,the observed trend of the α/Fe radial profiles are not consistent with strong inside-out or outside-in scenarios with pure monolithic collapse, where a positive gradient in the α-enhancement is expected (Martinelli *et al.* 1998). On the other hand the globally α/Fe enhanced stellar population is not expected in the hierarchical merging scenario (Thomas & Kaufmann 1999) where the star formation is triggered by the merger event (Bender & Surma 1992) and could give higher central values of α/Fe which decrease outwards (Thomas 1999).

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