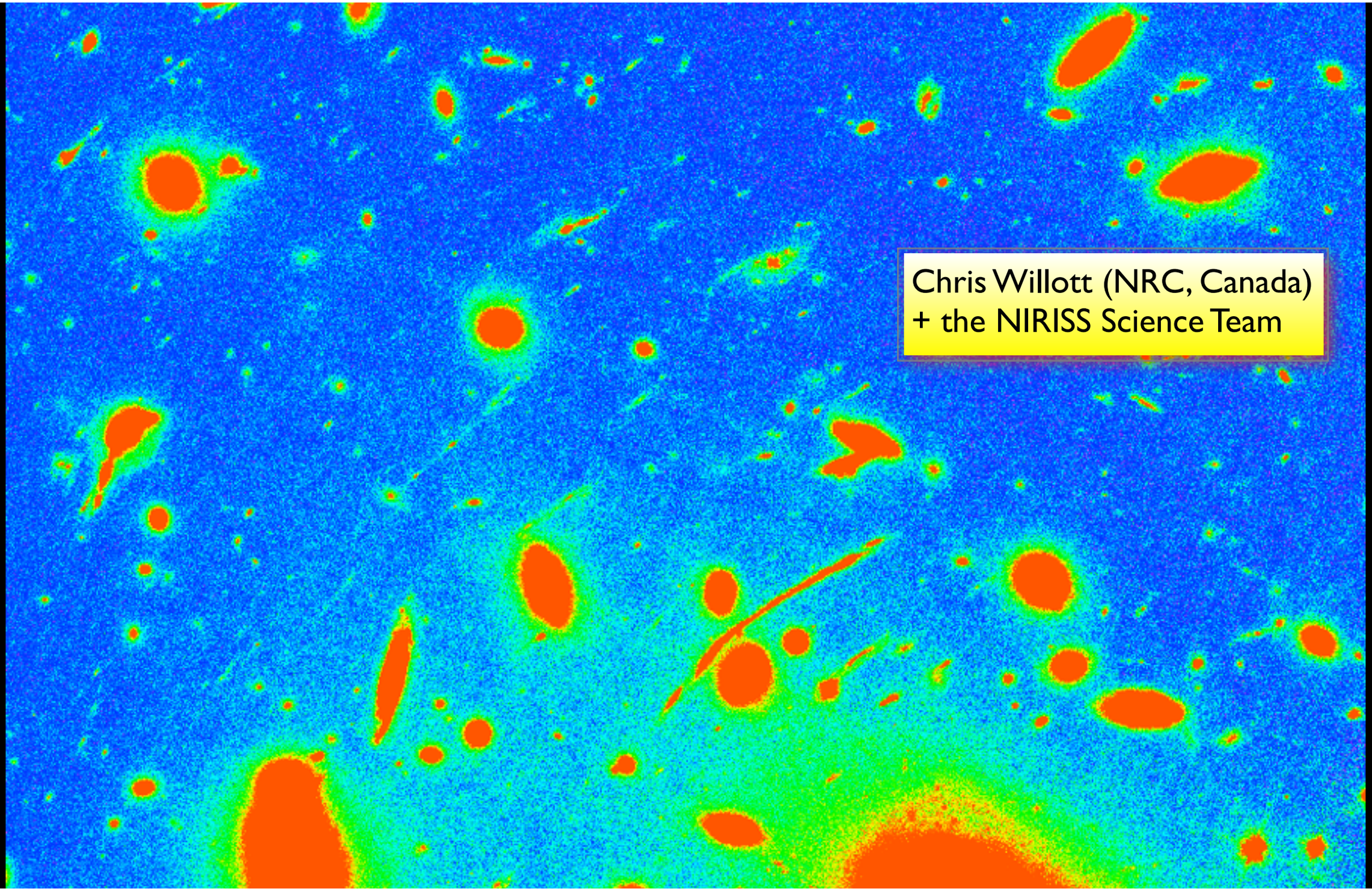
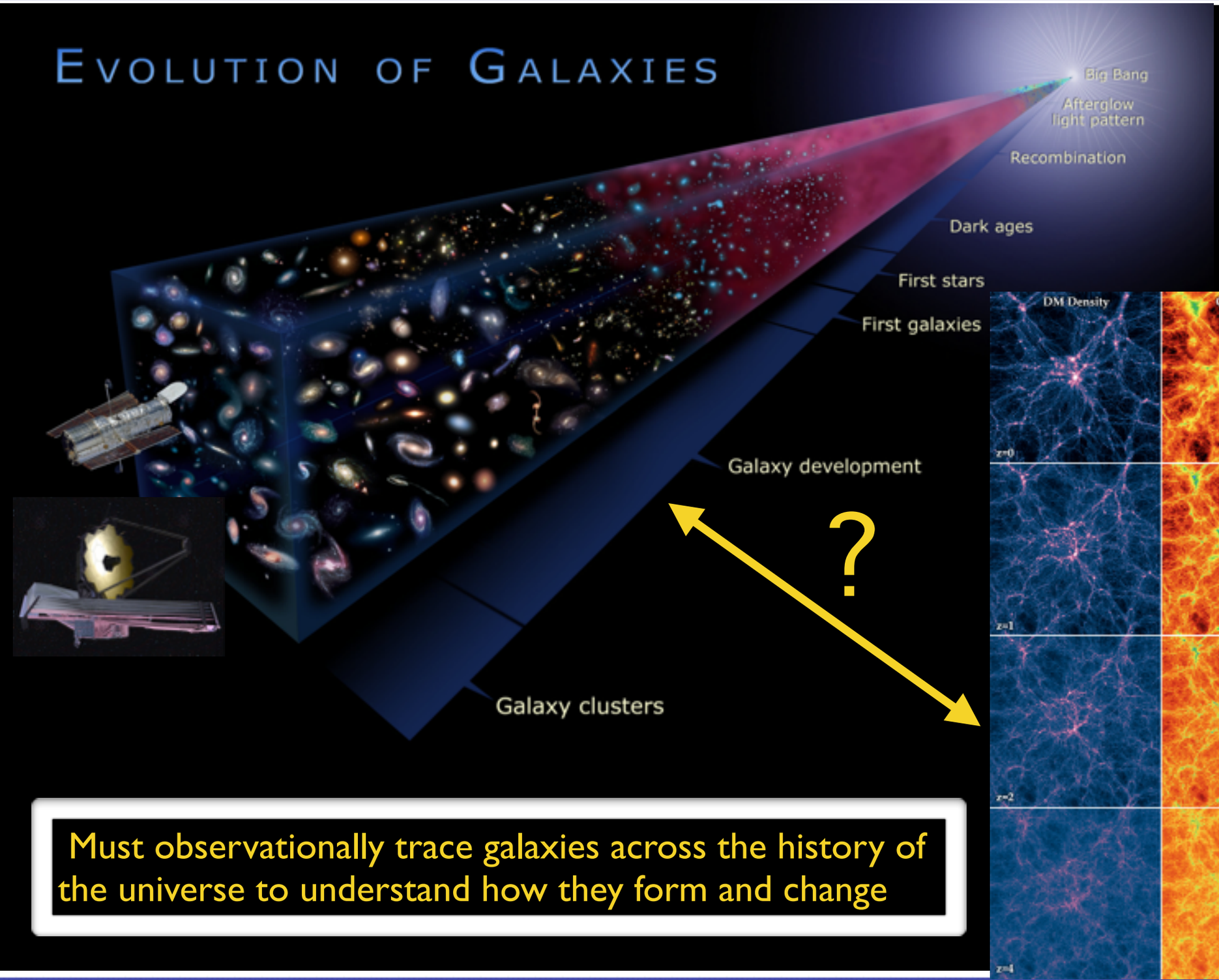
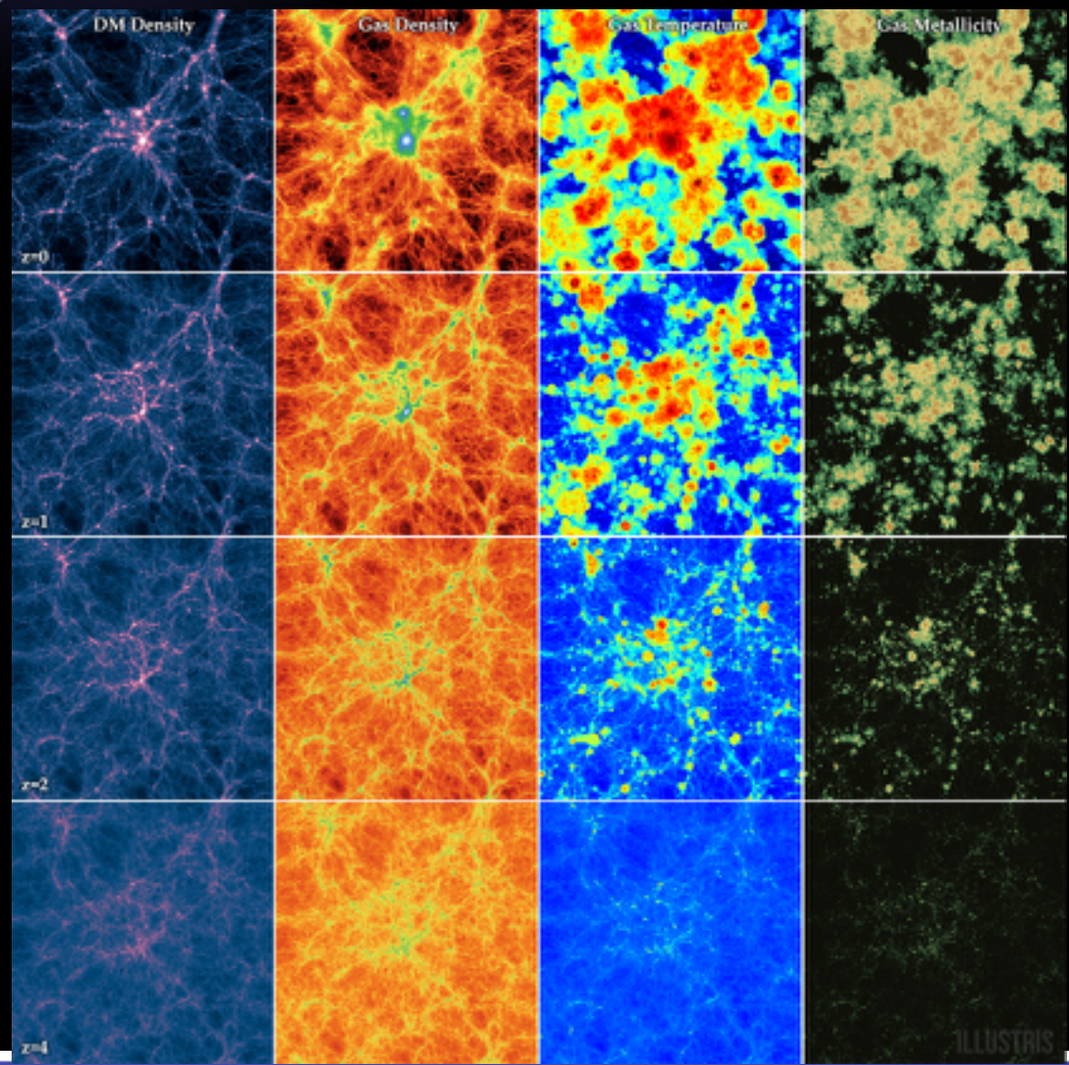
Galaxy Formation and Evolution with NIRISS



Chris Willott (NRC, Canada)
+ the NIRISS Science Team

Galaxy Formation and Evolution



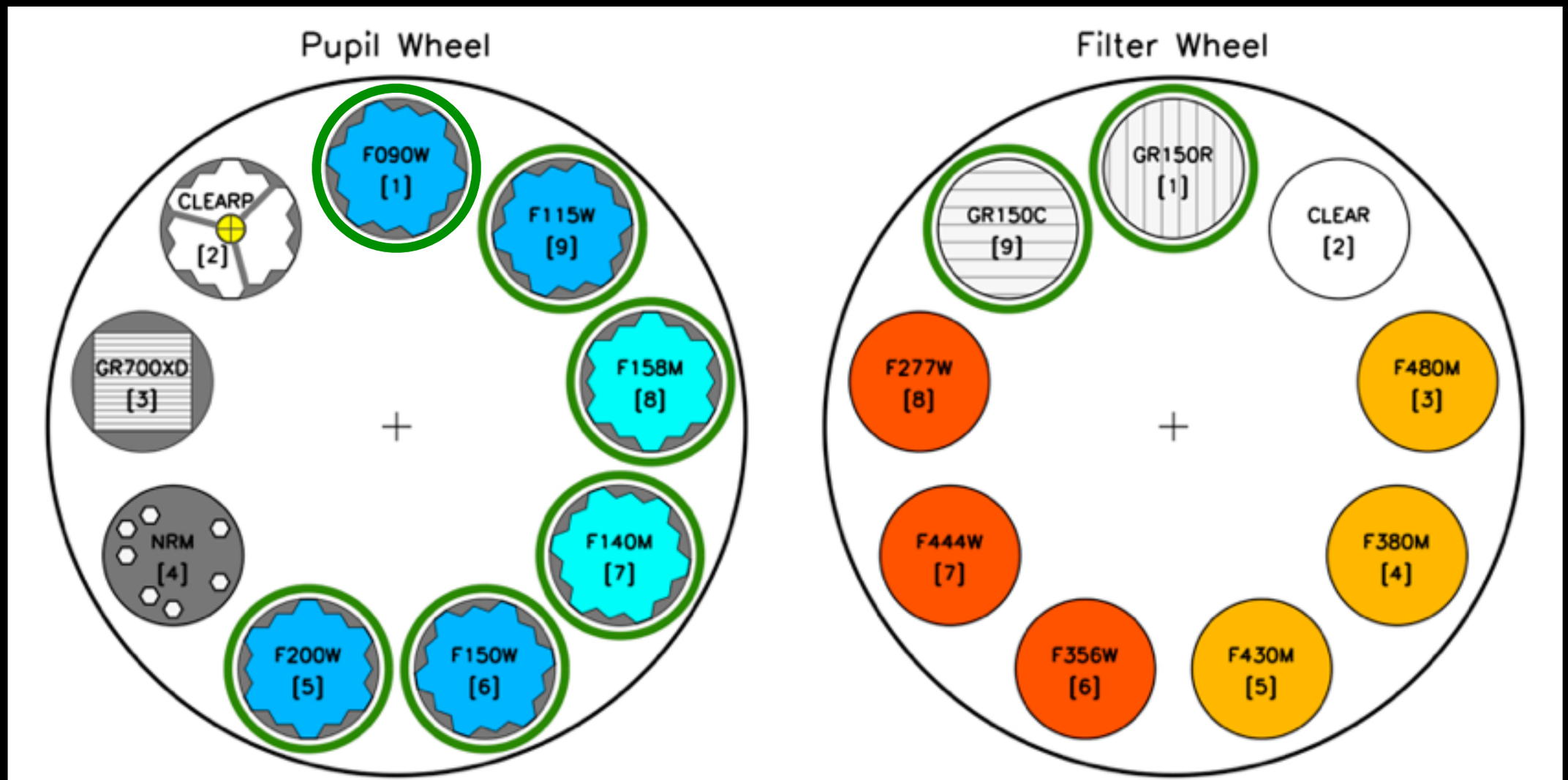


Must observationally trace galaxies across the history of the universe to understand how they form and change

NIRISS Wide-Field Slitless Spectroscopy

NIRISS can do wide-field slitless spectroscopy in FOV 2.2' x 2.2'

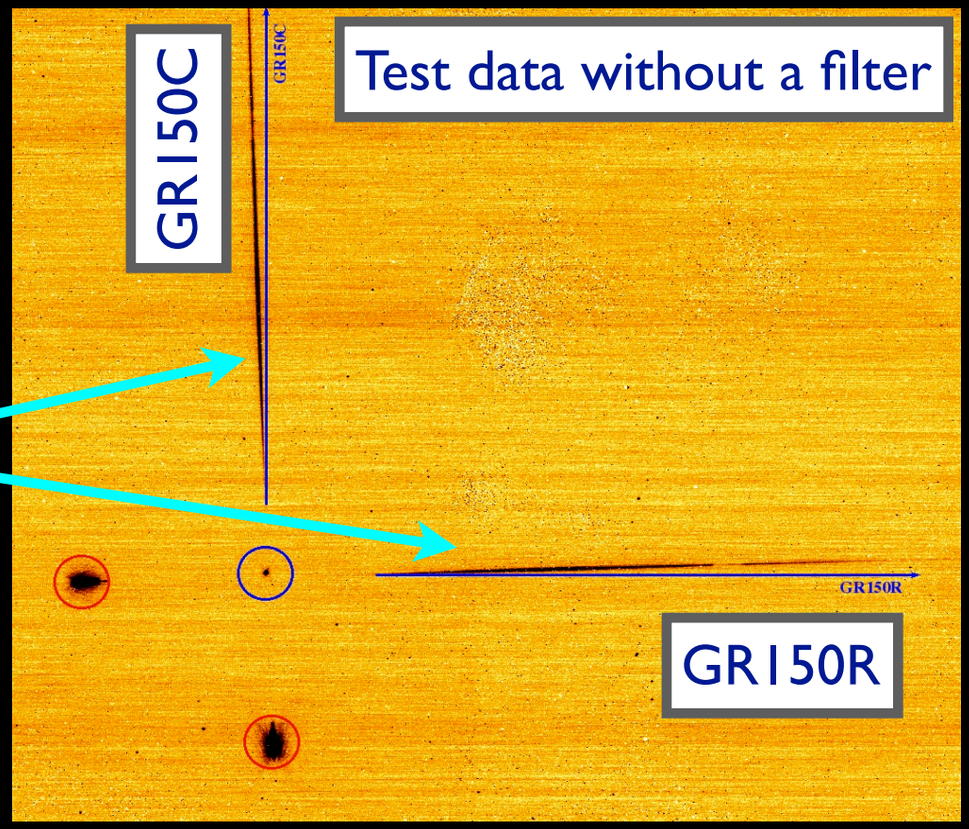
Two orthogonal R=150 grisms and six blocking filters from 0.9 to 2.2 microns



NIRISS Wide-Field Slitless Spectroscopy

- Spectra of **all** objects in the field. In a "blank" field there are **~3000** galaxies at mag < 28.
- Almost complete **wavelength coverage** from 0.9 to 2.2 microns (NIRCam: WFSS at >2.5micron).
- At least one strong **emission line** from z=0 to z=4.9. Lyman alpha if present at 6<z<17.

- Resolving power of 100 to 200.
- **Spatial resolution** of 0.06" ~ 0.5 kpc.
- **Cross-dispersed** grisms to mitigate contamination.
- **Point-and-shoot** observing - no target acquisition.

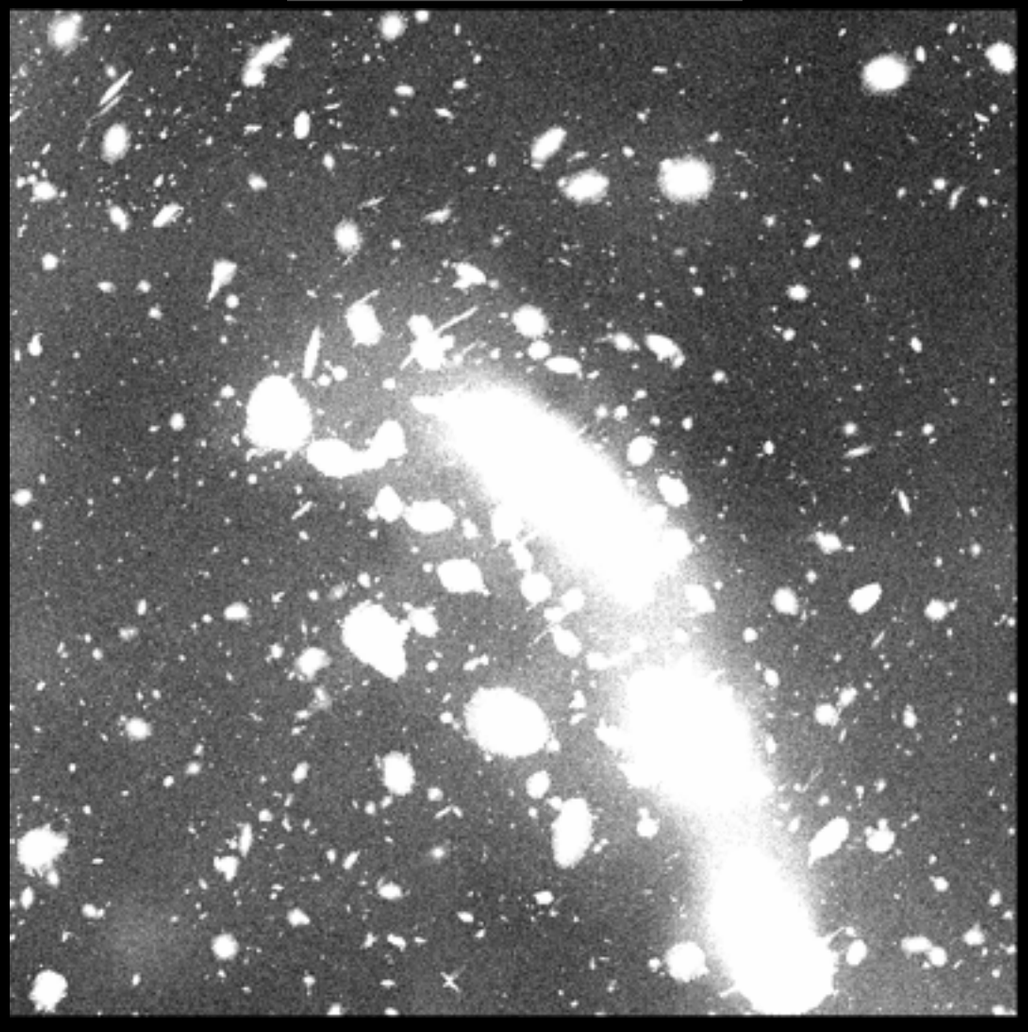


NIRISS Simulations

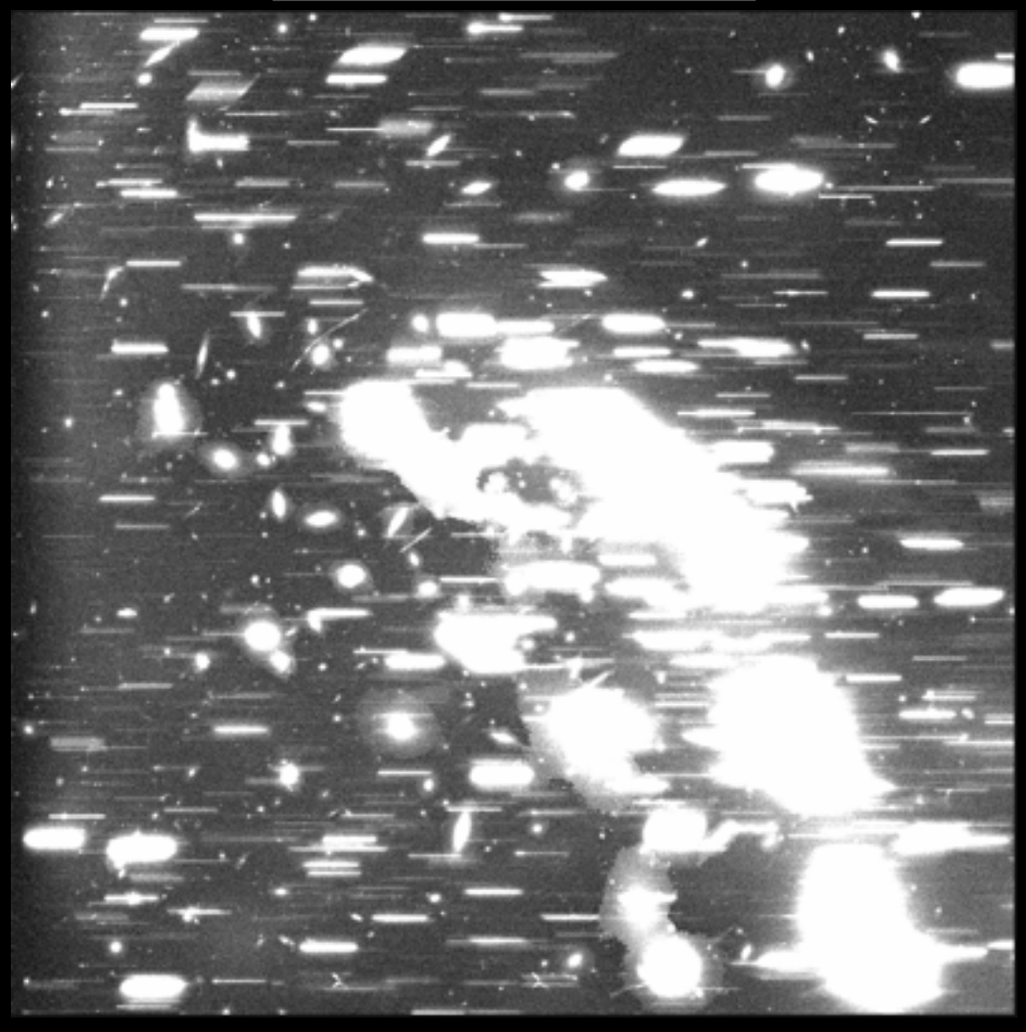
Using **threedhst** to simulate NIRISS WFSS observations of Frontier Fields lensing cluster.

Based on HST ACS and WFC3-IR imaging. Realistic galaxy spectra including emission lines.

F200W + CLEAR



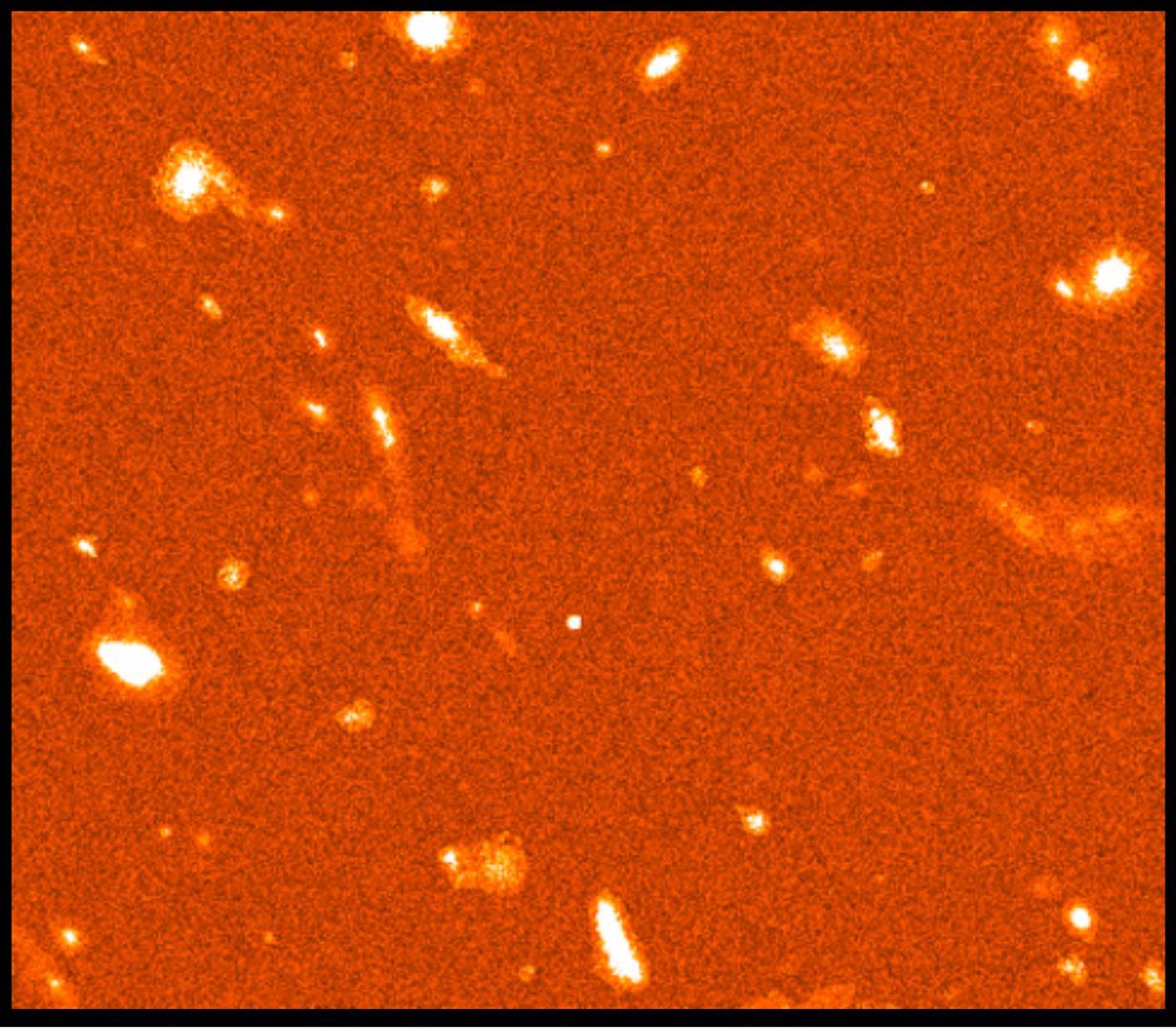
F200W + GR150R



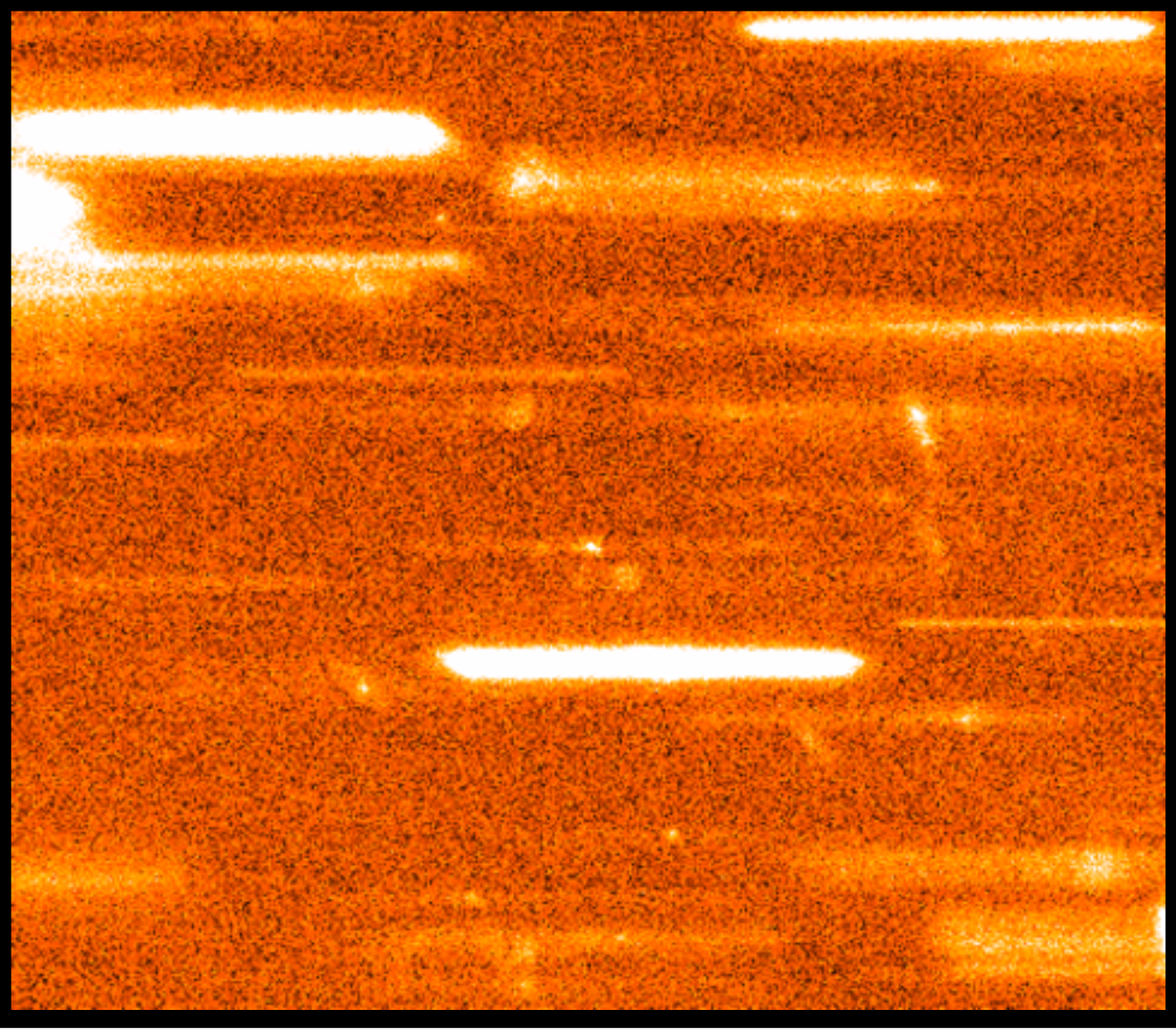
NIRISS Simulations

Zoom-in to 1% of the field shows many faint galaxies with emission lines

F150W + CLEAR



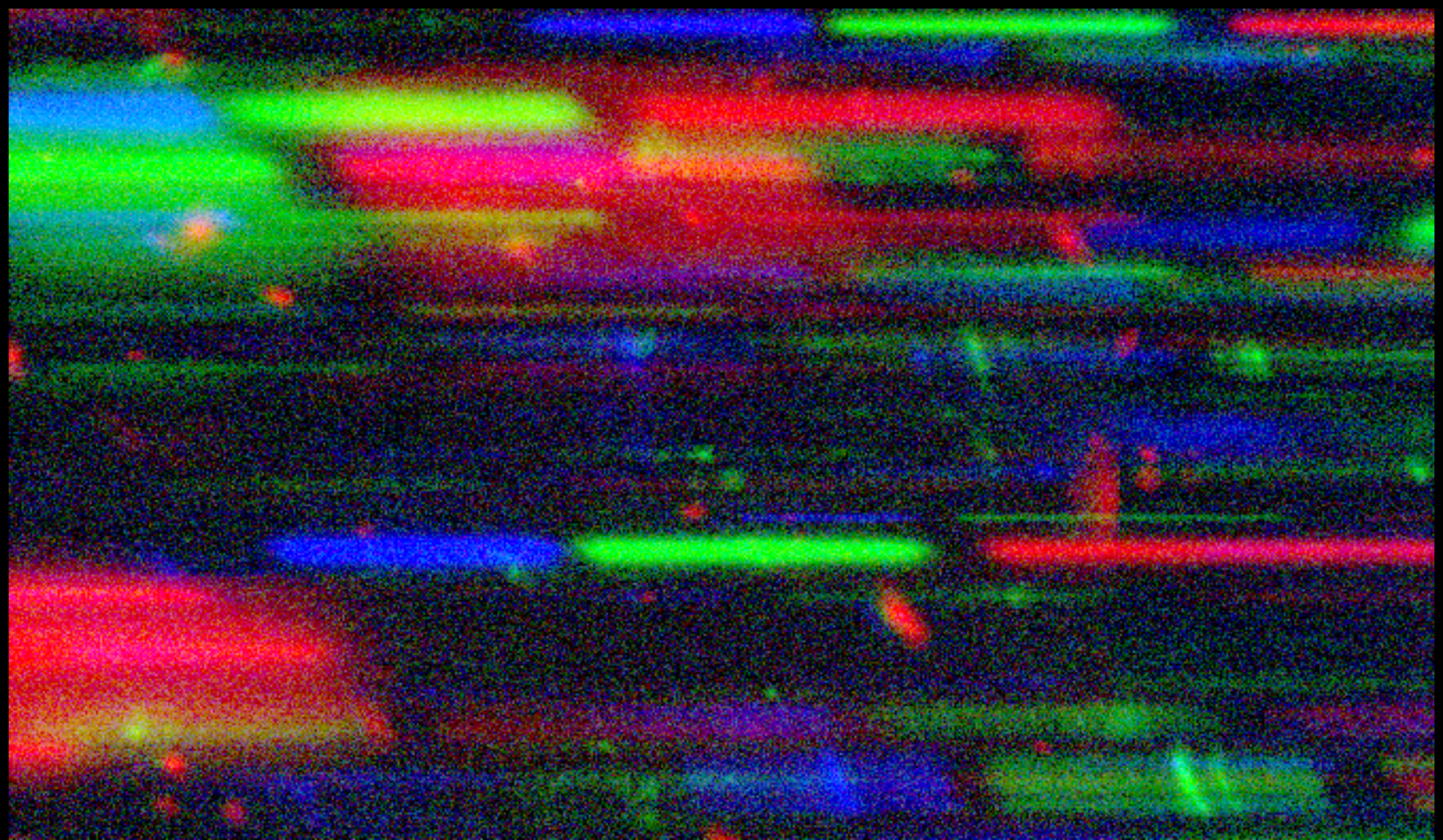
F150W + GR150C



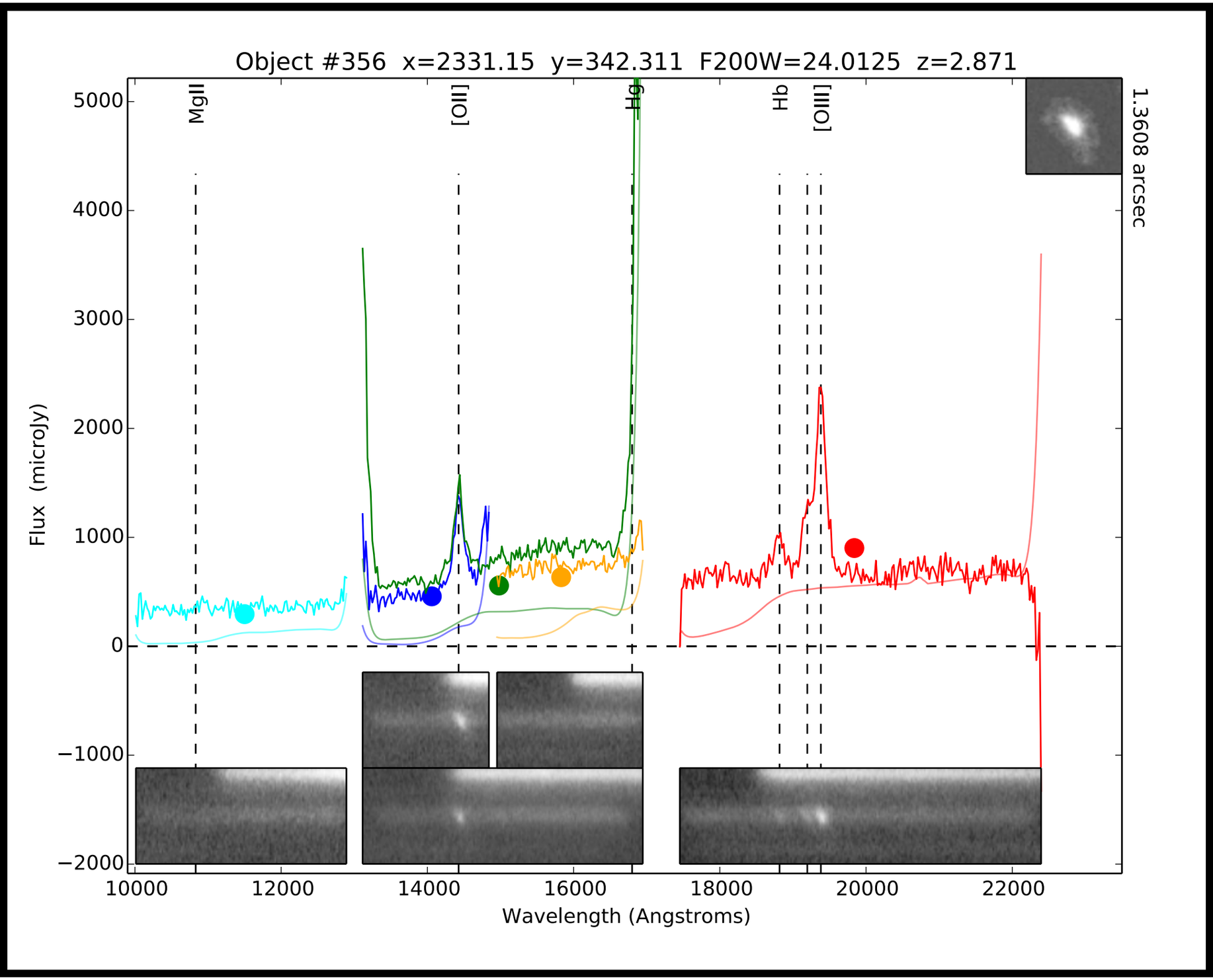
NIRISS Simulations

Zoom-in to 1% of the field shows many faint galaxies with emission lines

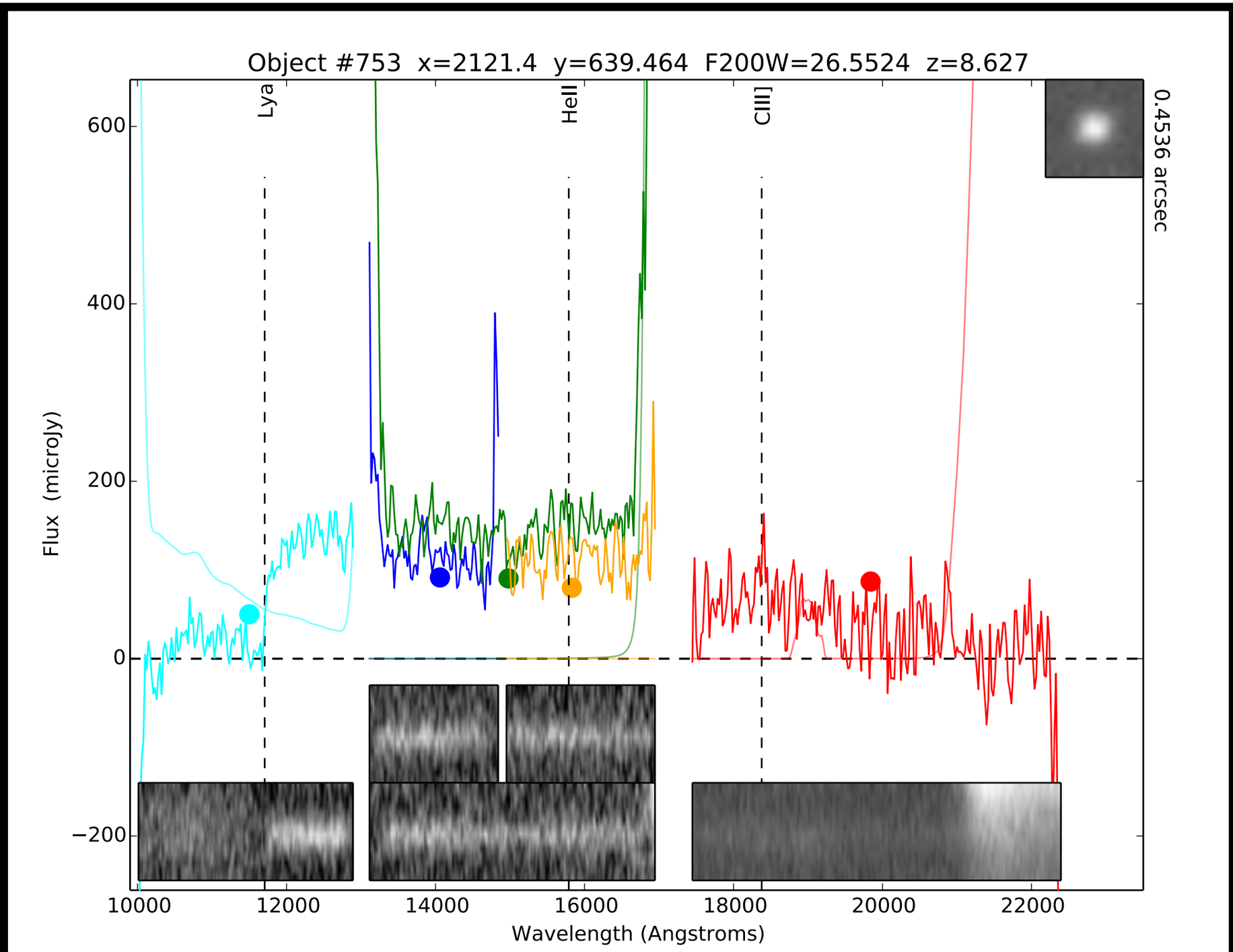
F115W, F150W, F200W + GR150C



NIRISS Simulations



NIRISS Simulations



The Hubble Experience

Surveys with WFC3-IR on HST have highlighted capabilities of space-based near-IR grisms: WISP, 3D-HST, FIGS, GLASS, …

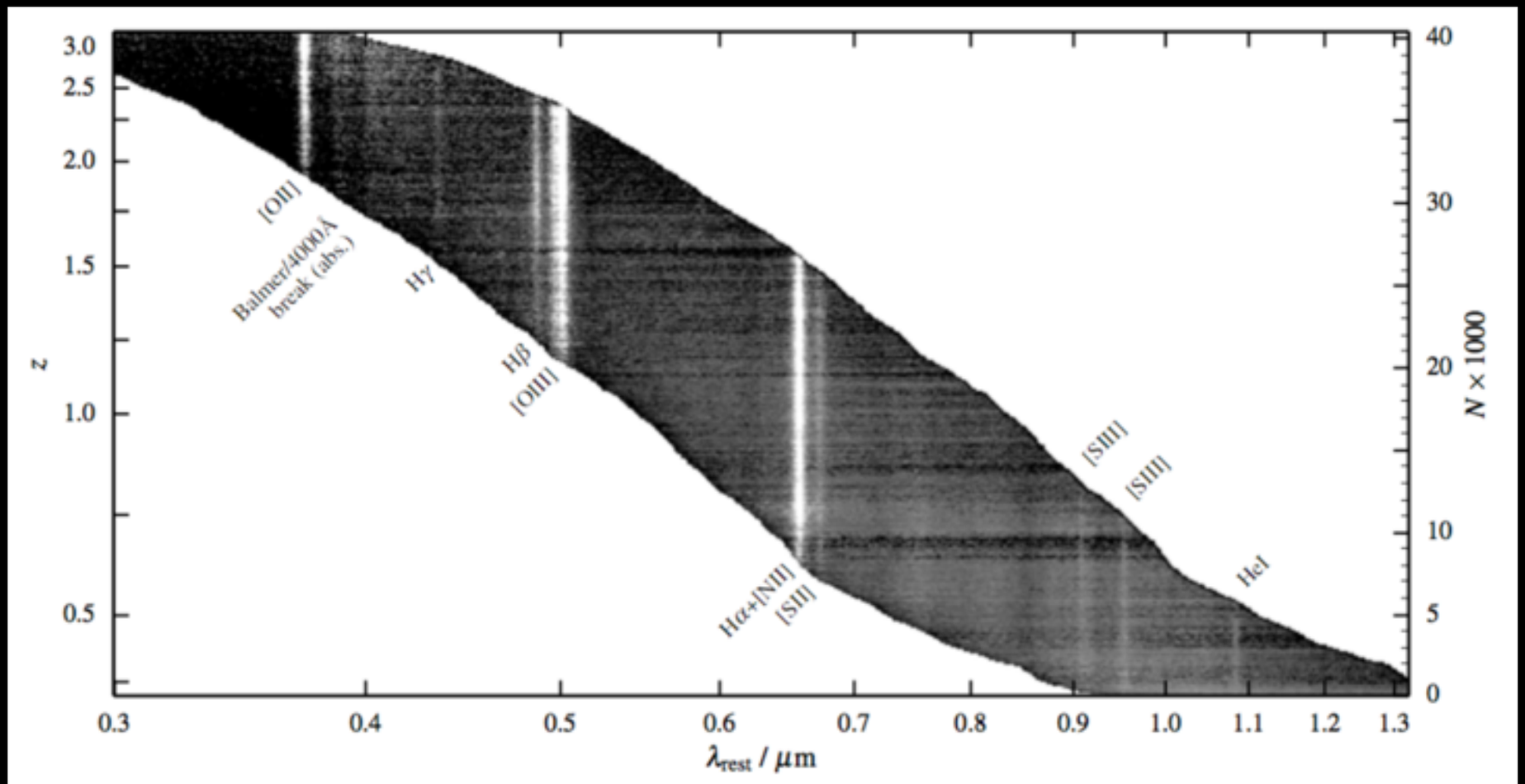


Figure 25. Overview of ∼ 40,000 3D-HST G141 grism spectra with $H_{160} < 25$. Each pixel row shown is the median of 100 individual 1D spectra sorted by redshift and shifted to the rest frame; ticks on the right axis mark every 1000 galaxies, and tick labels on the left axis indicate the corresponding redshift. Each spectrum is normalized by the object's JH_{140} flux. Absorption and emission lines that move through the G141 passband at different redshifts are indicated.

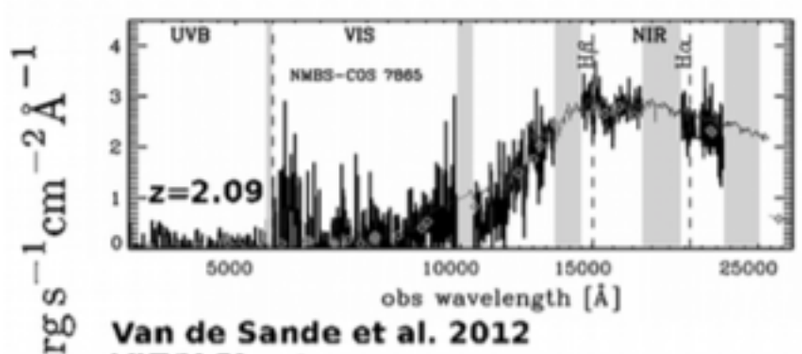
3D-HST, Momcheva+15

The Hubble Experience

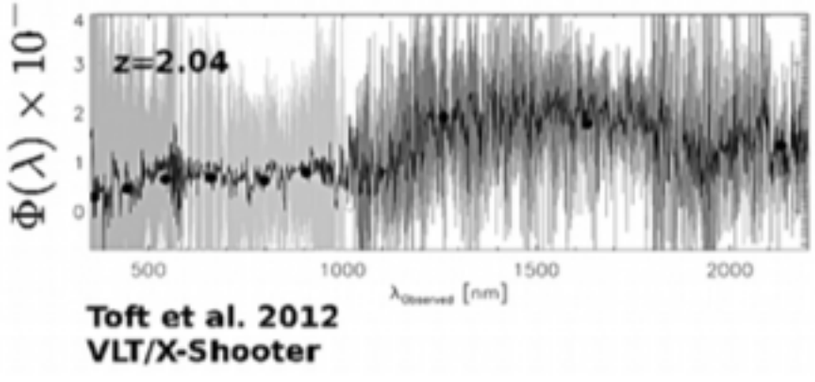
High sensitivity.
Continuous wavelength range (no atmospheric emission or absorption).

FIGS versus Ground Based Observations

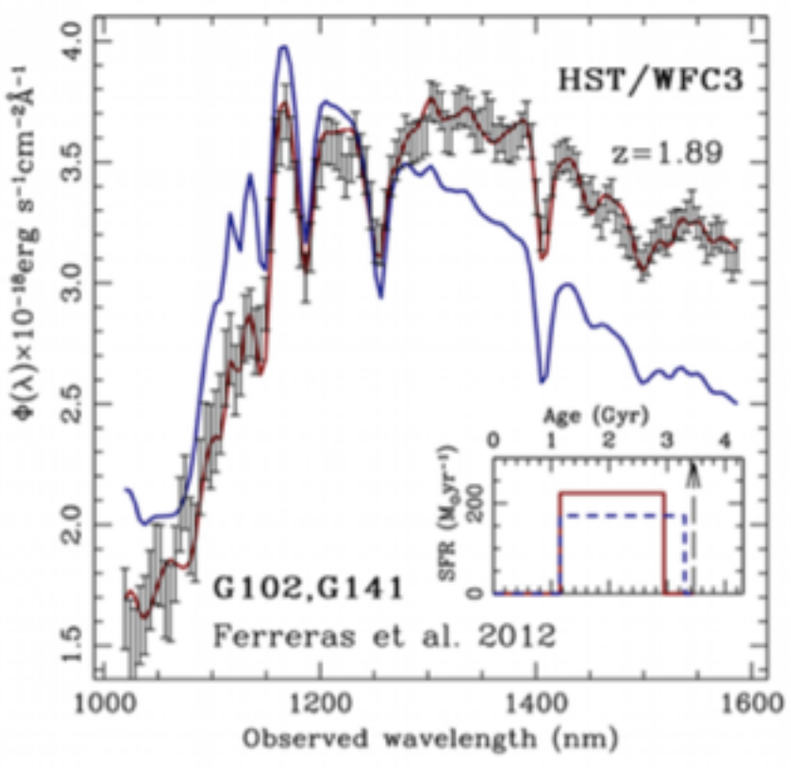
7 hrs



5 hrs



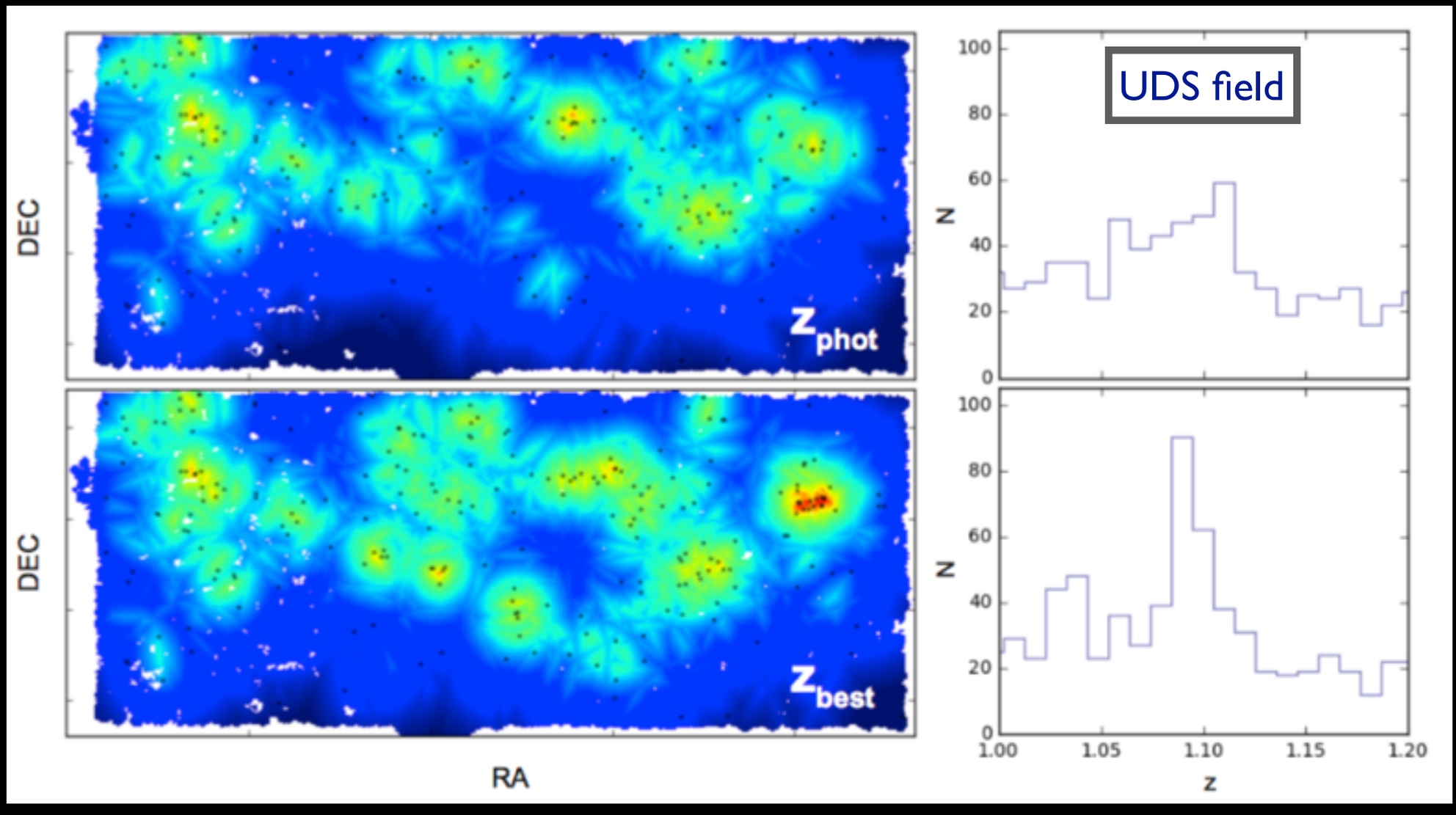
1 hr



FIGS, Pirzkal+14

The Hubble Experience

Grism redshifts accurate to ~0.003×(1+z) ➤ Environment



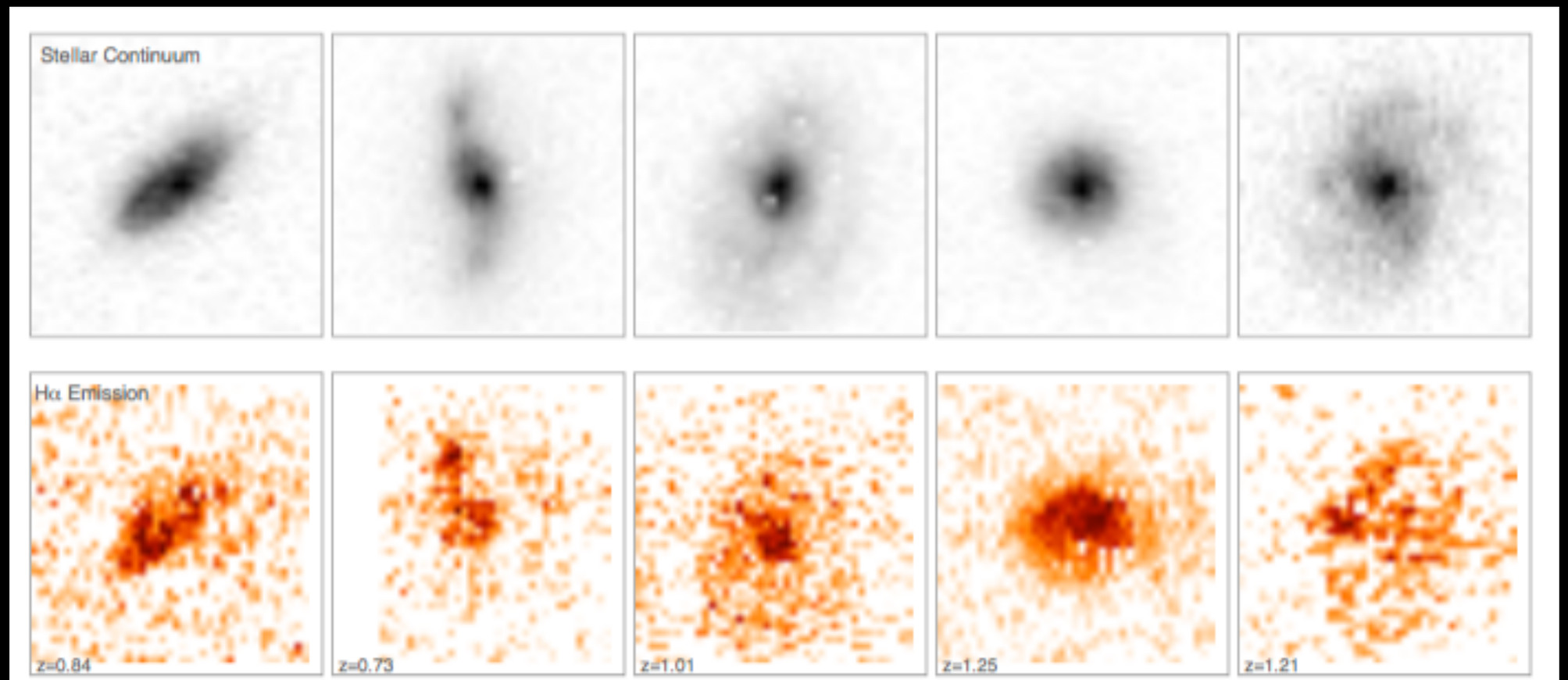
3D-HST, Momcheva+15

The Hubble Experience

Subtract stellar continuum model gives emission line maps

continuum

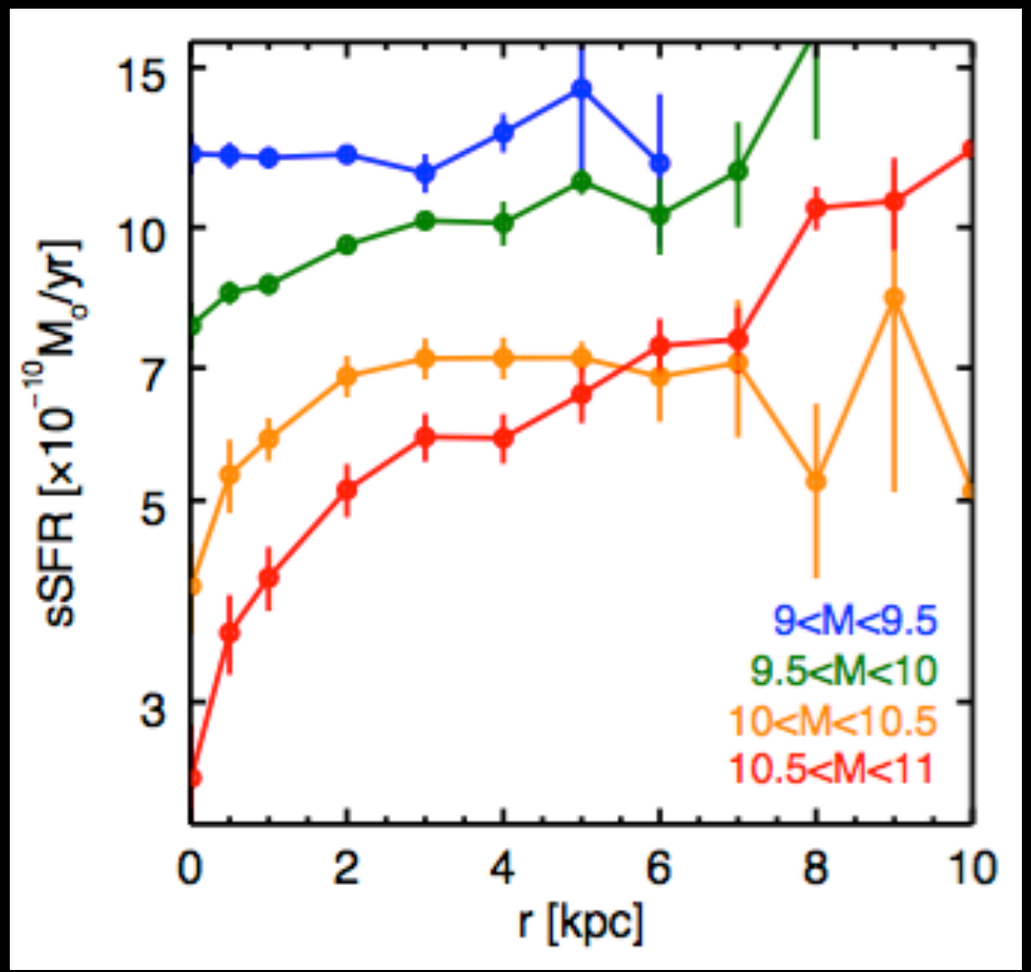
H alpha



3D-HST, Nelson+15

The Hubble Experience

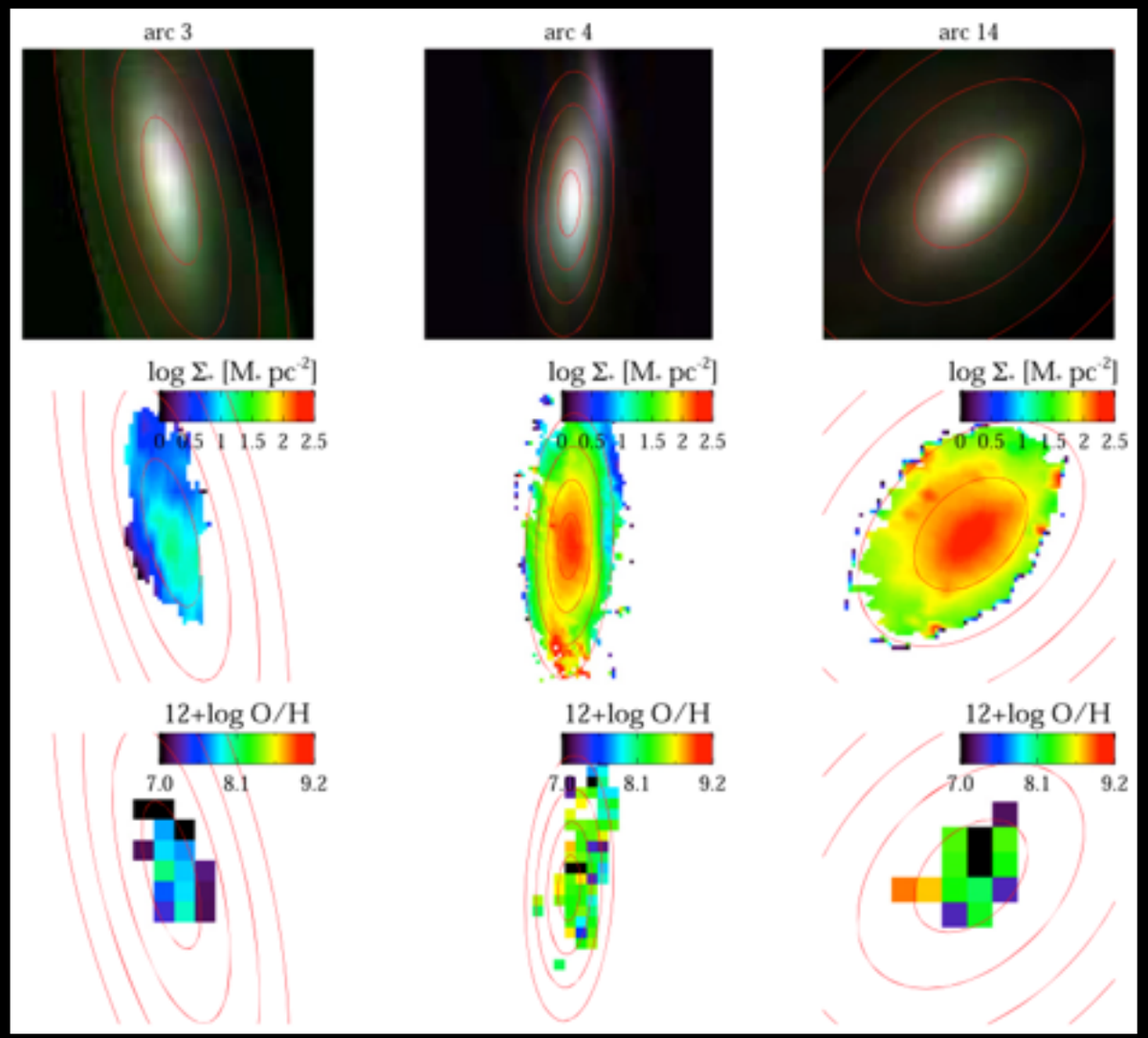
Trace spatially-resolved star formation
Evidence for inside-out star formation



3D-HST, Nelson+15

The Hubble Experience

Use gravitational lensing to determine spatially-resolved metallicity distribution in low-mass dwarf galaxies



GLASS, Jones+15

Conclusions

NIRISS wide-field slitless spectroscopy promises to be a powerful capability for very high multiplex factor spectroscopy of faint galaxies.

Key observational advantages over Hubble WFC3:

- Larger collecting area
- More stable background
- Higher spatial resolution
- Longer wavelength range
- Two orthogonal grisms
- More pixels, blocking filters ➤ lower contamination

Enables studies of:

- Large samples of low mass galaxies at the galaxy assembly epoch
- Resolved properties of high-z dwarf galaxies with gravitational lensing
- Lyman alpha, CIII] and UV continuum at the reionization epoch