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Alternative classification diagrams for AGN-starburst galaxies

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Abstract. The aim of diagnostic diagrams is to classify galactic nuclei according to their photoionizing source using emission-line ratios, differentiating starburst regions from active galactic nuclei (AGN). However, the three traditional diagnostic diagrams can sometimes be ambiguous with regard to a single object. The main goal of the present work is to propose alternative diagnostic diagrams by using distinct combinations of emission lines ratios. We present these diagrams using data from the Sloan Digital Sky Survey. With these new diagrams, it is possible to better distinguish the ionizing source in nuclei of galaxies and also to study the parameters that are relevant when considering both kinds of objects, starbursts and AGN.

Keywords. galaxies: nuclei, galaxies: active, galaxies: abundances, galaxies: starburst

1. Introduction

Galactic nuclei can be ionized by stellar sources and by the accretion of gas onto a supermassive black hole; the difference between these mechanisms can be identified through the analysis of the spectrum of that region. The BPT diagnostic diagrams (Baldwin, Phillips & Terlevich 1981) are schemes by which one can recognize the physical mechanism behind the spectral ionization. Along the years, they have been improved to classify the nuclei of galaxies as starbursts, transition objects, Low-Ionization Nuclear Emission-line Regions (hereafter LINERs) or Seyferts (Kewley *et al.* 2001; Kauffmann *et al.* 2003; Schawinski *et al.* 2007), represented in Figures 1 and 2 as green stars, purple circles, black triangles, and pink squares, respectively. However, galaxy nuclei classifications based on the classical BPT diagrams are, in some cases, ambiguous. In this context, we propose alternative diagnostic diagrams to be used in gaseous nebulae studies.

2. Goals and Methodology

Although the BPT diagrams persist as a general prognostic to classify the ionization source, alternative axis considering the same emission line ratios can be useful to distinguish the ionization source in galactic nuclei. We aim to explore new combinations of the line ratios [O III] λ5007/Hβ, [O I] λ6300/Hα, [N II] λ6583/Hα and ([S II] λ6716+[S II] λ6731)/Hα to find new insights in the physics of galactic nuclei and their host galaxies.

We considered data from Sloan Digital Sky Survey DR7 (Abazajian *et al.* 2009) with redshift $z < 0.016$ and error bars smaller than 0.1 dex in all the considered emission line ratios, in order to select only high quality data.

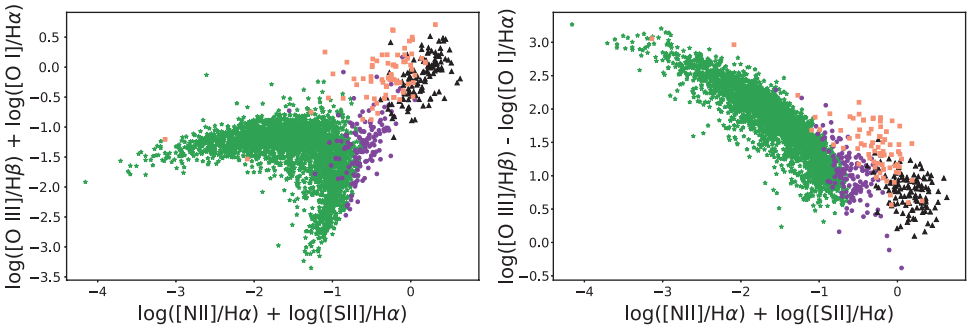

Figure 1. Alternative diagnostic diagrams with the sum of the logarithms of [N II]λ6584/Hα and [S II]λλ6716, 6731/Hα line ratios as abscissas. In the left panel, the ordinate is the sum of the logarithms of [O III]λ5007/Hβ and [O I]λ6300/Hα line ratios (that separates starbursts from AGN) and in the right panel the ordinate is the difference between such logarithms of line ratios (that distinguishes Seyferts and LINERs as in Heckman 1980).

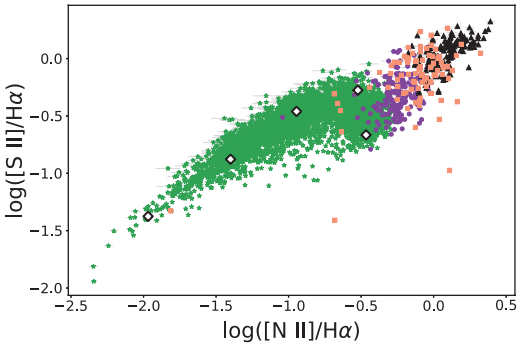

Figure 2. This alternative diagnostic diagram combines the line ratios of [N II]λ6584 and [S II]λλ6716, 6731 with respect to Hα. The wavelengths of such emission lines are similar, avoiding errors due to calibration or reddening effects. We can differentiate starbursts from AGN using only these two species. The white diamonds are the resulting models of starbursts simulated with Starburst99 and CLOUDY, considering equation (3.1).

3. Results and Conclusion

The relation between nitrogen and oxygen abundances commonly used in the literature (Vila-Costas & Edmunds 1993) is inadequate to describe the starbursts' distribution in Fig. 2. We propose the necessity of a second order term:

$$\log(\mathrm{N/H}) = \log(\mathrm{O/H}) + \log\left[0.039 + 20(\mathrm{O/H}) + 1.8\times10^{5}(\mathrm{O/H})^{2}\right] \qquad (3.1)$$

The alternative diagnostic diagrams proposed are successful to separate the different classes of objects - starbursts and AGN - and also to distinguish the two classes of AGN - Seyferts and LINERs. With these diagrams it is possible to distinguish uniquely the ionization source and also to study more accurately the model parameters that are relevant when considering both kinds of objects, starbursts and AGN.

References

Abazajian, K. N., Adelman-McCarthy, J. K., & The SDSS Colaboration *ApJS*, 182, 543
Baldwin, J. A., Phillips, M. M., & Terlevich, R. 1981, *PASP*, 93, 5

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Heckman, T. M. 1980, *A&A*, 87, 152
Kauffmann, G., Heckman, T. M., *et al. MNRAS*, 346, 1055
Kewley, L. J., Dopita, M. A., Sutherland, R. S., *et al. ApJ*, 556, 121
Schawinski, K., Thomas, D., Sarzi, M., *et al. MNRAS*, 382, 1415
Vila-Costas, M. B. & Edmunds, M. G. 1993, *MNRAS*, 265, 199

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