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Radial Metallicity Distribution of the Galaxies NGC5033 and NGC4254 Using GMOS Spectroscopy

Sabino, T. A.[1] & Scarano Jr, S.[2]

[1] Universidade de São Paulo e-mail: thaina.astro@usp.br
[2] Universidade Federal de Sergipe e-mail: scaranojr@ufs.br

Abstract. The study of chemical abundances in spiral galaxies is an important branch of Astronomy, especially because from them it is possible to determine others physical parameters, as ages, evolutionary tracers and secular effects. In this work we present GEMINI observations of HII regions in galaxies NGC5033 and NGC4254 using GMOS spectrograph in multislit mode in order to study them in terms of their chemical abundances. Using Strong Line Methods, we increased the number of objects that sample the radial metallicity profile of these galaxies and we compared our results with previous ones in the literature. We obtained a radial gradient of (0.01±0.01) dex/kpc for NGC5033 and (0.04±0.01) dex/kpc for NGC4254. Our results almost doubles the total amount of regions already observed, and combined with them provide a minimum amount of HII regions to discuss eventual corotation signatures in their metallicity gradients.

Resumo. O estudo das abundâncias químicas em galáxias espirais é um importante ramo da Astronomia, especialmente porque a partir delas é possível determinar outras grandezas fisicas, como idade, traçadores de evolução e efeitos seculares. Neste trabalho, apresentamos observações do GEMINI de regiões HII das galáxias NGC5033 e NGC4254 utilizando o espectrógrafo GMOS no modo multislit para estudá-las em termos das suas abundâncias químicas. Utilizando métodos de Linhas Fortes (do inglês, Strong Line methods), nós ampliamos o número de objetos amostrados no perfil radial de metalicidades destas galáxias e comparamos com resultados anteriores da literatura. Obtivemos um gradiente de (0.01±0.01) dex/kpc para a NGC5033 e (0.04±0.01) dex/kpc para a NGC4254. Nossos resultados quase dobram o total de regiões amostradas já observadas e se combinadas, fornecem a quantidade mínima de regiões HII necessária para discutirmos eventuais sinais de corrotação nos seus gradientes de metalicidades.

Keywords. Galaxies: Abundances – Techniques: imaging spectroscopy

1. Introduction

The evaluation of chemical abundances is a common tool in Astrophysics. When applied to spiral galaxies it allow us to determine a lot of others physical quantities as cosmological ages, metallicity distributions (related to structural and the galaxy evolution) or secular effects from spiral arms (Scarano & Lépine 2013). Currently, several procedures are involved to obtain the abundance of a region and many factors can influence the measurement. Statistical Methods, or Strong Line Methods, are relevant ways to estimates of metallicity by the flux of the emissions lines available in the optical part of the spectra. These methods are developed using statistical correlations between photoionization models, empirical calibrations (based on well-known measurements of electronic density and temperatures of photoionized gas) and correlations of those with the ratio between emission lines frequently observed in H ɪɪ regions spectra.

Two examples of Strong Line Methods are the methods O3N2 and O3, developed by Pettini & Pagel (2004). They are based on the determination of the ratio of spectral lines [O ɪɪɪ]/Hβ and [N ɪɪ]/Hα. Effects of extinction are minimized by these methods once they use ratio of lines in both extremes of the optical spectrum.

In this work, we present Gemini observations of the galaxies NGC5033 and NGC4254 with GMOS spectrograph in multislit mode to increase the amount of H ɪɪ regions observed on these objects in terms of their metallicity. Furthermore, by the use of Strong Line methods O3N2 and N2, we described the metallicity radial profile of these two galaxies.

2. Methodology

We have used DS9 and pyraf tasks to develop a simple method to combine spectra of several observations. It is based on the identification of the physical position of the spectral lines observed in the bidimensional spectra, from which we delineated the dispersion region to extract the unidimensional spectra.

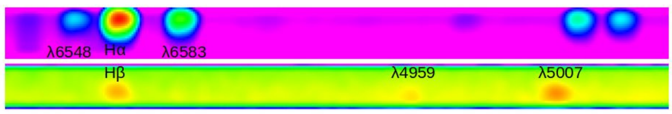

Figure 1. Bi-dimensional spectra extracted from two H ɪɪ analyzed in NGC5033. On the top is shown the emission lines Hα, [N ɪɪ] and [S ɪɪ] whereas on the bottom, lines of Hβ (left) and [O ɪɪɪ].

To identify the spectral emission lines and obtain their flux, we have used the pyraf task "splot". Gaussians curves were fitted to the emission lines from the Balmer series (Hα and Hβ), Nitrogen, Sulfur and Oxygen to obtain the integral flux of each line.

For each H ɪɪ region, we collected information about the flux of each spectral line and their galactocentric distances.

3. Results

From the total amount of slits observed (about 60 for each observation), we were able to obtain 15 and 10 useful spectra for NGC5033 and NGC4254, respectively. For all of these spectra

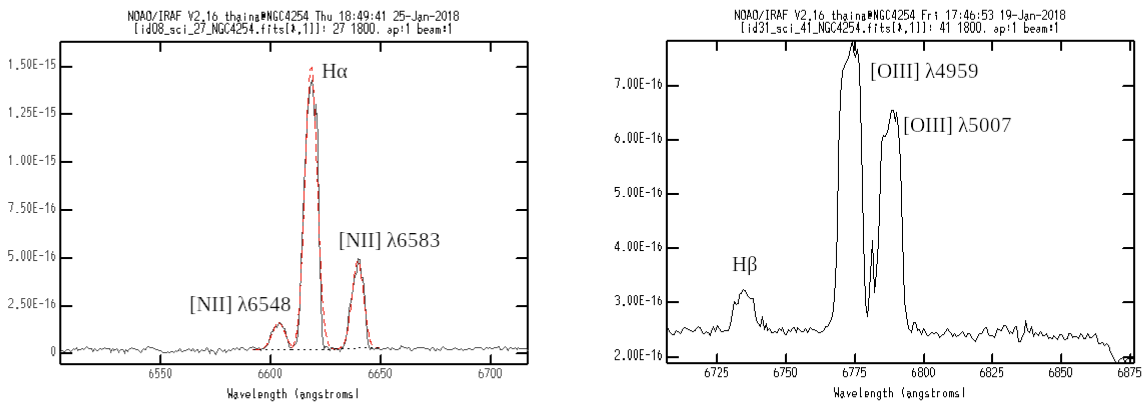

Figure 2. Example of emission lines of our spectra. On the left, the lines of [N ii] and Hα are superposed by Gaussian curves (in red).

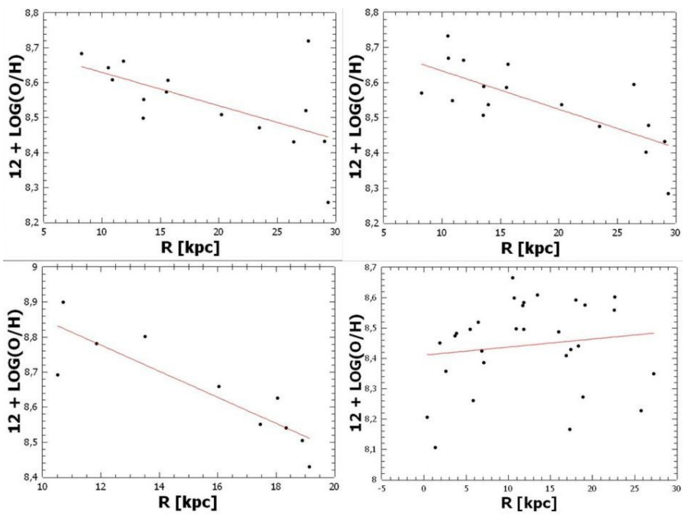

Figure 3. Metallicity radial profile obtained with our data for NGC5033 (first line) and NGC4254 (second line). On the left, we present results with the O3N2 method and on the right, the N2 method. The fitted curves represent the metallicity distribution with gradients (slopes) of (-0.01±0.01) dex/kpc for NGC5033 using both methods and (-0.04±0.01) dex/kpc for NGC4254 for the N2 method. The central metallicity (level) to these galaxies are around (8.7±0.1) dex and (9.2±0.1) dex respectively for NGC5033 and NGC4254.

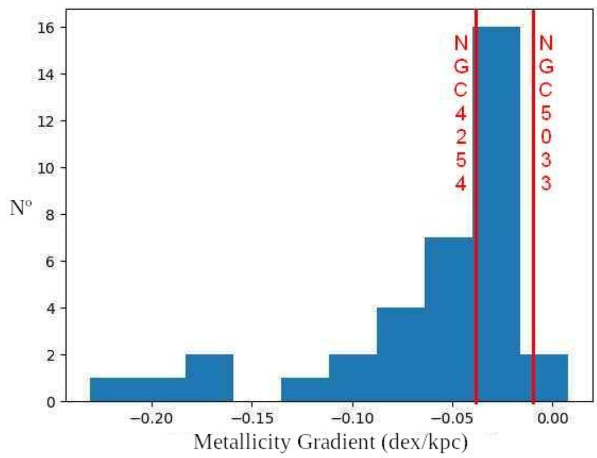

Figure 4. Histogram to estimate typical values of metallicity gradients where we used the results obtained by Zaritsky et al. (1994). The red vertical lines are the values determined by our group. Our results are in agreement with those presented by Zaritsky et al. but are more accurate

it was possible to apply the Strong Line Methods O3N2 and N2 to estimate Oxygen abundances. Thus we evaluated the metallicity from each region and plotted them against the radii. We obtained the metallicity radial profile and the metallicity gradient using linear regressions. Despite of the large number of metallicity measurements for NGC4254 using the N2 method (Figure 4) we were not able to determine a significant metallicity gradient for NGC4254 using the N2 method in reason of its larger dispersion when compared with the O3N2 method. So it was discarded from our analysis.

Comparing our results with the data obtained by Zaritsky et al. (1994), relative to the metallicities gradients for 39 galaxies, we verified that the metallicity radial profile of both galaxies are in agreement with their results. These galaxies were also observed by Zaritsky, however, their study was based on fewer regions (8 for NGC5033 and 9 for NGC4254) and with less accurate measurements. Our observations not only triple the covered regions, but also improved the accuracy of the results for both galaxies. Based on this overall agreement between observations and emphasizing that the new observed H ii regions were not previously observed, we intent combine our results with those by the Zaritsky's group. This will provide us with the minimum amount of H ii regions recommended by Dutil & Roy (2001) to a significant study on the variations of the radial metallicity profiles, which will allow us to identify signatures of the corotation radius (Scarano & Lépine 2013).

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