Investigating Connections Between Emission Line Spectra and Morphological Properties of Galaxies

Madeline Evenson,[1,2] Tim Miller[2], Allison Strom,[2]

[1]Department of Physics and Astronomy, University of Kansas, 1251 Wescoe Dr, Lawrence, KS 66045

[2]Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA), Northwestern University, 2145 Sheridan Road, Evanston, IL 60201, USA

Introduction:

The emission lines in a galaxy's spectrum tell us valuable information about the elements and physical processes present in galaxies. BPT diagrams compare the flux ratios of these emission lines and tell us information about the ionization mechanisms of galaxies. The purpose of this study is to compare the information gathered from studying emission lines with morphological (size and structure) measurements of galaxies. Six emission lines were analyzed in this study, and these ratios were selected because taking the ratio of two emission lines close together in wavelength reduce dust-reddening effects.

R_{eff} - radius of galaxy that contains half of its light

$\Delta\log(R_{eff})$ – quantitative measure of how compact/extended a galaxy is

Sérsic Index – number representing the shape of a galaxy's light distribution

Methods:

- Spectroscopic and morphological data from Dawn JWST Archive; (z=2.55-3.7)
- Moved each spectrum into rest-frame wavelengths and removed continuum
- SNR-based Gaussian emission line fitting method; chose line with highest SNR across bands
- Fit Sérsic profile to each galaxy, interpolated Sérsic value and R_{eff} values to rest frame wavelengths
- Model fit to remove confounding effects of mass and redshift and isolate effects of size
- Electron density calculated using PyNeb code and [SII] measurements
- Created BPT diagrams; studied relationships between emission lines and morphology

Main takeaways:

- Negative correlation between electron density and size of galaxy
- Possible positive correlation between S32 line ratio and size of galaxy

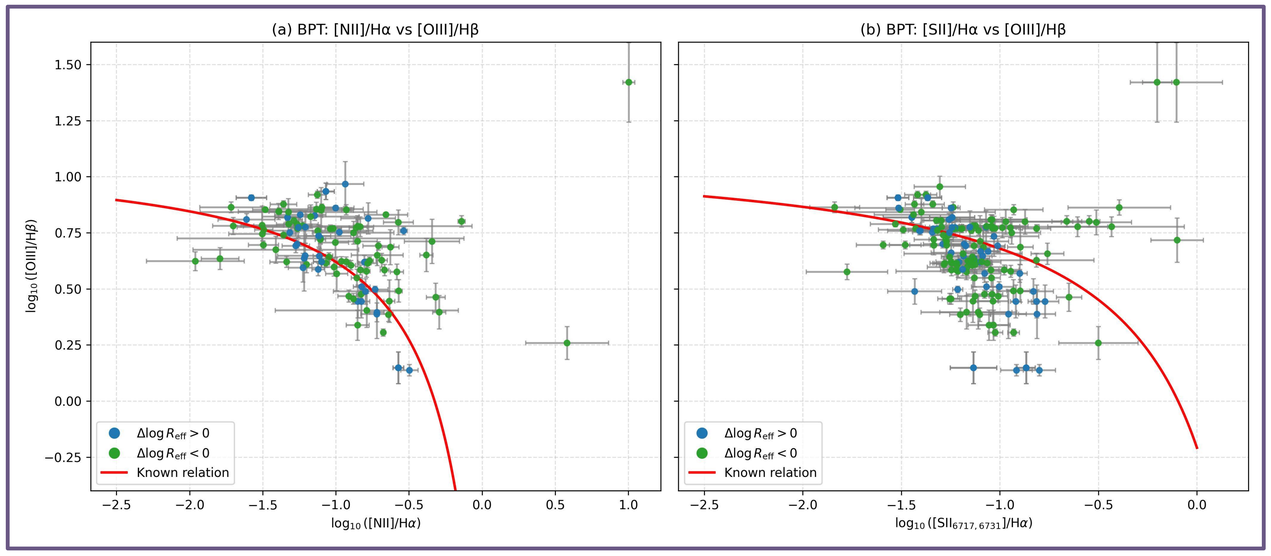

Fig 1. S2-BPT and N2-BPT, colored by positive/negative $\Delta\log(R_{eff})$ value, overlaid with known relations from Strom et al. (2017)

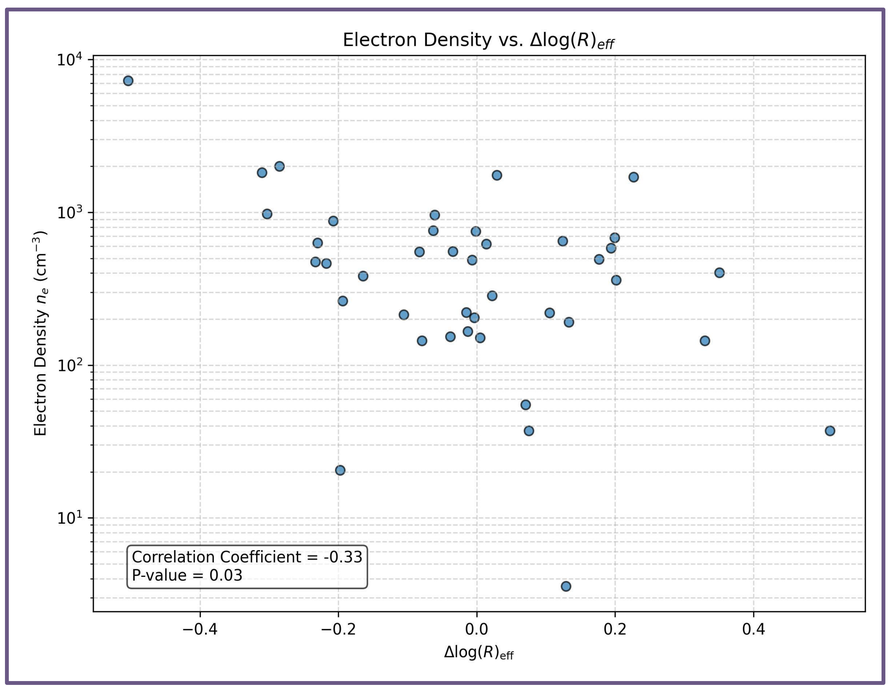

Fig 3. Relationship between electron density and $\Delta\log(R_{eff})$

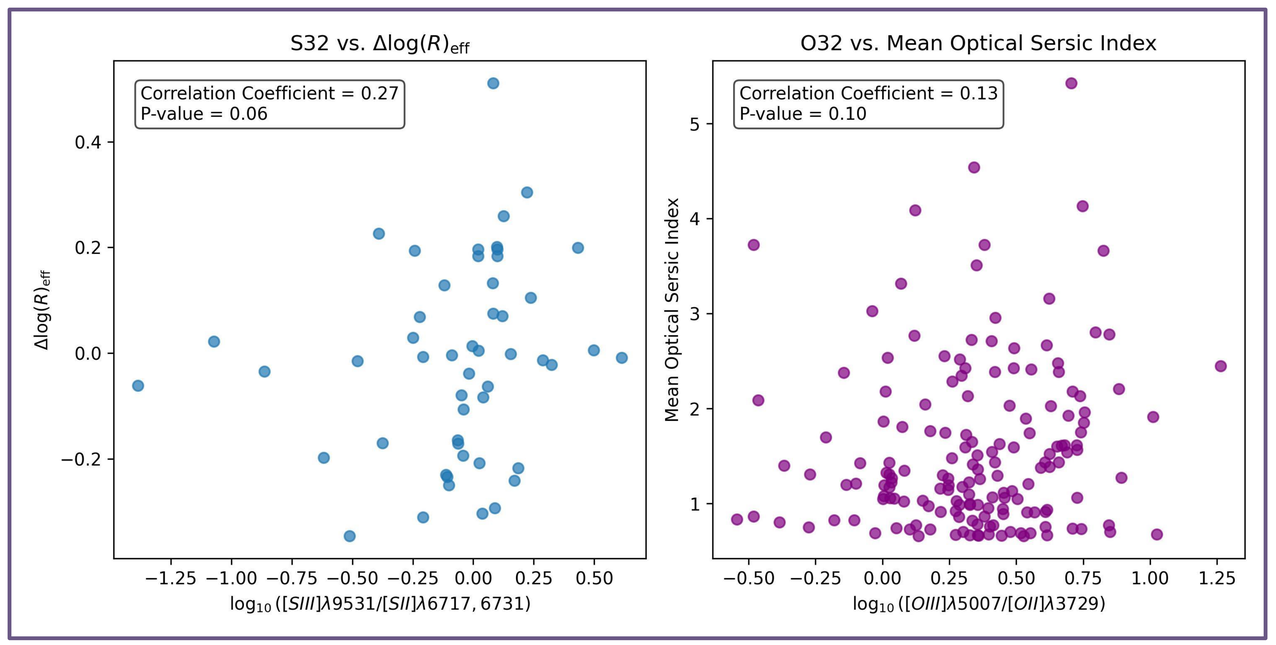

Fig 2. (left) Relationship between S32 and $\Delta\log(R_{eff})$; (right) relationship between O32 and mean optical Sérsic index

	$\log_{10}$([NII]/Hα)	$\log_{10}$([SII]/Hα)	$\log_{10}$([OIII]/Hβ)	$\log_{10}$(S32)	$\log_{10}$(O32)	$\log_{10}$(R23)
Correlation Coefficient: $\Delta\log(R_{eff})$	0.00	-0.05	-0.05	0.27	-0.02	-0.09
P-value: $\Delta\log(R_{eff})$	0.98	0.55	0.43	0.06	0.83	0.27
Correlation Coefficient: Mean Optical Sérsic Index	0.13	-0.03	0.09	-0.08	0.13	0.05
P-value: Mean Optical Sérsic Index	0.19	0.74	0.18	0.56	0.10	0.52

Results:

- Negative correlation found between electron density and $\Delta\log(R_{eff})$
- No observed connections between line ratios and $\Delta\log(R_{eff})$
  - Possible correlation between $\Delta\log(R_{eff})$ and S32
- No strong connection observed between line ratios and Sérsic index
- No strong connection observed between electron density and mass
- No strong connection observed between electron density and Sérsic index

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