Boletim da Sociedade Astronômica Brasileira, **30**, no. 1, 170-171

The role of environment on the formation of clumpy starburst galaxies

Santana-Silva, L., Gonçalves, T. S., Rigucinni, L., & Charbonnier, A.

[1] Federal University of Rio de Janeiro, Valongo Observatory e-mail: luidhy@astro.ufrj.br

Abstract. The study of galaxies at high redshift is challenging due to observational limitations, but investigations on how these objects form is of fundamental importance to understand the evolution of star formation processes throughout the history of the universe. Objects at $2 \leq z \leq 3$ present high star formation rates (up to $\sim 100\ M_{\odot} yr^{-1}$ and above) and irregular clumpy morphologies. The classical scenario for galaxy formation from the collapse of gas onto a dark matter halo and subsequent gradual cooling cannot explain these properties and more complex scenarios become necessary, such as cooling flows and galaxy mergers. In that sense, we are currently analyzing a sample of low-redshift galaxies ($z \sim 0.2$) with SFR and morphologies similar to those found in the distant universe (the Lyman break analog sample - LBAs). Here, we show preliminary results of our observations of 13 LBAs to identify possible relations between the environment and other properties of these galaxies. To this end we obtain deep ($r \sim 25.5$) images using the DECam, on the Blanco telescope, in four bands (*ugri*), yielding photometric redshifts with uncertainties of $dz(1+z)^{-1} \sim 0.07$. We will calculate environmental densities around the LBAs and compare these values with other star-forming galaxies of similar stellar masses in order to understand the impact of environmental properties on the intense star formation activity in these galaxies.

Resumo. O estudo de galáxias em alto redshift é um desafio devido a limitações observacionais, mas investigar como esses objetos são formados é de vital importância para entender a evolução do processo de formação estelar ao longo da história do universo. Objetos em $2 \leq z \leq 3$ apresentam elevada formação estelar ($\sim 100\ M_{\odot} yr^{-1}$ ou maior) e morfologia irregular. O cenário clássico para a formação de galáxias no qual o gás colapsa em um halo de matéria escura e sofre um processo gradual de resfriamento não consegue explicar todas propriedades observadas em galáxias do universo distante e cenários mais complexos são necessários, como cooling flows e fusão de galáxias. Nesse contexto, estamos analisando uma amostra de galáxias em baixo redshift ($z \sim 0.2$) com SFR e morfologia similares àquelas observadas no universo distante. Aqui são apresentados resultados preliminares das observações de 13 LBAs para identificar possíveis relações entre o ambiente dessas galáxias. Para isso foram obtidas imagens profundas ($r \sim 25.5$) usando a DECam, no telescópio Blanco, em quatro bandas (*ugri*), permitindo obter redshifts fotométricos com incertezas de $dz(1+z)^{-1} \sim 0.07$.

Keywords. Galaxies:starbursts — Galaxies:evolution

1. Introduction

Current models of galaxy formation and evolution describe galaxies in the local universe but fail to explain features in galaxies at high redshift ($2 \leq z \leq 3$) (Baugh 2006). In that sense, more complex scenarios are necessary to explain the observed properties in these galaxies, such as cold flows and galaxy mergers. The Cold-Flow model is an attempt to explain the high star formation rates in the distant universe by assuming that the transport of gas in the halo direction happens by cold fillament gas (Dekel et al. 2009). The cold gas in the filaments may be responsible for feed the halo. These filaments originate in regions outside the halo and keep the gas at high densities and are then fragmentend into smaller parts that move toward the center of the halo (Bournaud et al. 2008). Alternatively Di Matteo et al. (2007) propose that the star formation intensity can also be attributed to the occurrence of fusions and interactions between galaxies, found that the merger rate is higher at high redshift (Conselice 2006; Lee et al. 2006).

Galaxy clusters are a useful tool to investigate how the galaxy properties can change with the environment (Kelkar et al. 2017; Dressler 1980). Previous studies (e.g., Adelberger et al. 2005) analyzing the correlation function of Lyman break galaxies found that low-mass galaxy companions would be necessary to explain the large total masses of the halos inhabited by those objects. On the other hand a sample of local galaxies that share the same features with galaxies in the distant universe can be used as a tool to understand how these galaxies are formed.

2. Sample and Data

Lyman break analogs (LBAs) comprise a sample of local galaxies ($z \sim 0.2$) proposed by Heckman et al. (2005).These objects show metallicities, gas fractions, morphologies and attenuation values similar to those found in main-sequence galaxies at high redshift ($2 \leqslant z \leqslant 3$) (Hoopes et al. 2007; Basu-Zych et al. 2009; Overzier et al. 2010, 2011; Gonçalves et al. 2010, 2014) Our main goal in this work is to evaluate the effects of the environment (if any) on the formation of these objects. Our data was obtained using the DECam (Dark Energy Camera), installed on Blanco telescope. We observed 12 fields, one around each LBA in the sample in four photometric bands (*ugri*). This sample constitutes the ELBA survey (Environment of Lyman Break Analogs galaxies survey). We got very deep images in magnitude (22.7 in the *i* band for a 10σ detection). Table 1 presents a comparison between the detection limit for galaxies for ELBA and DES data (Drlica-Wagner et al. 2017) .

Table 1. Comparison of magnitudes limits between ELBA and Dark Energy Survey data

Filters	$ELBA_{10\sigma}$	$DES_{10\sigma}$
u	22.1	——
g	23.7	23.4
r	23.2	23.2
i	22.7	22.5

3. Results: photometric redshifts

In order to obtain photometric redshift measurements we apply LePhare (Ilbert et al. 2006) on the four photometric bands available on ELBA survey. By using a set of CFHTLS templates, we perform SED fitting for each source present in the survey. Figures 1 and 2 show the reliability of our photometric redshift measurements. Our typical uncertainty is $dz(1+z)^{-1} \sim 0.04$, similar with other surveys that use four photometric bands, such as the Dark Energy Survey (Sánchez et al. 2014).

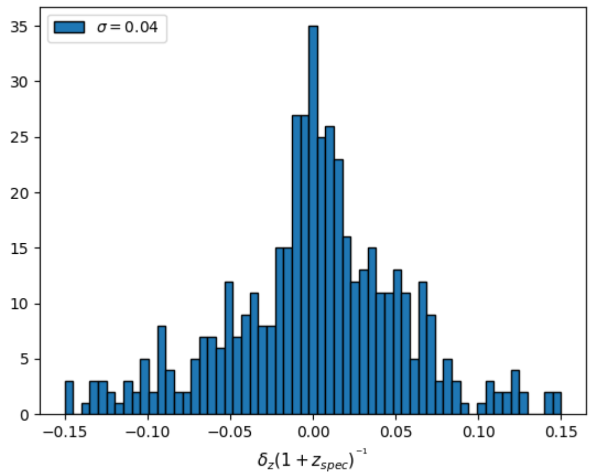

Figure 1. Distribution of differences between photometric and spectroscopic redshifts in the ELBA survey, when available. We conclude that, in general, $dz(1+z)^{-1} \sim 0.04$

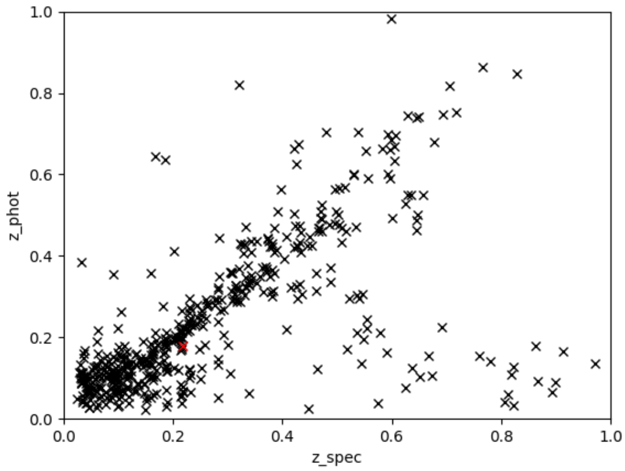

Figure 2. Comparison between z_{phot} and z_{spec} for the ELBA survey. The catastrophic photo-z rate is 20%.

4. Conclusions

In this work present preliminary results for the ELBA survey (Santana-Silva et al., in prep.). Our first analyses show that this is a deep and wide sample of galaxies, and the availability of u-band is particularly advantageous for low-z studies. Photometric redshifts are in good agreement with expected values, allowing for a good determination of the environment of objects in the sample. This will allow for a complete characterization of the effects of the environment on the formation of dense, compact star-forming galaxies.

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