# Properties of Lyα & non-Lyα emitters in the epoch of reionization

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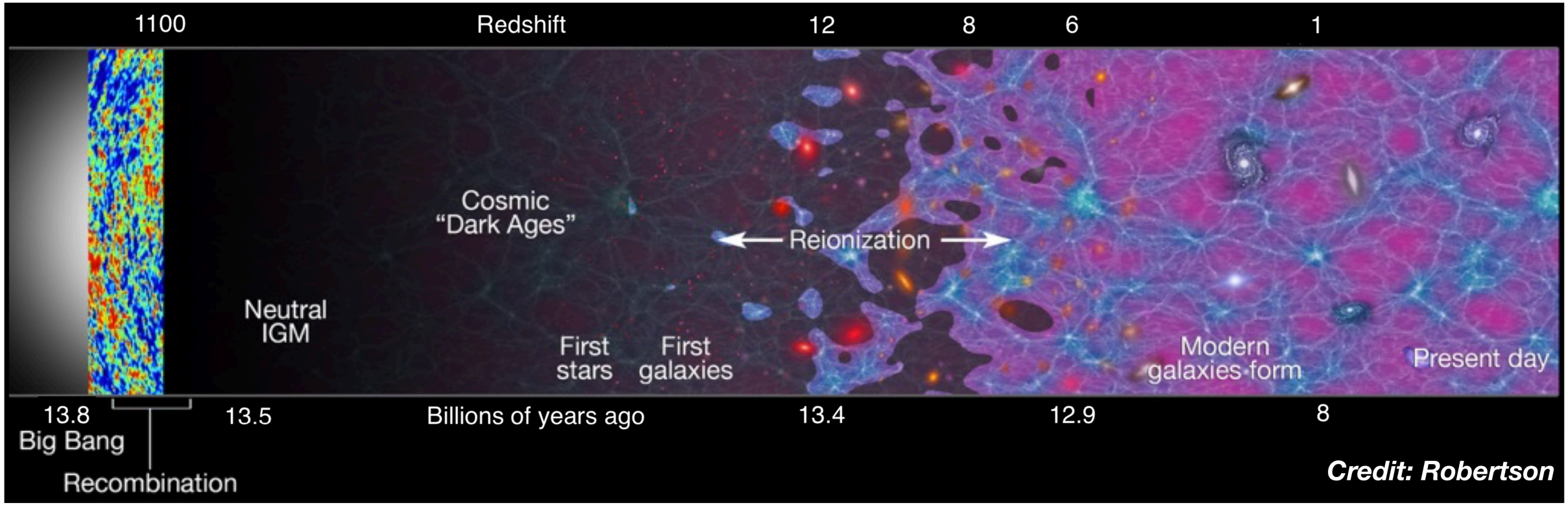
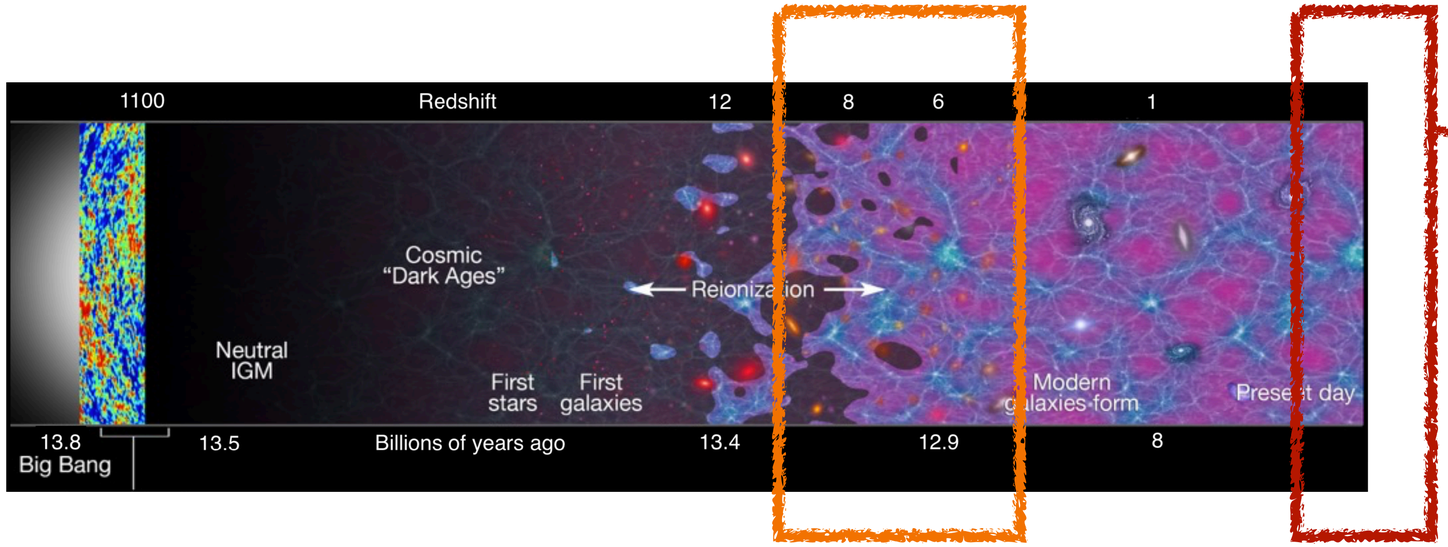
*Lyman 2025, Crete, April 10, 2024*

# Cosmic History



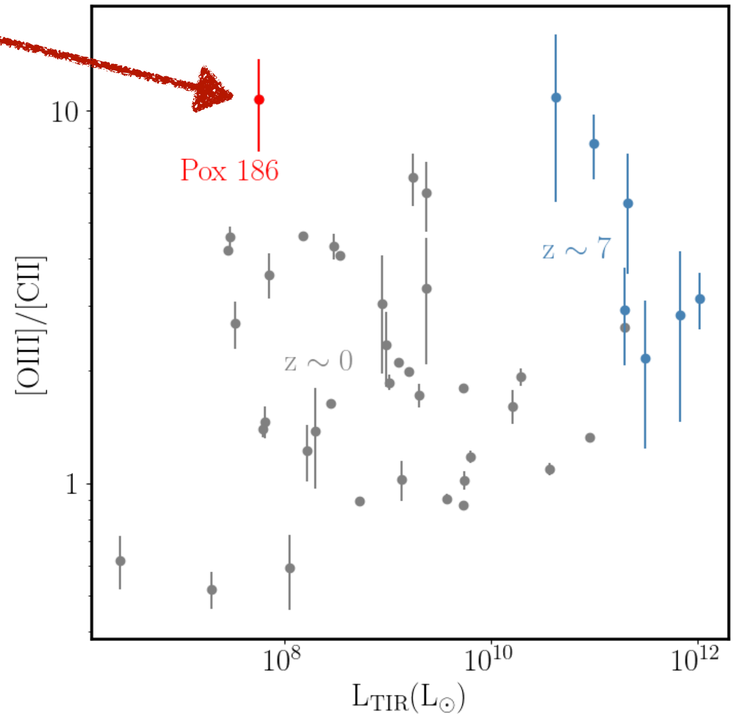

Potential sources of reionzation: AGNs, QSOs, SF galaxies, LBGs, Lyman alpha emitters (LAEs)?

# Talk outline




1. Lyα & non-Lyα emitters
In the EoR

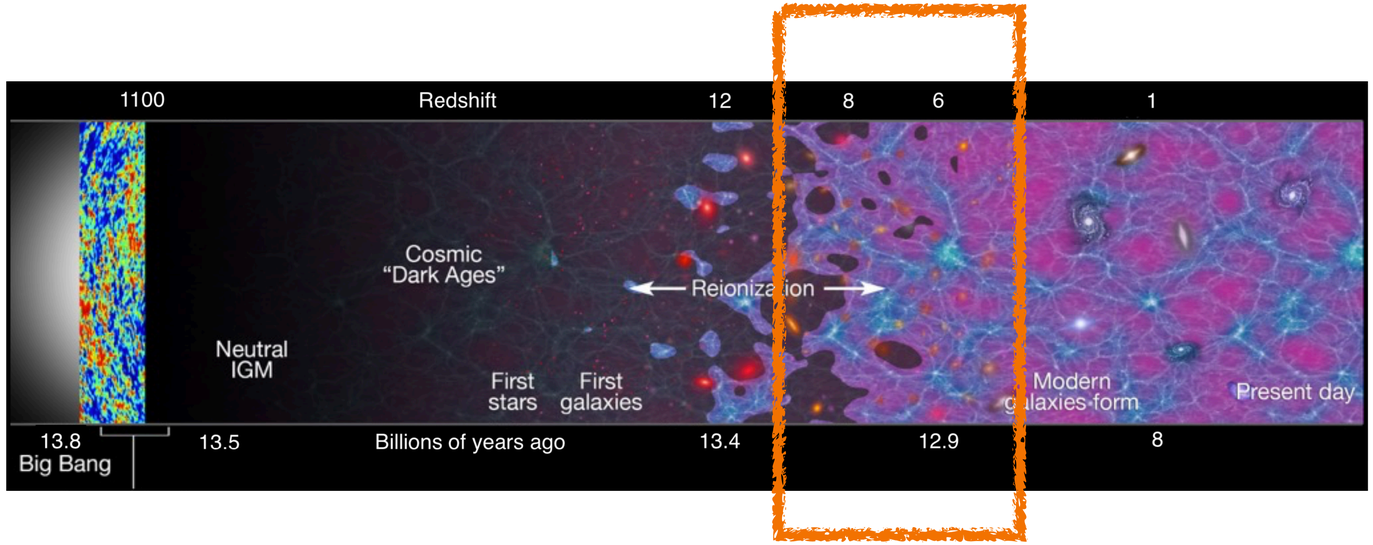
Kumari et al. arXiv:2406.11997




2. Potential best local EoR analog

Kumari et al. 2024, MNRAS, 529, 781

# Talk outline




1. Lyα & non-Lyα emitters
In the EoR

Kumari et al. arXiv:2406.11997

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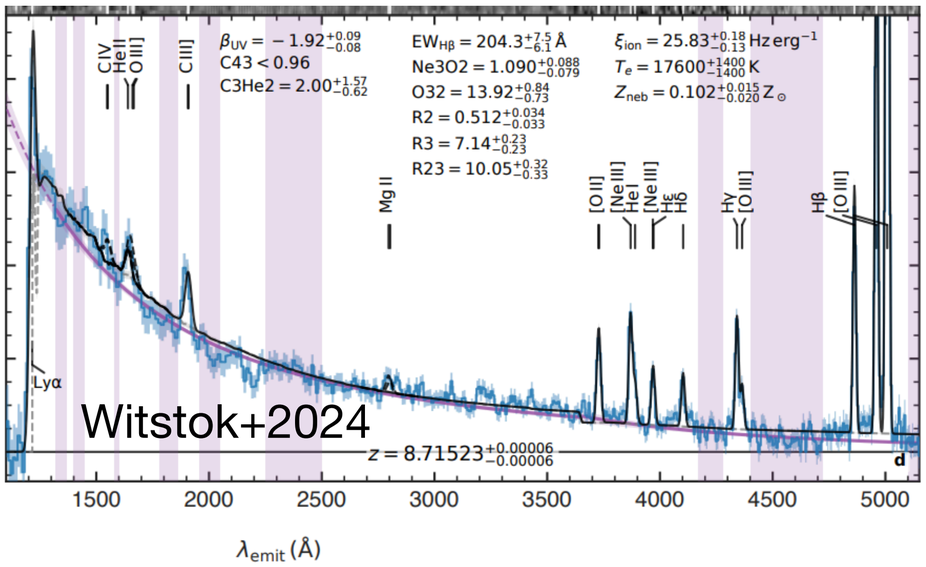
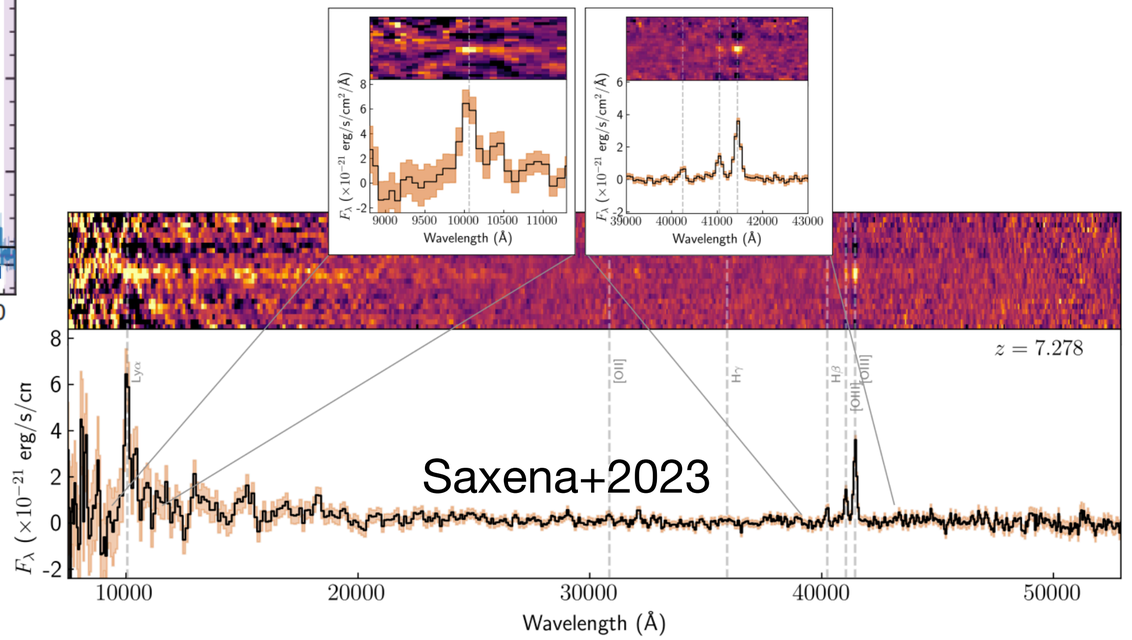
# Lyman alpha emitters in JWST era

Since Partridge & Peebles 1967….





Thanks to JWST/ NIRSpec:
Several spectroscopic detection & analysis

(e.g.,Bunker+2023, Jones+2023, Maseda+2023, Tang+2024, Saxena+2023a, 2023b, Witstok+2024a,2024b, see also, Heintze+2024, Roberts-Borsani+2024)

Various ground-breaking studies though difficult to draw broad conclusions on LAE and non-LAE populations.

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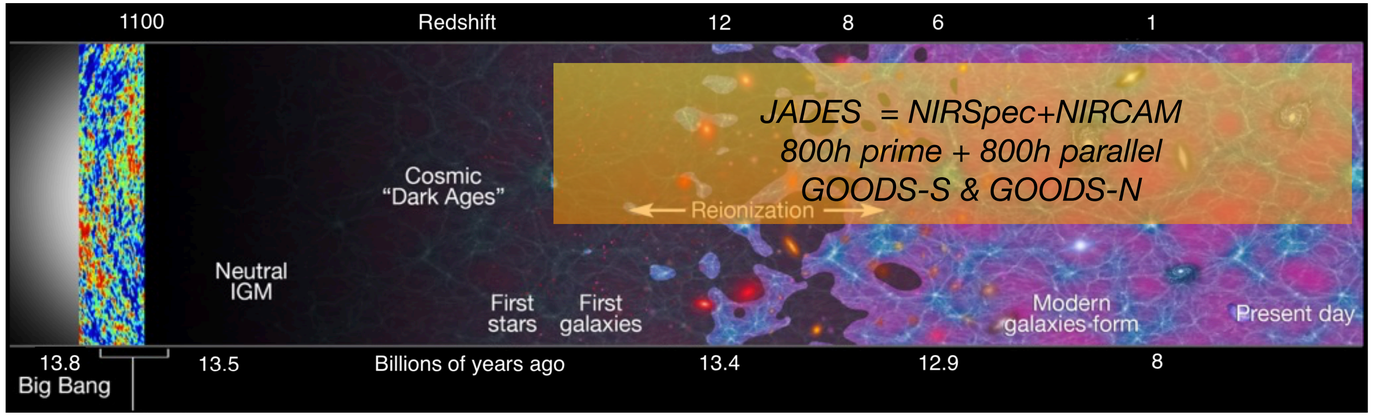
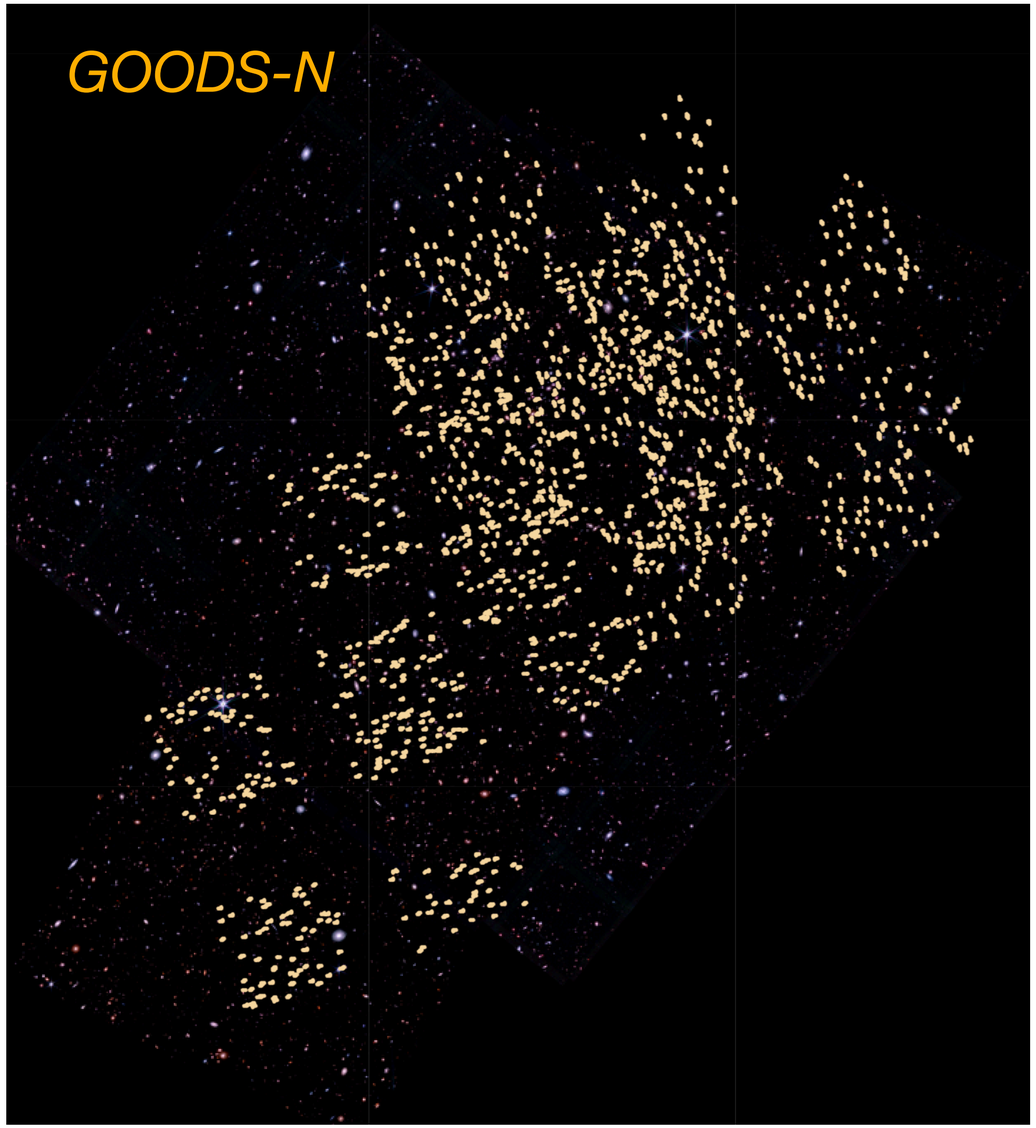
# JADES: Galaxies population

## *JADES Overview*




*Low (R~100), Medium (R~1000) &*
*High resolution (R~2700)*
***Multi-object spectroscopy (MOS) via NIRSpec***
*&*
*NIRCam imaging in 9 filters.*

See e.g., Bunker+2020, Rieke+2020, Eisenstein+2023, Bunker+2023



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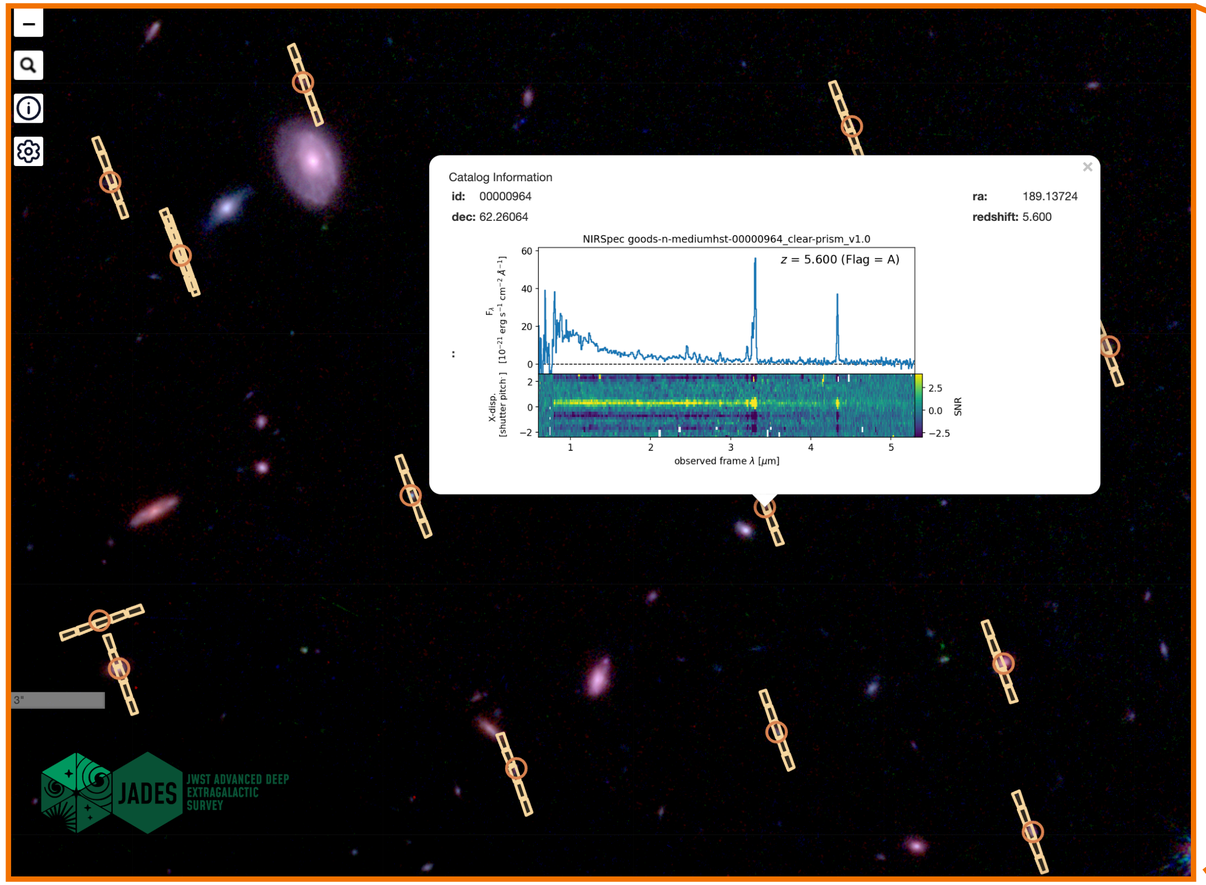
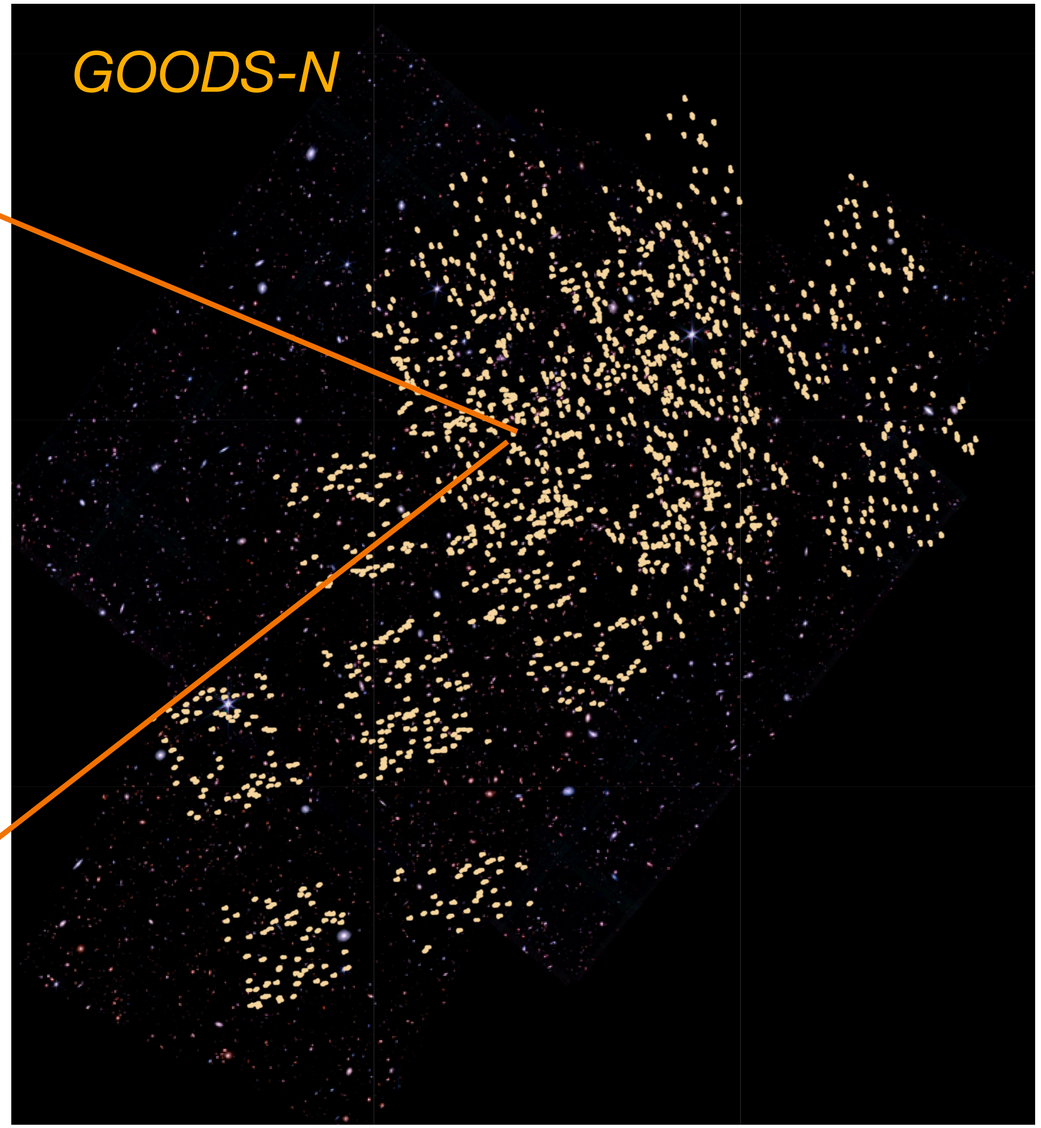
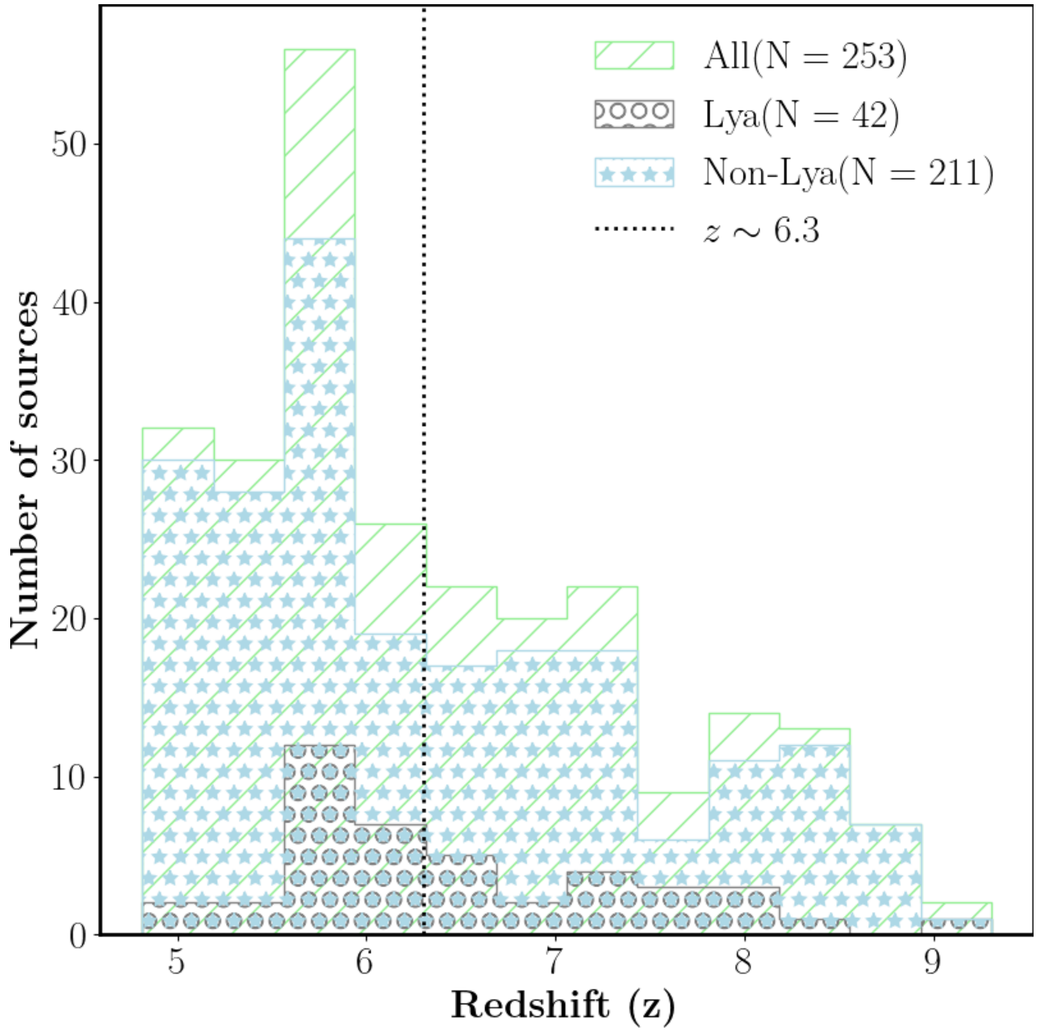
# JADES: Galaxies populations via MSA



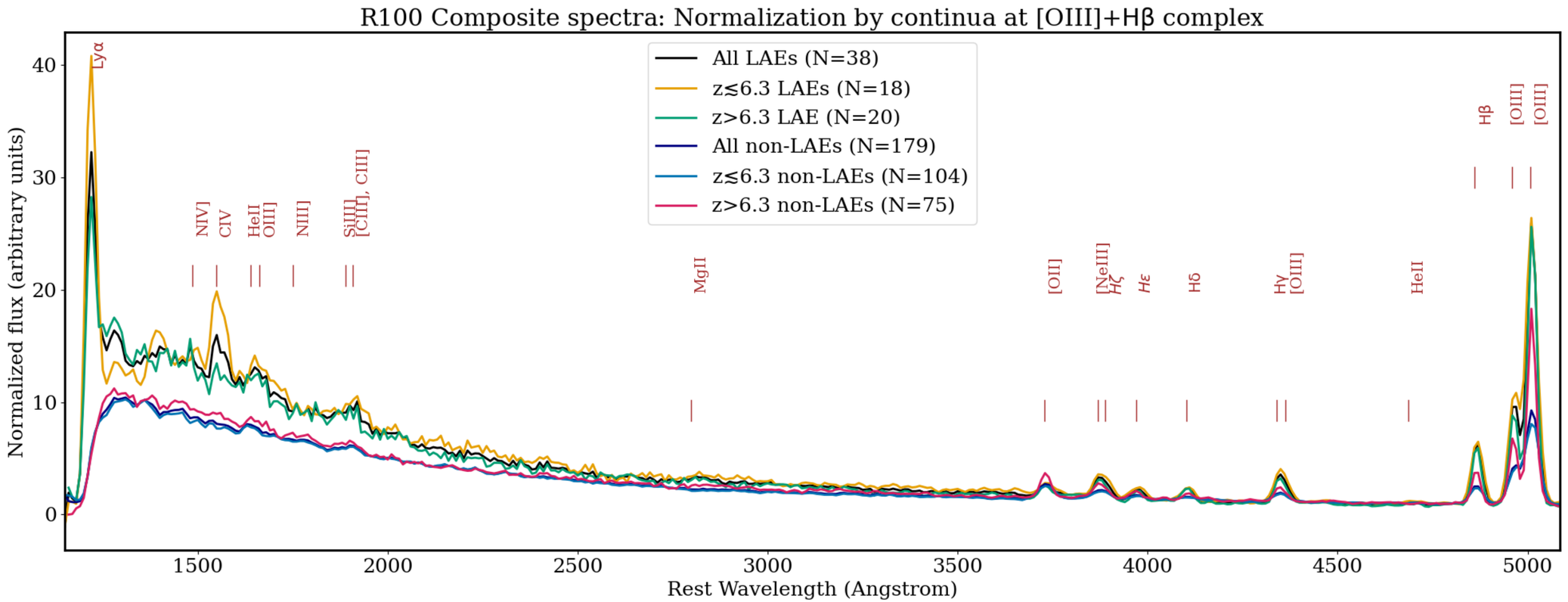



# JADES: LAE versus non-LAE population

- Sample Selection:
  - Redshift range: 4.8-9.6
  - Rest-wavelength range: Lya to [OIII]5007
- Sub-samples:
  - LAEs vs non-LAEs
  - Based on redshifts
- Stacking spectra within 6 sub-samples



# R100 Composites: LAEs versus non-LAEs




Large EW([OIII]4959,5007) for LAEs compared to non-LAEs —> large ionizing photon production efficiency

log(ξ*ion) LAE samples ~ 25.63-25.75 (Hz erg-1)

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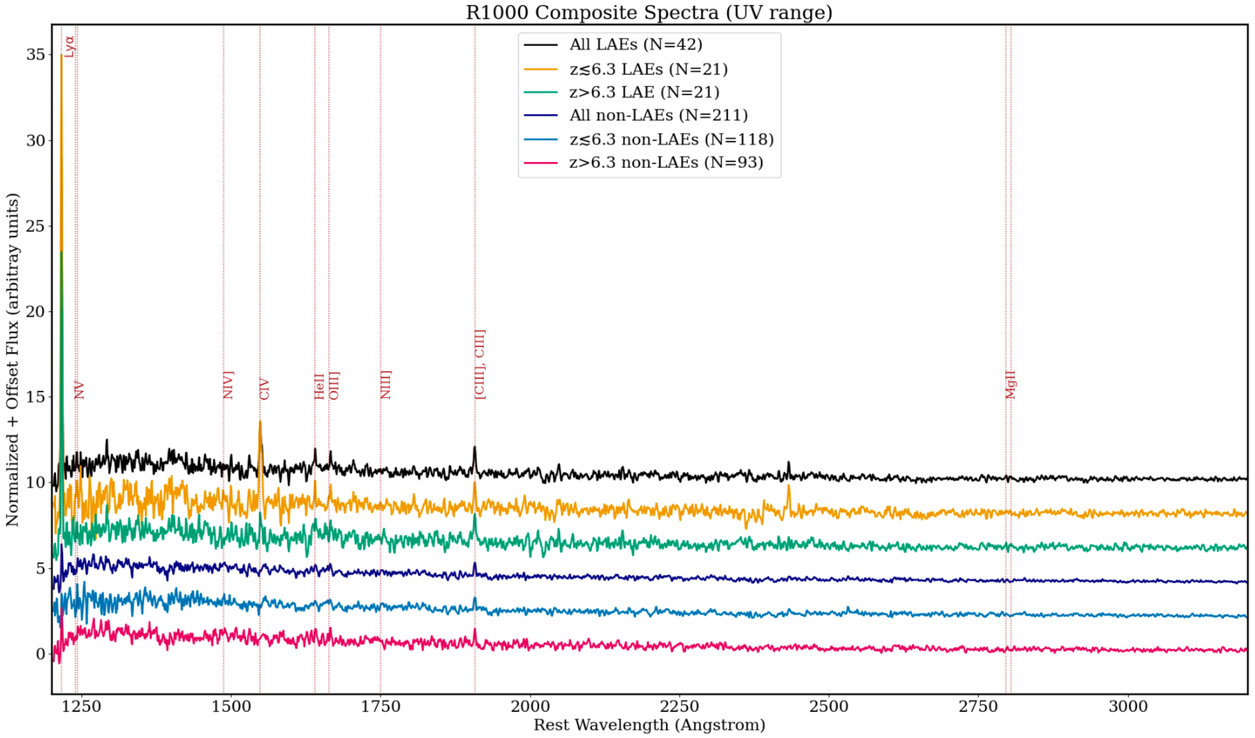
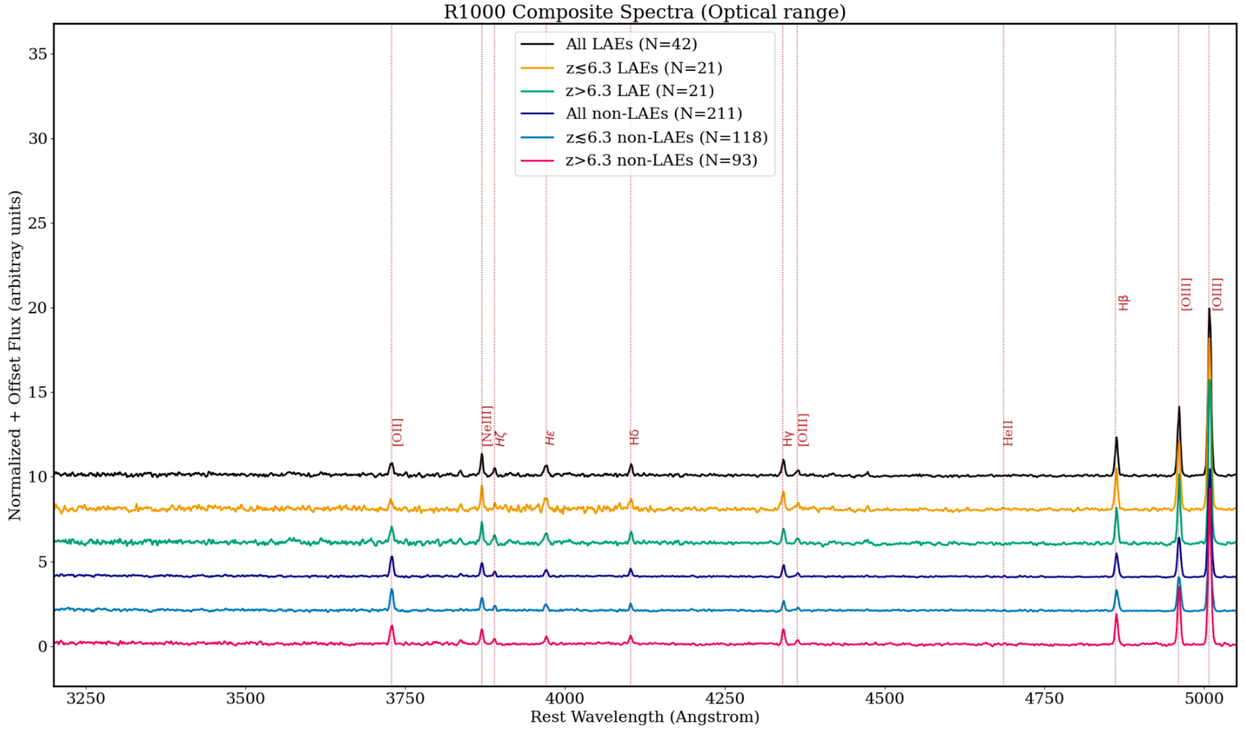
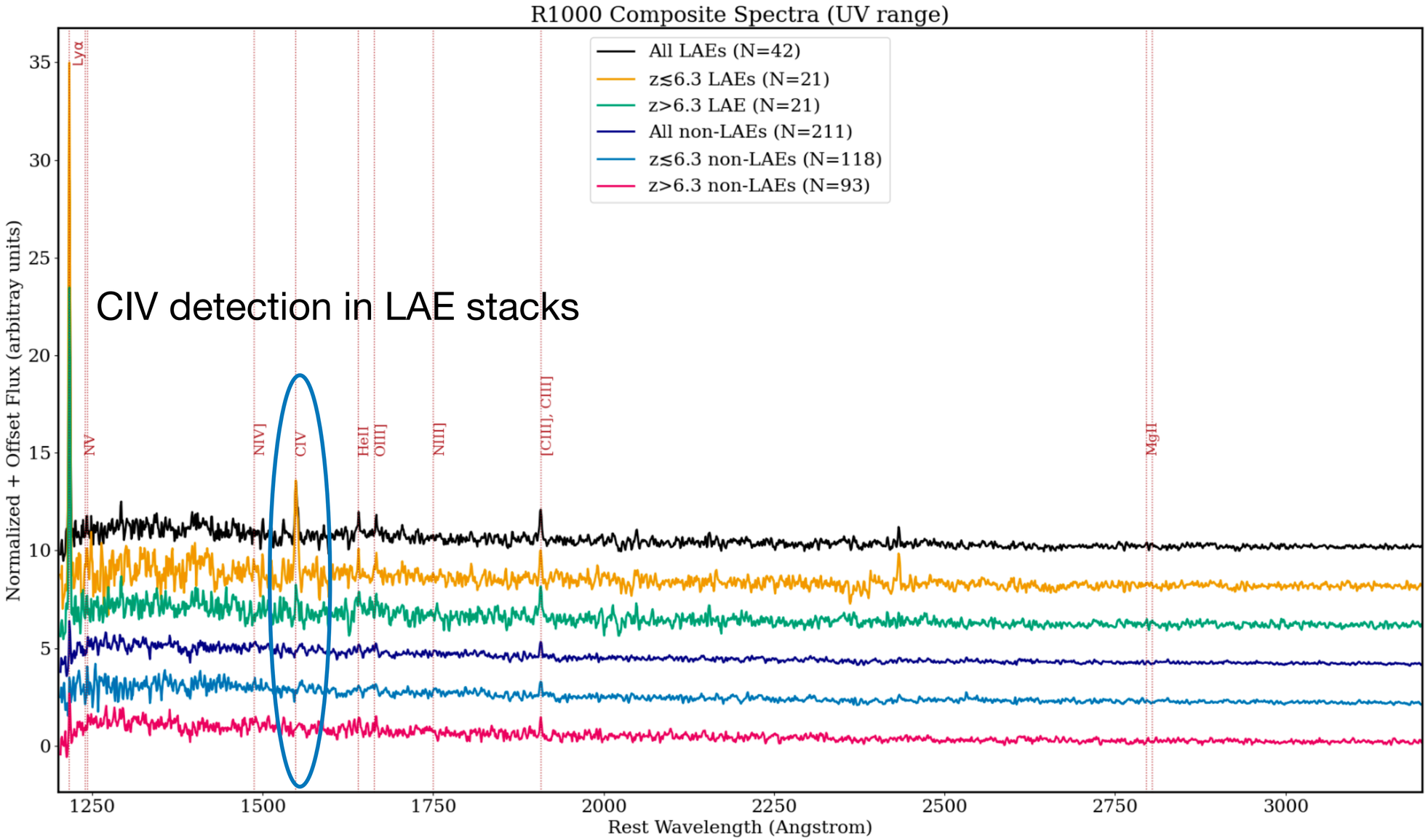
# R1000 Composites: LAEs versus non-LAEs



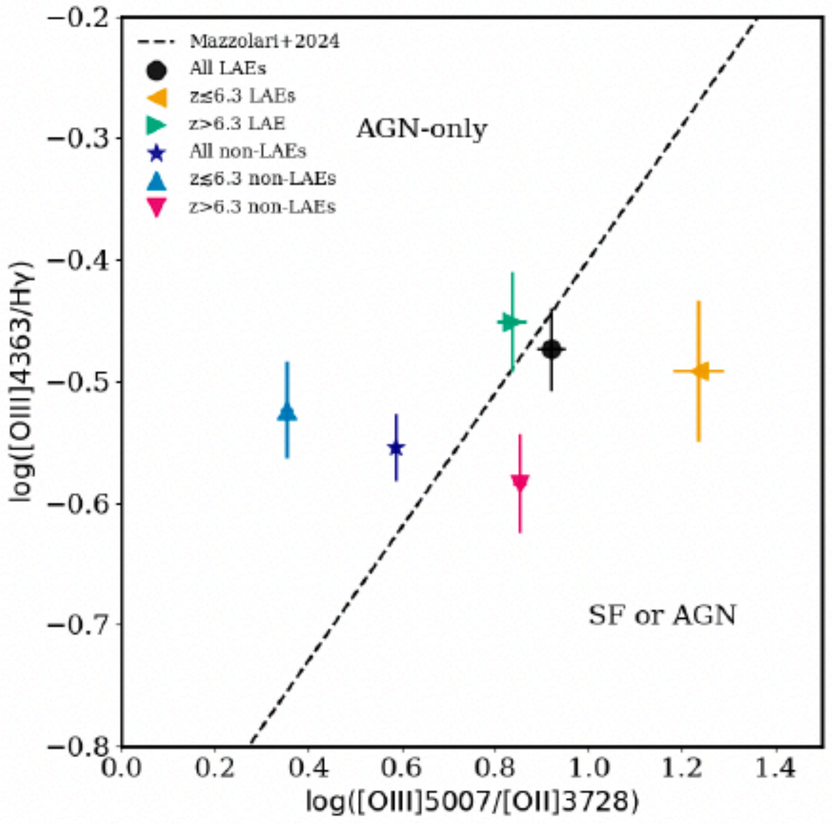




Various physical properties such as dust-extinction, electron temperatures, ionization parameter and escape fraction of Lya and LyC…

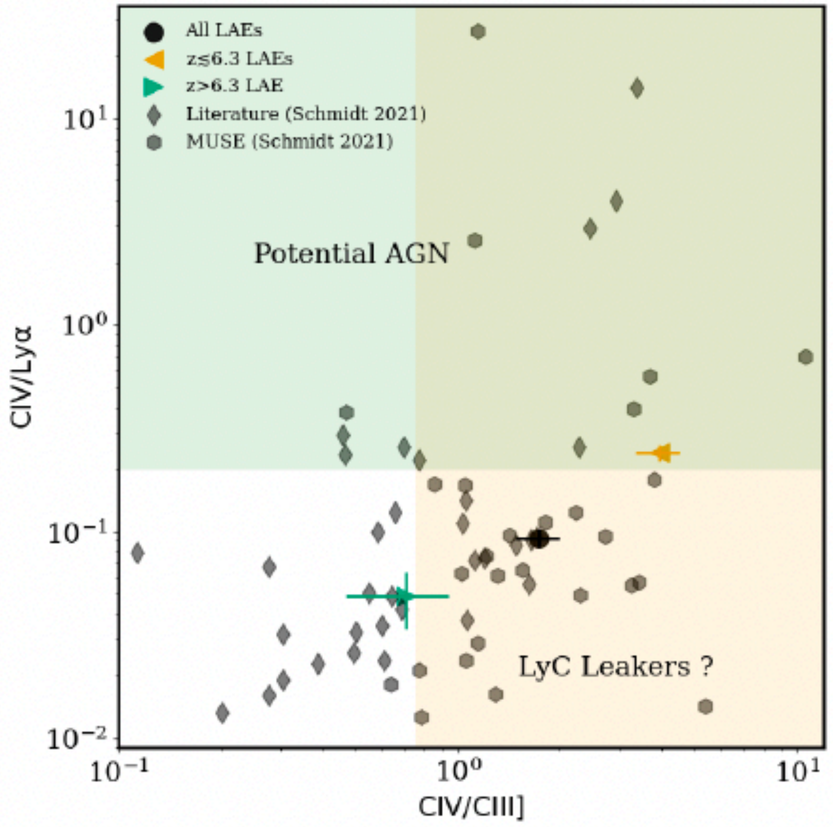
# R1000 Composites: LAEs versus non-LAEs



# LAEs versus non-LAEs

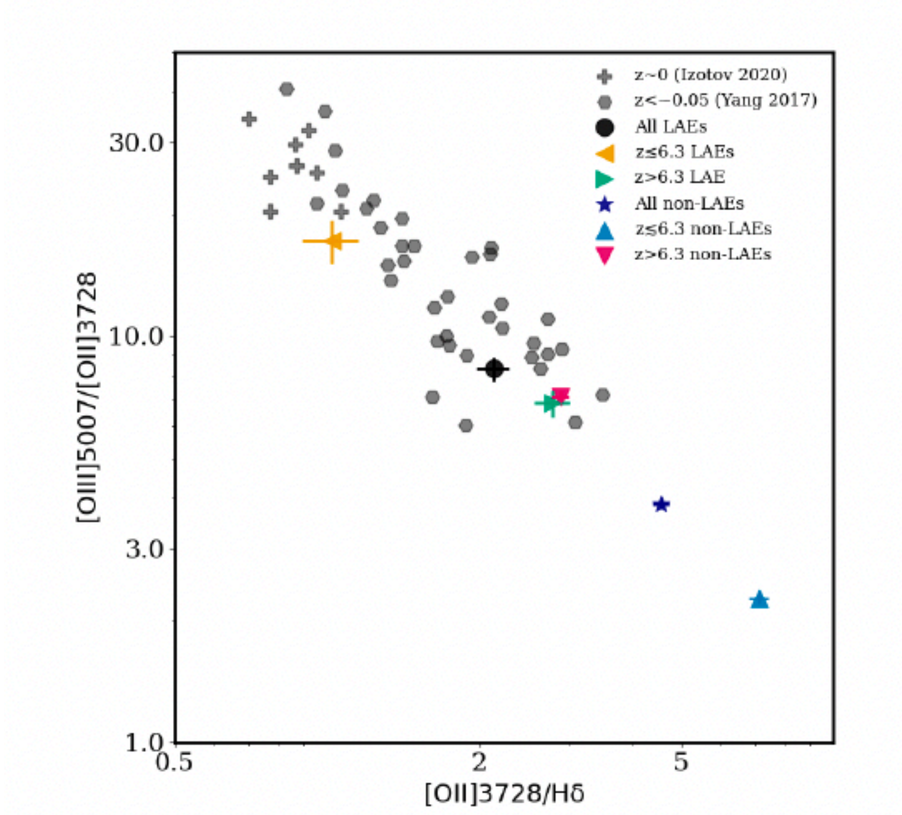



AGN dominating all samples?

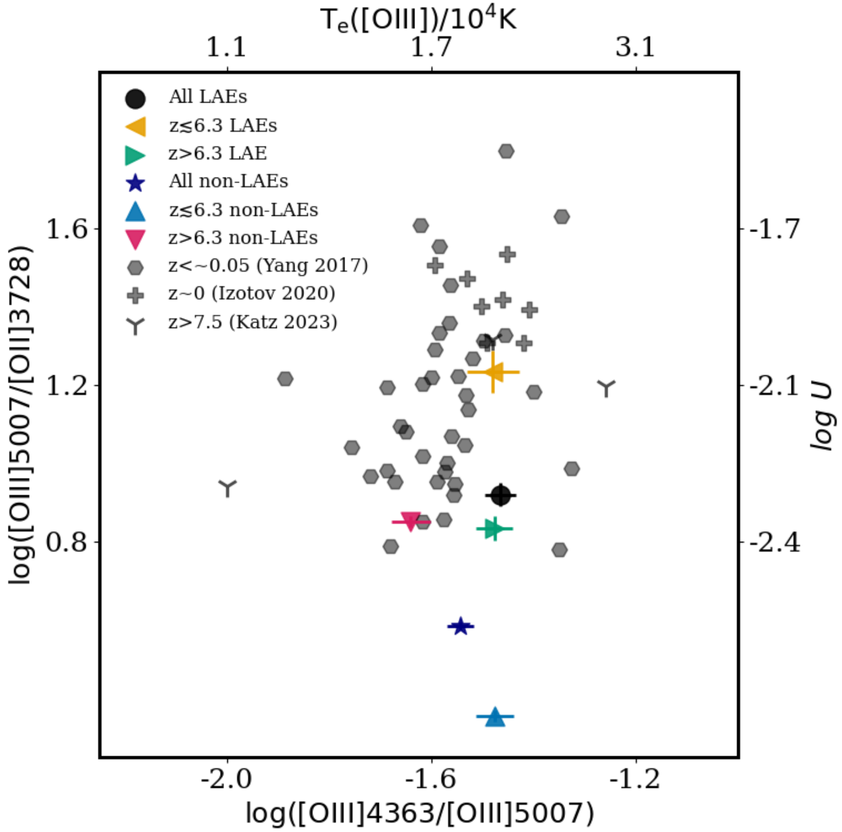



CIV/Lya & CIV/CIII] for LAEs at z<6.3
~ 5x for LAEs at z>6.3

# LAEs versus non-LAEs

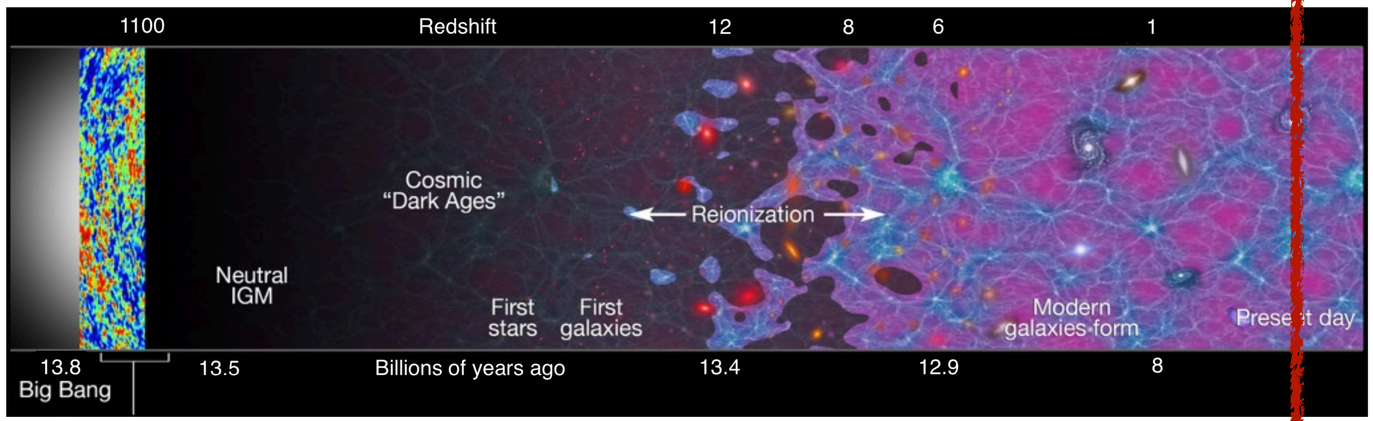


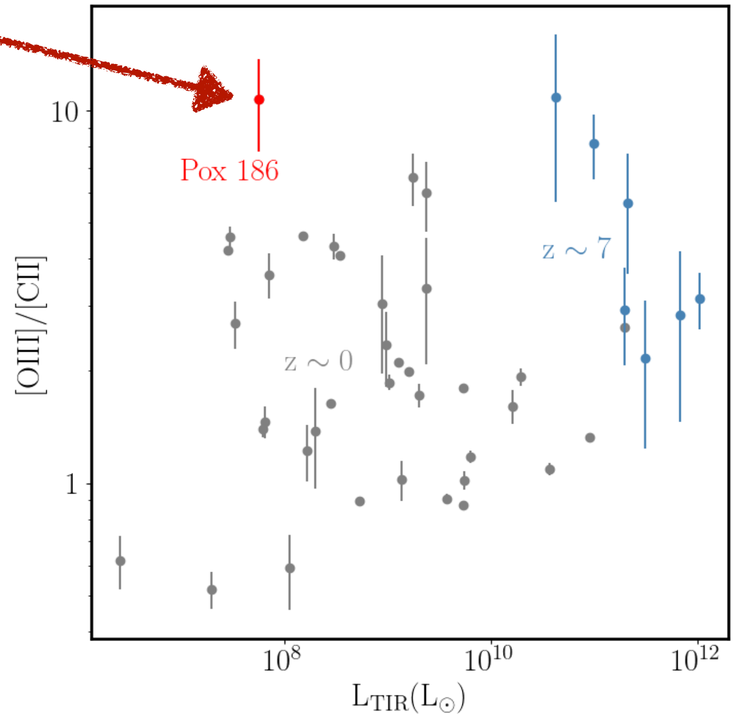

LAEs show much higher [O III]/[O II] and low [O II]/Hδ at z≲6.3 compared to non-LAEs, but these line ratios are not sufficient to distinguish the two populations at z>6.3.




Large variation in log U but comparable Te

# Talk outline

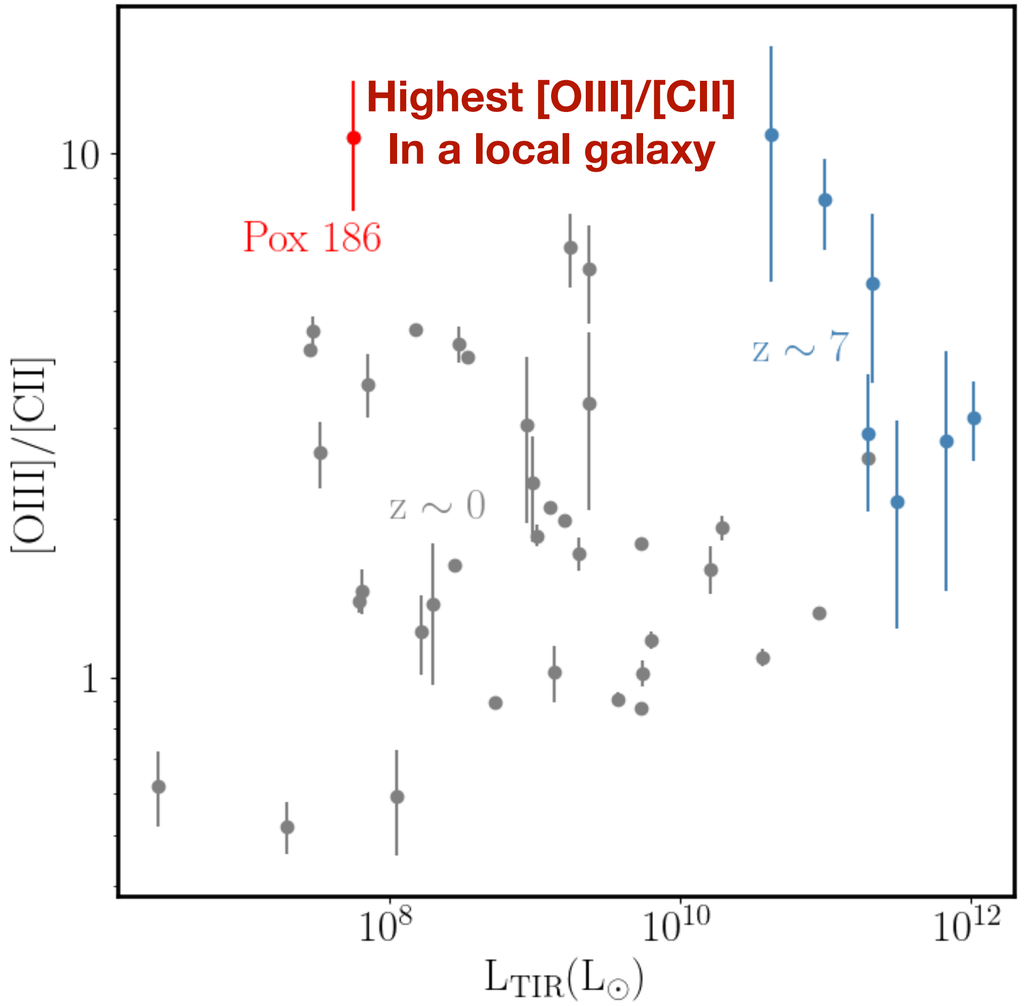



2. Potential best local EoR analog

Kumari et al. 2024, MNRAS, 529, 781

# Pox 186: Potential best local analogue of reionization-era galaxies




*Hashimoto+2019,*
*Witstok+2022*
*Ren+2023*

*Cormier+2015,*
*Madden+2013*

**ISM porosity**

# Pox 186: characterizing this potentially best analogue

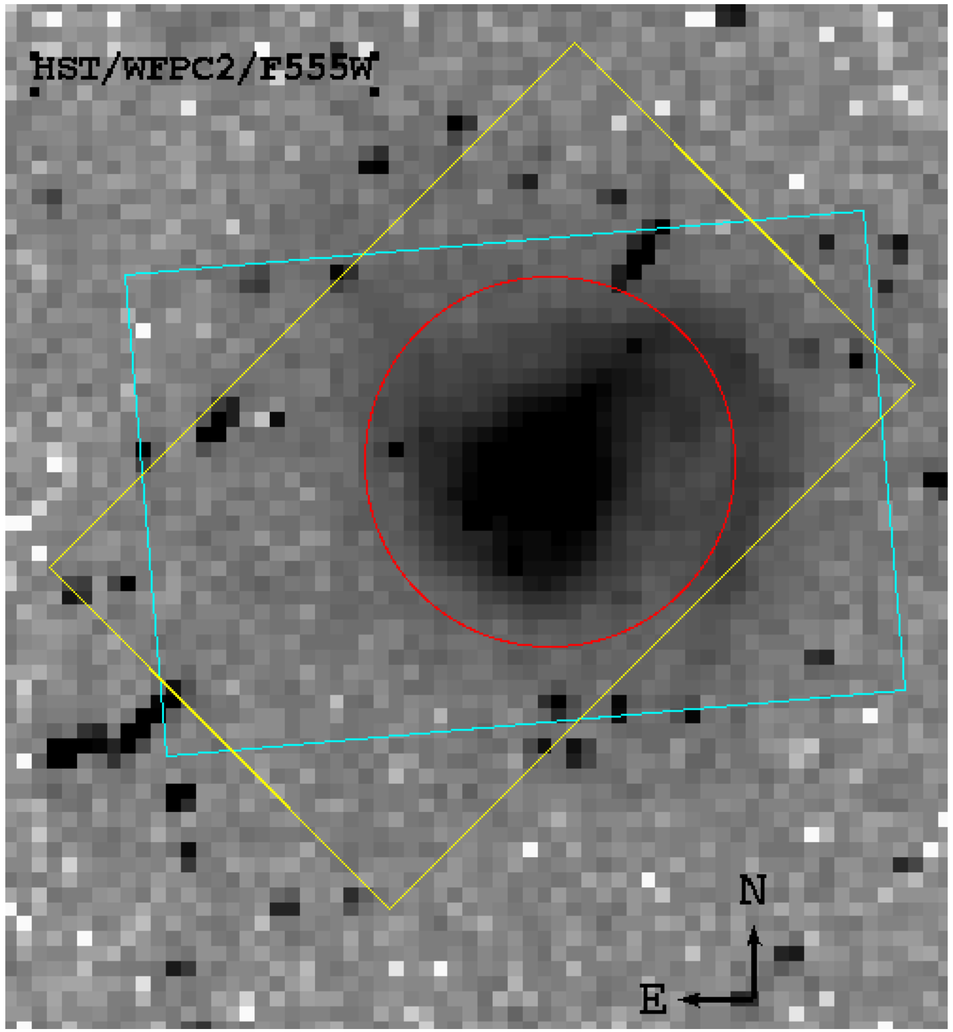
## UV, optical & IR

UV: HST/COS,  mid-cycle 27, 28
PI: Kumari

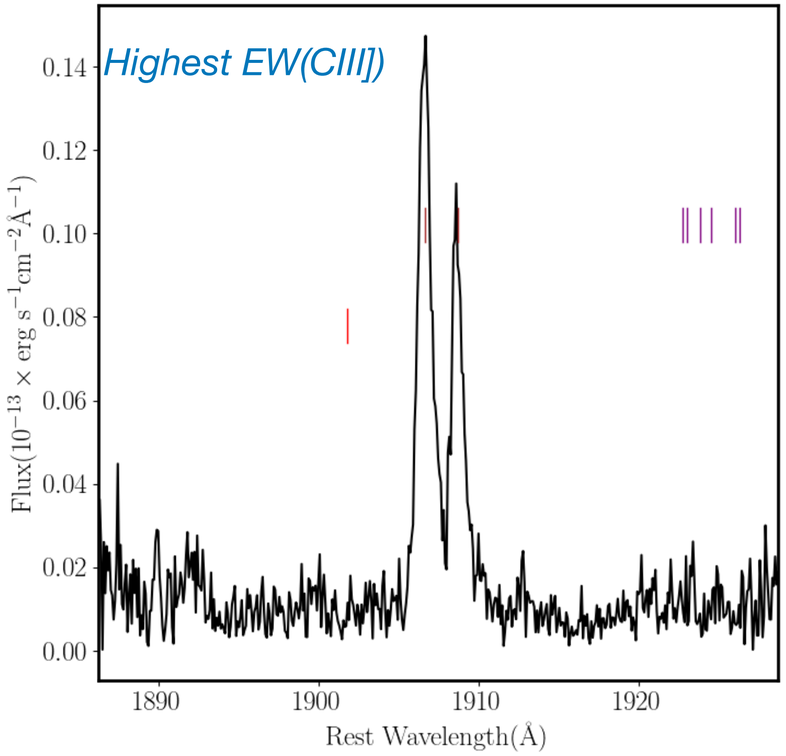
Optical: GMOS-IFU,
fast-turnaround proposals
GN-2020A, GN-2021A
PI: Kumari

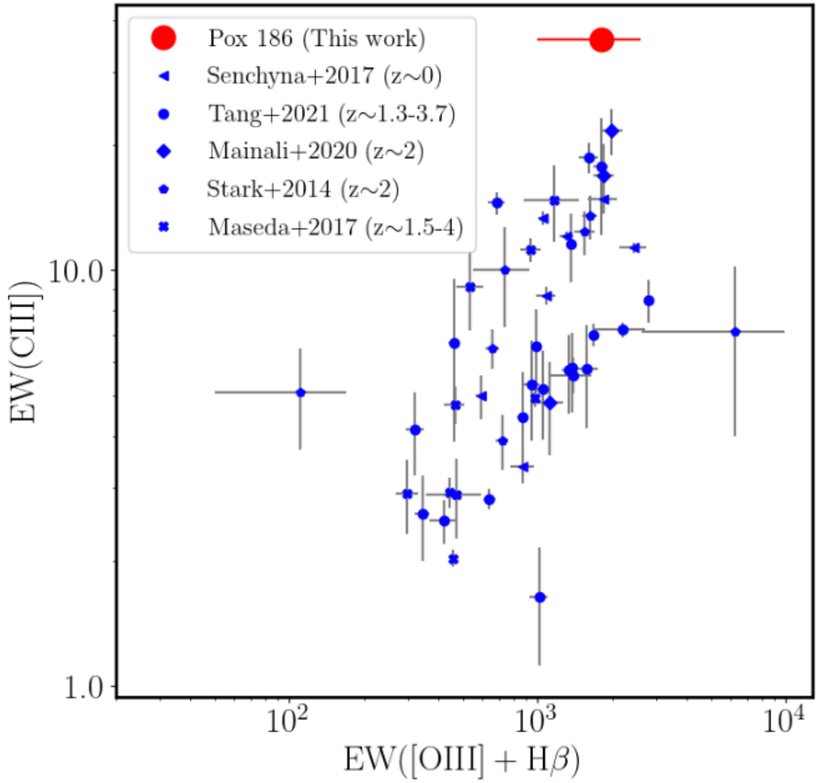
MIR: JWST/MIRI Cycle 3
PI: Kumari
+ Spitzer Archival

FIR: Herschel Archival data



# Pox 186: Highest EW(CIII])

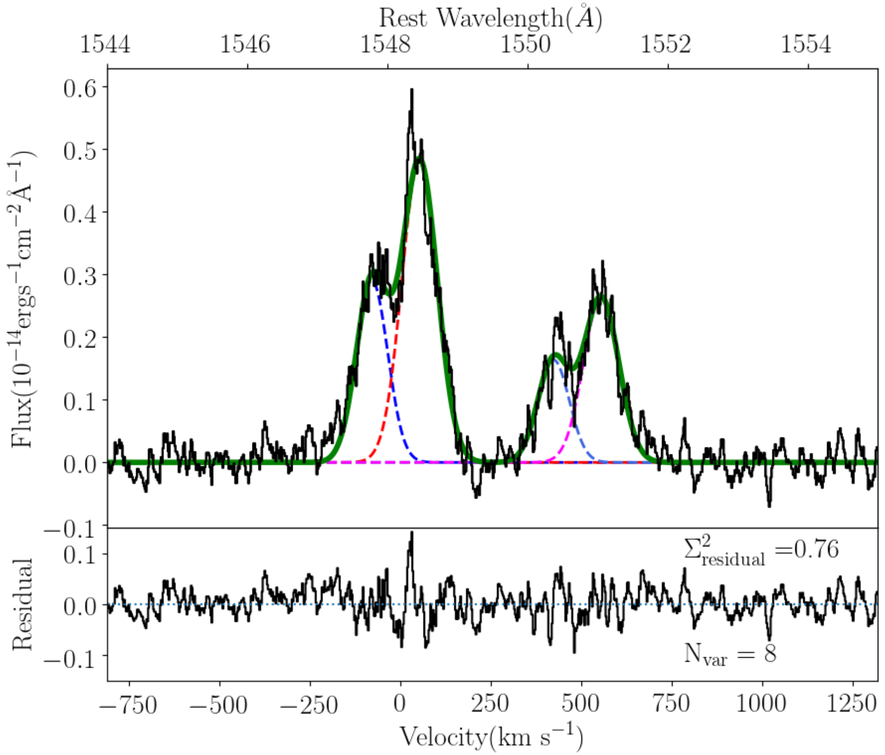


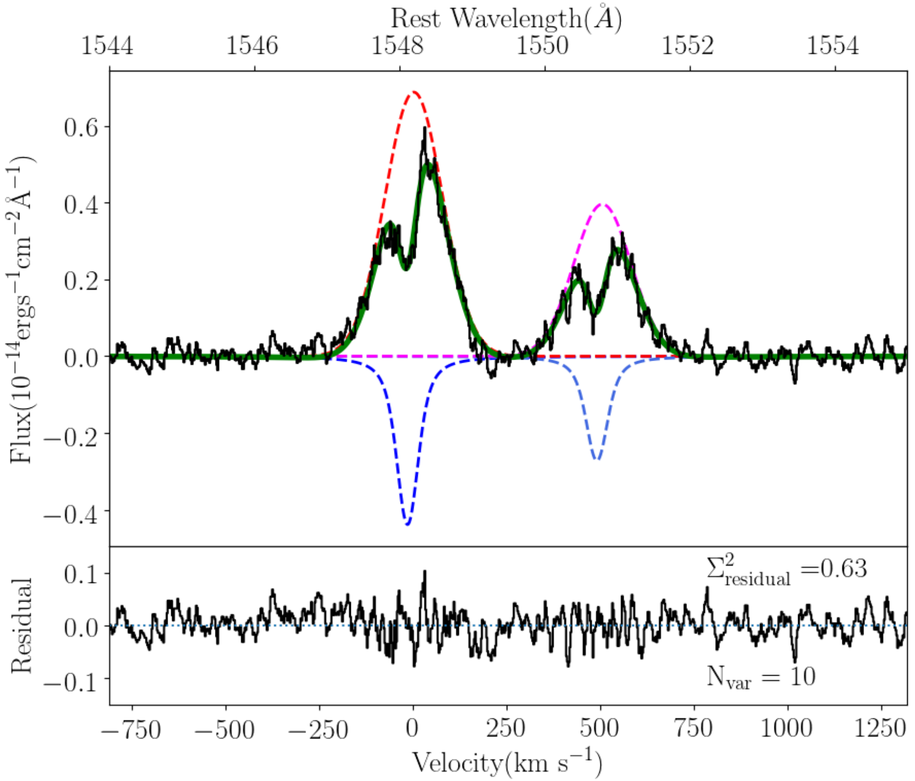

**Several scenarios explored:**

High C/O ratio, High effective temperature, Hard ionizing radiation, Top-heavy IMF, binary stars, In-homogeneous dust distribution.

# Pox 186: Double-peaked CIV doublets




Resonant scattering




Weak interstellar absorption

**First time when both CIV lines (1548, 1550) are resolved to show double peaks.**

# Pox 186: Lyman Continuum Leaker

**LyC leaker**

**High [OIII]/[CII]**
(e.g., Chevance+2017, Katz+2023)

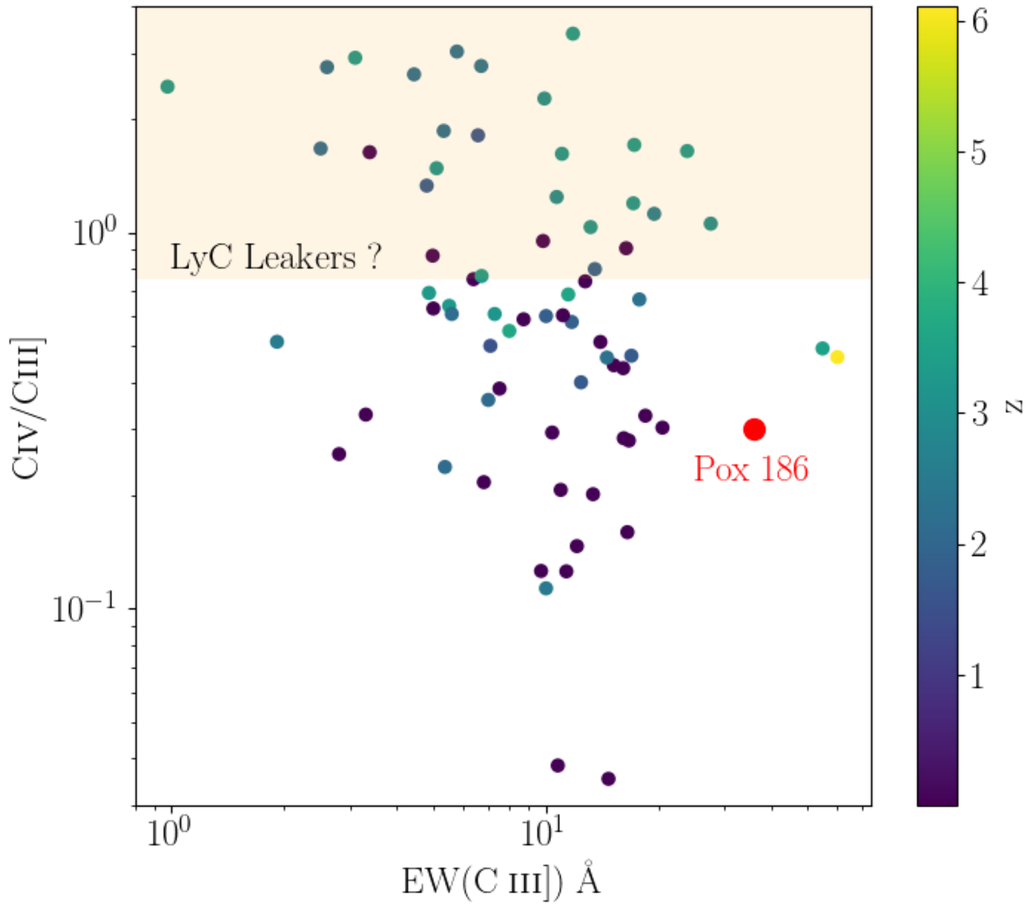
**High [OIII]/[OII]**
(e.g., Izotov+2018)

**40% escape fraction**
(Ramambason+2022)

**Not a LyC leaker?**

**CIV/CIII]**
(Schaerer+2022)

**β slope**
(Chisholm+2022)




Literature data from Schmidt+2021

# Summary

- The ionizing radiation for LAEs in the EoR is hard, as revealed from several diagnostics including CIV detection, high [O III]/[O II](>8), and large values of ξ*ion.
  Kumari et al. arXiv:2406.11997

- Multi-wavelength local reference sample of EoR galaxies on the basis of optical/UV + [OIII]/[CII] (IR) measurements for JWST+ALMA studies
  Kumari et al. 2024, MNRAS, 529, 781

- Stay tuned for more results:
  - HST/COS Cycle 32
  - JWST/MIRI Cycle 3
  (PI: Kumari)

*Thanks!*