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Jellyfish galaxies and AGNs with HSC, DESI and PFS

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Abstract. The connection between galaxies undergoing ram-pressure stripping (RPS), post-starburst galaxies, and AGN in clusters is far from being understood. In order to shed light on this topic, we are studying clusters in Subaru's Hyper Suprime-Cam (HSC) deep fields that will later be part of the Prime Focus Spectrograph (PFS) galaxy evolution (GE) survey. As part of the PFS project's preparation to select targets for observation in its 2400 fibers per field, our group is searching for jellyfish galaxies, post-starburst galaxies, and AGN candidates in HSCs deep fields. In this poster, we will present the first results from this project for the ELAIS-N1 field regarding galaxies undergoing stripping. Using catalogs and images from HSC, we have searched for Hα-emitting galaxies at redshifts $0.23 < z < 0.26$. The choice of this redshift range is so that the Hα emission line can be detected by the narrowband filter NB816 of the HSC. We use also the single-fiber spectra from DESI to constrain better the redshifts and find over 200 Hα-emitters. We also perform BPT and WHAN diagrams with the emission lines to find possible AGNs.

Resumo. A conexão entre galáxias passando por "ram-pressure stripping" (RPS), galáxias "post-starburst" e AGNs em aglomerados está longe de ser compreendida. Para lançar luz sobre esse tópico, estamos estudando aglomerados nos campos profundos do Hyper Suprime-Cam (HSC) do Subaru, que mais tarde farão parte da pesquisa de evolução galáctica (GE) do Prime Focus Spectrograph (PFS). Como parte da preparação do projeto PFS para selecionar alvos para observação em suas 2400 fibras por campo, nosso grupo está buscando galáxias "jellyfish", galáxias pós-explosão estelar e candidatos a AGN nos campos profundos do HSC. Neste pôster, apresentaremos os primeiros resultados deste projeto para o campo ELAIS-N1 referente a galáxias passando por "stripping". Utilizando catálogos e imagens do HSC, procuramos por galáxias que emitem Hα em deslocamentos para o vermelho $0.23 < z < 0.26$. A escolha desse intervalo de deslocamento para o vermelho é para que a linha de emissão Hα possa ser detectada pelo filtro de banda estreita NB816 do HSC. Também utilizamos os espectros de fibra única do DESI para melhor restringir os deslocamentos para o vermelho e encontramos mais de 200 emissores de Hα. Realizamos também diagramas BPT e WHAN com as linhas de emissão para encontrar possíveis AGNs.

Keywords. Galaxies: evolution – Galaxies: structure

1. Introduction

Galaxies moving in dense environments, such as clusters, groups, and even filaments, may suffer ram pressure stripping (RPS) and have their gas removed from their disks (Gunn & Gott 1972). The most extreme cases give rise to unilateral asymmetries and structures of stripped gas that resemble the tentacles (Poggianti et al. 2017). Such objects are known as "jellyfish galaxies", due to their similarity to the sea being. The RPS plays a key role in galaxy evolution, since it may end up removing almost all gas of the galaxy and quench it (Larson, Tinsley, & Caldwell 1980), although it also enhances the star formation rate (SFR) of the galaxies during the process (Vulcani et al. 2020). An open question is whether there is a connection between RPS and AGNs. It has been proposed in some works that the stripping may ignite AGN activity and that there is an excess of AGN hosts among the jellyfish galaxies compared to other star-forming galaxies (Peluso et al. 2023). On the other hand, large samples of jellyfish are found with almost no AGN host (Roman-Oliveira et al. 2019). The goal of this work is to search for jellyfish candidates and AGNs in the deep fields of HSC-SSP survey and shed some light on this problem. We are currently working with the ELAIS-N1 field, which is in the DESI EDR. Our final goal is to select targets for the PFS survey.

2. Methods

This work involves the search for a sample of rem pressure stripping candidates and AGN hosts in the ELAIS-N1 field. For that we are using three different instruments: HSC, DESI, and PFS.

The Hyper Suprime-Cam (HSC) is an imaging instrument in the 8-m Subaru Telescope, in Hawaii. It covers a circular FoV of 1.5^o in diameter with a pixel scale of 0.17 arcsec. We use data from the Deep mode of the HSC Subaru Strategic Program (HSC-SSP) observations, which counts comprises 5 broad-band and 3 narrow-band filters that cover a wavelength range of approximately 4000-11000 Å.

The Dark Energy Spectroscopic Instrument (DESI) is a multi-fiber spectrograph at the 4-m Nicholas U. Mayall Telescope, in Arizona, USA. It consists of 5000 optical fibers, with a diameter aperture of 3 arcsec each, that measure spectra in the wavelength range 3600-9800 Å. Spectra from DESI are very noisy, mainly in the bluer portion of the spectrum, and we use them only to confirm redshifts and model emission lines.

The Prime Focus Spectrograph (PFS) is a new instrument that is also being implemented in the Subaru telescope. It consists of 2400 optical fibers that can be positioned within a 1.3^o diameter field of view. As it is in the initial stages of its observations, we still do not have PFS data to use in this work, but we intend to select potential targets for the instrument.

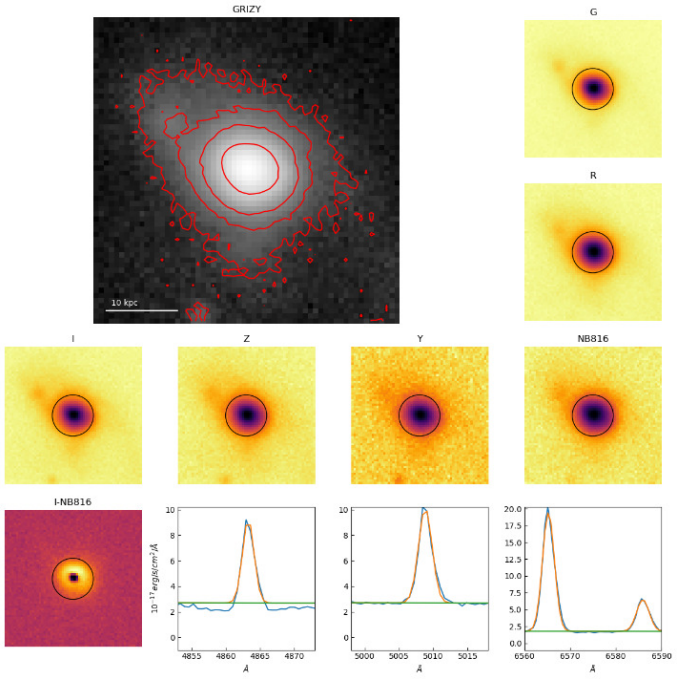

Figure 1. A stripping candidate in the ELAIS-N1. The multiple smaller figures show the fluxes in different HSC filters and the color I-NB816. The black circle in those stamps indicates the DESI's fiber aperture. The 3 graphs in the lower right show zoomed regions of the DESI spectrum of the emission lines Hβ, [O III]λ5007, Hα and [N II]λ6583, respectively. The observed fluxes are in blue, the continuum in green, and the modeled emission lines in orange. The greater image in the lower right shows the sum of the fluxes in the 5 broad bands, plus the contours of the NB816 flux that are 3, 9, and 27 σ higher than the mean flux of the sky.

3. Results and discussions

The jellyfish morphology is mainly highlighted in the Hα emission, which traces recent star formation. Because of that, we first searched for objects classified as probable emission-line galaxies from HSC-SSP data release 2, and at redshift $0.23 < z < 0.26$, so that the Hα and [N II] lines are encompassed in the NB816 narrow band. As a first step, since photometric redshifts are very uncertain, we selected only the galaxies with spectral observations in DESI, thus we have reliable redshift measurements and can model the emission lines. Our final sample consists of more than 200 emission-line galaxies and we are currently working on identifying jellyfish and AGN hosts among them.

In order to find possible AGN hosts among the galaxies, we model their emission lines using the python library Ifscube (Ruschel-Dutra et al. 2021). Then we use the line fluxes ratios and equivalent widths to construct BPT (Baldwin, Phillips, & Terlevich 1981) and WHAN (Cid Fernandes et al. 2011) diagrams, which indicate the main mechanism responsible for the ionization of the gas in the galaxies. It can be star formation, AGN activity (both Seyfert and LINER), or a composition of both.

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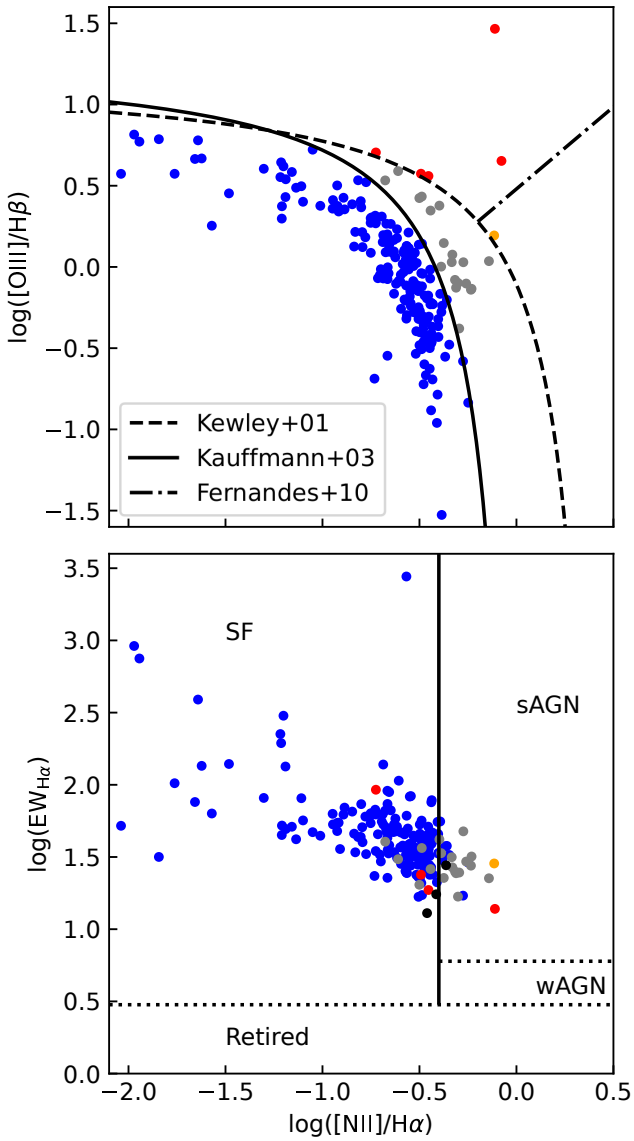

Figure 2. BPT diagram (top) and WHAN diagram (bottom) for the galaxies in our sample. Most of them are star-forming, and a few are composite or AGN-powered.

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