HST WFC3 Early Release Science: Emission–Line Galaxies from IR Grism Observations

Amber N. Straughn

NASA Postdoctoral Program Fellow

NASA's Goddard Space Flight Center

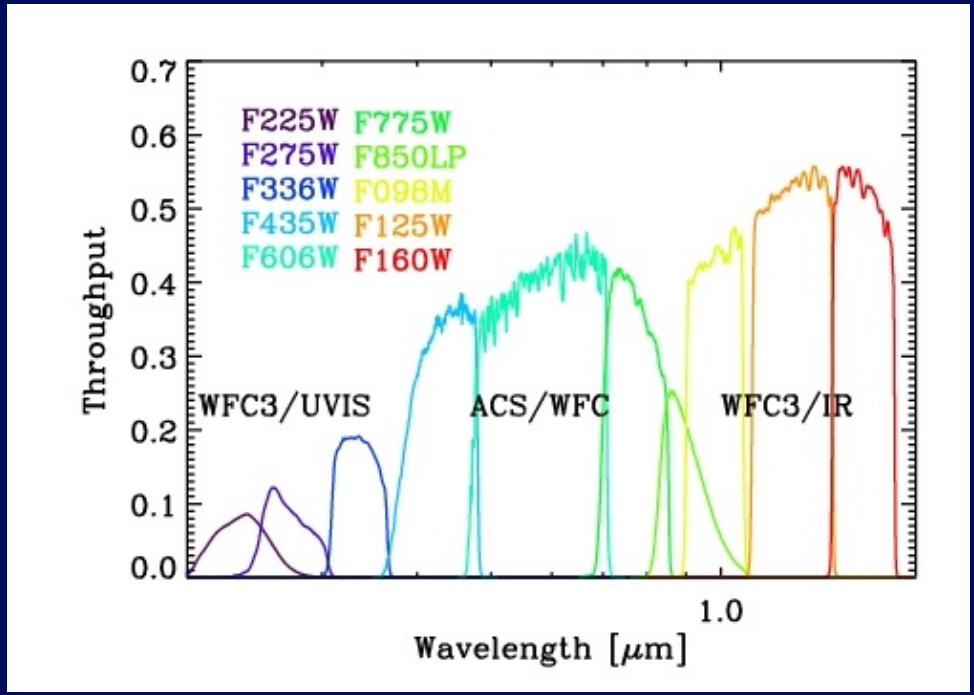
Collaborators: H. Kuntschner, M. Kümmel, J. R. Walsh, S. H. Cohen, J.P. Gardner, R. A. Windhorst, R. W. O'Connell, N. Pirzkal, G. Meurer, P.J. McCarthy, N. P. Hathi, S. Malhotra, J. Rhoads, M. Mutchler, & the WFC3 SOC

14 October 2010`

Science with the Hubble Space Telescope III Venice, Italy

WFC3 Early Release Science II Program

- Eight pointings with UVIS channel
  - F225W, F275W, and F336W
- Ten pointings with IR channel
  - F098M, F125W, F160W
  - 4.65 arcmin^2 FOV; 0.13 arcsec/pix
- One grism field
  - G102 (R~210) & G141 (R~130): 2 orbits each
- Windhorst et al. 2010



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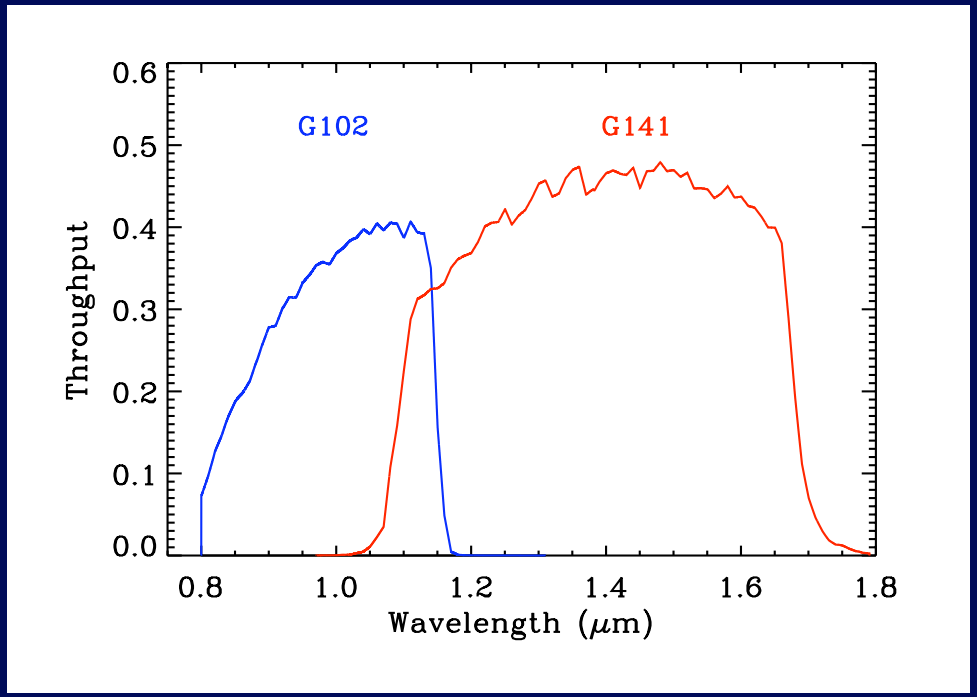

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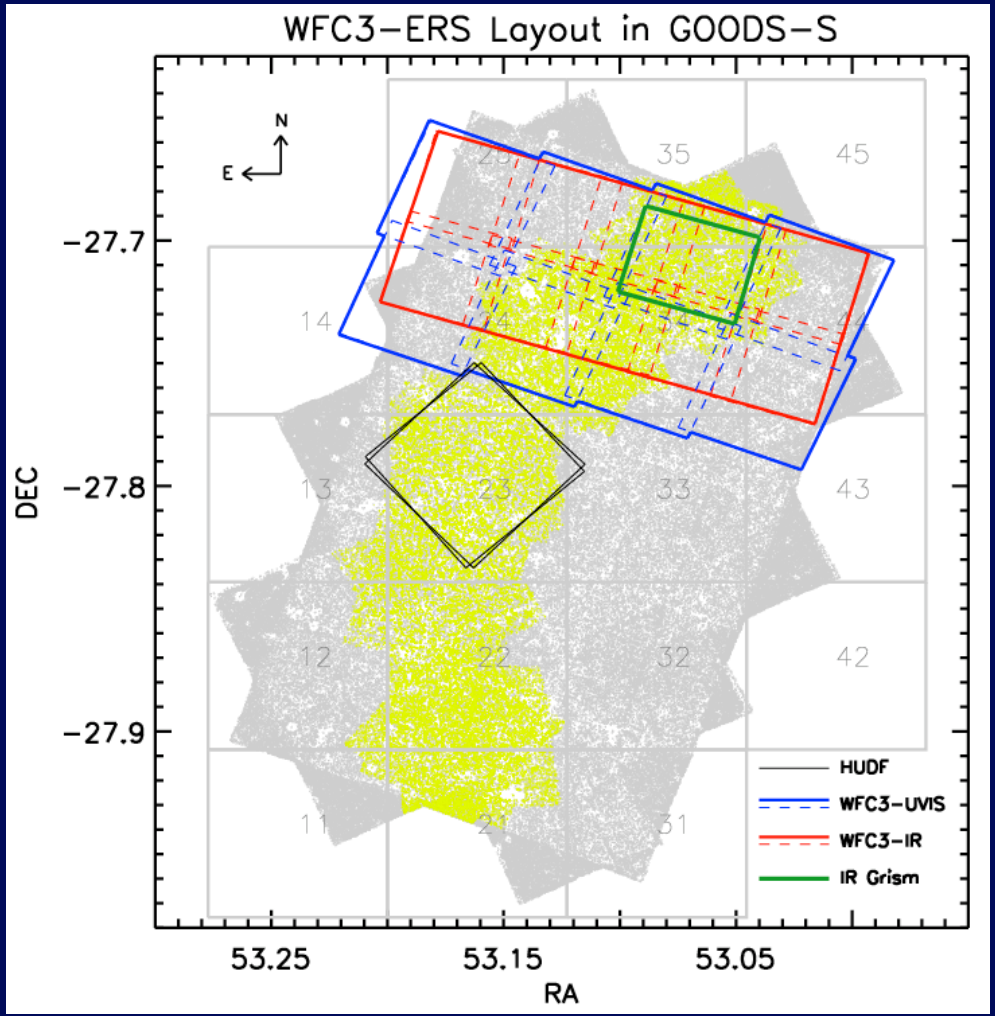
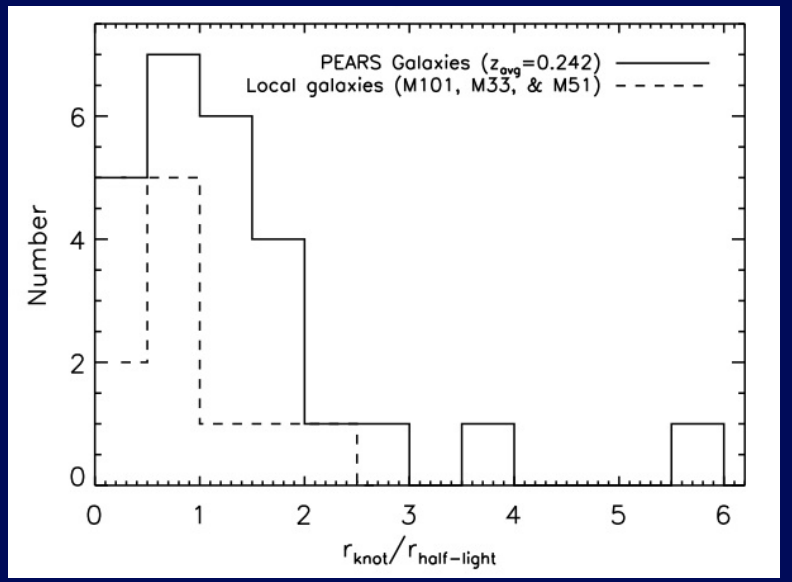
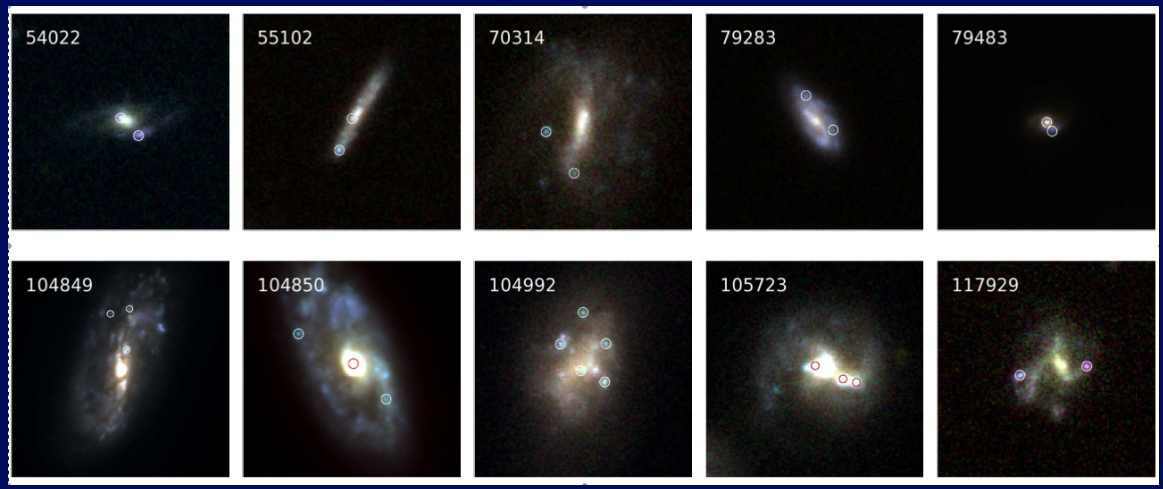


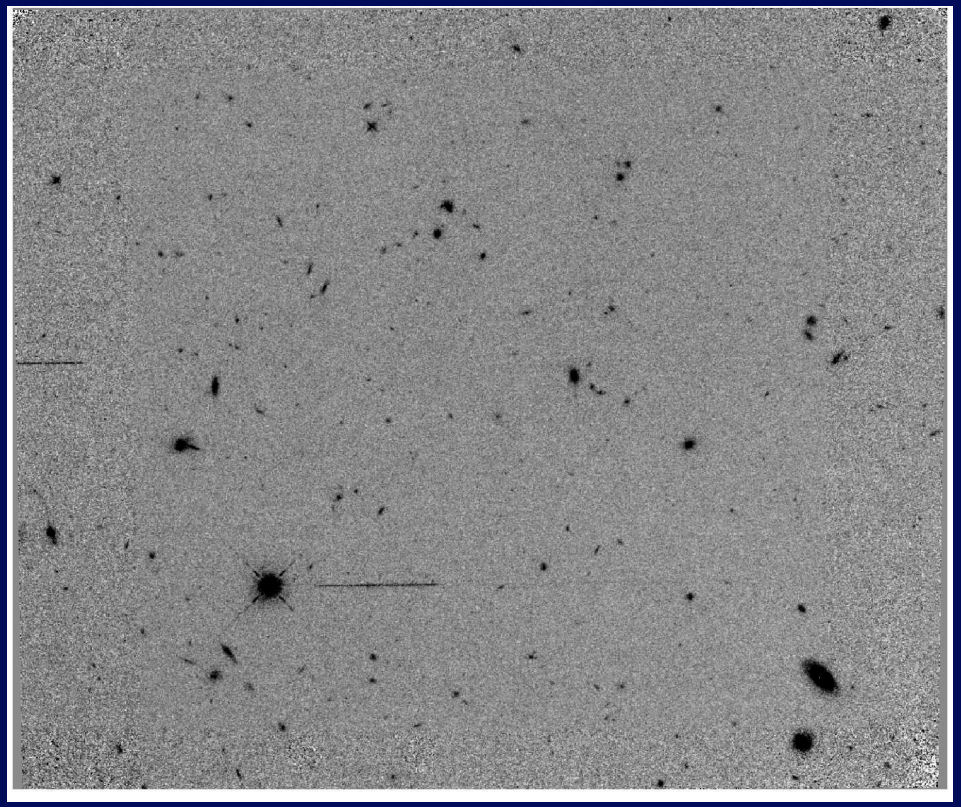
Background: The *Probing Evolution And Reionization Spectroscopically* (PEARS) ACS Grism Survey

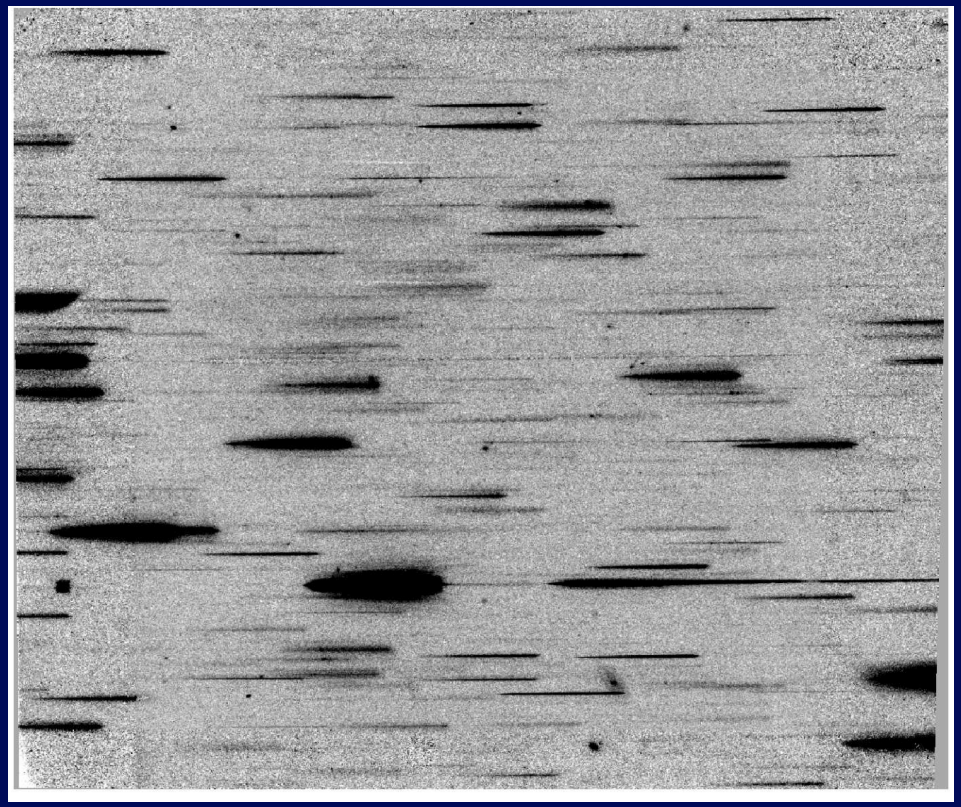
- Sample of ~200 faint emission-line galaxies in GOODS-South (Straughn et al. 2008, 2009)
- HST/ACS G800L grism (6000-9500 Å; R~100)
- Majority of sources have a single line; line ID & grism redshift determination possible with photz



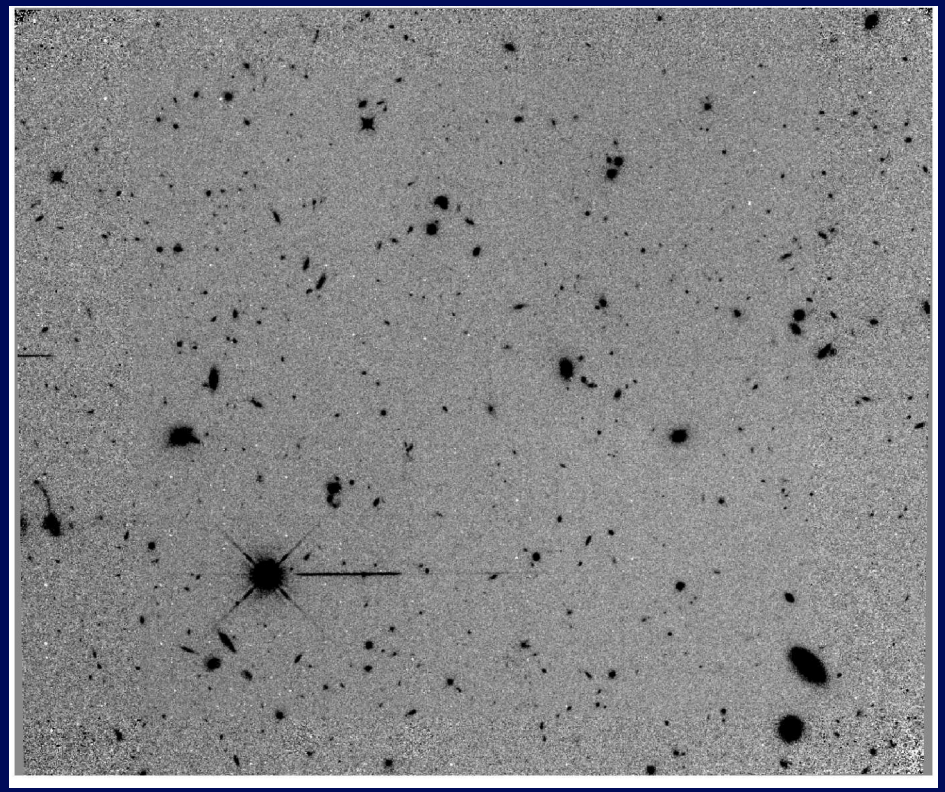


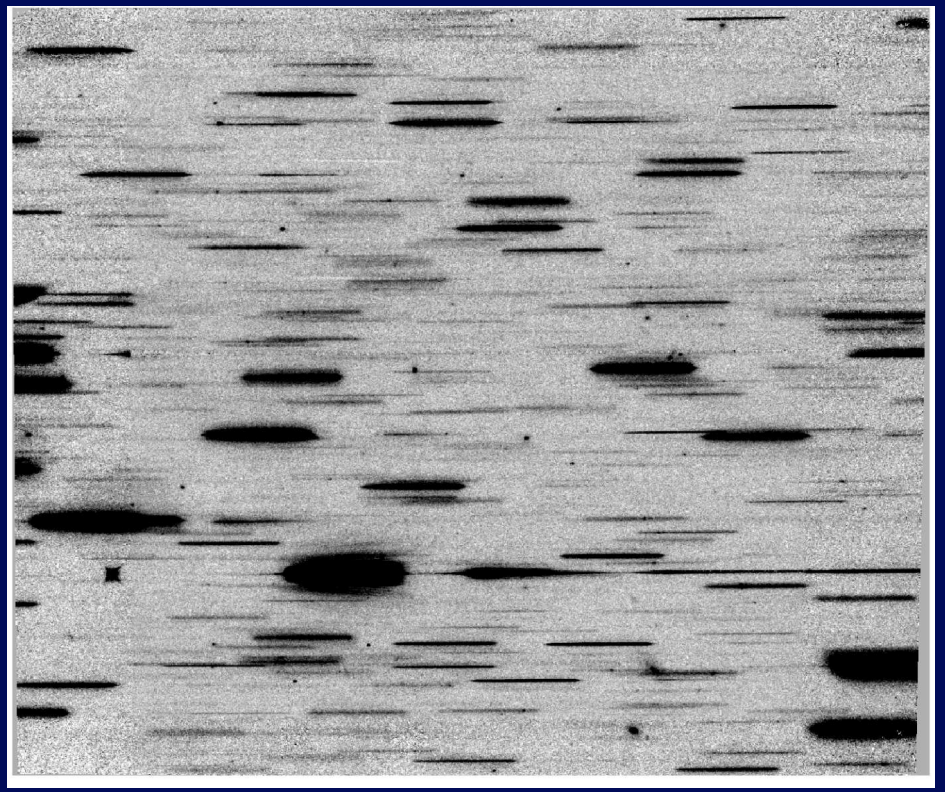
F098M + G102 (2 orbits)

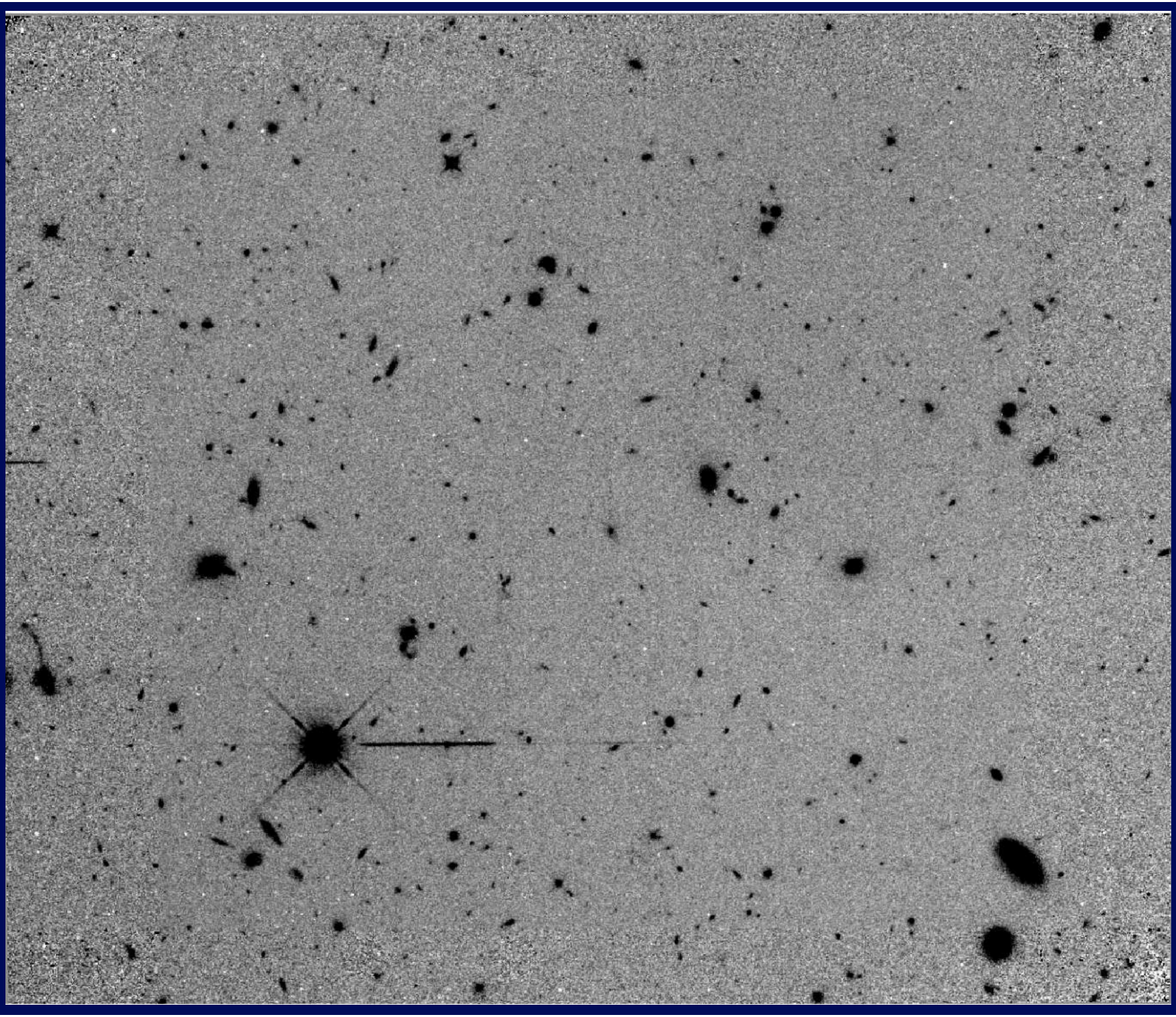


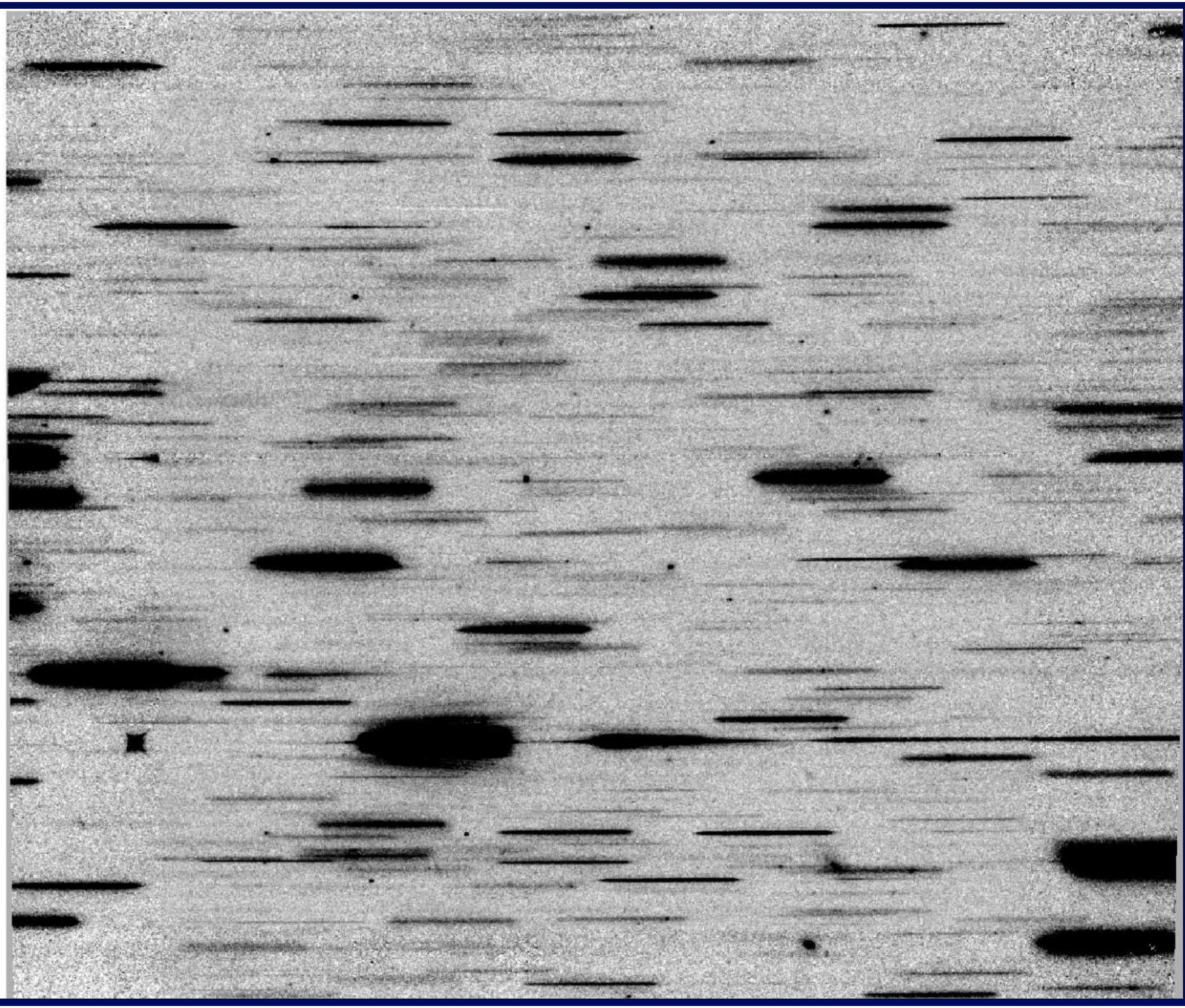


F140W + G141 (2 orbits)





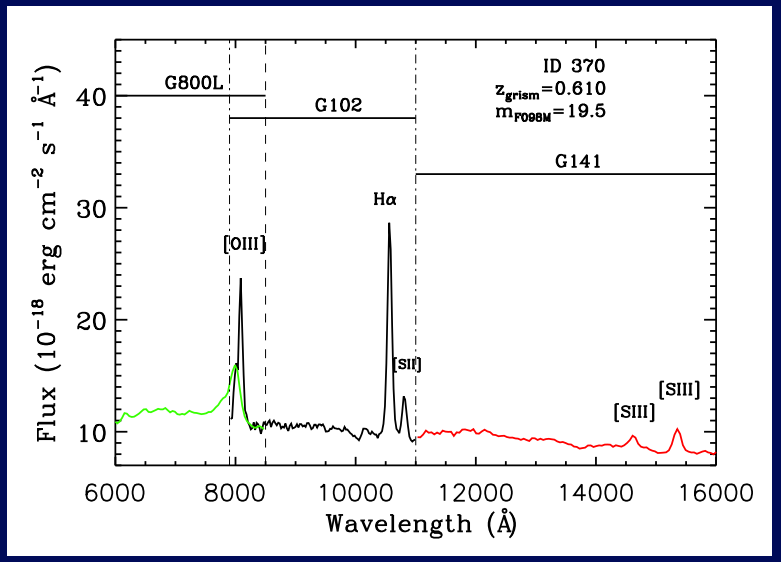


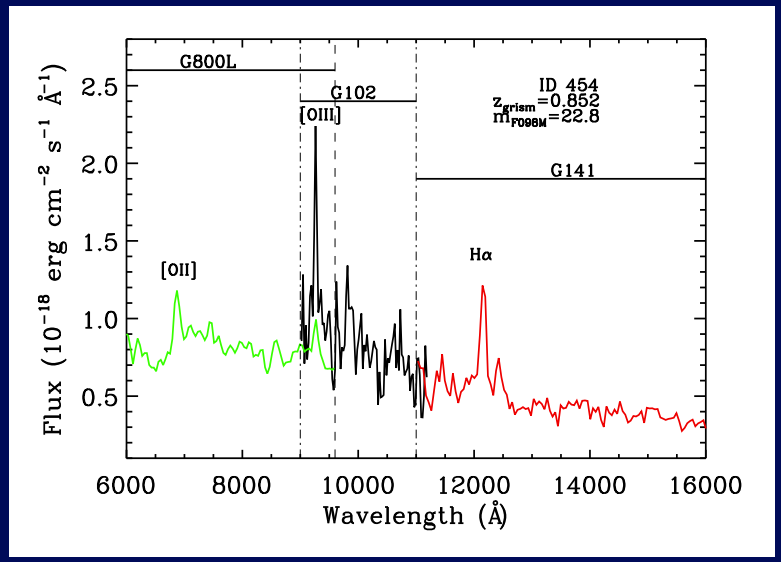


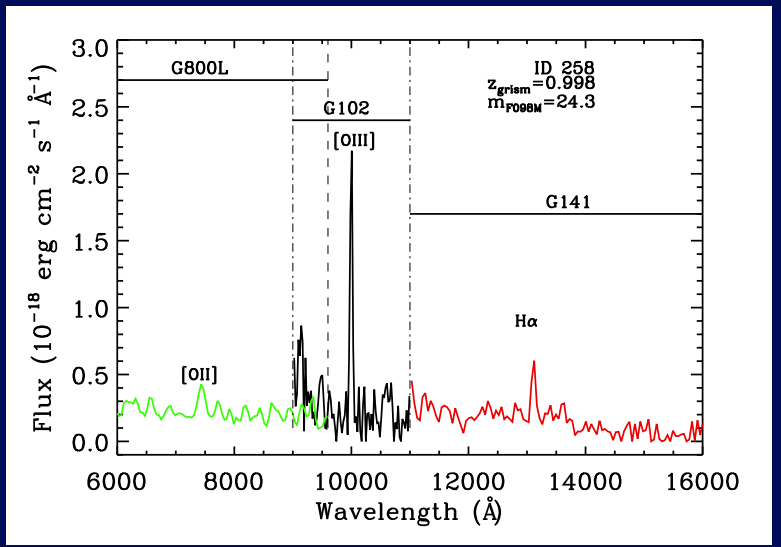
Summary of ELG Detections

- WFC3 IR grism spectra augment previous optical ACS grism PEARS data in the ERS field, yielding spectra of galaxies from 0.6-1.6 μm
- 48 galaxies with 73 emission lines
  - 29 Hα, 27 [OIII], 6 [OII], 2 [SII], 2 [SIII]λ9069, 2 [SIII]λ9532, 5 unidentified
  - Hα: 0.2<z<1.4; [OIII]: 1.2<z<2.2; [OII]: 2.0<z<3.3
- Average redshift: z=1.200; 0.227<z<2.315
  - 18 new grism-spectroscopic redshifts for GOODS-S galaxies
- Average F098M magnitude: m=23.7 mag; 18.7 < m < 26.9 (!)

Emission-line Galaxies with ACS + WFC3 spectra (0.6 – 1.6 μm)







-13 ACS/PEARS ELGs with lines in IR
(Straughn et al. 2010, submitted)

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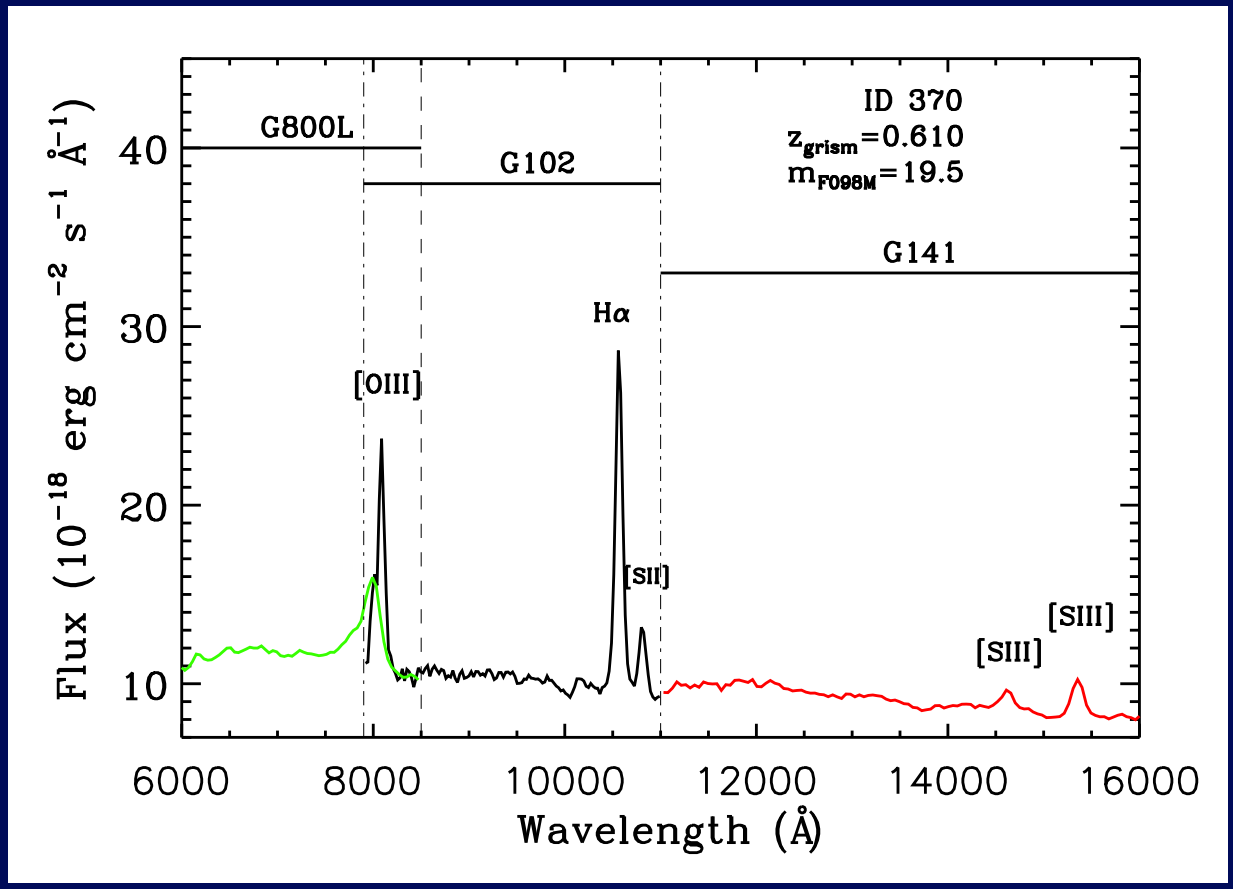
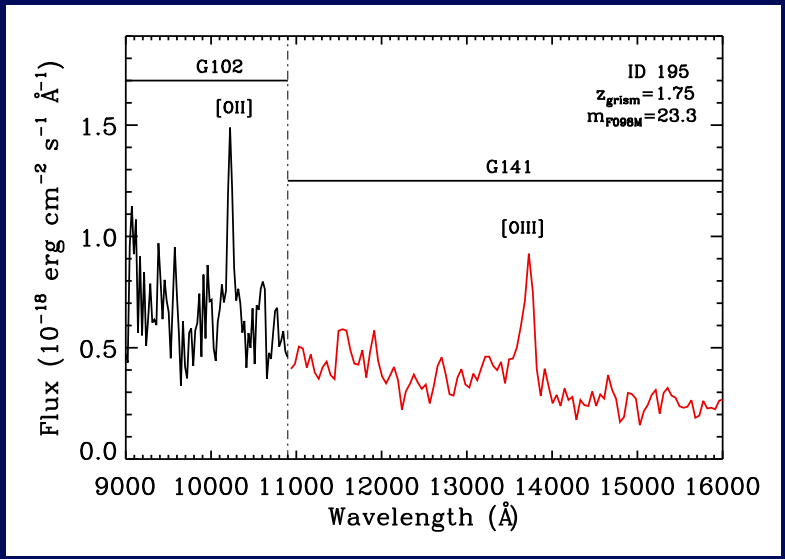
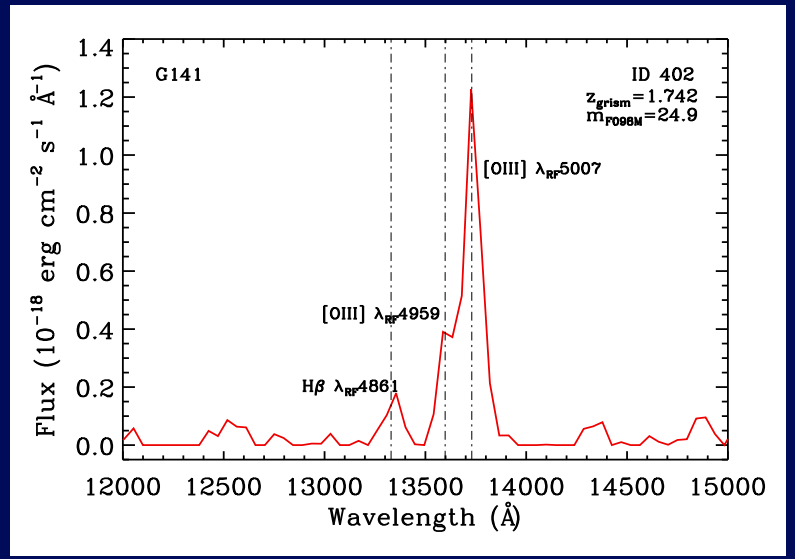
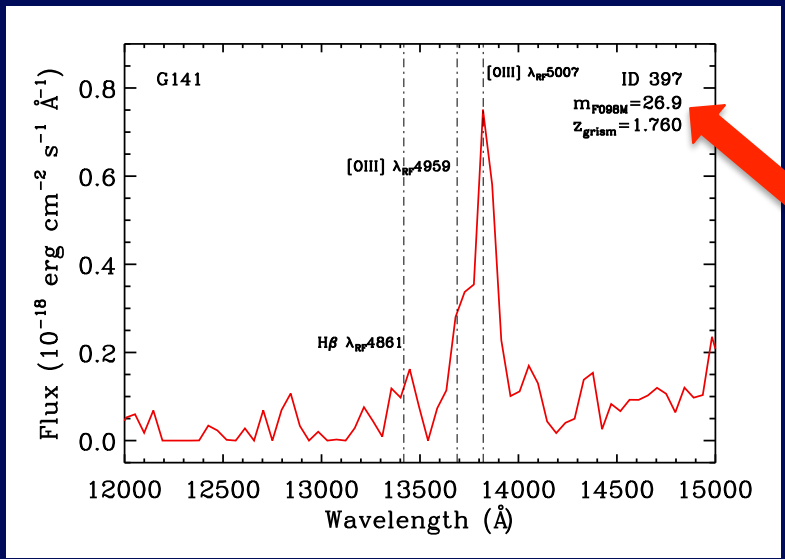
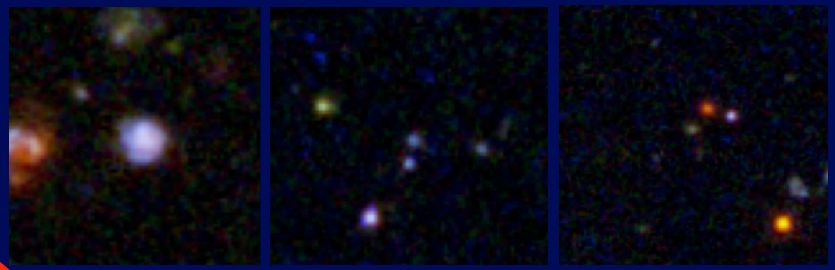


New WFC3 ELGs





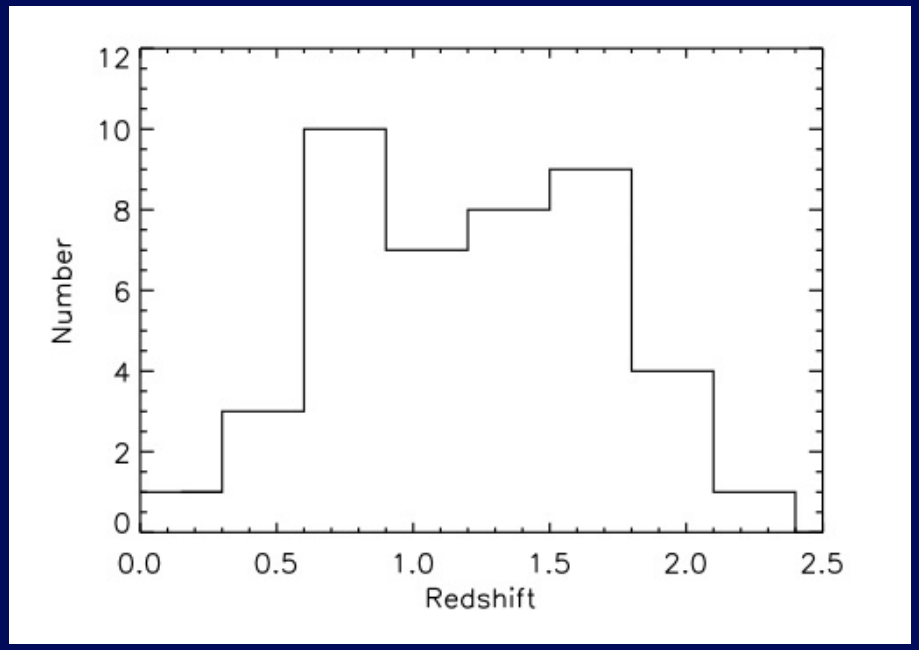




m_{F098M}=26.9 !

- 35 new WFC3 ELGs
- [OIII] at λ4959, λ5007 marginally resolved

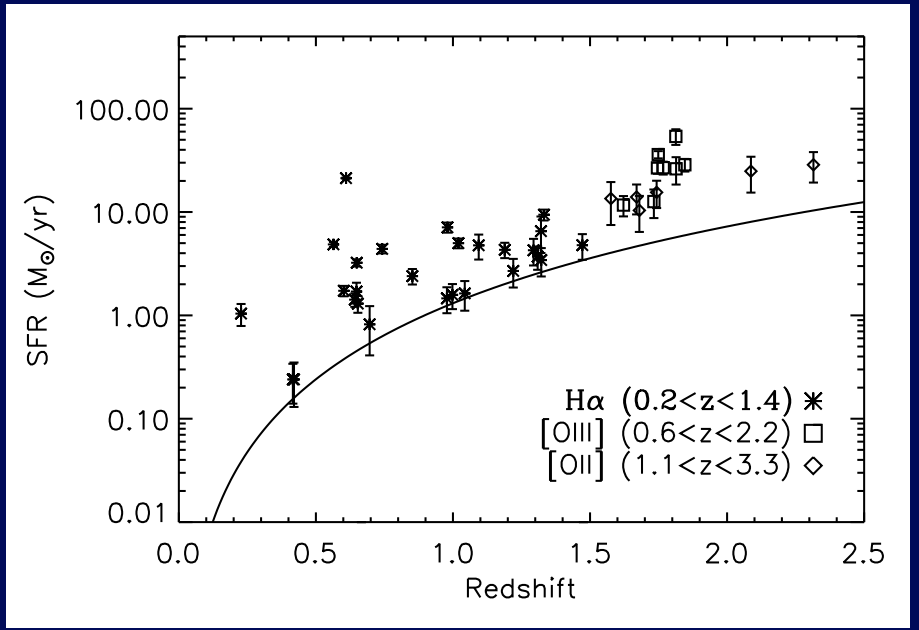
Redshifts of WFC3 ELGs



- Hα: $0.2<z<1.4$
- [OIII]: $1.2<z<2.2$
- [OII]: $2.0<z<3.3$

Star Formation Rates of ELGs

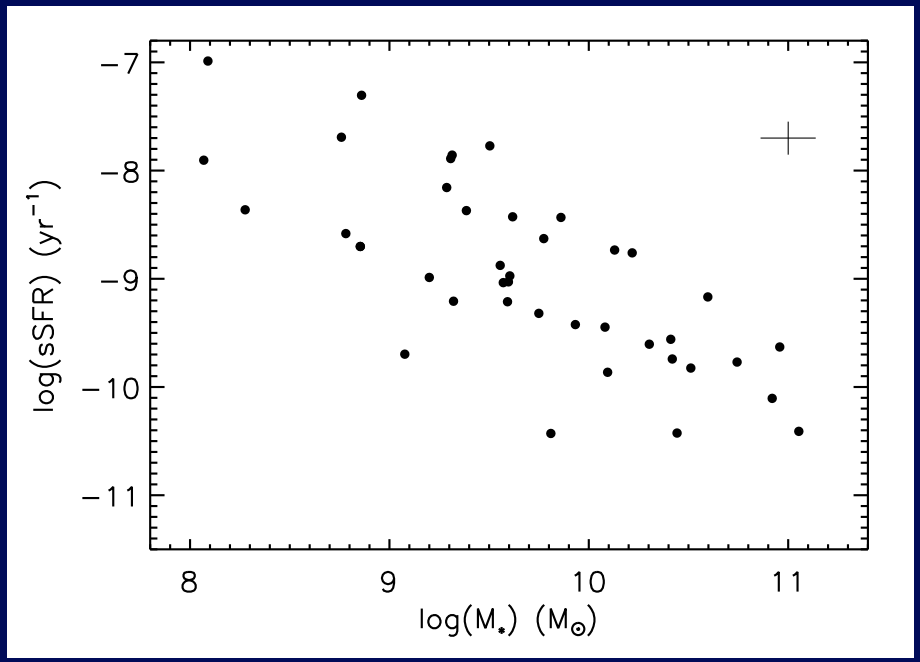
- SFRs calculated using Hα, [OII], & [OIII] line fluxes
- Compare SFR_{EL} to SFR_{SED}
- Lowest SFR_{EL}:SFR_{SED} galaxies generally redder; highest are blue and compact



Straughn et al. 2010, in press

Specific Star Formation Rates of ELGs

- SFRs calculated using Hα, [OII], & [OIII] line fluxes
- Masses calculated by fitting ACS+WFC3 (0.2-1.7 μm) SEDs to BC03 models
- Result consistent with general negative trend observed in previous studies



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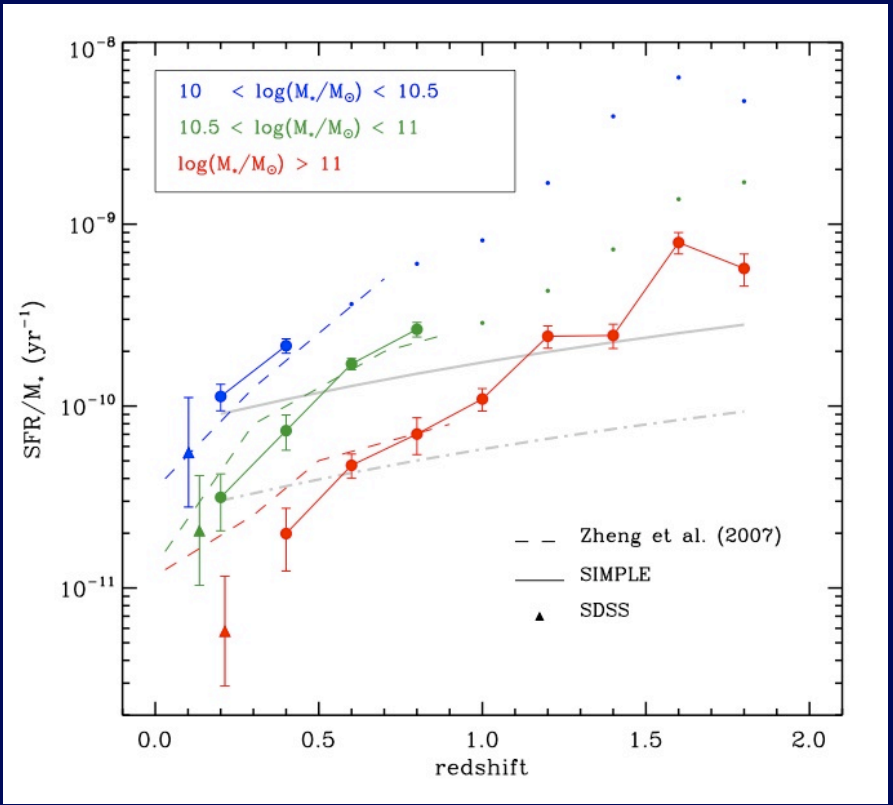
Specific Star-formation Rate of ELGs



Damen et al. 2009, ApJ, 690, 937

- Previous studies of SSFR vs. z have used very large galaxy samples (e.g., GOODS, COMBO-17, SIMPLE etc.)
  - Damen+09, Zheng+07, Martin+07, Perez-Gonzalez +08
- Find lower SSFR for higher mass galaxies

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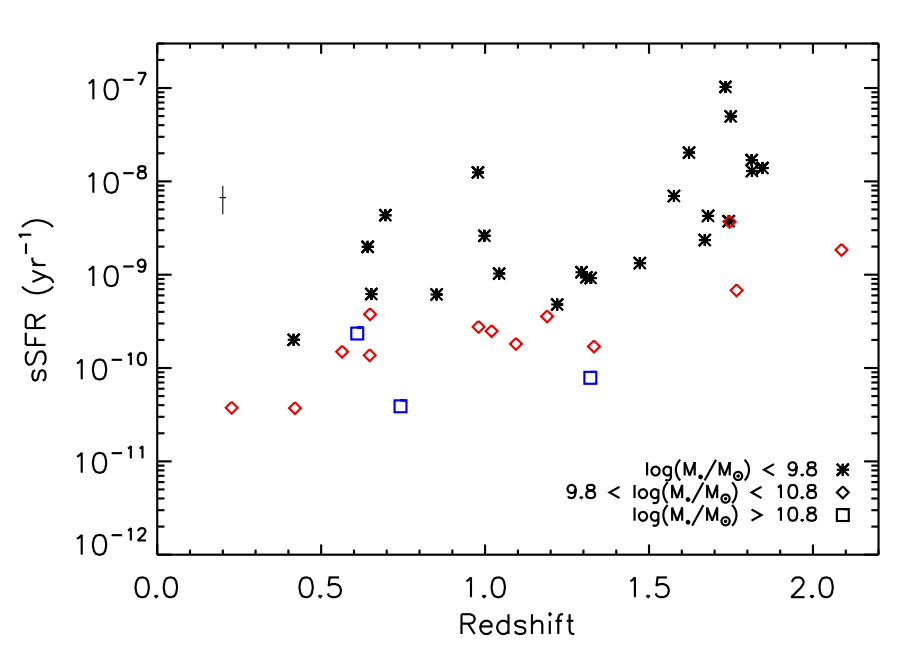

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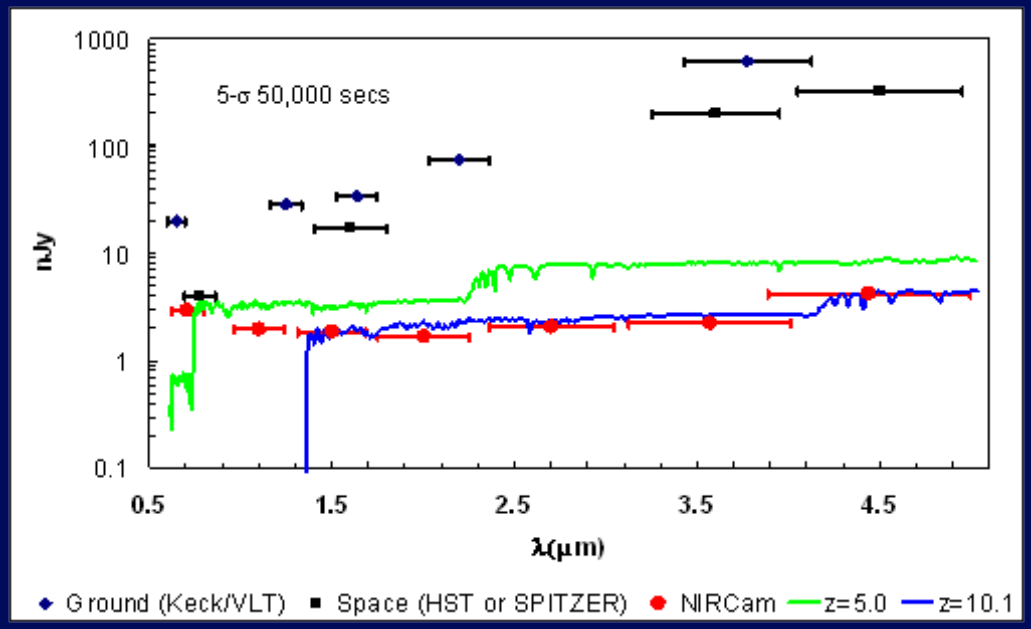
We detect this general trend with just two orbits of HST time.

The Future

- More to do with ERS grism data!
- CANDELS
- JWST NIRCam Grisms



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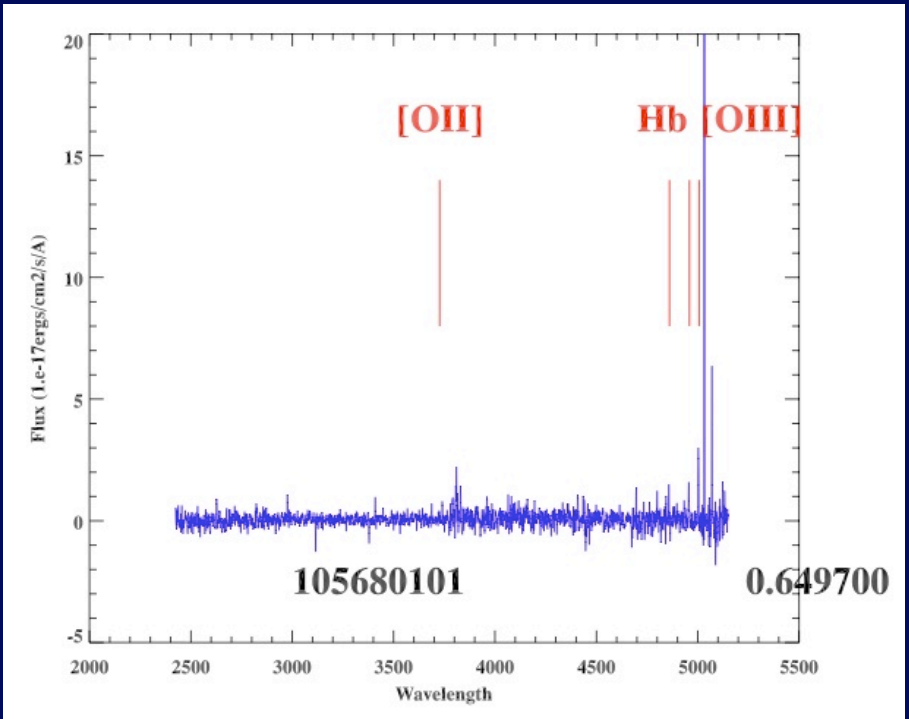
  - 18 new grism-spectroscopic redshifts for GOODS-S galaxies
- Average F098M magnitude: m=23.7 mag; 18.7 < m < 26.9 (!)
- Our results are consistent with previous studies showing that the sSFRs of the most massive SF galaxies are generally lower than their lower mass counterparts as a function of redshift
- These data demonstrate the efficiency of the WFC3 grisms in detecting faint SF galaxies at z≈0.2-2.5. This work sets the stage for larger area and deeper studies of star–forming galaxies with WFC3 in the future.

The next era: NIRCam grisms

- Two identical long wavelength grisms
- Used for coarse phasing
- Also science applications (see, eg., Greene et al. 2007 for detailed discussion on exoplanets)
- Some advantages over NIRSpec for particular science objectives:
  - Higher spatial resolution spectroscopic obs.
  - No slit losses
  - Ability to dither slitless spectra: better flat-fielding
  - Sample entire NIRCam FOV
- Emission lines to much higher redshifts

ELGs with JWST & ELTs



General strategy:

Imaging

Grism

Ground-based spectroscopy

The next era: NIRCam grisms