TMT
THIRTY METER TELESCOPE

Resolved Spectroscopy of Adolescent and Infant Galaxies (1 < z < 10)

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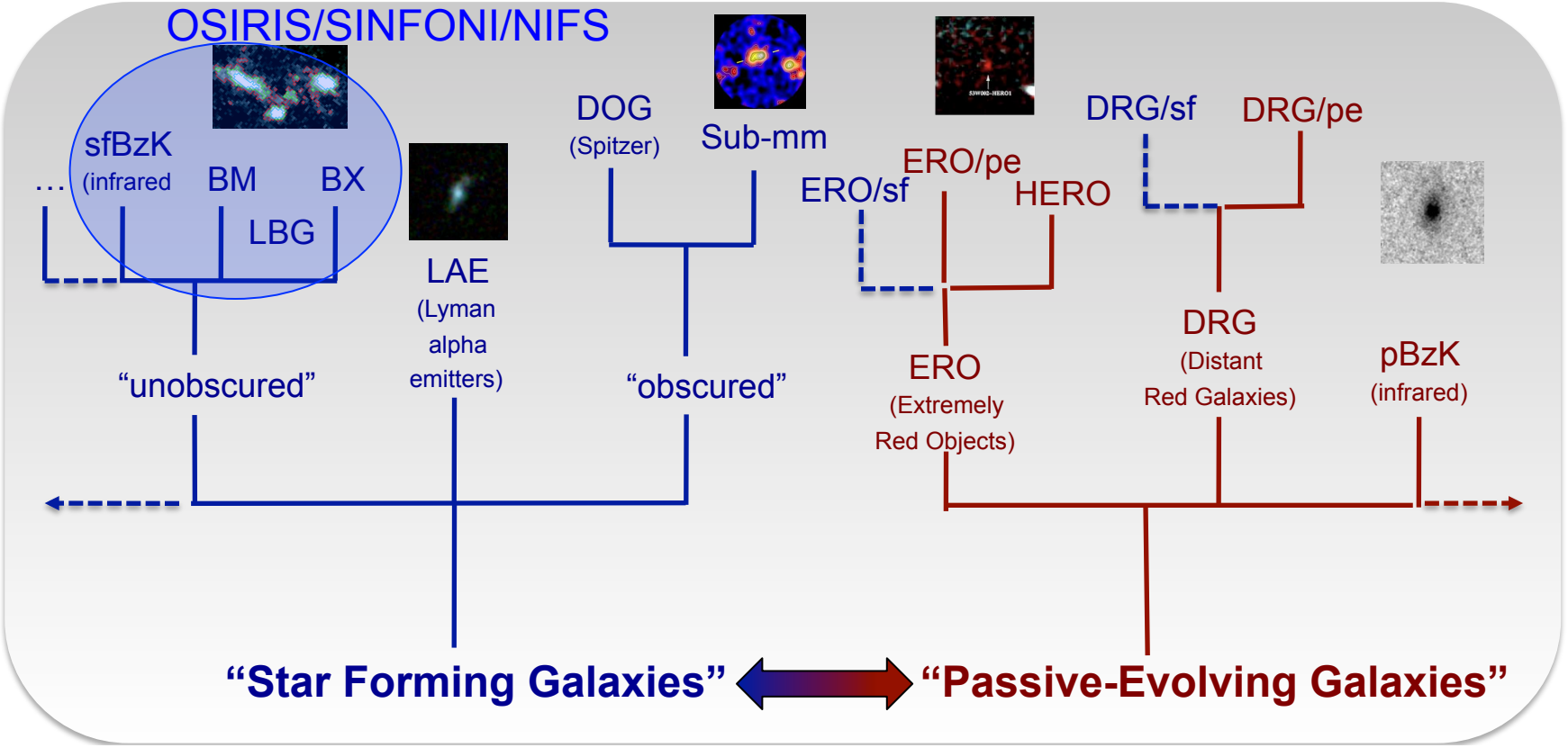
and IRIS Science Team

How does the "zoology" of high-z galaxies evolve into present-day

- Determined by wavelength selection and redshift
  - Color-color selection (optical and NIR) produce differing types
  - Sub-mm (Scuba, 850 μm, dust obscured)
- Parameter space: M*, SFR, extinction ,ages, clustering



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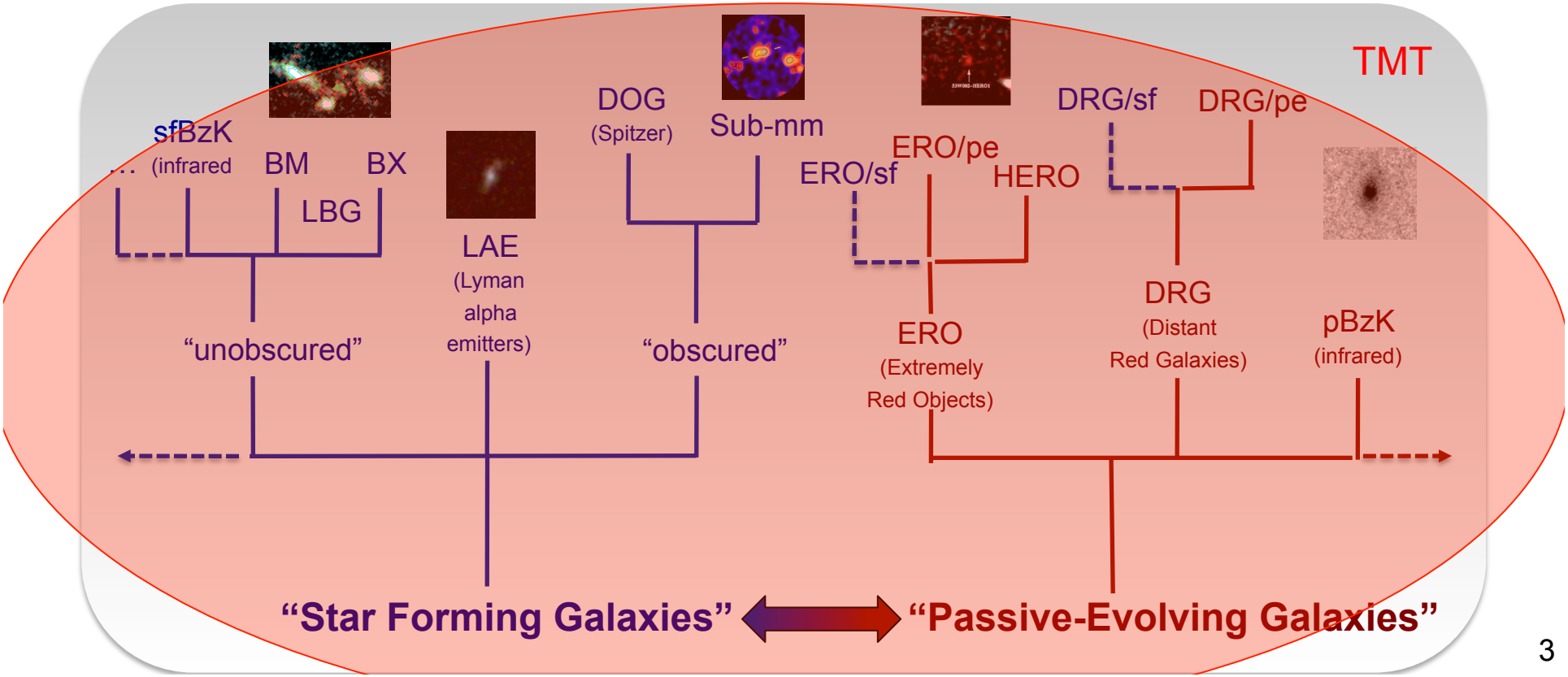
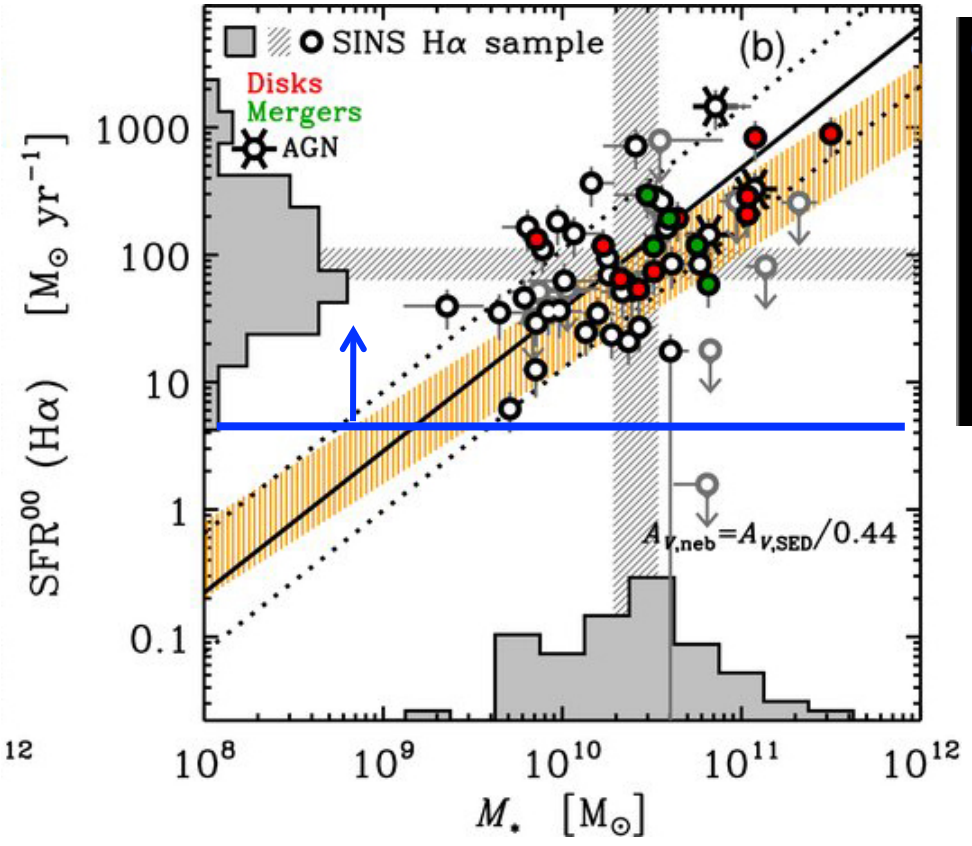
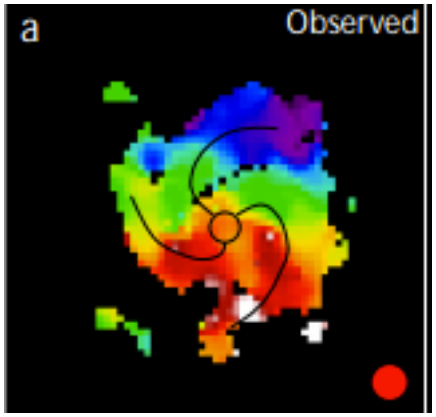


Current IFS probing the massive, luminous galaxies at high-z

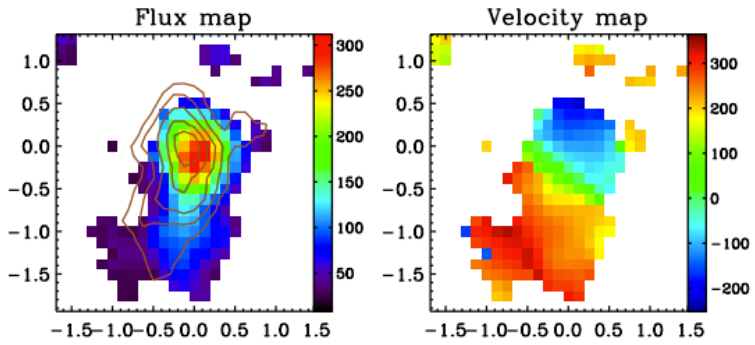
- OSIRIS and SINFONI primarily targeting brightest emission lines on the "tip of the iceberg" of mass function



Forster-Schreiber et al. 2009, mostly seeing-limited

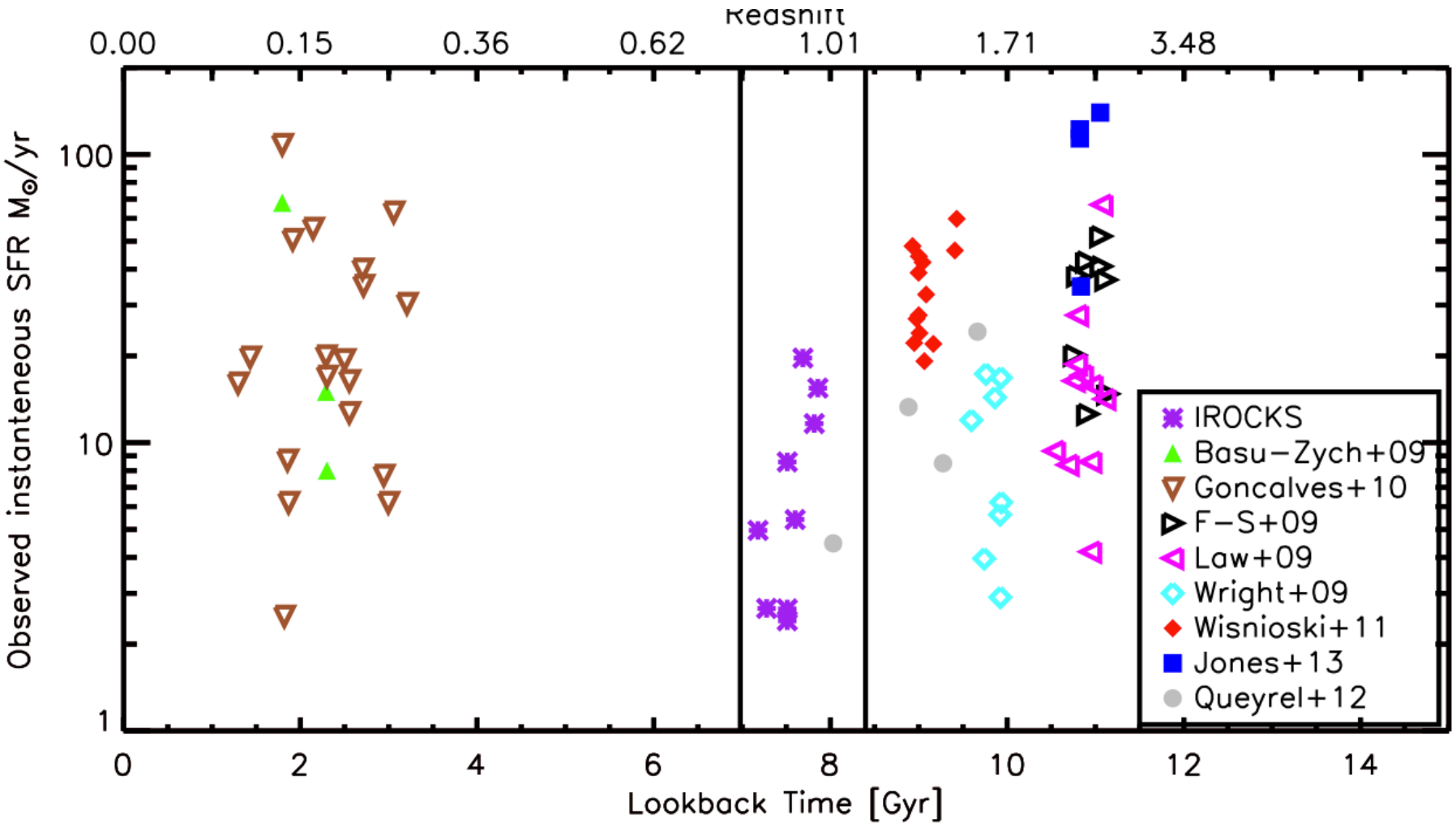


z~2 Hα grand spiral
OSIRIS LGS-AO
45 $M_\odot$/yr
Law et al. 2012



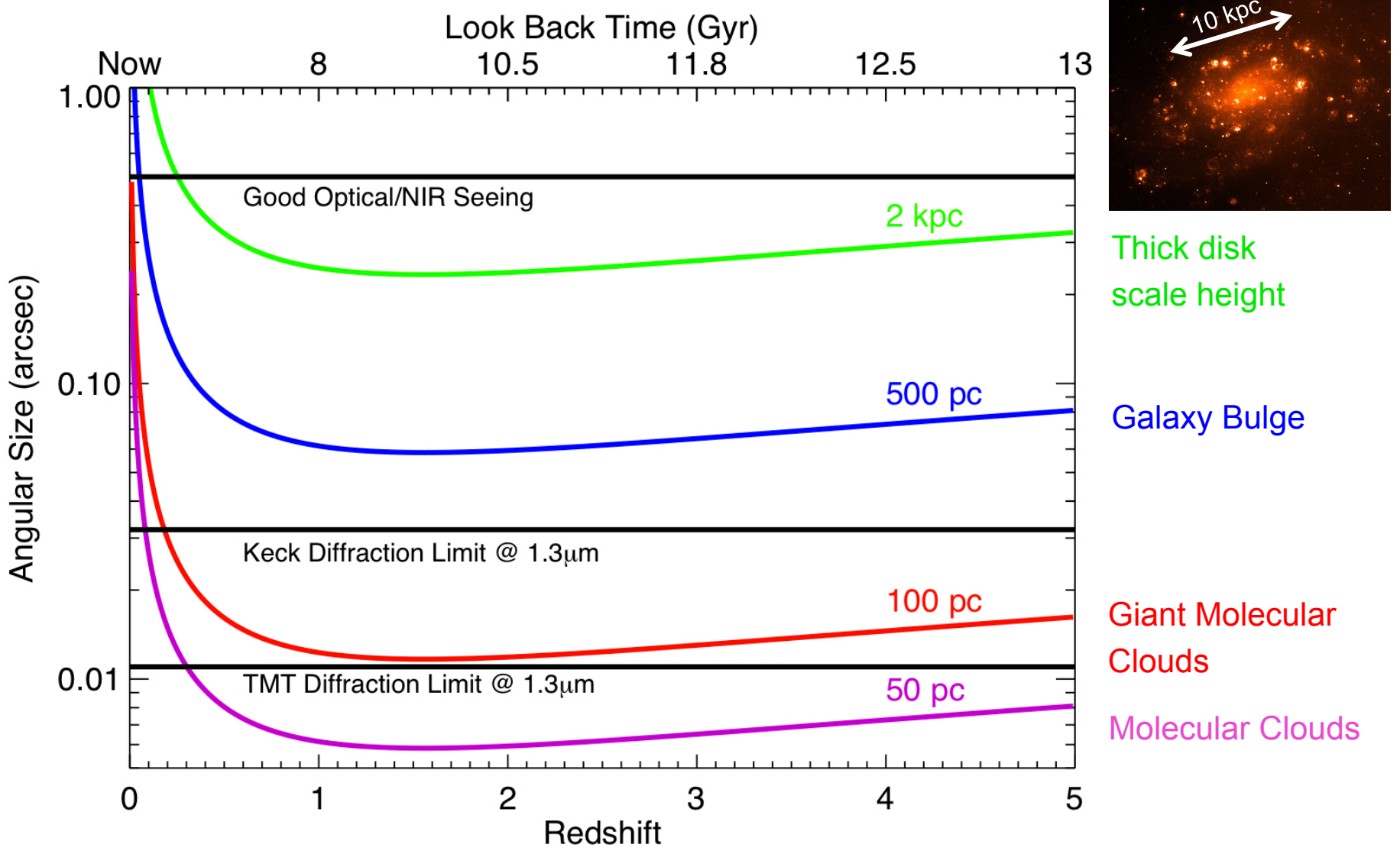
z~3 [OIII] - SINFONI - 115 $M_\odot$/yr
Gnerrucci et al. 2011

Limited number of IFS + AO observations of high-z



Courtesy of Etsuko Mieda, z~1 OSIRIS-LGSAO sample

IRIS will resolve high-z individual star forming regions



Thick disk scale height

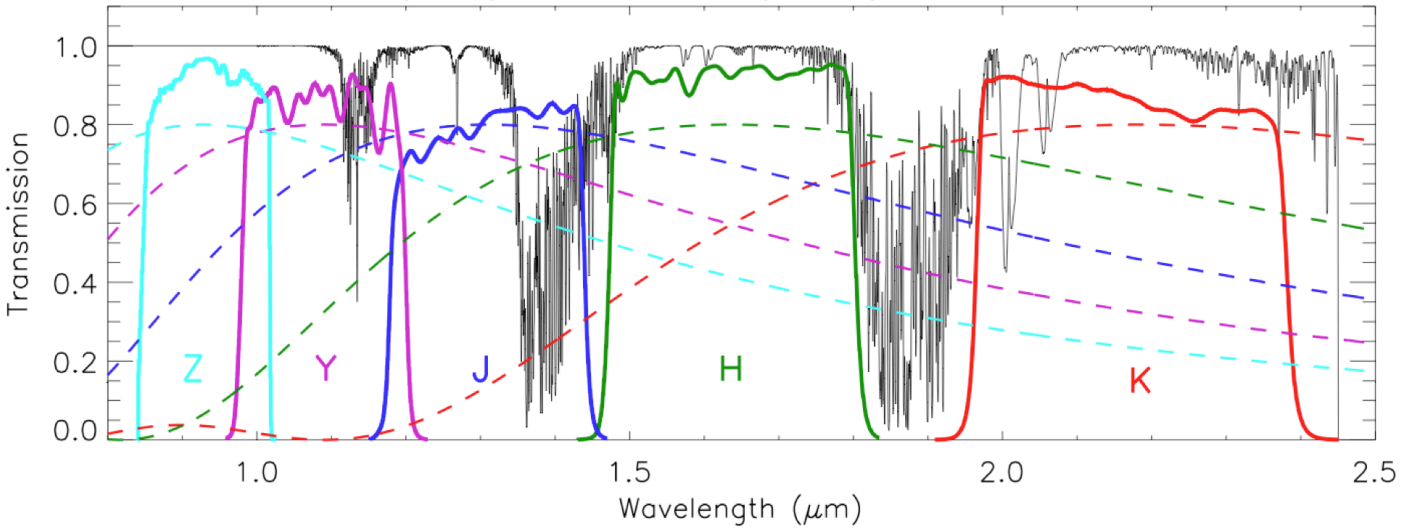
Galaxy Bulge

Giant Molecular Clouds

Molecular Clouds

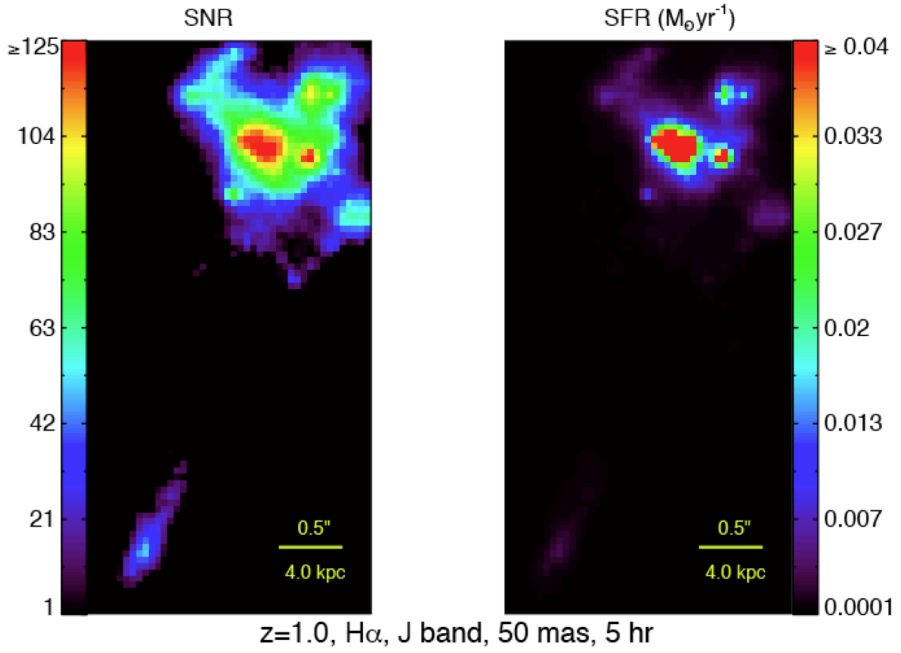
Using IRIS simulator to investigate sensitivities/capabilities at high-z

- Simulator designed to investigate science cases and constrain instrument requirements
  - See Tuan Do et al. 2014 & Wright et al. 2010
- A major science driver for IRIS will be dynamics, abundances, morphologies of z = 1 – 5 galaxies
- Resolve spectroscopy of first light galaxies (6 < z < 12)
- Narrowband imaging of first light galaxies

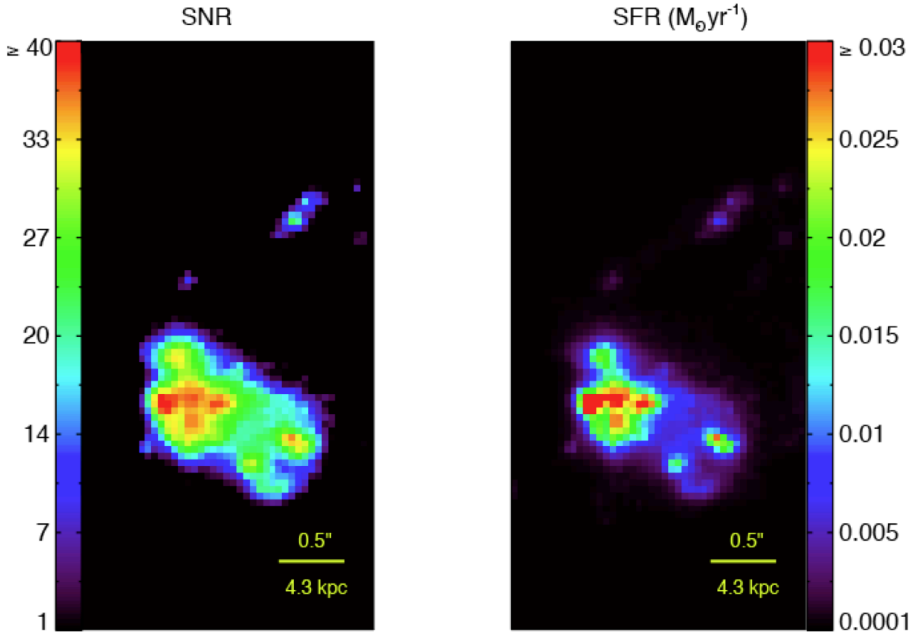


Simulations of adolescent high-z (1 < z < 3) star forming galaxies

- Parameter space to explore is vast – what redshift range, emission lines (Hα, Hβ, [OIII], [OII], [NII]), flux distributions, velocity profiles, dispersions, extinction, stellar mass, AGN



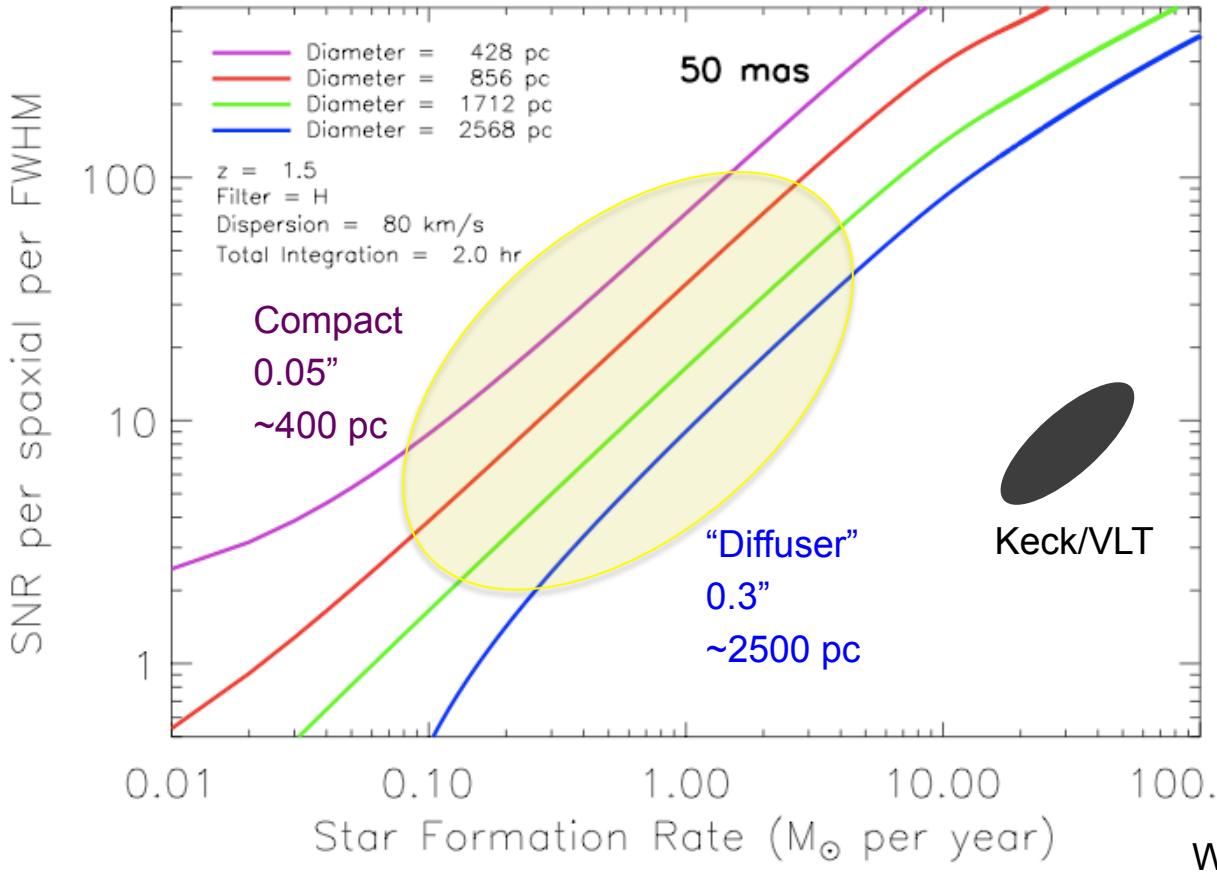
z=1.0, Hα, J band, 50 mas, 5 hr



z=1.5, Hα, H band, 50 mas, 5 hr

IRIS at coarse scales observing lower luminosity high-z galaxies

- Mean SNR per spaxial vs. SFR for Hα emission across a z~1.5 galaxy observed in H-band (1.6 μm)

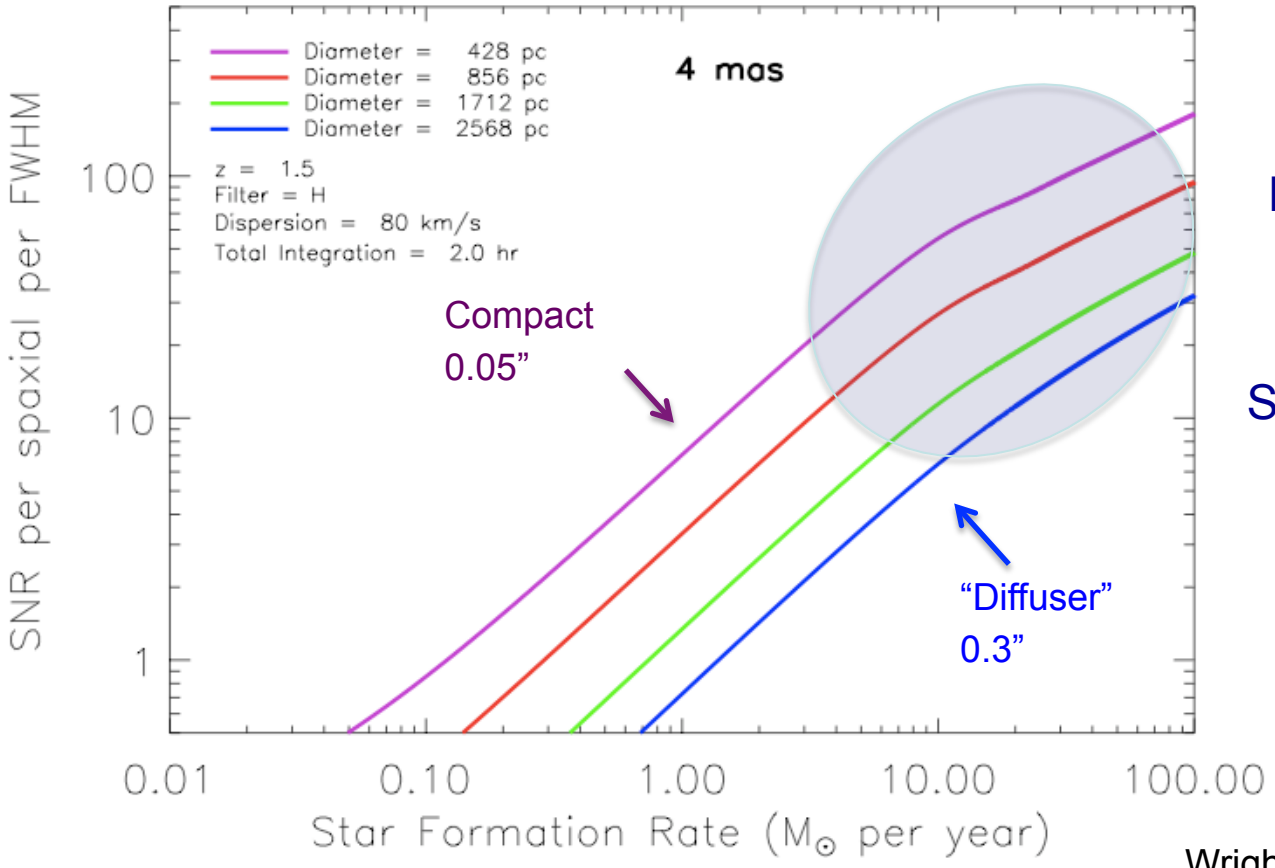


Probing Lower SFR Galaxies at Coarser Scale

Wright + 2010

IRIS at fine spatial scales observing luminous high-z galaxies

- Mean SNR per spaxial vs. SFR for Hα emission across a z~1.5 galaxy observed in H-band (1.6 μm)

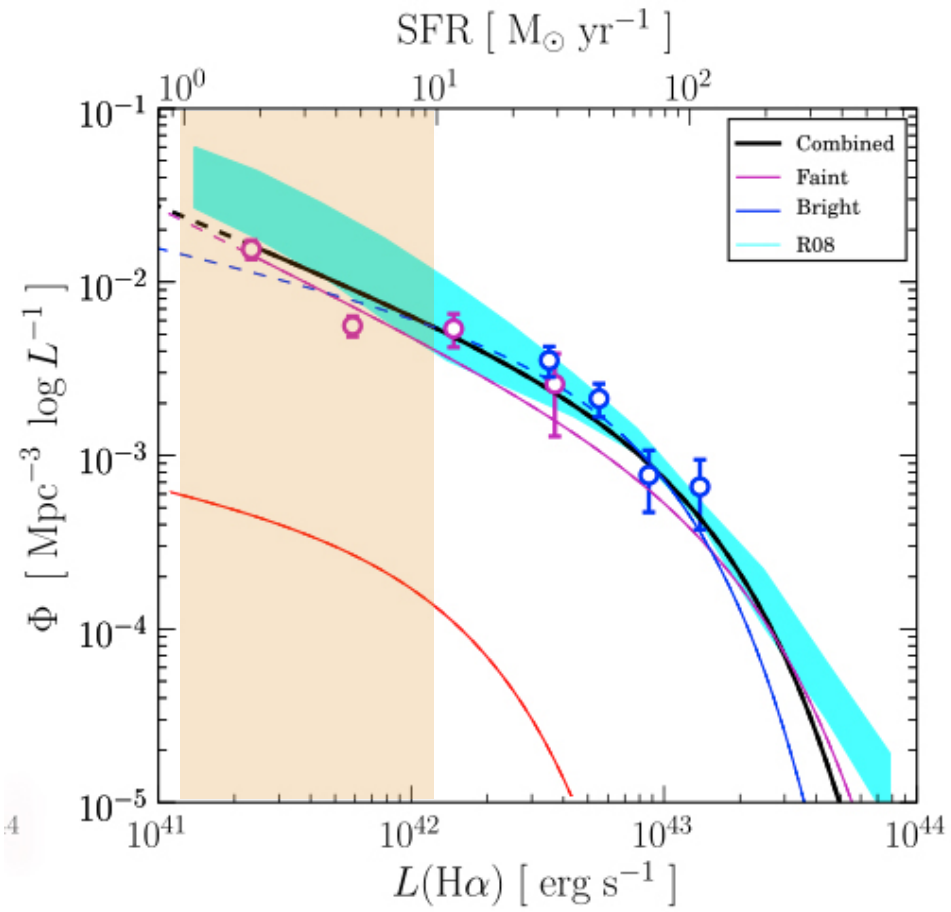


Exploring Higher SFR Galaxies at Fine Scale (34 pc!)

Wright + 2010

IRIS probes 20-30 times fainter than current IFS observations at high-z

- Probing down to sub-L_* to more “typical” high-z galaxies
- Observing lower surface brightness at larger radii
- Other emission lines at high-z (1 < z < 5) like [SII], [NII], [OII], [OIII], etc.
- Passive, quiescent galaxies
- Studying AGN and host galaxies
- IRIS will is unique
  - JWST IFS has only 0.1” spatial scale
  - JWST IFS has R=2000 max

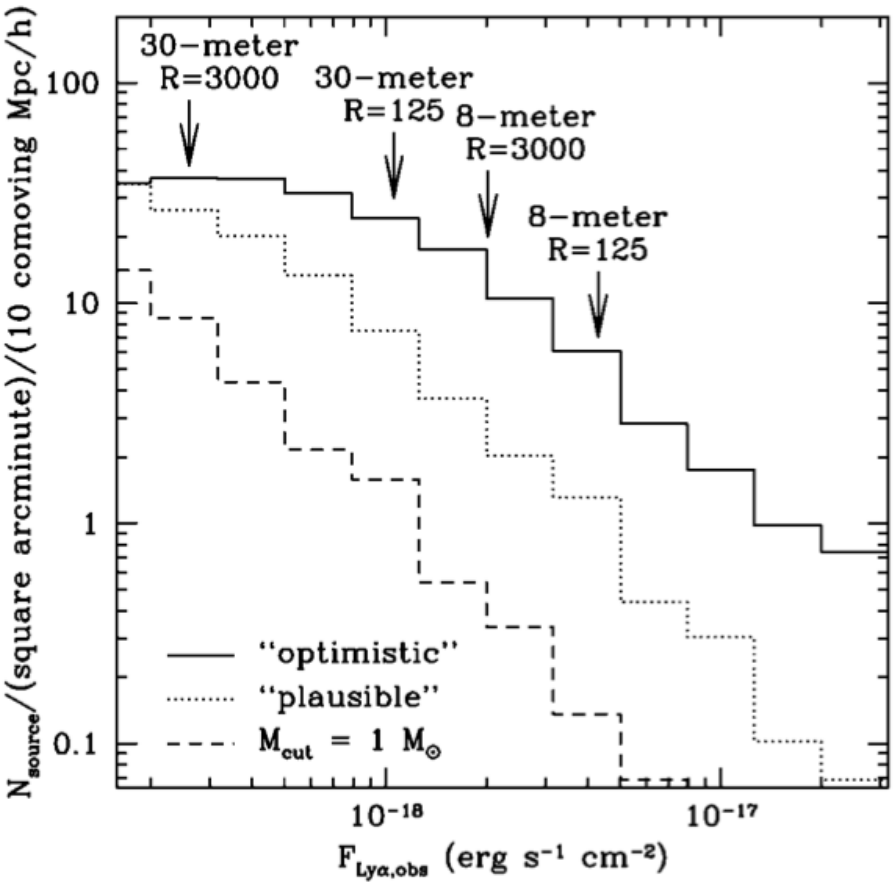


TMT spectroscopy

Hayes et al. 2010

IRIS targeting first light galaxies

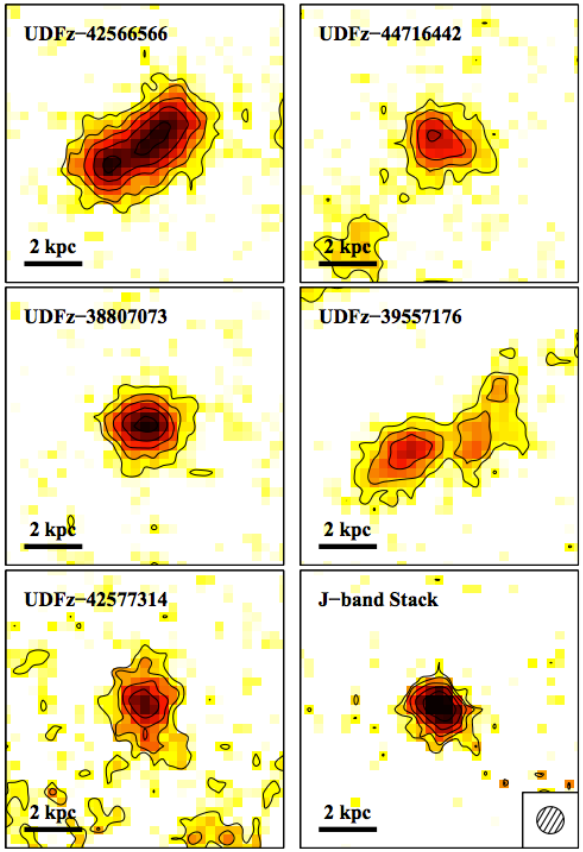
- Ly-α survey done with narrowband imaging
  - Special filters in prime z
  - Ly-α Luminosity Function and clustering of Ly-α (topology of reionization)
- Ly-α spectroscopy of detected candidates from JWST/TMT imaging
  - First light galaxies are compact => need AO+TMT!
  - Velocity structures and winds of first galaxies using Ly-α and searching for Pop III stars (identifying He II)

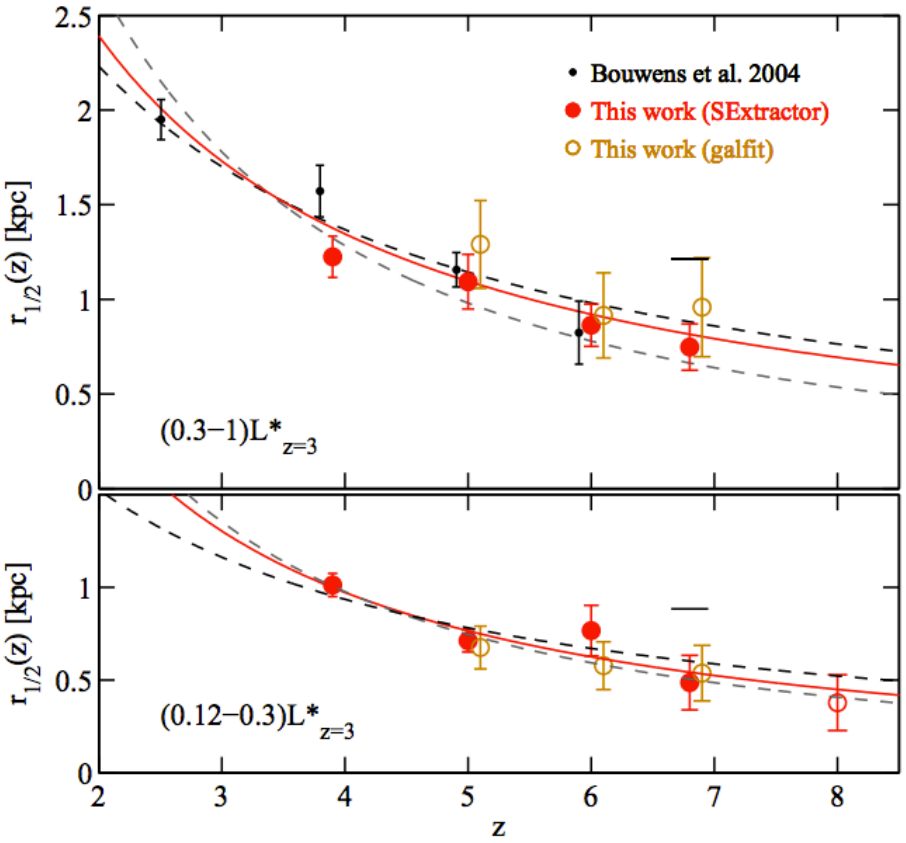


z=8.277 in J-band, Barton et al. 2004

AO resolution well-suited for first light resolved spectroscopy of Ly-α

- Sizes of first light galaxies are tiny
  - 0.2 – 0.8 kpc (0.09 – 0.18” at z=9)

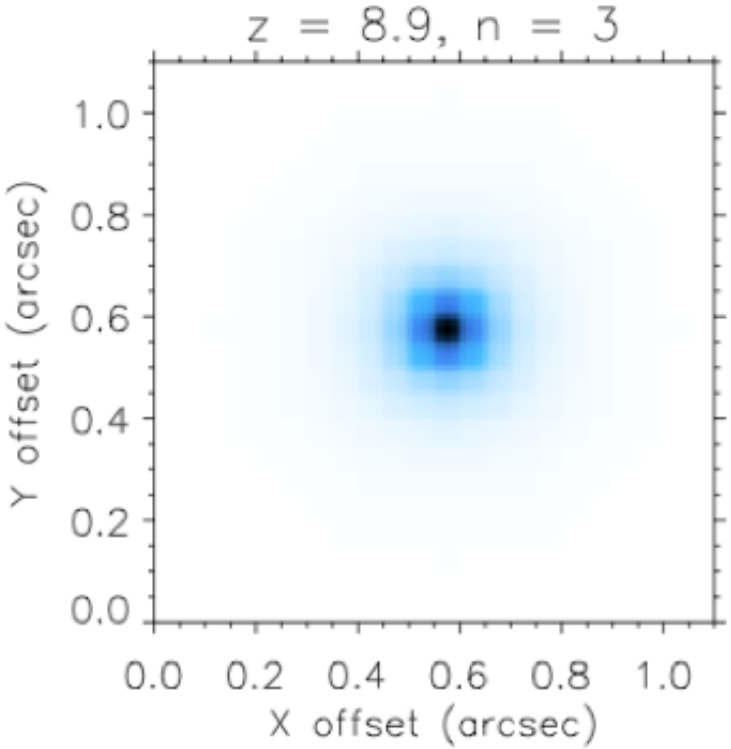


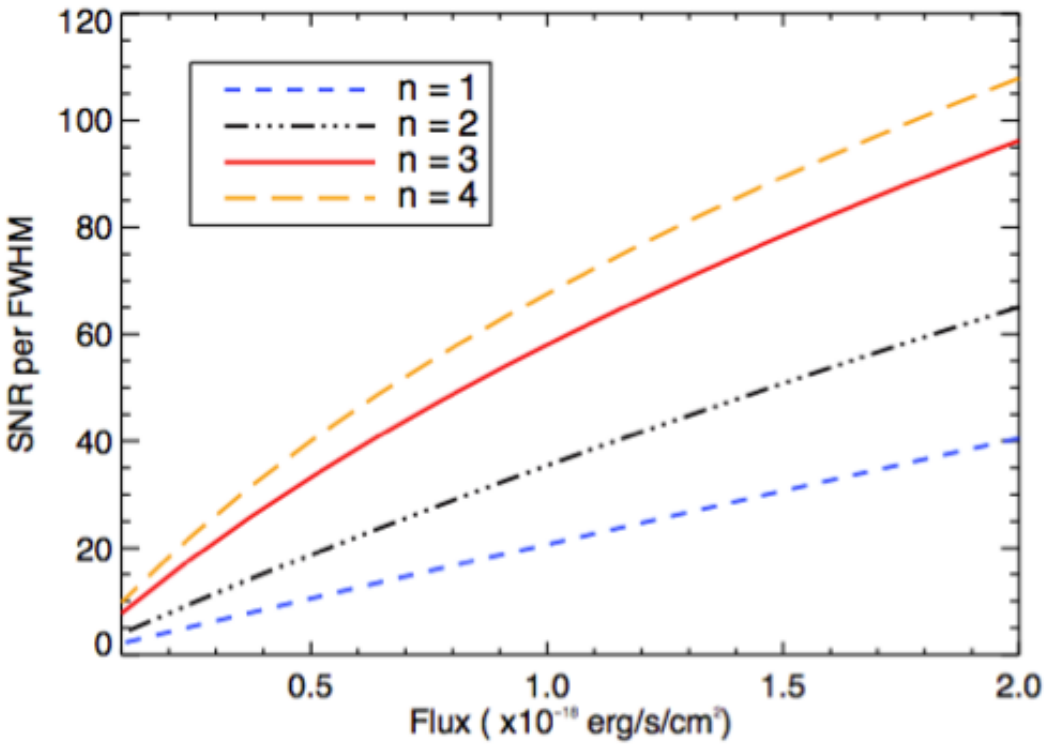


Oesch et al. 2010

Using IRIS IFS simulator to investigate capabilities of Ly-α

- Detectability of Lyα emission largely dominated by the escape fraction and optical depth to Lyα
  - Current 5σ limit 0.4-0.6x10-17 erg s^{-1} cm^{-2} for z=8 (Treu+2014)
  - Although, still 2-20 times brighter than IRIS sensitivity limit





Hope Boyce, undergrad summer student

Current work in progress…

- Investigating a range of redshifts, velocity dispersions, surface brightness profiles of Ly-α
- Investigating performance on current WFC3 dropout candidates and the SNR level for IRIS follow-up
- Investigating other lines, HeII (164.0 nm), CIII (190.9 nm)
  - Suggestions of looking into CIII since its redder, but still may be a strong line at first light galaxies