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Post-starburst galaxies in different environments

Rodolfo Spindler, Marina Trevisan and Allan Schnorr-Müller

Department of Astronomy, Institute of Physics, Federal University of Rio Grande do Sul, 9500 Bento Gonçalves Avenue, Porto Alegre, RS, 91501-970, Brazil
email: rodolfo.spindler@ufrgs.br

Abstract. Post-starburst galaxies (PSBGs) are systems that experienced a burst followed by a rapid quenching of star formation. However, it is still unclear what causes these events and what is the environmental role in the origin of PSBGs. To address this, we analysed sizes, morphologies, ages, and metallicities of PSBGs at $0.05 \leqslant z \leqslant 0.1$ in groups and clusters of galaxies. We find a statistically significant excess of compact PSBGs in groups compared to a control sample of passive galaxies. Satellite PSBGs in groups tend to be more compact compared to their counterparts in clusters. Additionally, the PSBGs in groups have smaller T-type values and are likely to be found in inner group regions compared to PSBGs in clusters. Our results are compatible with dissipative wet merger events being an important mechanism responsible for the origin of PSBGs in groups, but other – less dissipative – processes may be producing PSBGs in cluster environments.

Keywords. galaxies: post-starburst, galaxies: quenching, galaxies: environment

1. Introduction

Post-starbust galaxies (PSBGs) are a rare class of objects with atypical spectral properties, such as strong Balmer absorption lines – a signature of A-type stars (Dressler & Gunn 1983). Studies have shown that these spectral features can only be reproduced by models of a recent burst followed by a rapid quenching of the star formation (e.g. Wild *et al.* 2007; von der Linden *et al.* 2010). However, it is still unclear what mechanisms are responsible for these events.

There is evidence pointing to a major-merger origin of PSBGs, such as disturbed morphologies and the high PSBG frequency in poor galaxy groups (Zabludoff *et al.* 1996; Blake *et al.* 2004). Alternatively, the redshift evolution of the PSBG number density (Wild *et al.* 2009) is not compatible with that of the major-merger rate (de Ravel *et al.* 2018). Additionally, PSBGs are found in rich clusters, where merger events are rare due to high velocity dispersions (Dressler *et al.* 2013). In this work, we investigate the physical processes responsible for the origin of PSBGs by analysing how the properties of PSBGs depend on the environment.

2. Data and Sample selection

To define the sample of PSBGs, we used the data from the *Sloan Digital Sky Survey - Data Release 12* (SDSS-DR12). We selected galaxies: *i*) at $0.05 \leqslant z \leqslant 0.1$; *ii*) brighter than $M_r \leqslant -20.4$, where M_r is the k-corrected absolute magnitude in the r band; *iii*) with low Hα equivalent widths (EW[Hα] $\leqslant 1$ Å); and *iv*) high Hδ_A index values (H$\delta_{\rm A} \geqslant 1.5$ Å). The galaxy ages and metallicities were inferred from the SDSS spectra using the STARLIGHT code (Cid Fernandes *et al.* 2005) with spectral models by (Vazdekis *et al.* 2015).

We retrieved the galaxy effective radii and morphologies from the catalogues by Simard *et al.* (2011) and by Dominguéz Sanchéz *et al.* (2018), respectively. We used an updated version† of the catalogue of groups and clusters by Yang *et al.* (2007) to identify the galaxies that are centrals and satellites in groups ($M_{\rm halo} \leqslant 10^{14}\,{\rm M}_{\odot}$), and satellites in clusters ($M_{\rm halo} > 10^{14}\,{\rm M}_{\odot}$). Finally, the control sample galaxies (CSGs) were selected to have similar distributions of stellar masses and specific star formation rates, and to reside in similar environments as the PSBGs.

3. Results and Perspectives

Our results can be summarized as follows:

• Using a mass-size relation of passive galaxies defined by van der Wel *et al.* (2014), we find that the central PSBGs are more compact than the central passive CSGs.

• The PSBGs that are satellites in groups also tend to be more compact than the satellite PSBGs in clusters. In addition, the PSBGs in groups have smaller T-type values (galaxy morphology index related to the Hubble sequence) and are more likely to be found in the inner group regions compared to satellite PSBGs in clusters.

• The PSBGs are young and metal-rich systems, regardless of the environment where they reside. The ages of the PSBGs are similar to those of the star-forming CSGs, but the PSBG metallicities are more compatible with those of the passive CSGs.

The small sizes of the PSBGs and their position within the host group are compatible with dissipative wet-merger events being an important mechanism responsible for the origin of the PSBG population in groups of galaxies. However, the differences that we find between the PSBGs in groups and in clusters suggest that other physical mechanisms produce PSBGs in these environments, as already suggested by Dressler *et al.* (2013). We will continue our investigation by performing a detailed morphological and structural analysis of group and cluster PSBGs.

It has been proposed that PSBGs are a transitioning population between star-forming and passive galaxies (Wild *et al.* 2009), and the ages and metallicities of our PSBGs compared to those of the CSGs lead us to two possible scenarios: *i*) the progenitors of PSBGs were star-forming systems that were enriched very efficiently; or *ii*) they were passive galaxies that got rejuvenated. To continue this investigation, we will trace the chemical enrichment histories of PSBGs following the approach by Trevisan *et al.* (2012).

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† Available at www.astro.umass.edu/ xhyang/Group.html.