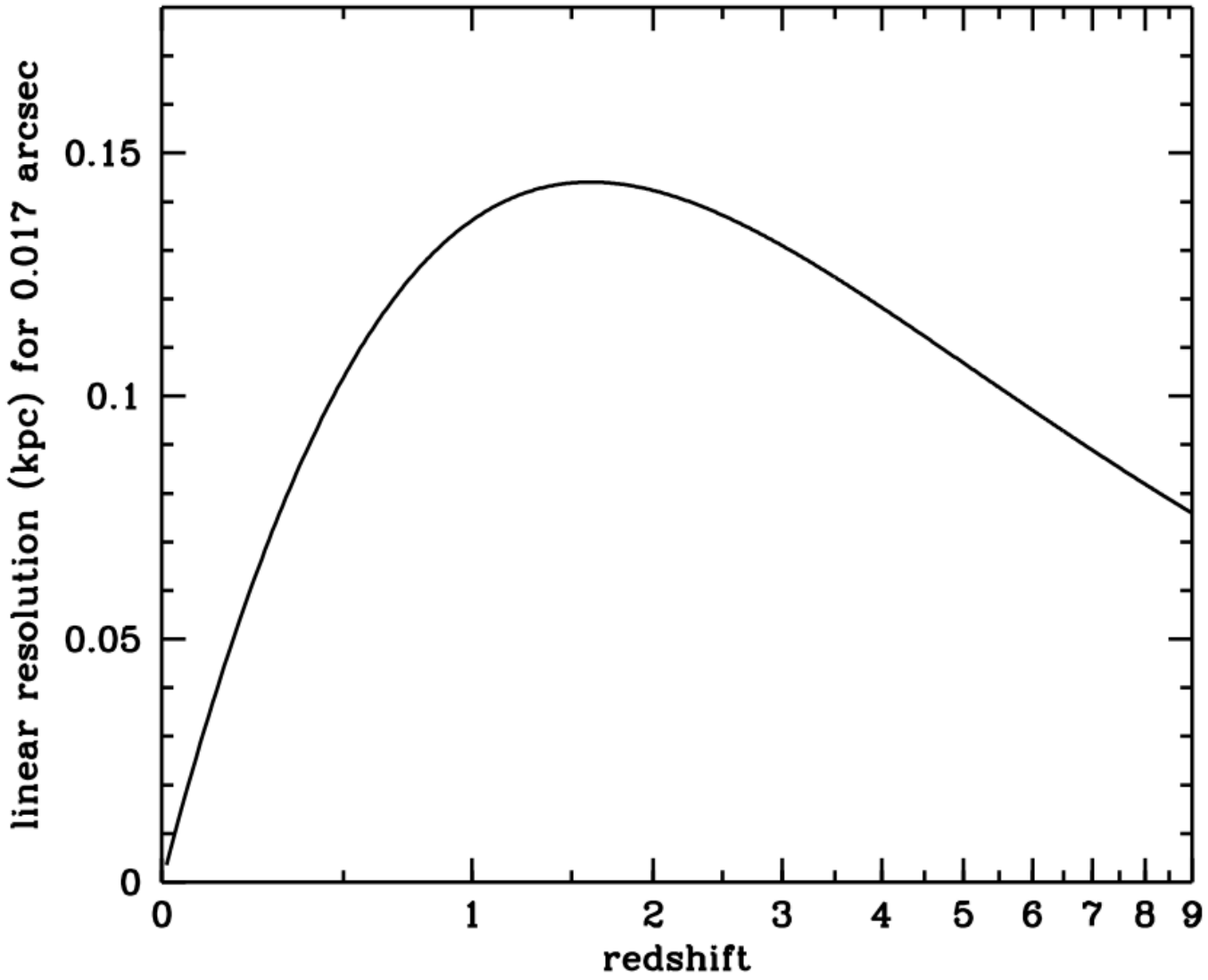
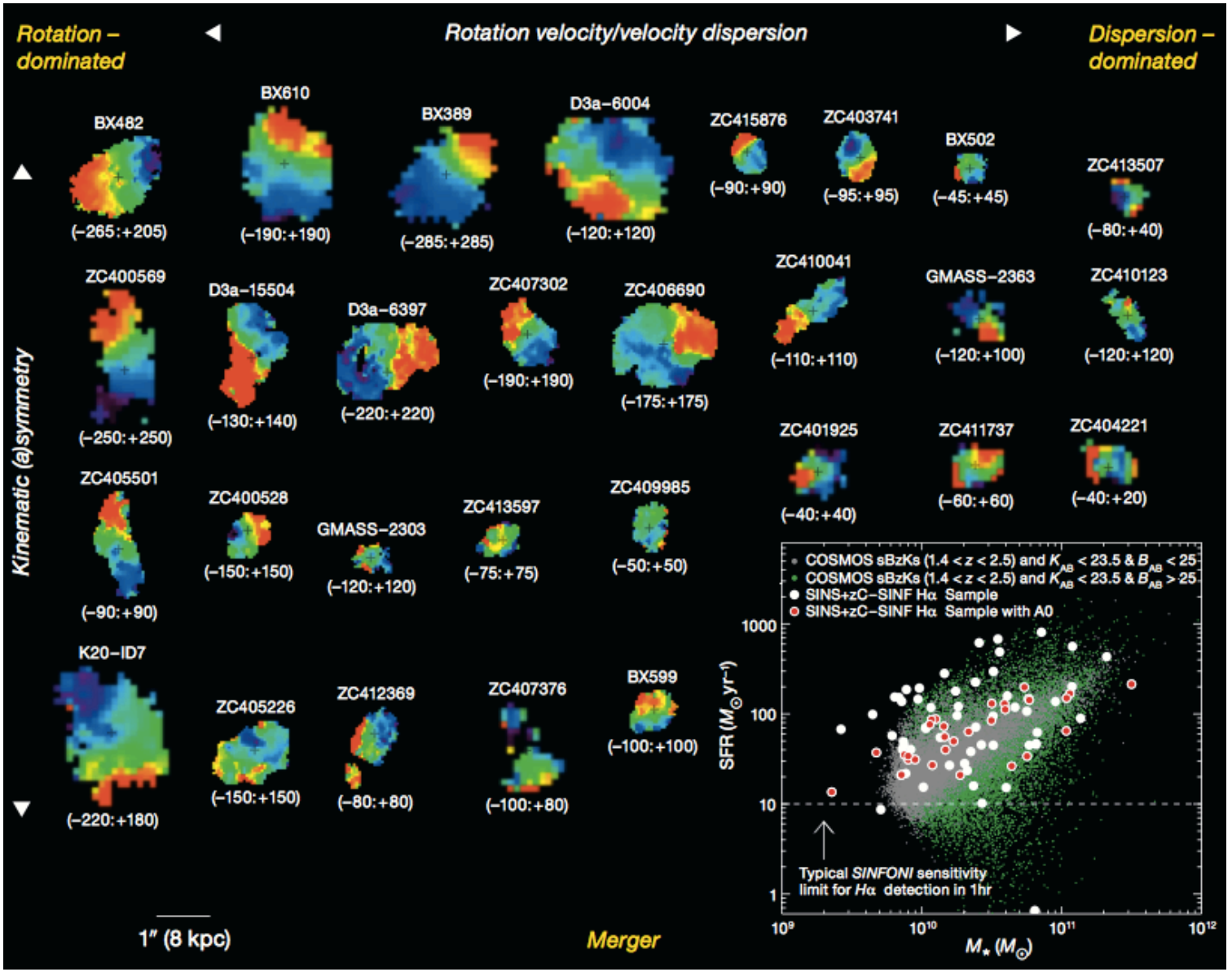
Key Project concepts
Early Universe, Galaxy Formation & the IGM

Mark Dickinson for the High-z ISDT

Linear scale at the TMT K-band diffraction limit (17 mas)



Förster-Schreiber et al. 2009, 2011 Shelley Wright's talk Tuesday



Evolution of galaxy structure, kinematics, star formation, extinction, and ISM properties

- Mainly an IFU/AO spectroscopic survey (+ imaging?) of galaxies
  - 2D spectroscopy of nebular emission lines and stellar absorption lines
- Probably mainly $1 < z < 5.5$
  - Optical rest-frame nebular lines in YJHK
- Galaxy structure at ~100 pc scale (~5x better than JWST)
- Kinematics of gas & stars
- Winds, infall, outflow
- Nebular excitation – ISM properties, nuclear ionization
- Metal content & distribution (gas & stars)
- Star formation distributions (e.g., Hα) at high angular resolution
- Extinction & attenuation mapping – relation to ALMA dust maps
- Observations are likely to require ~several hours per IRIS bandpass, perhaps 1 to 4 galaxies per night depending on science goals.

Evolution of galaxy structure, kinematics, star formation, extinction, and ISM properties

It's likely that the ISDT will prepare two proposals:

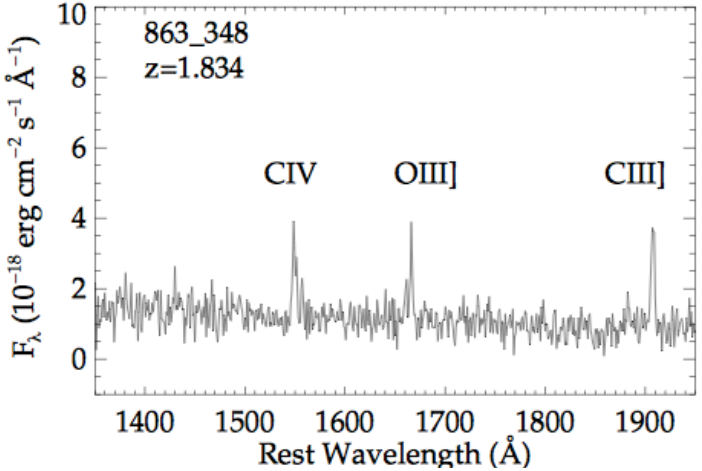
- Kinematic evolution, $1 < z < 5.5$
  - Growth of galaxy mass, size, and evolution of kinematic "settledness" of galaxies
  - Observe strongest emission lines available per redshift interval: Hα, [OIII]+Hβ, [OII]
  - Exposure times mostly from pre-knowledge of line fluxes from slit spectra (8-10m MOS pre-surveys, JWST, IRMS)
  - Sample selected to span parameter space of (1) redshift, (2) stellar mass, (3) star formation rate?
- Structure, star formation, and ISM properties at the peak era of galaxy growth
  - $2 < z < 2.5$: nearly all important optical rest-frame nebular lines observable, allowing rich diagnostics of star formation, extinction, excitation, metallicity
  - K-band imaging samples optical rest frame (IRIS imaging at ~5x JWST resolution)
  - Sample selected to span the SFR vs. M* plane, perhaps also integrated Z from previous MOS surveys
- TBD: What science really demands a multi-IFU instrument (IRMOS) ?

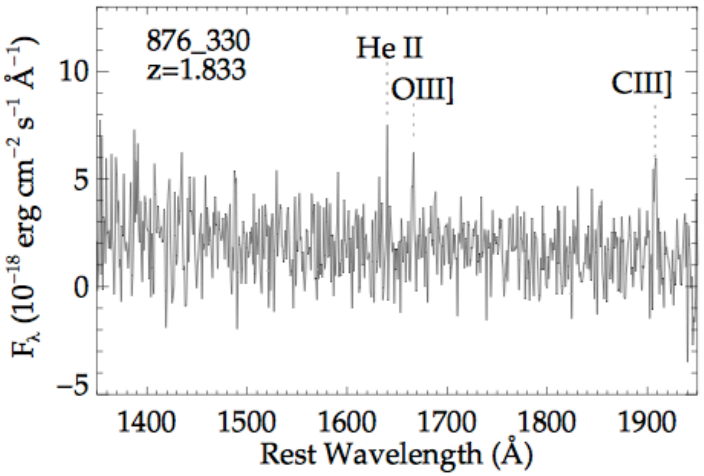
Early galaxy formation during the epoch of reionization

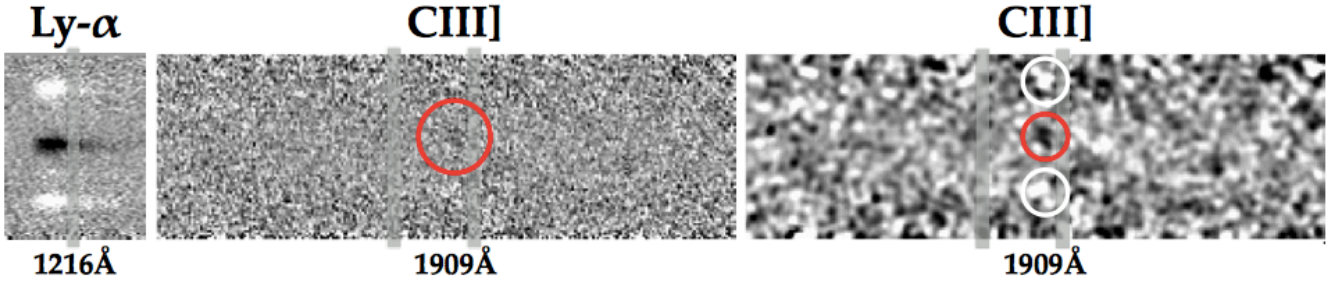
- Spectroscopy with IRMS & IRIS and diffraction-limited imaging (IRIS)
- Lyα @ $z > 7$ ($z < 7$ requires WFOS)
- High-excitation UV lines: NIV]1487, CIV 1549, HeII 1640, OIII]1661,1666, CIII]1909
- Stellar and ISM FUV absorption lines

High excitation FUV lines at z ≈ 2

Stark et al. 2014

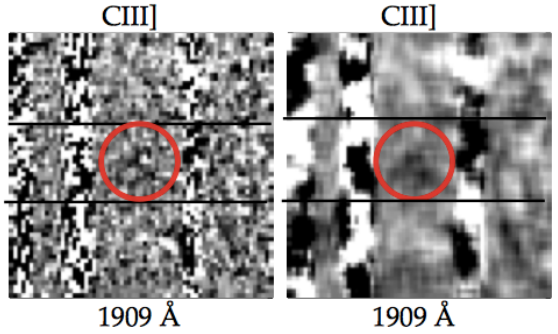






z = 6.027

Stark et al. 2015



z = 7.213

Early galaxy formation during the epoch of reionization

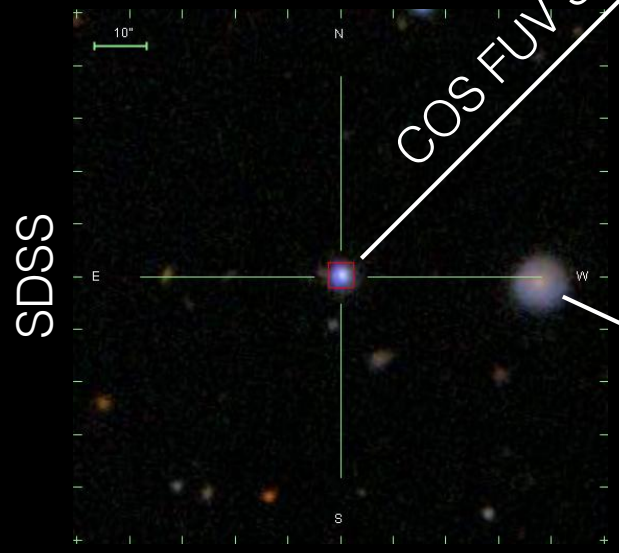
Where do we aim after ~5 years of JWST science?

- JWST will have already identified and studied samples of galaxies at these redshifts, obtaining redshifts for many
- TMT may primarily be used to study detailed properties of those galaxies
- Structure of early galaxies on linear scales ~5x smaller than JWST
- Line profiles (kinematics, etc.) at 1.5-3x higher spectral resolution than JWST (IRIS R ≈ 4000 – 8000; IRMS R ≈ 5000)
- Fainter spectroscopic limits than JWST, esp. for compact sources, narrow lines
- Some science cases:
  - Evolution of size, structure, kinematics, inflow/outflows
  - Excitation from low-metallicity populations (Pop III via HeII)
  - Stellar metallicities (FUV features @ 1360-2020A) at the level of galaxy substructure
  - Understanding ISM properties that may relate to LyC escape
  - Timeline and tomography of reionization (Lyα incidence at fainter luminosities and more dense volume sampling than is possible with JWST)

Tomography of the IGM

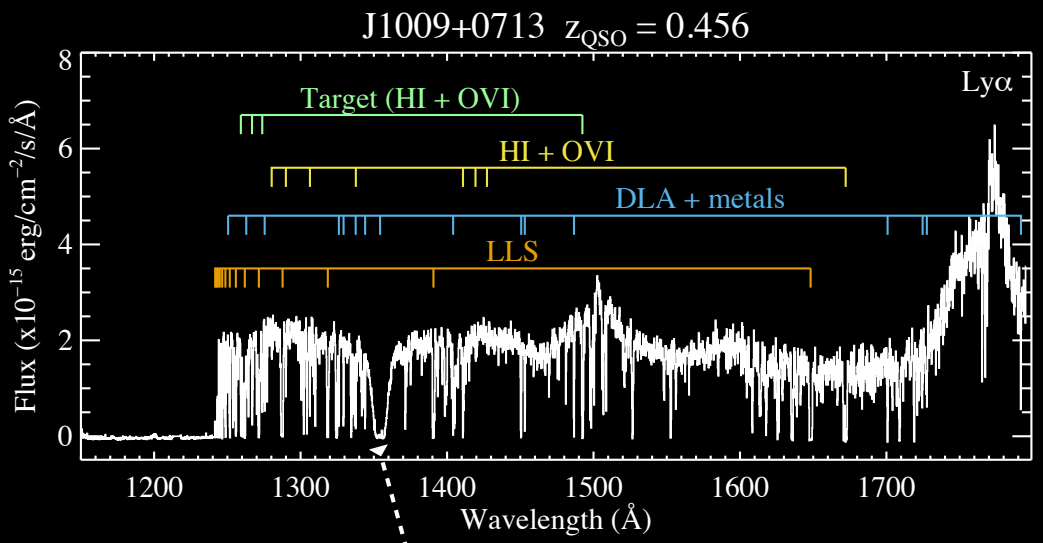
The Current State of the Art

see Srianand's talk



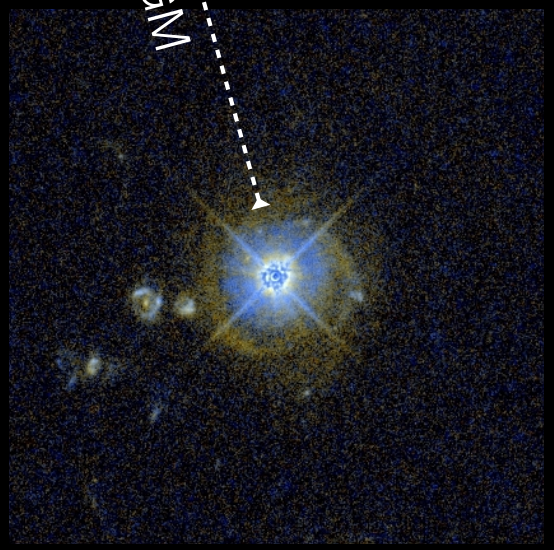
SDSS

COS FUV Spectroscopy



WFC3 Imaging

CGM

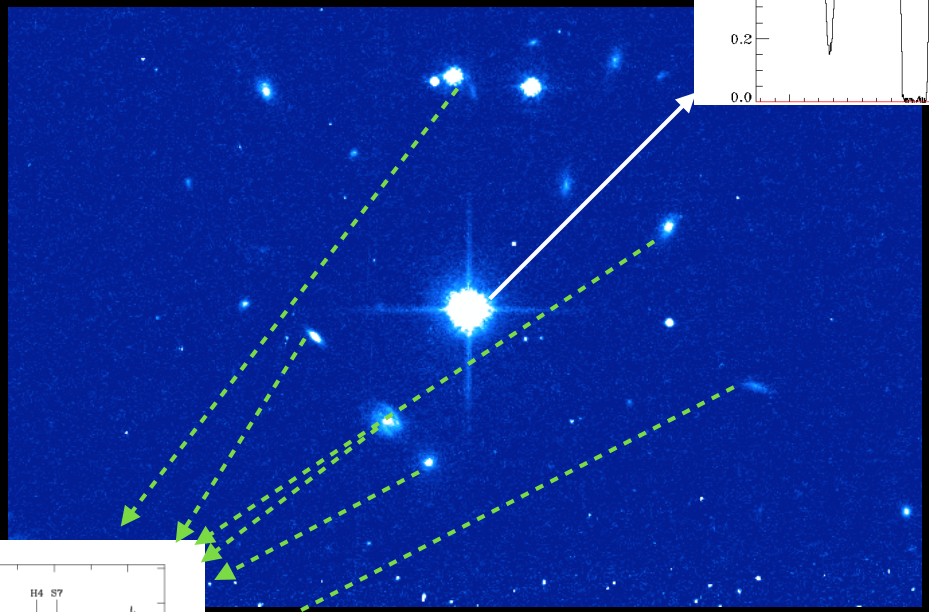


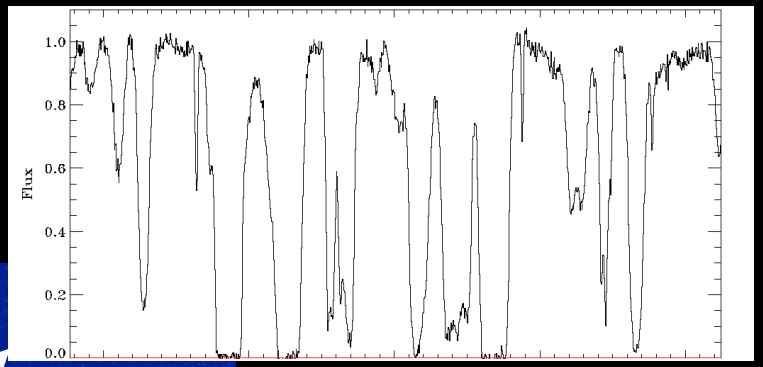
Currently limited to single, bright QSOs to probe the IGM and CGM

Tumlinson+ 2011

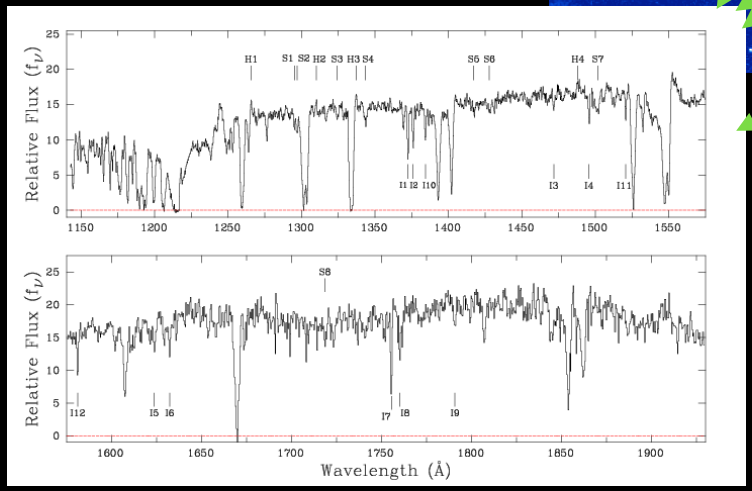
The Future With TMT+WFOS

Ultra-Deep imaging detects L<<0.1L* galaxies to large redshifts





R~70,000 Ultra-High SNR QSO spectrum detects weak absorption



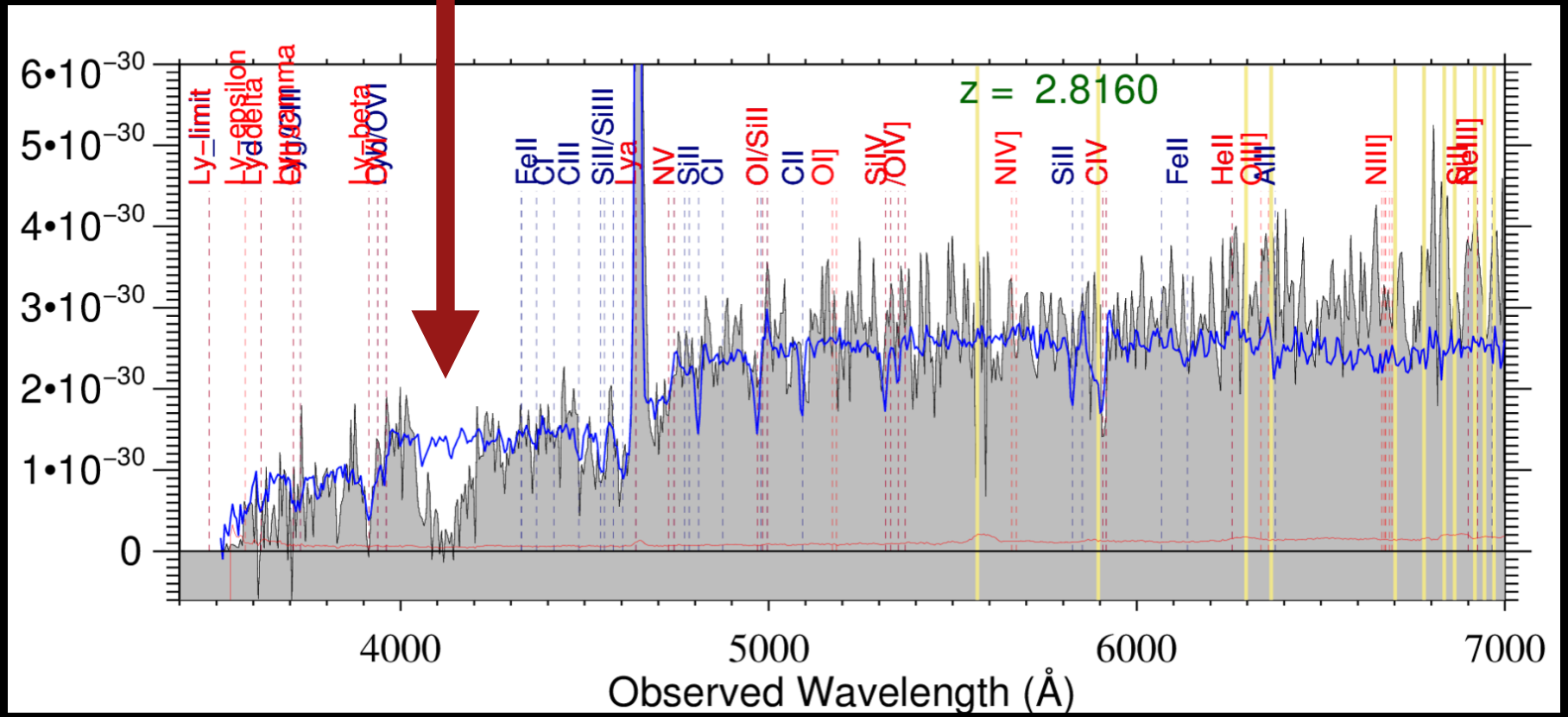
Multi-Object spectroscopy for galaxy redshifts AND IGM+CGM absorption *along galaxy line of sight*

True 3D Mapping of the IGM and CGM!

Not just vapor-ware!

DLA!

18 hours VIMOS



Cooke & O'Meara 2015

More key project suggestions

- T. Kodama: Very deep / ultradeep optical & near-IR MOS surveys
  - Primarily using TMT to get redshifts or spectroscopic properties 3-10x fainter than 8-10m telescopes
- M. Lemoine-Busserolle: IRMOS multi-IFU of ~250 gravitationally lensed high-z galaxies magnified by massive lensing clusters
  - Galaxy properties, kinematics, etc. at scales < 100 pc
  - Galaxy properties 1-3 mag fainter than unlensed sources
- Yiping Wang: Size evolution of compact quiescent galaxies and QSO host galaxies at high redshift
  - Higher angular resolution than JWST for structure of compact galaxies
- Linhua Jiang: Spectroscopy of z > 6 QSOs
  - Evolution of lower luminosity AGN, lower-mass BHs
  - More numerous than bright QSOs; probes of IGM and reionization
- R. Chary: Tracing evolution of large-scale structure using massive, IR-luminous galaxies
- R. Chary: Properties of rare galaxy-galaxy lenses (e.g., from Euclid, LSST) to study DM halo substructure
- R. Chary: Spectroscopy of high-z transients (e.g., GRBs)

Science with MOS: towards the E-ELT Era

Home

Registration

List of Participants

Program

Location

Hotels

Social Events

Other Activities

7 - 11 Sept 2015
Cefalu, Sicily, ITALY