The First Galaxies and Reionization

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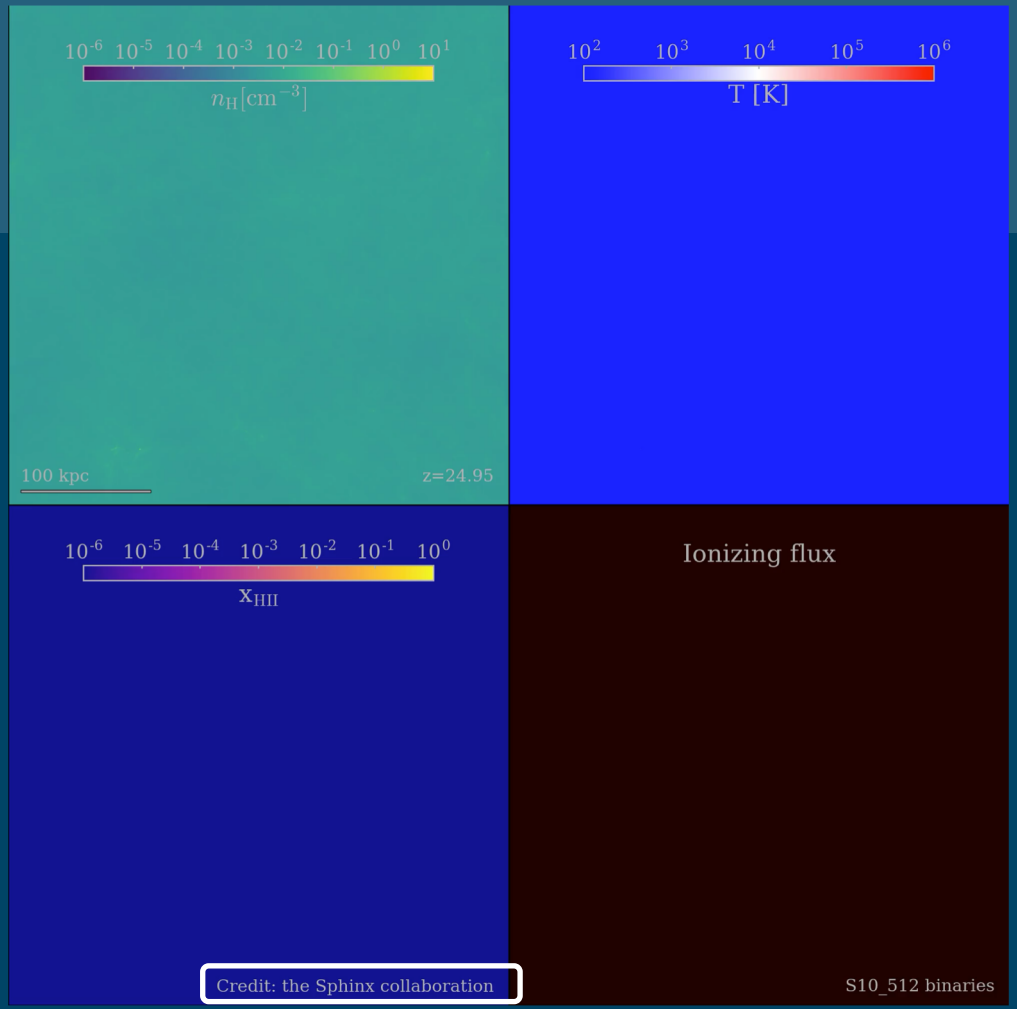
Reionization

Gas Density

Gas Temperature

Ionized Fraction

Ionizing Flux

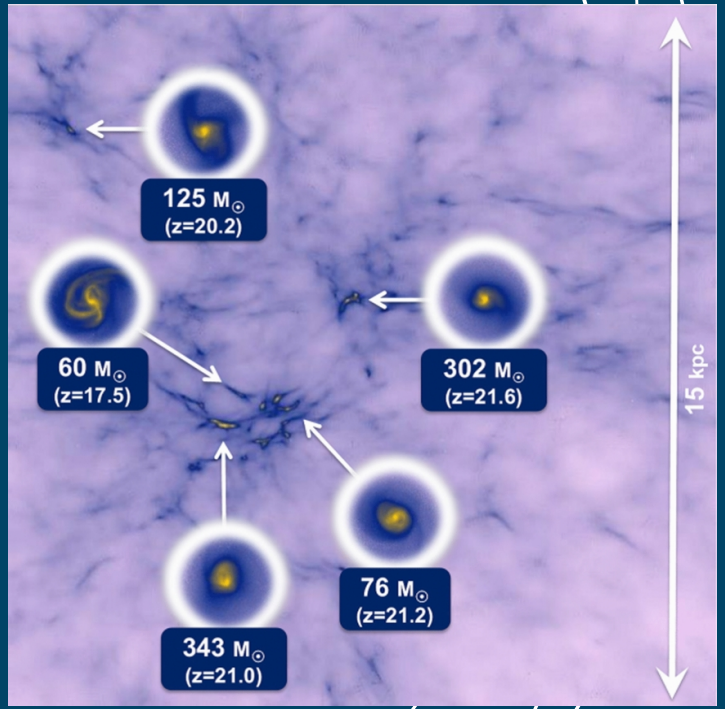


https://sphinx.univ-lyon1.fr/animations/

Rosdahl+18

The First Stars

- First stars are metal-free (Pop III)
- Massive, but too faint to see even with JWST unless highly magnified
- Can we detect Pop III stars at any redshift?
- Direct Collapse Black Holes could be easier to detect (longer lifetime + brighter)

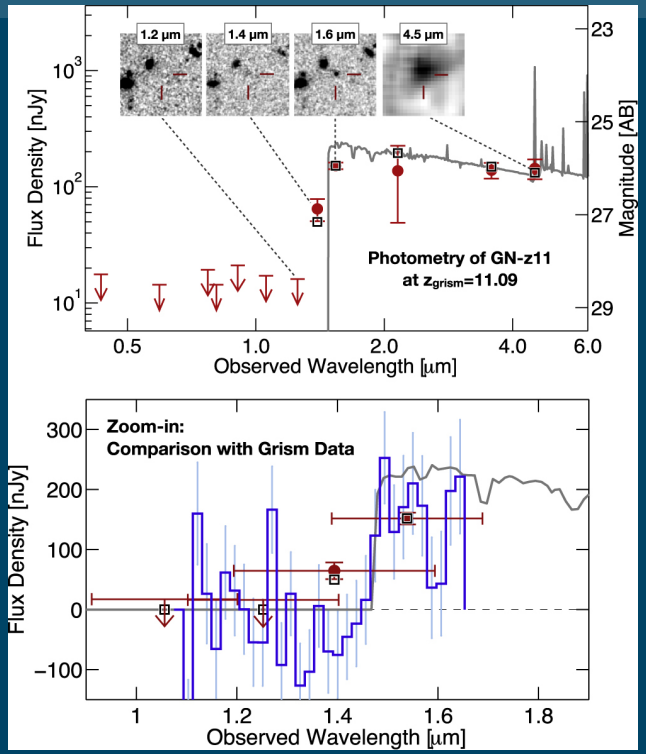


Hirano+14

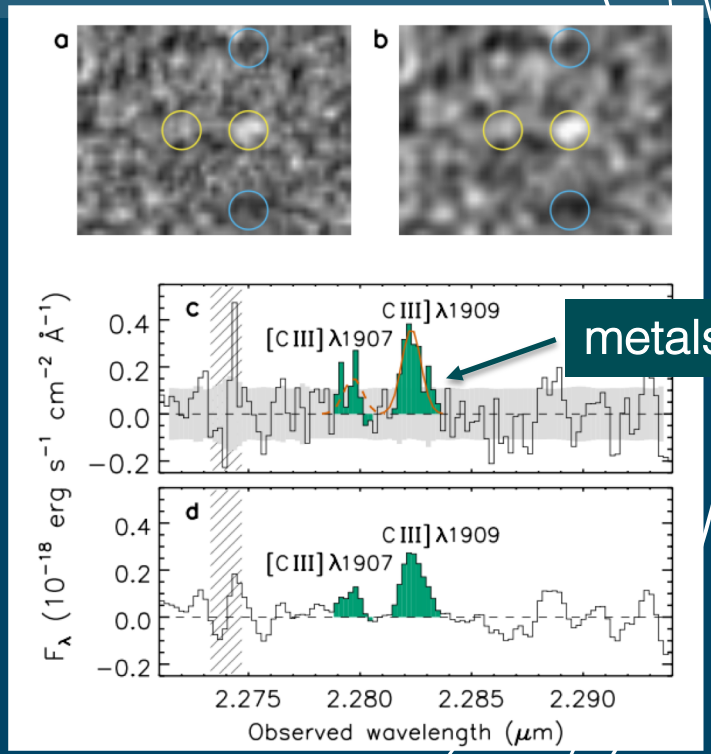
The First Galaxies

Most distant galaxy known at z=11

Surprisingly luminous considering known luminosity function.



Oesch+16



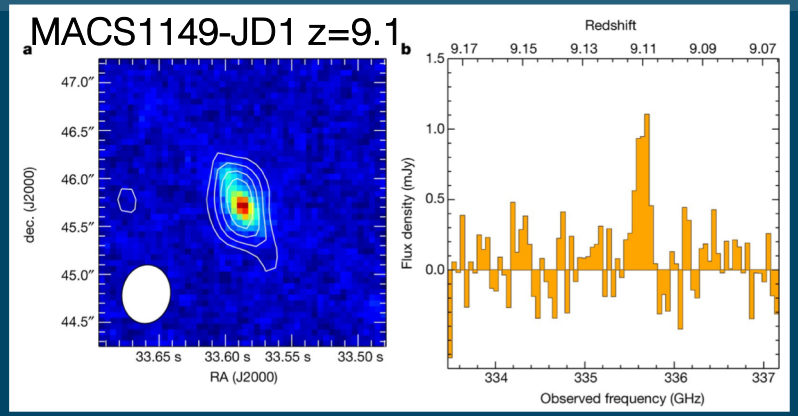
Jiang+20

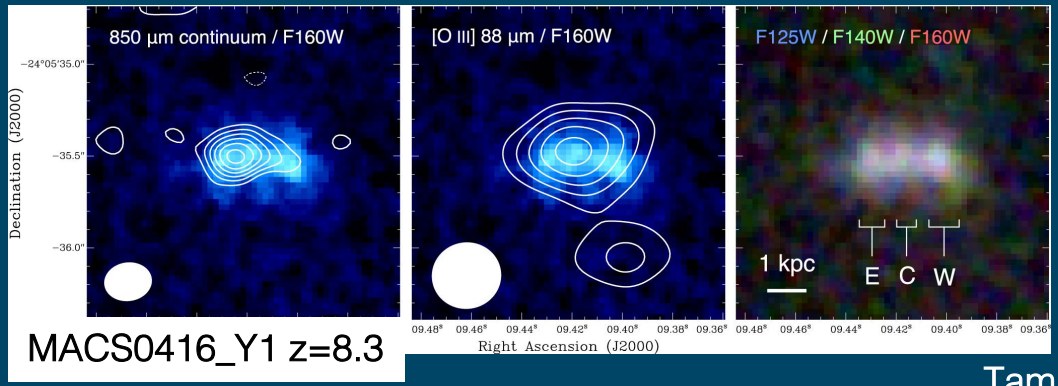
The First Galaxies

ISM lines detected with ALMA for many HST-selected 6<z<9 galaxies

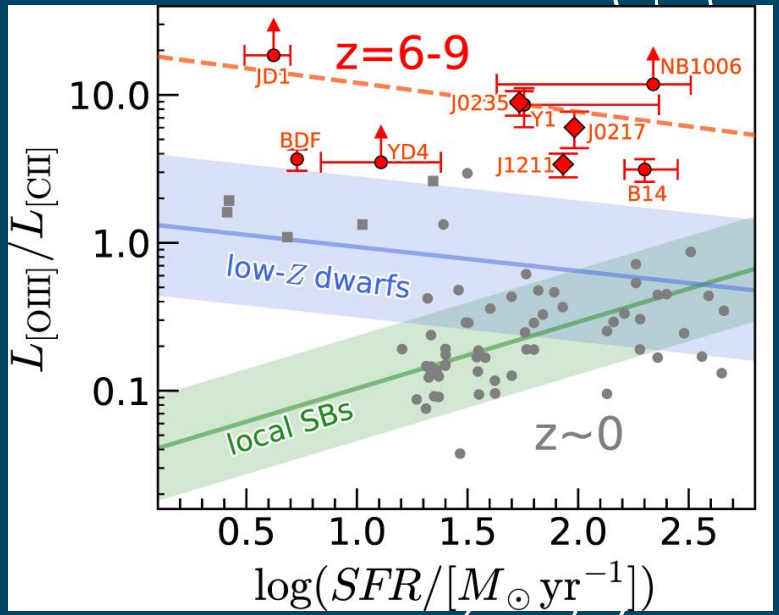
SED fit reveals stars formed at z~15

Hashimoto+18





Harikane+20

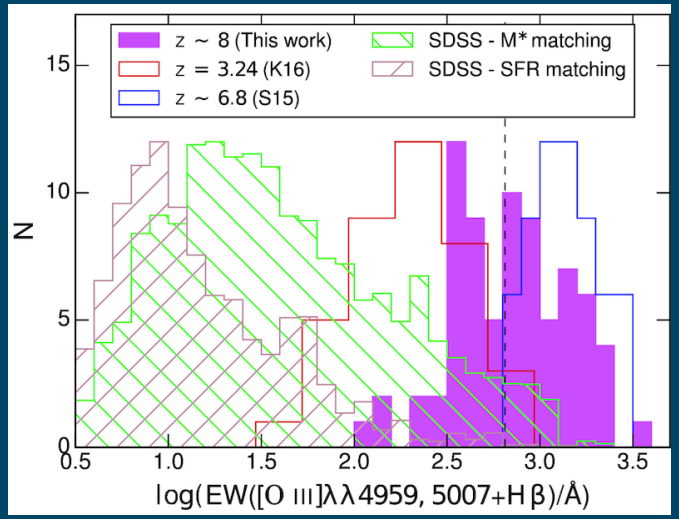


Tamura+19

The First Galaxies

Strong, highly-ionized emission lines

Line EW and O_{32} ratio increases with redshift

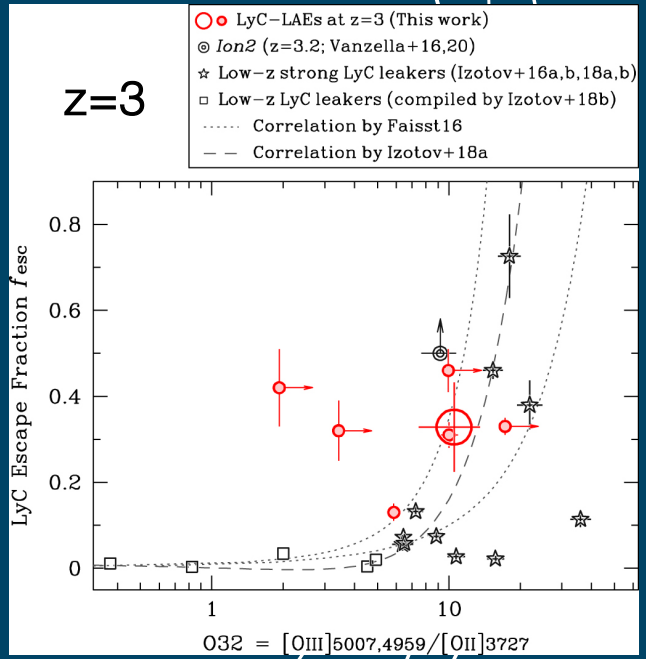


De Barros+19

At z≲3 Lyman continuum escape correlates with

- Compact size
- O_{32}
- Lyman-α EW
- Lyman-α blue leak

⇒ high-z galaxies efficient for reionization?

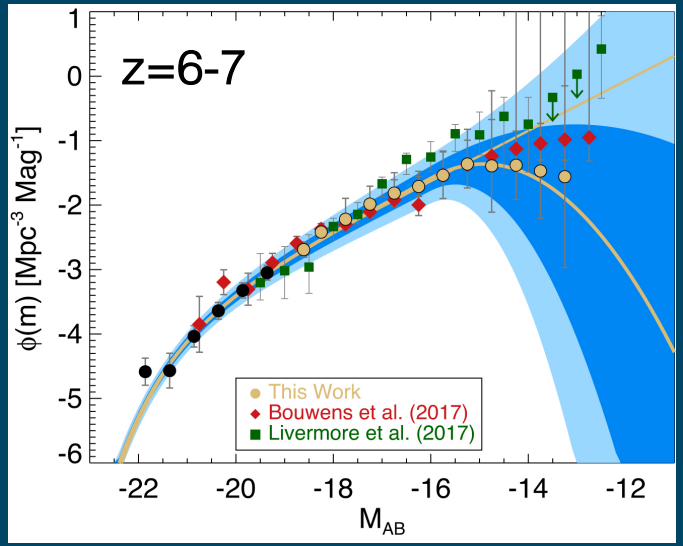


Nakajima+20

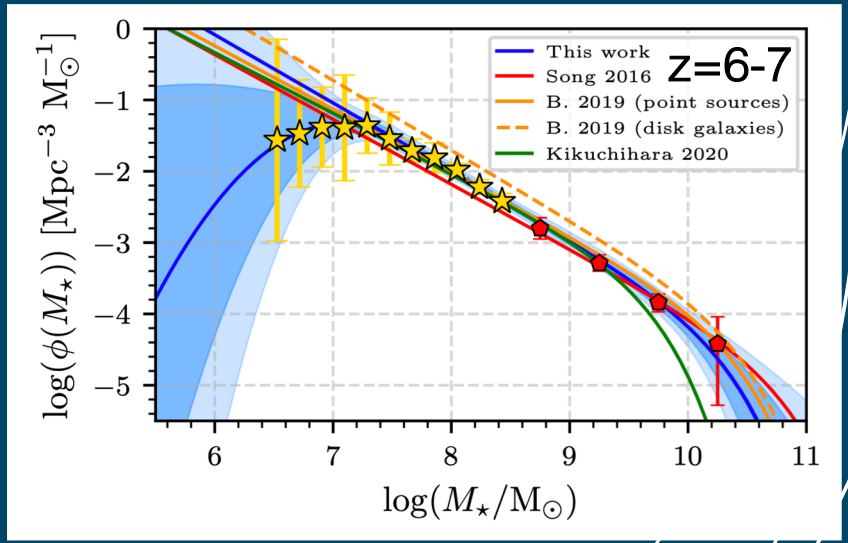
The First Galaxies

Tracing feedback in low mass halos

With lensing, reach stellar masses approaching $10^6\,M_\odot$ at high redshift.
Flattening or turnover of luminosity/mass function depends on feedback.



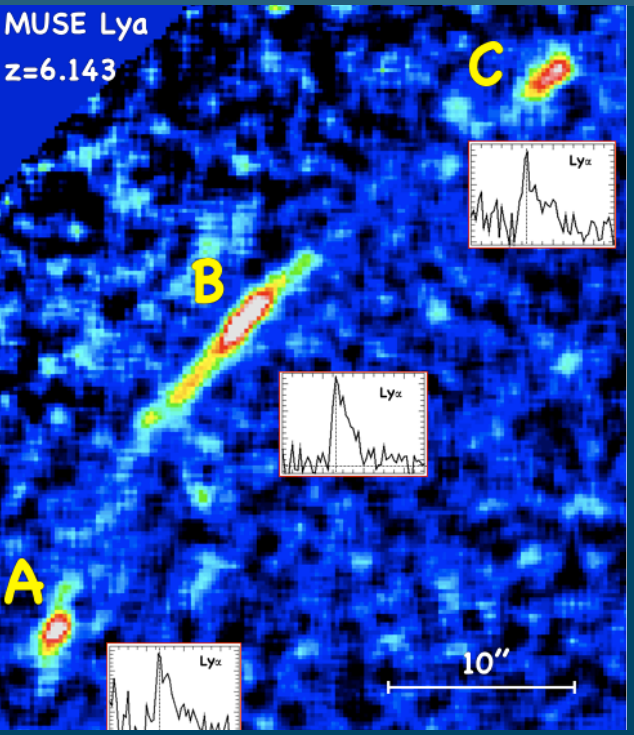
Atek+18



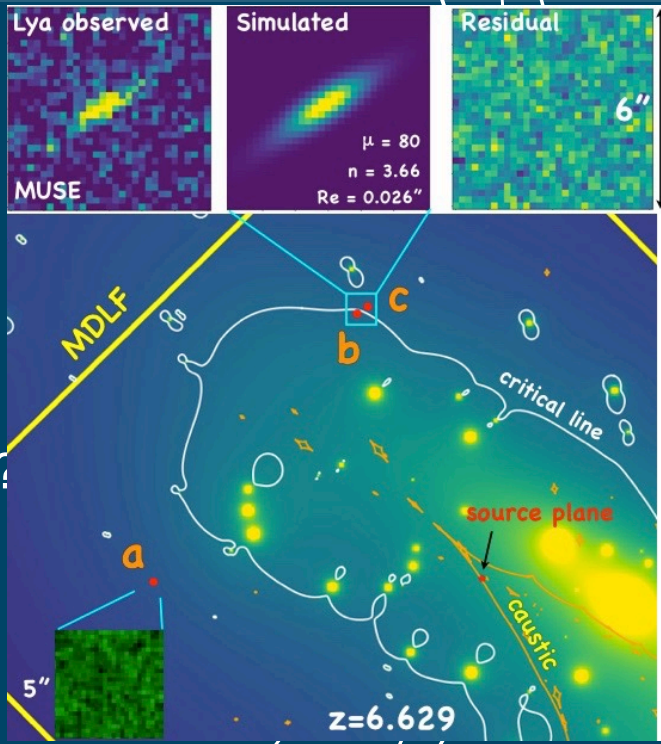
Furtak+20

The First Galaxies

Lensed low mass primordial(?) galaxies



- High magnification
- Compact SF regions
- High Lyman-α EW
- Forming globular clusters?
- Pop III ?



Vanzella+19

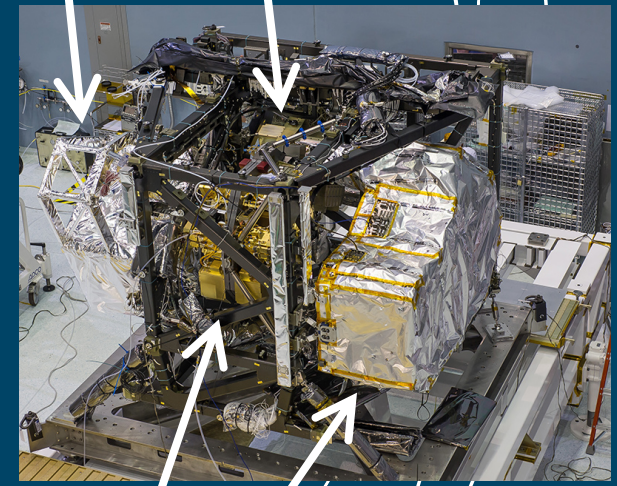
Vanzella+20

The James Webb Space Telescope

The James Webb Space Telescope

JWST advantages:

- + sensitivity
- + wavelength range (0.6-28 microns)
- + spatial resolution
- + instrumentation
  - imaging
  - slitless spectra
  - IFU spectra
  - MOS spectra



CAnadian NIRISS Unbiased Cluster Survey

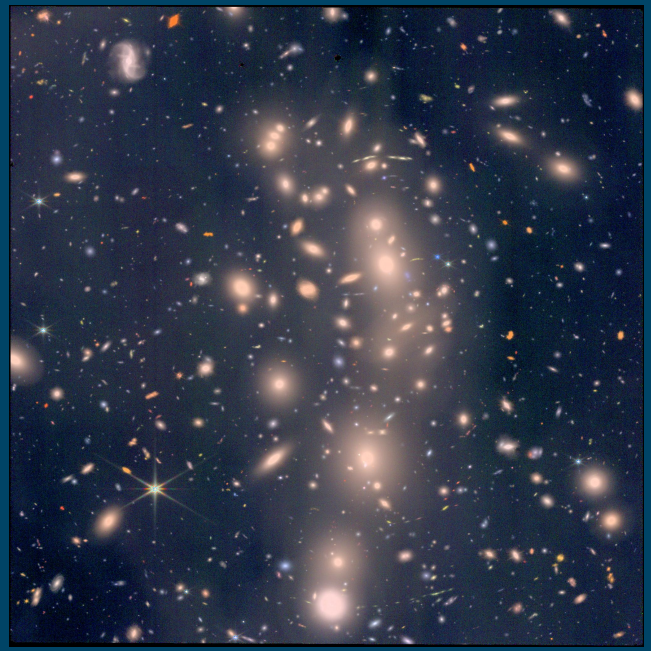
(NIRISS Instrument Team; PI C. Willott)

Targeting 5 strong lensing clusters and 10 parallel fields.

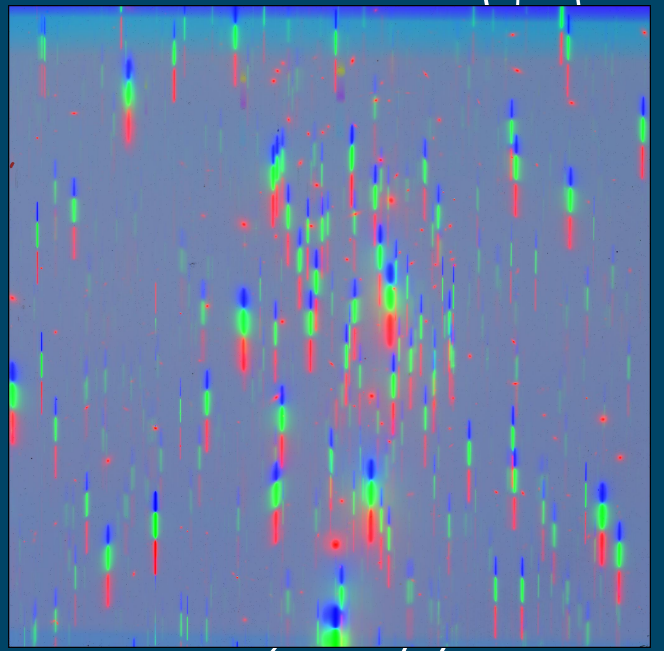
NIRISS, NIRCam & NIRSpec follow-up.

Measure evolution of key physical parameters for low-mass galaxies across epochs.

Image



Slitless Spectra



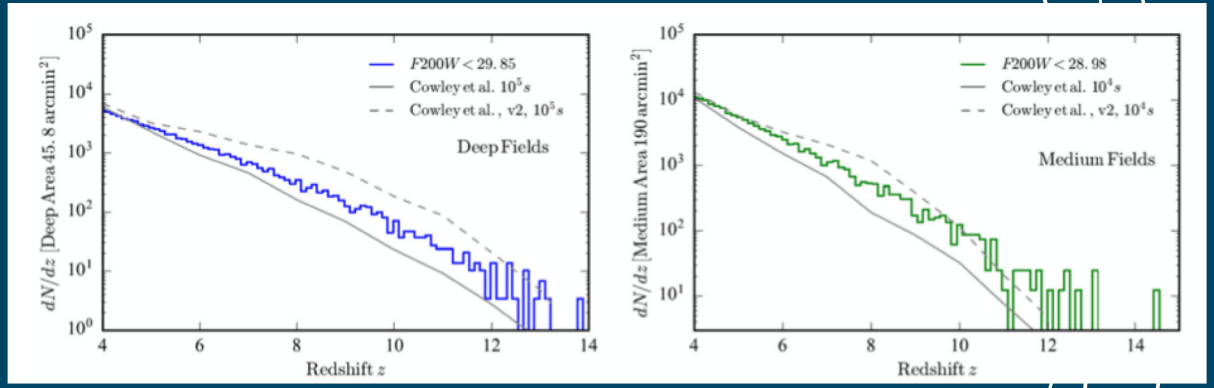
JWST Advanced Deep Extragalactic Survey

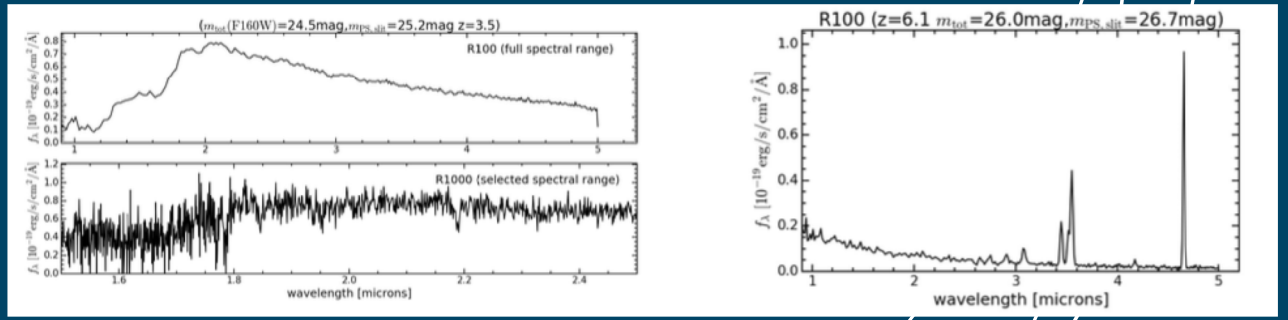
(NIRCam+NIRSpec Instrument Teams; PIs M. Rieke & R. Ferruit)

Survey the two GOODS fields with deep imaging and spectroscopy.

Find the earliest galaxies and characterize them.

Determine how cosmic reionization occurred.





Rieke+ Astro2020 WP

Summary

Recent observations with HST, SPITZER, ALMA, and optical/NIR telescopes show galaxies during reionization are:

- young
- compact
- low mass
- blue UV spectra
- strong, high-ionization lines
- likely efficient reionizers

Formation mechanism and physical nature of these galaxies to be investigated with JWST, ALMA, EUCLID, ROMAN, ELTs, ngVLA, …

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