Characterization of Spectral Lines of Galaxies in the Green Valley

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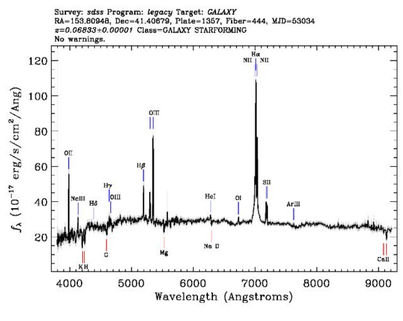
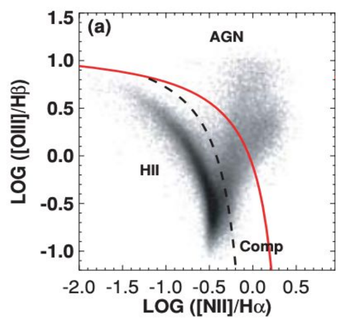
Using the emission-line flux ratios for galaxies from the DR17 of the SDSS, we found that these ratios can serve as indicators of different populations in the Color-Magnitude Diagram. Additionally, there is a population of galaxies with high color indices that are not classified as AGNs under any of the three BPT diagram criteria but are recognized as a subcluster within the line-ratio-space. These galaxies appear in the AGN regions of the various flux ratio diagrams.

Context

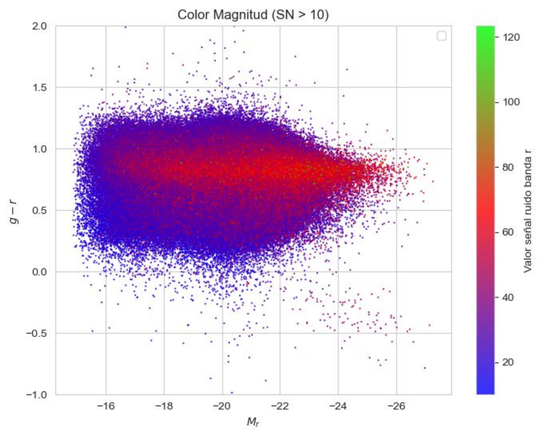
Classification of galaxies is a task far from trivial. Photometric and spectroscopic data should be used simultaneously in order to provide a reliable classification.

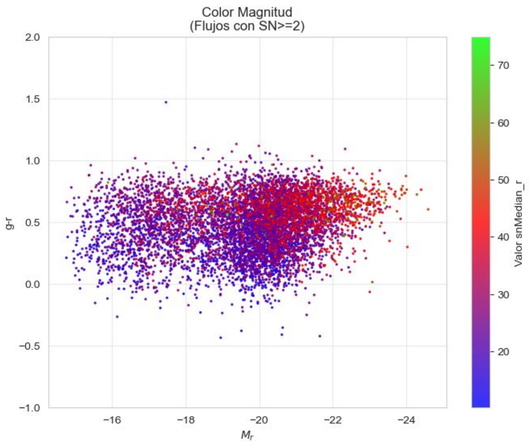




(Left) Visualization of the spectrum of an SDSS galaxy. **(Right)** Galaxy diagnostic diagram of [NII]/Hα versus [OIII]/Hβ for SDSS galaxies with S/N > 3. Separation lines between star-forming regions and AGNs are shown as solid lines (Ke01) and dashed lines (Ka03). Kewley, et. al. 2006.

Methodology

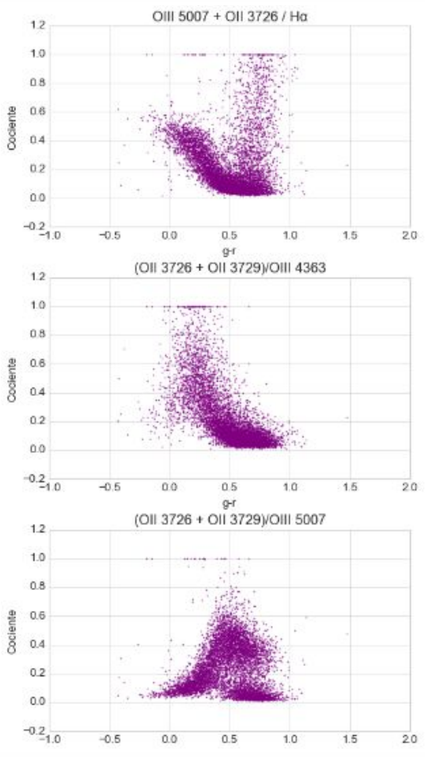


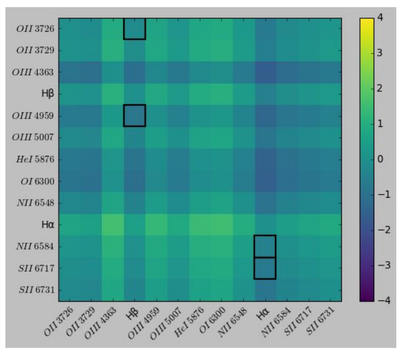


Data from the Data Release 17 (DR17) of the Sloan Digital Sky Survey (SDSS) were used, starting with photometry before acquiring the spectra to better understand the population. The necessary K-corrections, evolutionary corrections, and reddening corrections were applied. On the left, the selected sample with a signal-to-noise ratio larger than 10 is shown, from which the corresponding emission fluxes were obtained. These fluxes were then filtered for SN≥2, resulting in the population displayed on the right.

Emission-Line Flux Ratios

Next, using 13 emission lines in the spectra (SN>=1) we define the "line-ratio-space". In this space each galaxy is identified by a vector with 83 independent components. Different features can be observed in this space:

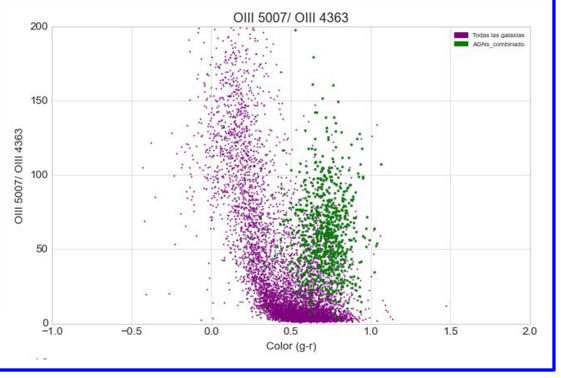




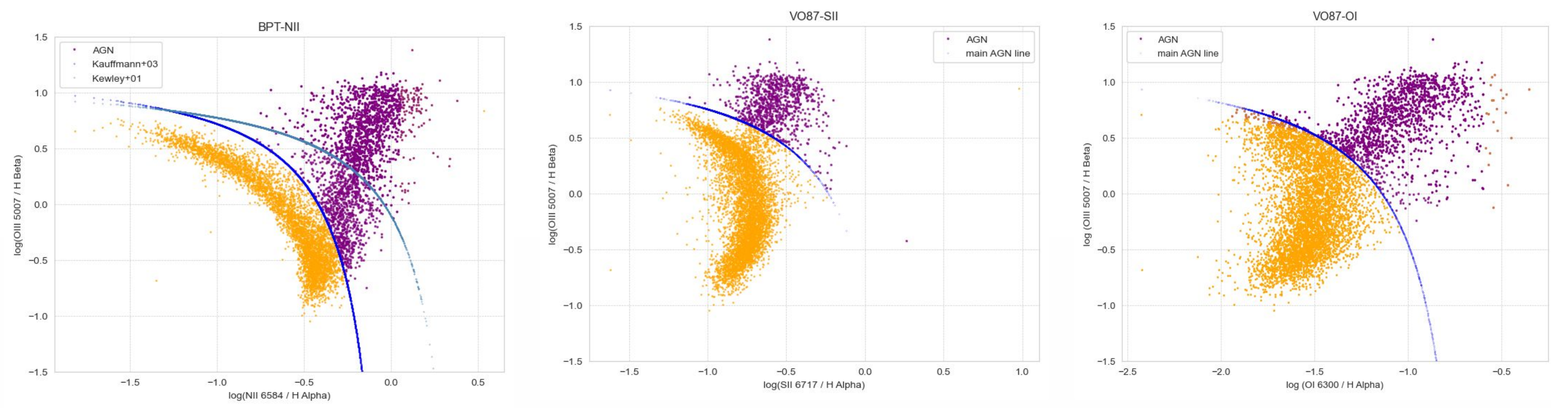
Ratio matrices among the 13 selected lines.

(Left) Selected ratios from the space of 82 (including doublet sums such as OII 3726 and OII 3729).

Population of galaxies with AGN within one of the marked flux ratios.



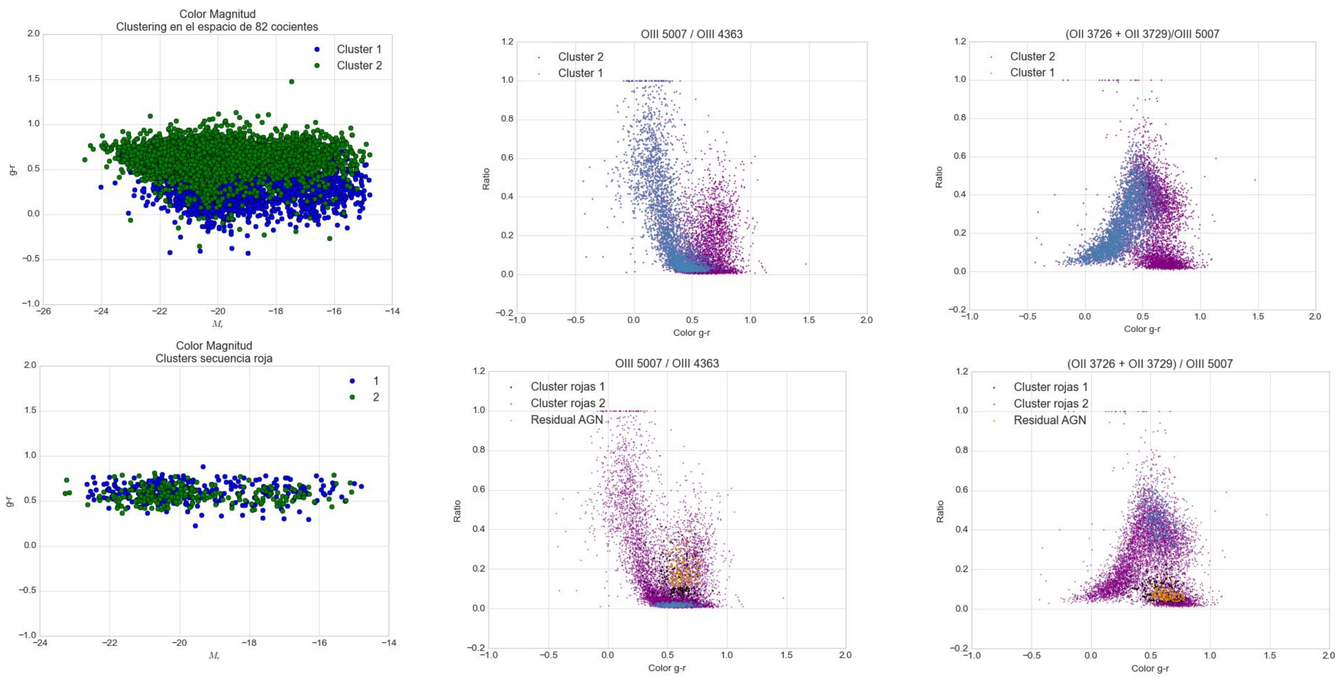
Diagnostics of AGN



Classification of the final sample in the BPT diagnostic diagrams (Baldwin et al. 1981). A novel and robust determination of definitive nuclear activity classification was achieved by combining the results from the three diagnostics simultaneously (BPT-NII, VO87-SII and VO87-OI).

Clustering

Search for clustering in the full line-ratio-space allows for the identification of features (Using DBSCAN algorithm)



Top (from left to right): A marked bimodality expected in the galaxy populations, segmenting the blue sequence from the red sequence.
Bottom (from left to right): Two subclusters within the red sequence (in blue and black), one of which is related to the residuals from the AGN classification (in orange).

References:

Kewley, L. J., Groves, B., Kauffmann, G., & Heckman, T. (2006).

Tremonti, C. A., Heckman, T. M., Kauffmann, G., Brinchmann, J. (2004).

Brinchmann et al (2004).