Comparing Methods of Mixing Excitation Mechanisms for Modeling Composite Galaxies

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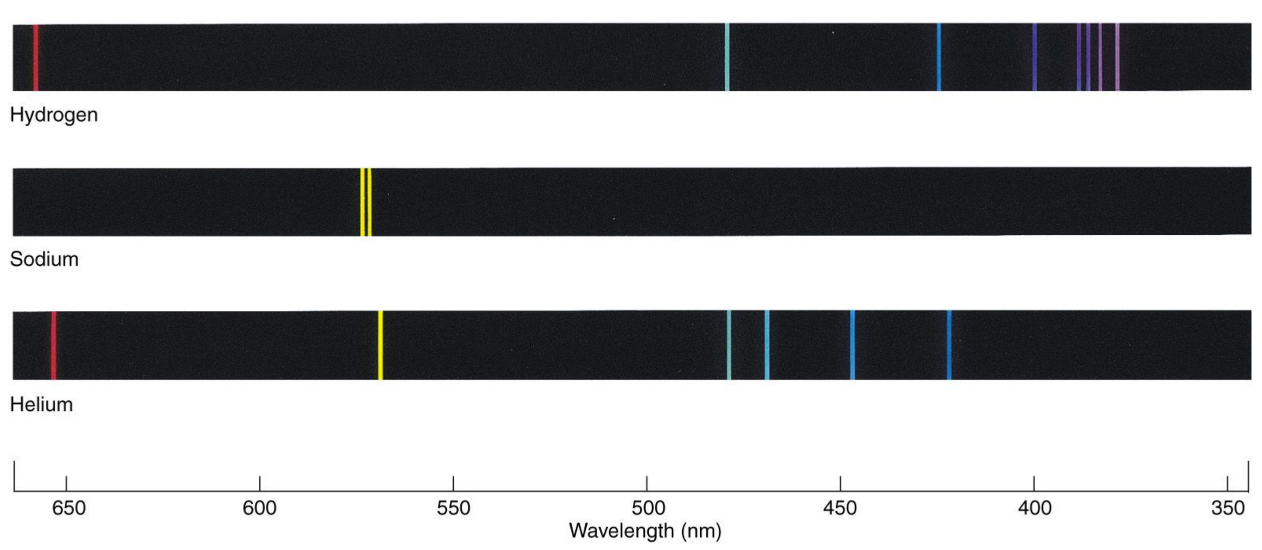
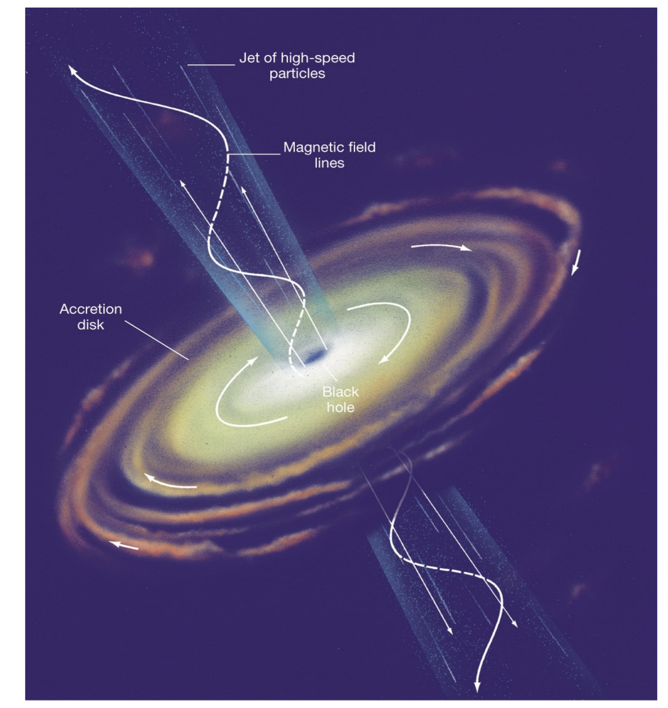
Introduction

- Emission lines are the foundation of the research being undertaken
- When light hits a cloud of gas or dust, it absorbs some of the light and then lets light in the wavelengths of the elements it is comprised of known as the emission spectrum.
- The light let off only comes out in these colors and wavelengths depending on the cloud composition
- The emission line spectrum tells us about density, temperature, and excitation source about these clouds



Star Forming Galaxy M83

- The clouds we are looking at are specifically those in star forming galaxies or galaxies with an active galactic nuclei (AGN)
- Star forming galaxies are galaxies which are currently creating stars in gas clouds within their spiral arms



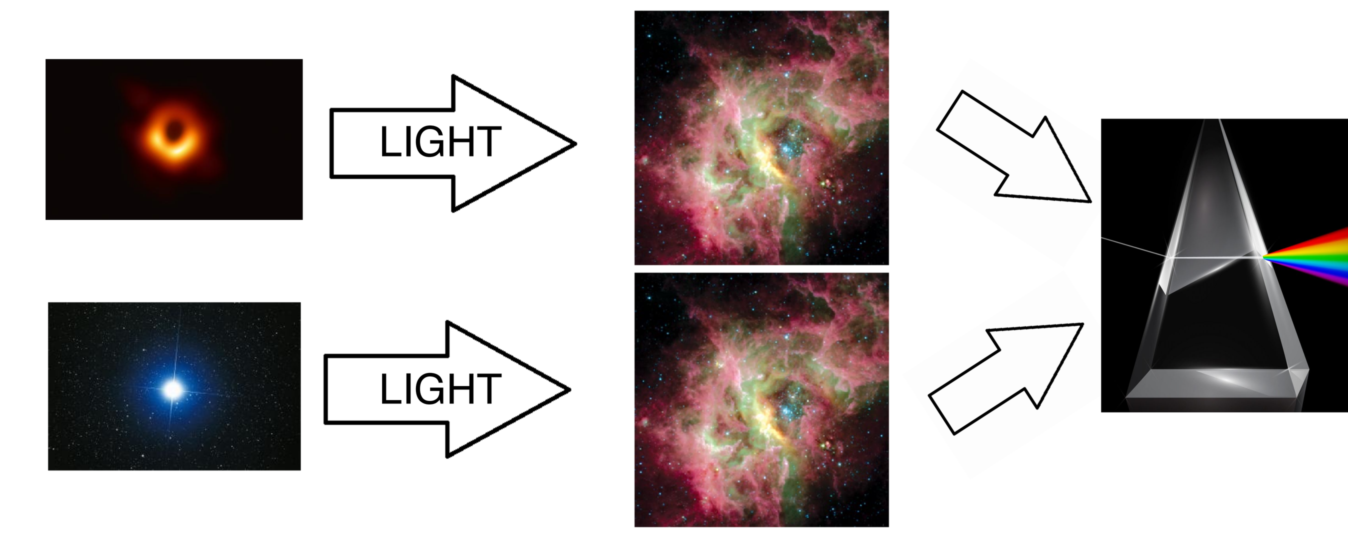
AGN Galaxy Depiction

- AGN are galaxies with a supermassive black hole at the center of the galaxy
- Hot gas close to black hole gives off light that hits gas clouds in the surrounding area

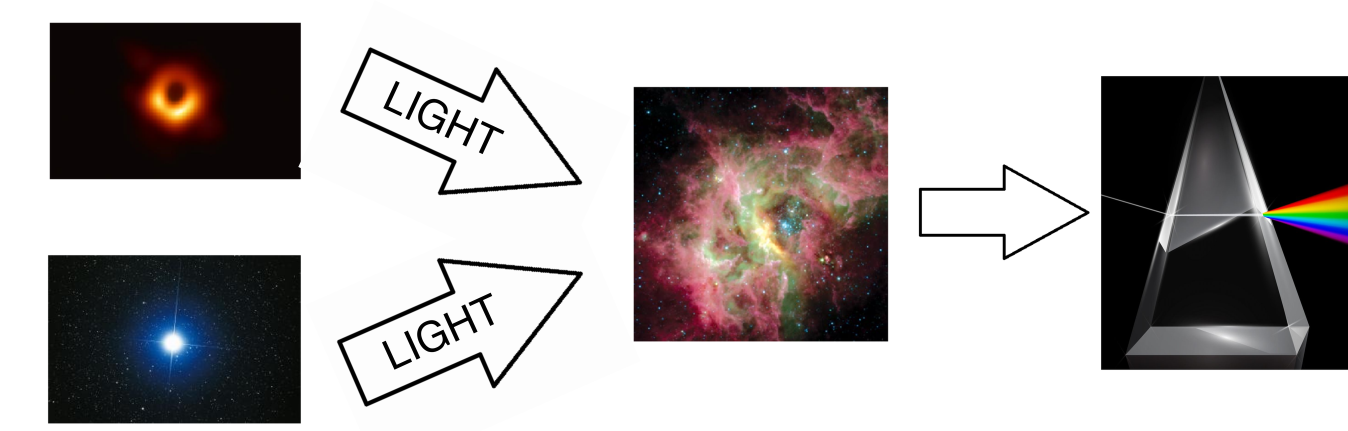
Composite Galaxy Antennae

- Many galaxies exhibit properties of both star forming galaxies and AGN
- Composite galaxies present are particularly difficult challenge in modeling the resulting emission line spectrum

Empirical



Self Consistent

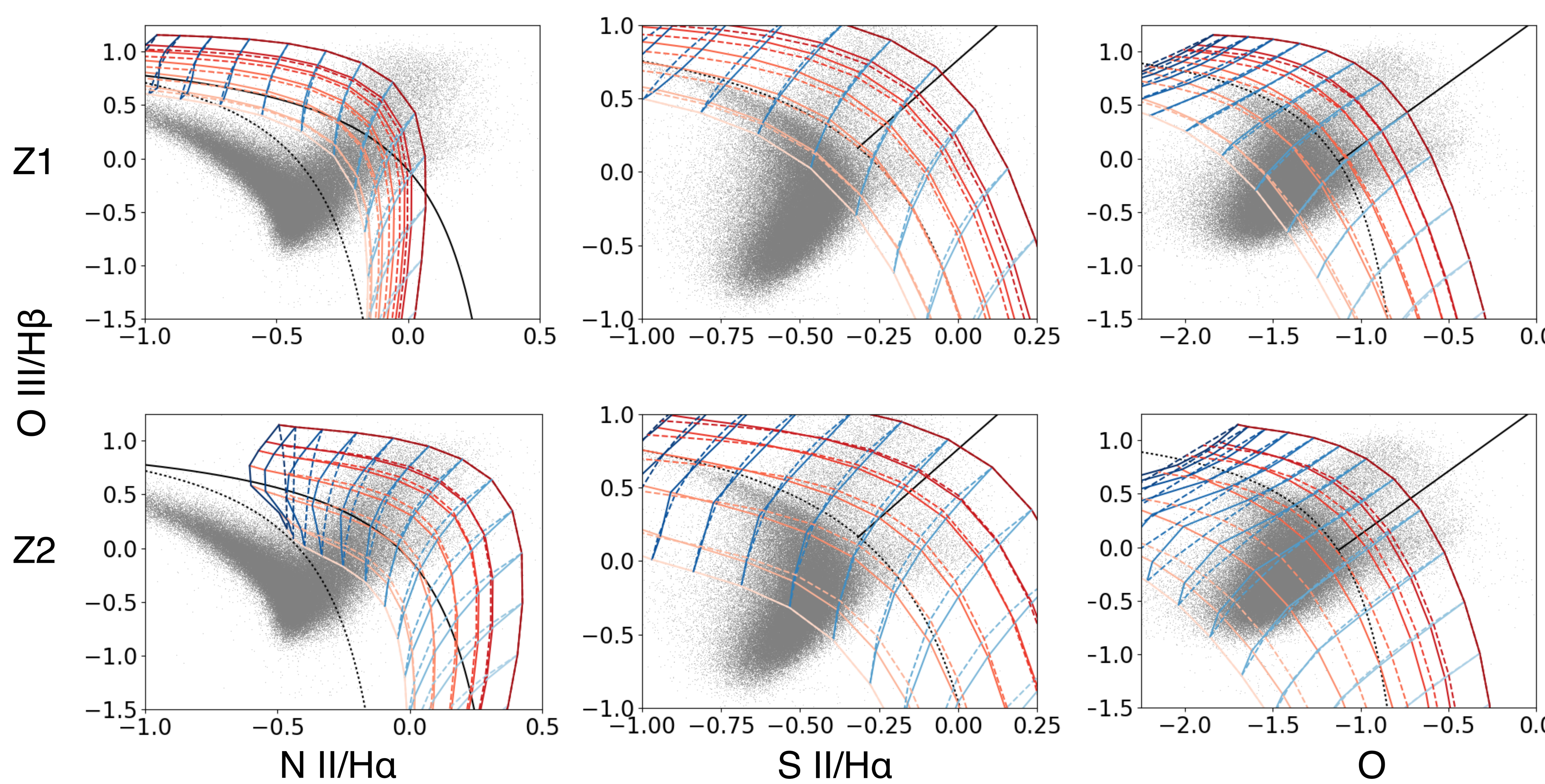


- The research we are doing compares two different mixing methods called self consistent and empirical and informing the community of the differences between each method.
- These two approaches could lead to demarcation lines being misplaced and therefore misclassified galaxies
- **Our goal is to find the statistical difference between the predicted emission line spectrum that results from using two different mixing methodologies**

Method and Data

- Gathered emission line intensities on 160,000+ galaxies from Sloan Digital Sky Survey 13 (Albareti, et al. 2017)
- Organized the emission line intensities into a readable format for Python code through excel spreadsheets
- Cloudy simulations (Ferland et al. 2018) allow users to input physical parameters for a source (AGN and/or stars) along with conditions in the gas cloud, and then predict the emitted spectrum
  - Assume a hydrogen density of 10^3 cm^{-3}, constant pressure holds, and grains from the Orion nebula
  - Vary AGN fraction (0%, 4%, 16%, 32%, 50%, 64%, 100%), abundances (Z), and ionization level
- Took in the data from CLOUDY simulations and plotted with standard demarcation lines to verify visual similarity to other BPT plots
- Plotted emission line strengths on the diagnostic diagrams using self consistent and empirical methods at varying AGN fractions and ionization parameters and expanded into other plots such as OIII/Hb vs. SII/Ha
- Analyze difference in demarcation methods and amount of galaxies which would be misclassified by this difference

Results



These are the Veilleux & Osterbrock Plots (1987) which show a graphical representation of how different galaxies would be classified. The dark lines are the standard used in the (Kewley, et al. 2006) paper. The colored lines range from all star forming galaxies being used at the tan line in the bottom left to all AGN being used at the dark red line at the top right. The dotted lines are using the empirical method and solid uses self consistent method. The blue lines demonstrate difference in ionization parameters along the demarcation lines. Z is representative of elemental abundances relative to our solar abundance being Z1 and Z2 being twice solar. The largest difference between methods is shown at 16% AGN on the OIII/Hb vs. OI/Ha of about 50%. This is consistent with the results found when mixing light from the AGN and star formation with AGN weighted 16% of all light received.

Future Work

- Model photometric bands of current optical tools to identify discrepancies in light collection and wavelength identifying instruments.
- Apply this comparison of self consistent versus empirical methodology to other emission line diagnostic diagrams with other adjusted parameters such as density and metallicity.

References

- Kewley, L., Groves, B., Kauffmann, G., Heckman, T., 2006, MNRAS, 372, 961
- Thomas, et al., 2018, ApJ, 861L, 2
- Veilleux, S., Osterbrock, D., 1987, ApJS, 63, 295
- Chatzikos, M., Ferland, G., Guzman, F., van Hoof, P., Williams, R., 2018, wtl, confE, 13
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