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The effects of interactions and mergers on the formation and properties of compact starburst galaxies

Sabrina Isis B. Dopico[1], Marina Trevisan[1], Basílio Xavier Santiago[1], Vitor Bootz[1], Trinh Thuan[2], Yuri Izotov[3], Rogério Riffel[1], Allan Schnorr Müller[1], Angela Krabbe[4], & Oli Dors[5]

[1] Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil e-mail: `isisdopico@gmail.com`, marina.trevisan@ufrgs.br, basilio.santiago@ufrgs.br, vitorbootz@gmail.com, riffel@ufrgs.br, allanschnorr@gmail.com
[2] University of Virginia, Charlottesville, USA e-mail: `txt@virginia.edu`
[3] Bogolyubov Institut for Theoretical Physics, Kyiv, Ukraine e-mail: `izotov@mao.kiev.ua`
[4] Universidade de São Paulo, São Paulo, Brazil e-mail: `angela.krabbe@gmail.com`
[5] Universidade do Vale do Paraíba, São José dos Campos, Brazil e-mail: `olidors@univap.br`

Abstract. Local Compact Starburst Galaxies (CSBGs) may be analogous to dwarf galaxies at higher redshifts, often regarded as the main contributors to the reionization of the Universe at $z \sim 6$. However, the mechanisms that enabled this reionization process still need to be fully understood. In this work, we investigate the effects of mergers and interactions in CSBGs on the escape of ionizing radiation, aiming to compare them with isolated CSBGs. Through this analysis, we seek to identify how these processes may impact the interstellar medium of these galaxies.

Resumo. Galáxias *Starburst* Compactas (CSBGs) locais podem ser análogas às galáxias anãs a mais altos *redshifts*, frequentemente apontadas como principais responsáveis pela reionização do Universo em ~ 6. No entanto, os mecanismos que permitiram esse processo de reionização ainda não estão completamente compreendidos. Neste trabalho, investigamos os efeitos de fusões e interações em CSBGs no escape de radiação ionizante, com o objetivo de compará-las a CSBGs isoladas. Por meio dessa análise, buscamos identificar como esses processos podem impactar o meio interestelar dessas galáxias.

Keywords. Galaxies: starburst – Galaxies: dwarf – ISM: kinematics and dynamics

1. Introduction

In the local universe, there are low-mass galaxies ($M_\star \lesssim 10^{9.5}$ M$_\odot$) undergoing intense and compact bursts of star formation, with extremely high specific star formation rates (sSFR $\gtrsim 10^{-9.5}$ yr^{-1}) and small effective radii ($r_e \sim 1$ kpc). The most extreme among these Compact Starburst Galaxies (CSBGs) may be analogous to those that, in early times ($z \sim 6$), are considered the primary sources responsible for the reionization of the universe (Izotov et al. 2021). However, observations of these local CSBGs reveal that they are opaque, allowing only a small fraction of ionizing photons to escape ($f_{esc} \lesssim 10\%$, Izotov et al. 2016). The physical mechanisms leading to high f_{esc} values are still poorly established. These values likely result from a combination of factors, such as the age and compactness of the starburst events, the geometry of the interstellar medium (ISM), and the gas kinematics (McClymont et al. 2024). Moreover, processes related to the environment in which the galaxy resides, such as interactions and mergers, can trigger intense bursts of star formation, generating turbulence and inhomogeneities in the ISM gas, which may create escape paths for ionizing photons. In this context, we are investigating the role of interactions and mergers in the formation of CSBGs and the effects of these processes on the ISM and the properties of these galaxies.

2. Sample Selection

The sample of CSBGs was defined using SDSS galaxies in the range $0.022 \leq z \leq 0.2$ with $m_r \leq 18$, where m_r is the extinction-corrected apparent magnitude in the r band. We then selected starburst galaxies ($g-i < 0.7$, EW([OIII]λ_{5007} + Hβ) > 20 Å and log([NII]λ_{5007}/Hα) < −0.6) that are compact (surface brightness $\mu_r < 21.5$ and the fraction of light within the 3″ SDSS fiber > 30%). These criteria resulted in a sample of approximately 3500 CSBGs (Trevisan et al. in prep.). After that, we identified groups of dwarf galaxies that contained at least one of these CSBGs. The group selection criteria were as follows:

Figure 1. Images from the SDSS showing the groups that host the CSBG 17182 (SDSS J013623.50+135701.5, *left*) and the CSBG 7776 (SDSS J030501.14-000504.9, *right*). The CSBGs are indicated by the red circles.

- Group containing at least three blue galaxies, including the CSBG, brighter than $m \leq m_{CSBG} + 1 \leq 19$ (m_{CSBG} is the extinction-corrected apparent magnitude in the r band of the CSBG).
- Group radius $R_{group} \leq 100$ kpc.
- No galaxies in the red sequence within $R < R_{group} + 50$ kpc.

Then, we observed two CSBGs residing in two of these groups of dwarf galaxies (see Fig. 1) using spatially resolved spectroscopic data obtained with GMOS@Gemini.

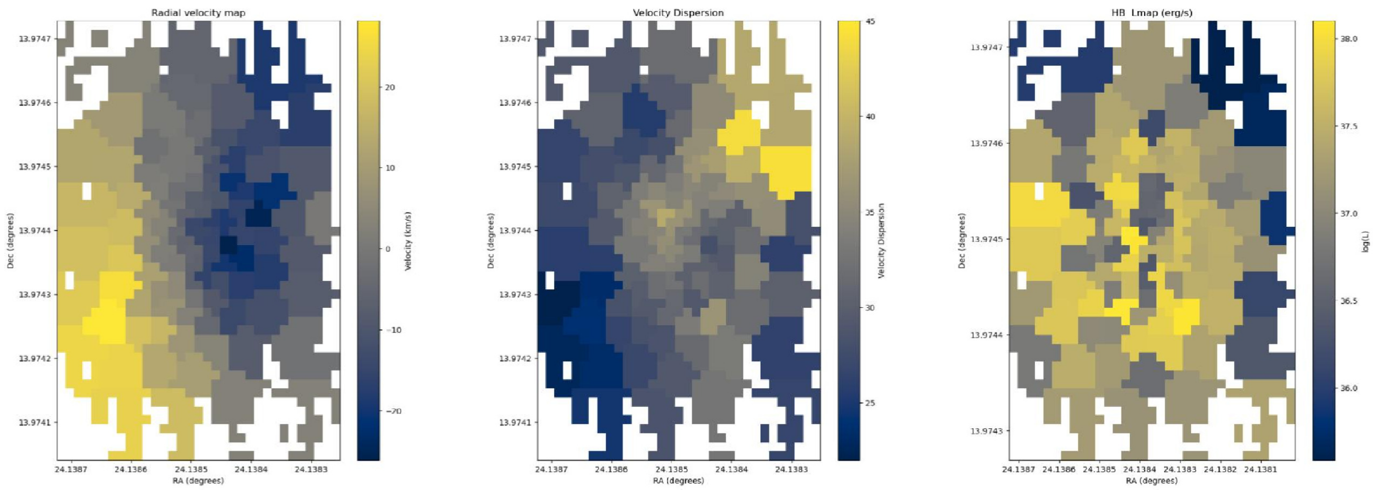

Figure 2. Maps of line-of-sight velocity (*left panel*), velocity dispersion (*middle panel*), and Hβ luminosity (*right panel*) of CSBG 7776.

3. Methodology

The data reduction was performed using the Gemini IRAF package. The raw data underwent bias and overscan corrections, Mask Definition File fibre check, flatfield correction, quantum efficiency corrections to account for differences between the CCDs, wavelength calibration, scattered light removal, cosmic ray and bad column removal, spectrum rectification, sky subtraction, and spectrophotometric calibration. Finally, we combined the data cubes of all exposures taken for each object, and the spectra were corrected to the rest frame. We started the analysis with the brighter galaxy, CSBG 7776, and the same process will be applied to CSBG 17182 in the future. We used the `vorbin` package (Cappelari 2003), which performs spatial binning on the cube to achieve a constant signal-to-noise ratio of ~ 10 for the Hβ line. With the Voronoi-binned cube, we applied the `pPXF` package (Cappelari 2012) for IFU. By fitting the stellar continuum and the gas component simultaneously with `pPXF`, we measured the gas kinematics and the fluxes of the emission lines. Using the luminosity distance of the galaxy (based on the cosmology $H_0 = 70\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$, $\Omega_\mathrm{m} = 0.3$, $\Omega_\Lambda = 0.7$), we calculated the luminosities of the emission lines. In Fig. 2, we show the resulting maps of velocity (v), velocity dispersion (σ) and luminosity obtained for the Hβ line.

4. Preliminary Results

In the left panel of Fig. 2, we observe that the galaxy shows signs of rotation with a maximum velocity of $v_\mathrm{max} \sim 25 - 30\,\mathrm{km\,s^{-1}}$. In the middle panel, we have the velocity dispersion map with σ values in the range $10 \lesssim \sigma \lesssim 45\,\mathrm{km\,s^{-1}}$. The regions with the highest σ values do not coincide with the galaxy centre. This increased velocity dispersion of the gas in the galaxy outskirts might be a consequence of the interactions of the CSBG with other group members. In the right panel, we have a map of the Hβ luminosity, used as a tracer of ionized gas in star-forming regions. The more yellowish areas show higher luminosities, where higher star formation activity might be occurring.

To understand the effects of the group environment on the star-formation activity and the ISM properties of these CSBGs, we will continue our analysis to characterize the properties of the ISM gas and compare the results with those of isolated CSBGs. Our final goal is to identify how (and if) interactions affect the ISM of these galaxies.

References

Cappelari, M., 2012, Astrophysics Source Code Library, pp ascl–1210.002
Cappellari M., Copin Y., 2003, MNRAS, 342, 345
Izotov Y., Guseva N., Fricke K., Henkel C., Schaerer D., Thuan T., 2021, A&A, 646, A138
Izotov, Y., Schaerer D., Thuan T., Worseck G., Guseva N., Orlitova I., Verhamme A., 2016,MNRAS, 461, 3683
McClymont, W., et al., 2024, arXiv:2405.15859
Trevisan et al (in prep.)