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The environment of local analogues to high-redshift star forming galaxies

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Abstract. High-redshift galaxies form about 10 times more stars per unit of time compared with galaxies in the local universe, but we don't know if the trigger for this high star formation rate is related with interactions with the environment or star formation in clumps, due to instabilities. This project main goal is to investigate the environment of high-redshift analogues, like Lyman Break Analogues (LBAs), in order to better understand the influence of the local environment on its properties. Then, this results will be compared with galaxies in the distant universe in order to evaluate the influence of the local environment on the formation of galaxies 10 billion years ago. Our methodology consists of a code that analyzes the fields of the analogues and measures their respective densities using the k-th nearest neighbor method with $K = 4$, 5 and 10, and compares the value of the densities with different Ks. This algorithm was applied to the S-PLUS survey data. Our preliminaries results are the densities of the environment of the galaxies in the DR1 S-PLUS. To find the analogues, we did a match between the DR3 S-PLUS with the GALEX All Sky Survey data, so we can have UV data on the DR3 galaxies.

Resumo. Galáxias em alto redshift formam cerca de 10 vezes mais estrelas por unidade de tempo comparadas com galáxias no nosso universo local, mas não sabemos se o gatilho para essa alta taxa de formação estelar está relacionado à interações com o ambiente destas galáxias ou à formação estelar em condensações internas devido a instabilidades. Este projeto tem como objetivo principal investigar o ambiente de galáxias análogas de alto redshift, como as galáxias análogas de Lyman Break (LBAs em inglês), a fim de entender melhor sua influência sobre suas propriedades. Estes resultados são posteriormente comparados com galáxias no universo distante, de modo a permitir uma avaliação da influência do ambiente local sobre a formação de galáxias há 10 bilhões de anos. Nossa metodologia consiste em um código que analisa os campos das análogas e mede suas respectivas densidades utilizando o método da K-ésima vizinha próxima com $K = 4$, 5 e 10, e compara os valores das densidades com Ks diferentes entre si. Este algoritmo foi aplicado nos dados do levantamento S-PLUS. Os resultados preliminares da nossa análise são as densidades calculadas para as galáxias presentes no DR1 do S-PLUS. Para encontrar as galáxias análogas, fizemos um combinação do DR3 S-PLUS com os dados do GALEX All-Sky-Survey, a fim de obter os dados no UV das galáxias presentes no DR3.

Keywords. Galaxies: evolution – Galaxies: high-redshift – Galaxies: starburst – Galaxies: interactions

1. Introduction

Galaxies in the distant universe form significantly more stars per unit of time Whitaker et al. (2012), but we still don't know whether there is any relation with the environment in which they are embedded. In order to investigate this possible connection, we analyze the medium of galaxies analogous to those in high-redshift, which are present in the local universe and have similar properties, like the Lyman Break Analogs (LBAs), which are analogs to the Lyman Break Galaxies (LBGs) in luminosity, mass, star formation rate, specific star formation rate, UV attenuation and metallicity Hoopes et al. (2007).

2. Sample

Our main sample consists of the DR3 of the S-PLUS Mendes de Oliveira et al. (2019), a imaging survey of the Southern Hemisphere in 12 magnitude bands, 5 broad-bands (ugriz) and 7 narrow-bands (centered on the Balmer jump/[OII], Ca H+K, H_δ, G-band, Mg b triplet, H_α and the Ca triplet), using the T80-South telescope, at the Cerro Tololo Interamerican Observatory. In addition, the DR3-SPLUS also provides the photometric redshift and the probability of an object being a galaxy (PROB_GAL), star or quasar. To reduce the errors and select only the objects of interest in our sample, we consider PROB_GAL higher than 70%, and the magnitude in the r-band being less than 22.

To find the LBAs, we use the NUV and FUV data from the GALEX All Sky Survey. We matched the DR3 S-PLUS data with the GALEX data, totalizing approximately 300 000 objects with the 12 band photometry from S-PLUS and NUV/FUV photometry from GALEX. Then, we converted the UV magnitudes to luminosity, and applied the intervals described at Hoopes et al. 2007 for the LBAs, totalizing approximately 5000 UV luminous objects. Our next step is to filter the sample of UV luminous objects by surface brightness, in order to find the Supercompact UV Luminous Galaxies (Supercompact UVLGs), i. e., the LBAs Hoopes et al. (2007).

3. Methodology

To calculate the density of the environment we used the k-th nearest neighbors method, where we selected the k-th neighbors close to the galaxy, filtering this selection by velocity to take into account the line of sight, measured the distance in Mpc between them and apply a correction function (ψ) to take into account the Malmquist bias, thus obtaining a surface density given by

$$\Sigma_= \frac{k}{\pi D_k^2} \frac{1}{\psi}. \qquad (1)$$

In order to determine how the density of the environment changes on small and large scales, we use $k = 4, 5$ and 10.

4. Results

We applied the code to the DR1 S-PLUS first, in order to illustrate the capabilities of the code. Our preliminary results of the

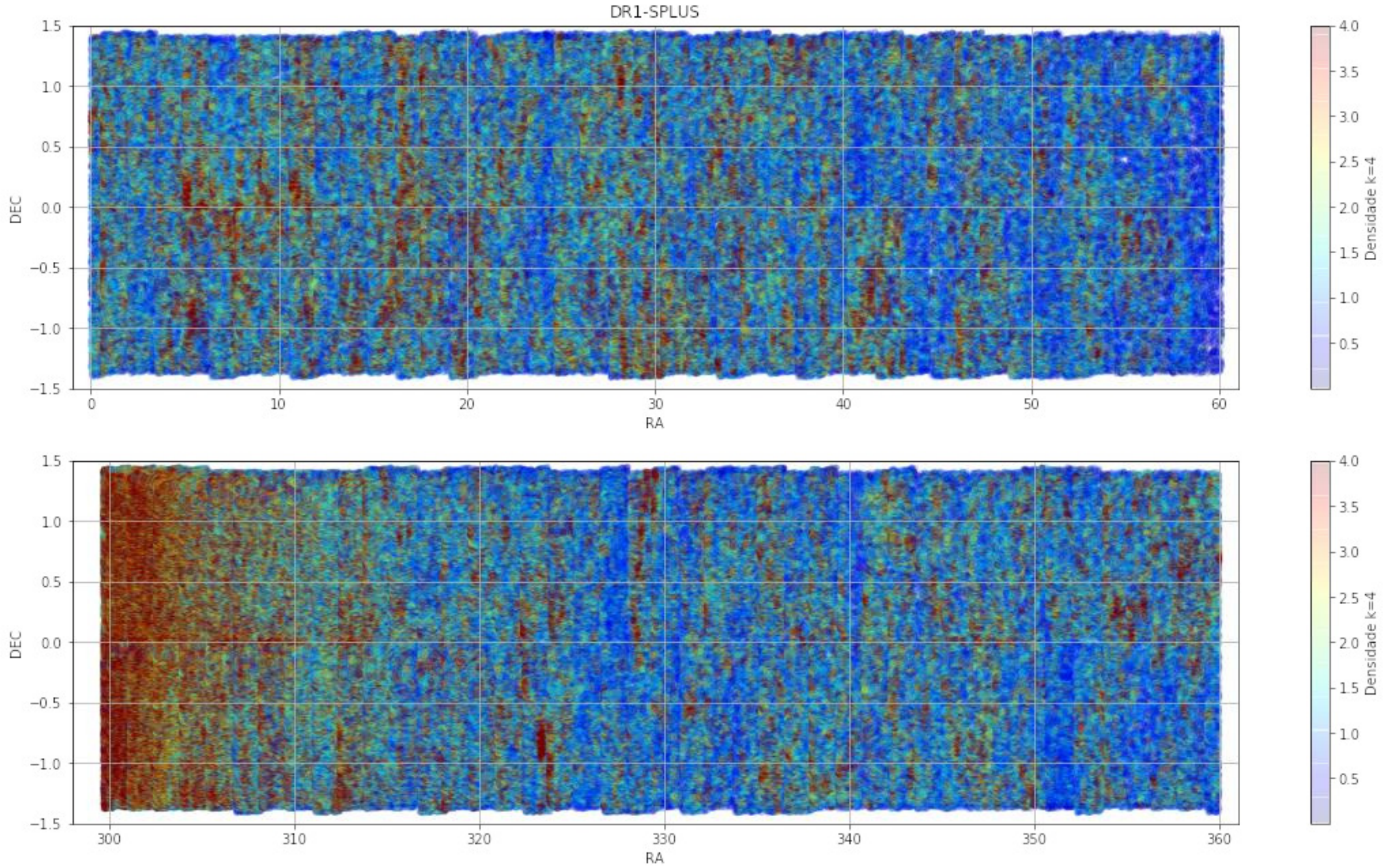

Figure 1. Density map of the DR1 S-PLUS using $k = 4$. Redder points indicate a high density region, while bluer points represent less dense regions.

DR1 sample consists of 900 000 galaxies with the k = 4, 5, 10 densities calculated. In Figure 1, we have a map of the DR1 S-PLUS region, with the k = 4 density represented in color. Redder points indicate a high density region, while bluer points represent less dense regions.

5. Future Perspectives

Our next step is to apply the code to the DR3 S-PLUS, totalizing more than 8 000 000 galaxies with the $k = 4, 5, 10$ densities calculated, i. e., a density map of the southern hemisphere, including the Fornax and Hydra regions. With the densities calculated for all galaxies in the sample and the LBAs found, we will analyze how the environment of LBAs affects their properties, and consequentially how the environment of the high-z star forming galaxies, like LBGs, affects their properties.

We expect to find results similar to Santana-Silva et al. (2020), that showed that the LBAs resides in low density environments in large scale but denser environments in small scale. Since the sample used in Santana-Silva et al. (2020) consists in only 9 LBAs, increasing the sample of LBAs like we are doing allow us to get statistically better results. If our hypothesis proves correct, the analogs being present in small groups give us evidence that interactions with the environment, like mergers, can be responsible for the high star formation rate.

References

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