Rest-UV Properties of MUSE HUDF DR2 Galaxies

Redshifts 2.8 < z < 4

Tiffany Liou
Supervisor: Dr. Nimisha Kumari

UC San Diego

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

Overview

Aim:

To study the properties of high-redshift galaxies

Dataset:

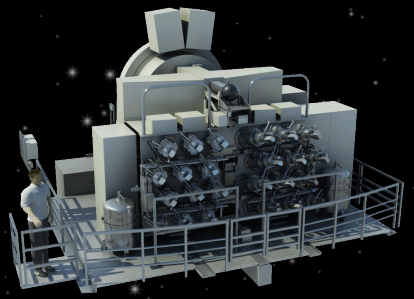
MUSE Hubble-Ultra-Deep-Field Data Release 2

Analysis:

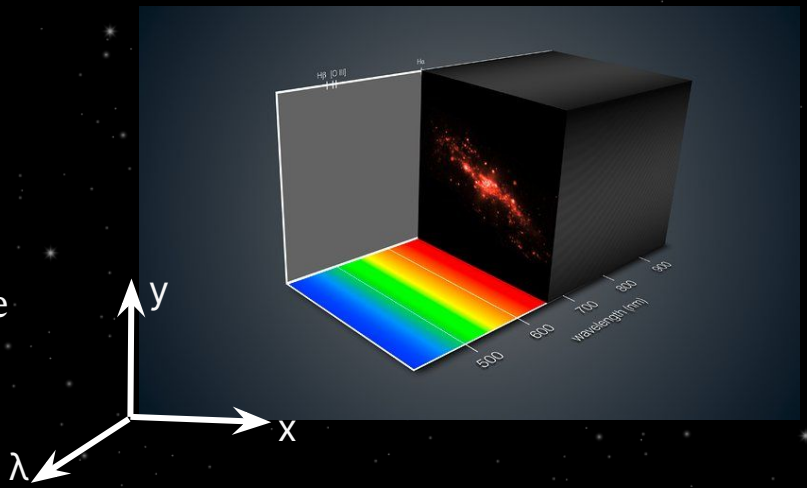
Scaling relations between different physical properties

MUSE

Multi Unit Spectroscopic Explorer



MUSE :
Ground-based integral field spectrograph on the Very Large Telescope in Chile



Integral Field Spectroscopy (IFS)

- Combines spectrum and imaging
- Takes spectrum over wavelength range within 2D spatial region
- Creates 3D data cube

Images: ESO

MUSE HUDF DR2

Hubble Ultra Deep Field Data Release 2

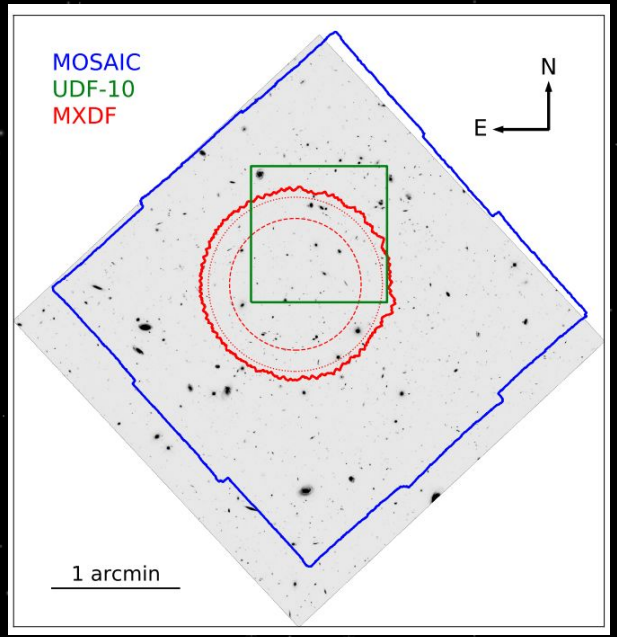
Survey Properties:
3 different deep fields

- **MOSAIC** – 3x3 arcmin^2 & 10-h depth
- **UDF-10** – 1x1 arcmin^2 & 31-h depth
- **MXDF** – 1 arcmin diameter 141-h depth

MUSE has high sensitivity

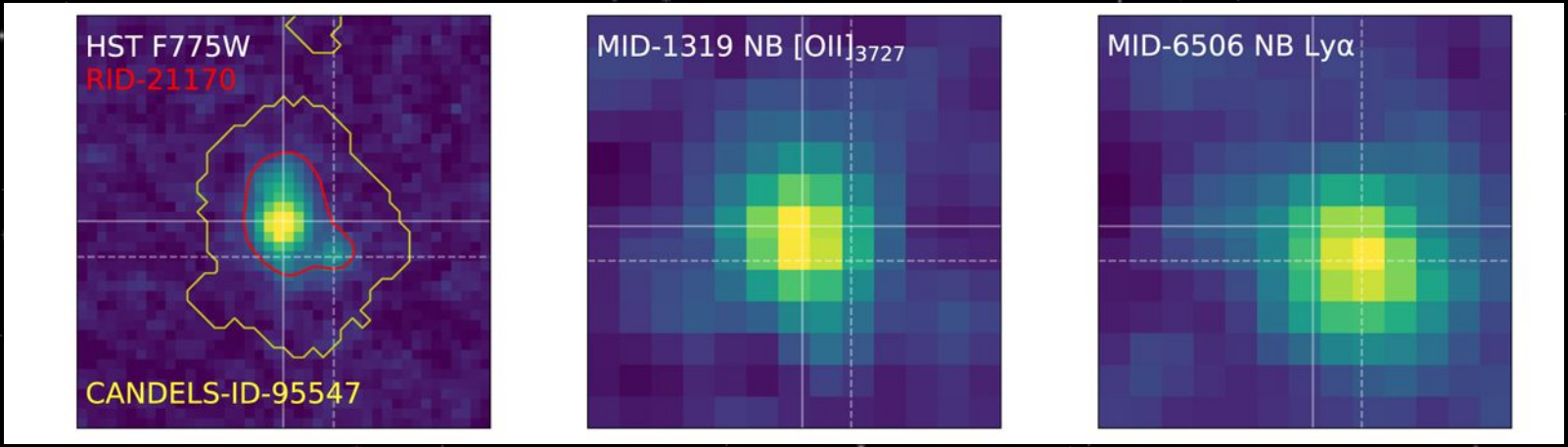
- Spatial resolution of 0.55 arcsec at 7000Å
- Better redshift confidence

→ **detections of faint, high redshift galaxies**



Bacon et al. 2022

MUSE Detections of Faint Galaxies



Left: HST UV Image
- Light from one object

Middle & Right: MUSE UV Images
- two sources at different redshifts

Unique opportunity for studying rest-UV properties of galaxies

Bacon et al. 2022

Objective

To analyze rest-UV properties through various relations between

- Stellar mass
- Gas-phase metallicity (12+log(O/H)
- Star-Formation Rate (SFR)
- Redshift

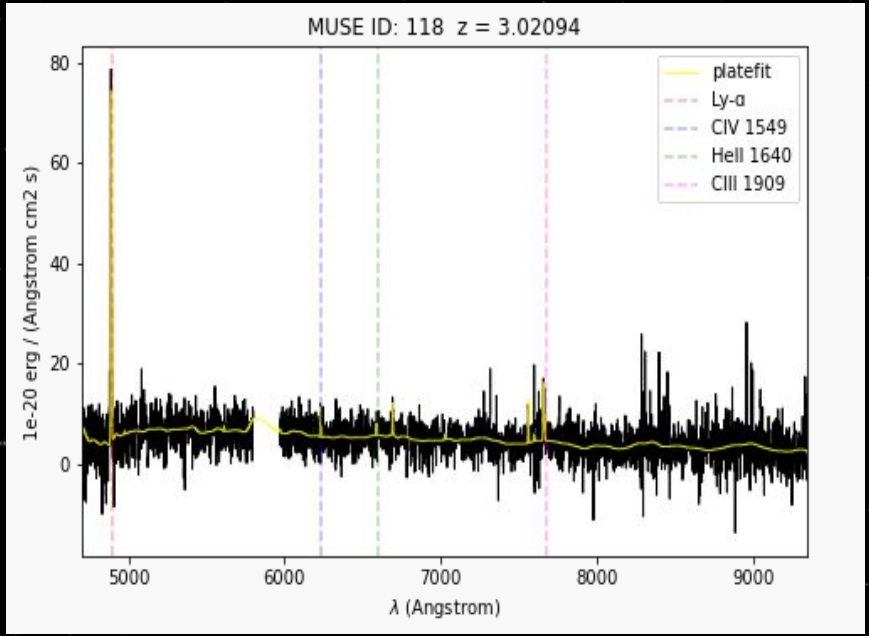
Data Selection

Lines of Interest:

- Lyα
- CIV λ1548, 1550
- HeII λ1640
- CIII] λ1907,1909

Selected redshift range where all the lines are covered in spectral range
→ **2.803 < z < 3.973**

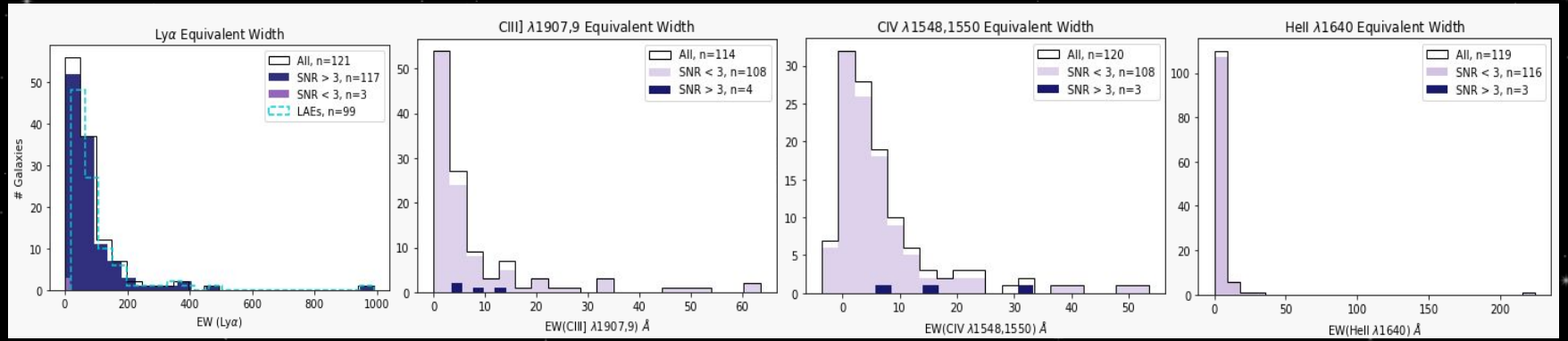
Galaxies with signal-to-noise ratio > 3 and high redshift confidence



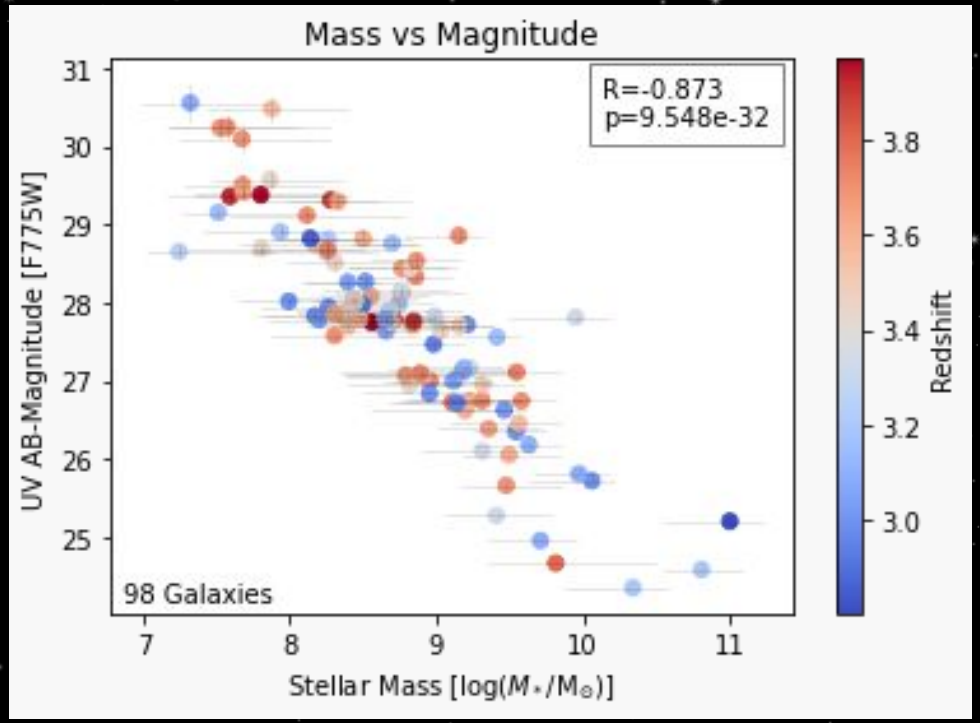
Data Selection

Total sample: 121 galaxies
Analysis focuses on galaxies with Lyα SNR > 3

Note: Small sample → Unable to study correlations based on CIII], CIV, and HeII

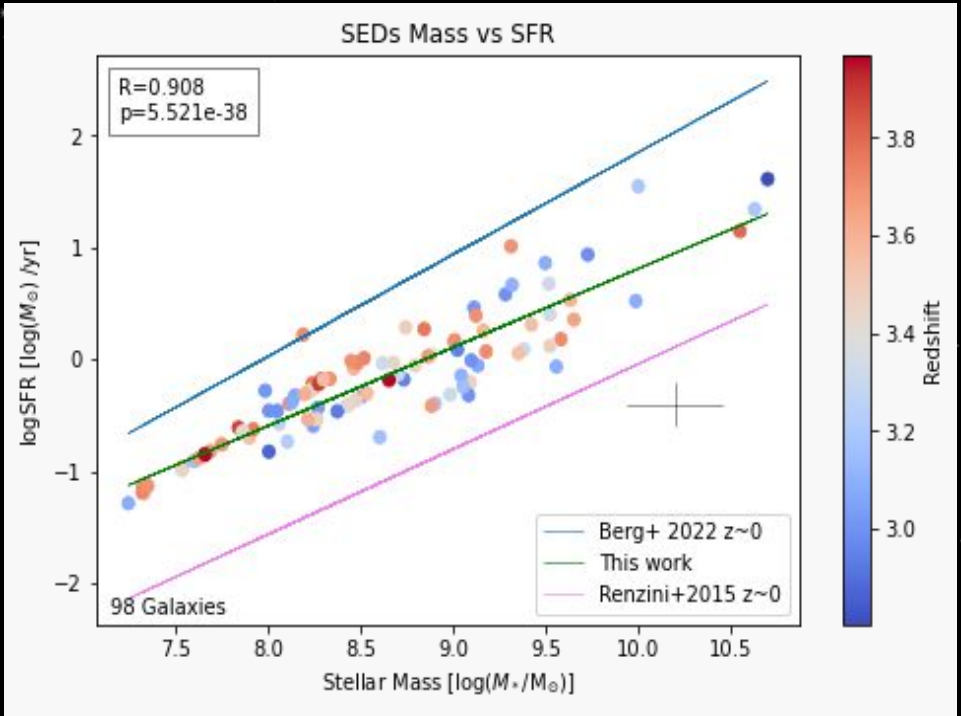


Mass v. Magnitude



- Anticorrelation between mass and magnitude
- Massive galaxies are brighter in UV
- No correlation with redshift

Mass v. SFR



- Positive correlation
- Massive galaxies have higher SFR

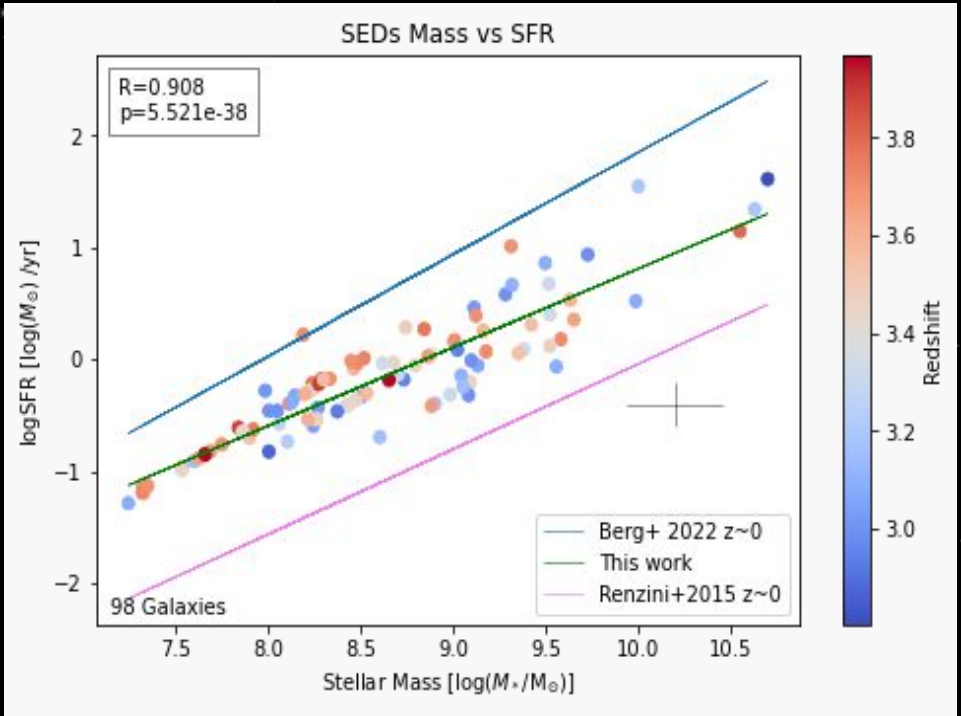
Berg et al. 2022:

- SFR of **"local analogs"**
- z > 2 galaxies should be comparable

Renzini & Peng 2015:

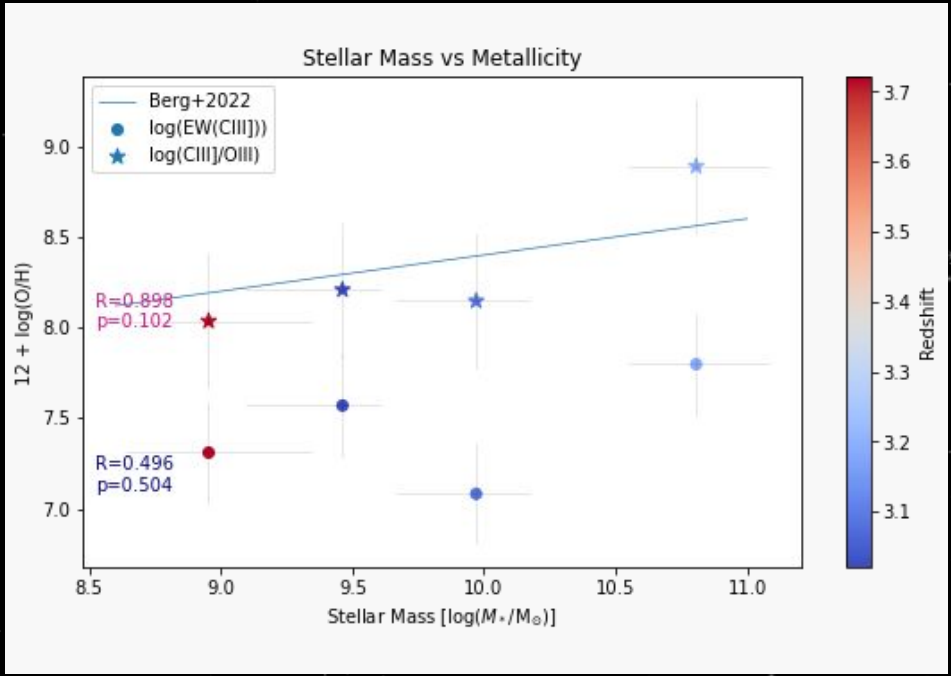
- Local main sequence galaxies

Mass v. SFR



- Higher SFR than local main sequence galaxies
- Earlier galaxies have higher SFR
- Lower SFR galaxies than suggested “local analogs”
- **Galaxies in Berg+2022 are not local analogs of galaxies $2.8 > z > 4$**

Mass v. Metallicity



**Equivalent Width (EW) is a measure of the strength of a spectral feature

- Estimated metallicity based on Mingozzi+ 2022
  - EW(CIII]) and CIII]/OIII
- Which estimate is correct?
- CIII]/OIII has higher correlation and close fit with Berg+ 2022
- Note: small sample

Conclusion

In our study:

- Explored the general trends of galaxies $2.8<z<4$
- How sample compares to local analogs

Future works:

- Small sample for SNR>3 CIV, CIII] and HeII lines
- Verify if CIV, CIII], HeII lines are common at high redshifts
- Study line ratios to uncover physical properties of galaxies
- Understand star-formation in early galaxies and their environments

References

1) **Bacon et al.** (**2022**). The MUSE Hubble Ultra Deep Field surveys: Data release II. *Astronomy & Astrophysics, Volume 670*, 42,pp., . 10.1051/0004-6361/202244187
2) **Bacon et al.** (**2022**). VizieR Online Data Catalog: MUSE Hubble Ultra Deep Field surveys. DR2. *VizieR Online Data Catalog: J/A+A/670/A4.*
3) **Berg et al.** (**2022**). The COS Legacy Archive Spectroscopy Survey (CLASSY) Treasury Atlas. *ApJ, Volume 261:31,* 41 pp., 10.3847/1538-4357/ac952c
4) **European Southern Observatory** (ESO) (2014). Datacube MUSE on NGC 4650A with IFU [Image], https://commons.wikimedia.org/wiki/File:Datacube_MUSE_on_NGC_4650A_with_IFU.jpg
5) **European Southern Observatory** (ESO), [Image], https://www.eso.org/sci/facilities/develop/instruments/muse.html
6) **Kumari et al.** (**2023**). A study of extreme CIII]1908 & [OIII]88/[CII]157 emission in Pox 186: implications for JWST+ALMA (FUV+FIR) studies of distant galaxies. *MNRAS 000*, pp. 1–17, arXiv:2307.00059v1
7) **Mingozzi et al.** (**2022**). CLASSY IV. Exploring UV Diagnostics of the Interstellar Medium in Local High-z Analogs at the Dawn of the JWST Era. *ApJ, Volume 939,* 10.3847/1538-4357/ac952c
8) **Renzini, A., Peng, Y.,** (**2015**). An Objective Definition for the Main Sequence of Star-forming Galaxies. *ApJ, Volume 801,* 6 pp., 10.1088/2041-8205/801/2/L29

Thank you!

Dr. Nimisha Kumari
Brad, Kayla, Mikayla,
and all the SPS Interns!

Contact me:
Tiffany Liou
tiffy12536@gmail.con
UC San Diego
BS in Physics with Specialization in Astrophysics