JWST Sensitivity

Jane Rigby (NASA Goddard Space Flight Center)

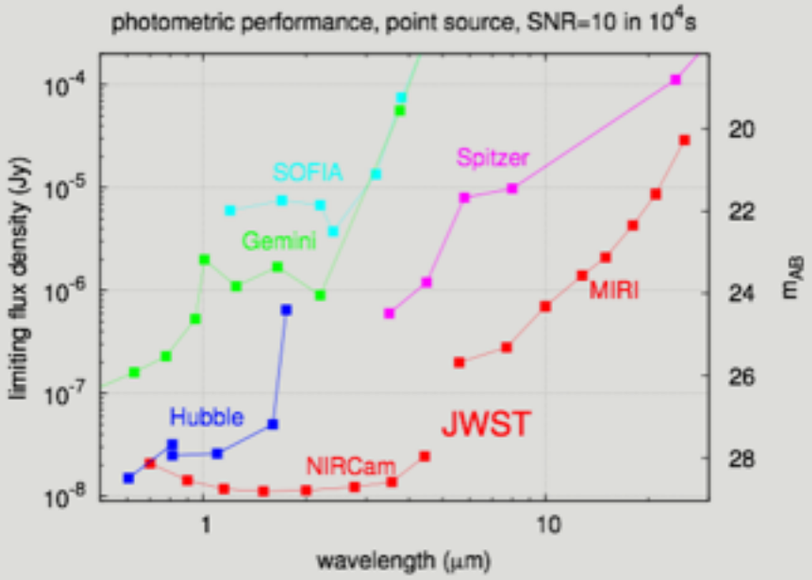
ABSTRACT: We compare the sensitivity of JWST's instruments to those of current observatories. The purpose is to help astronomers visualize JWST's capabilities, and how JWST will advance their own science. Requirements are plotted. We summarize the key sources of background emission for JWST. JWST Exposure Time Calculators will be available 1/2017.

Where to learn more:

- **Sensitivity plots: http://www.stsci.edu/jwst/science/sensitivity**
- **Backgrounds: http://ssc.spitzer.caltech.edu/warmmission/propkit/som/bg/**
- **Quickly estimate Zodiacal emission: https://youtu.be/4TpNd9WF29k**

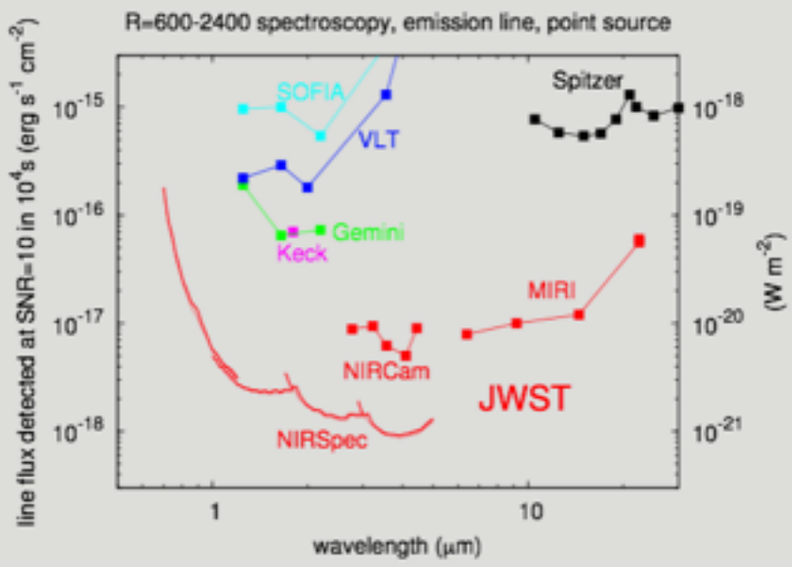
Photometric performance:

Here is the limiting flux density of a point source that would achieve S/N=10 in in 10^4 s. JWST points are in red.



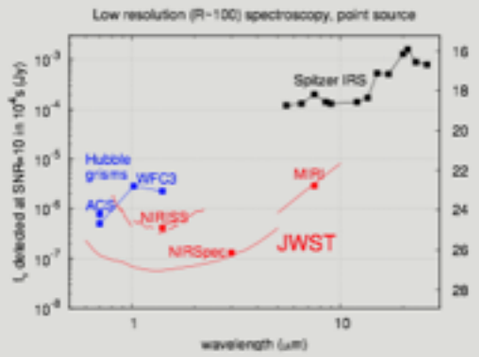
Spectroscopic performance:

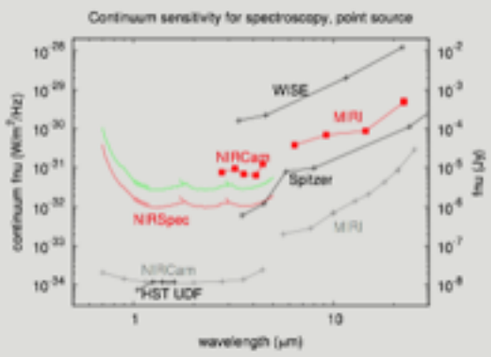
Here, for medium-resolution spectroscopy, is the limiting line flux of a point source that would achieve S/N=10 in 10^4 s. JWST points are in red.



More on Spectroscopy:

LEFT: Continuum flux density for which R=100 spectrum has S/N=10 per resolution element in 10^4 s.
RIGHT: The same, for higher-resolution spectroscopy. In red and green are JWST spectroscopy; in grey are photometric limits of JWST and other observatories. This is a way to compare the spectroscopic and photometric performance of JWST.





Details and context: We select illustrative simple cases for fairly short (ten thousand second) integrations. I have published these plots, and the data tables that generate them, on the STScI JWST website (link at top left.) JWST sensitivities used here are requirements: the minimum performance required of each instrument. This is a conservative approach; on-orbit performance may be better. Sensitivities for other observatories are taken from instrument handbooks, online calculators, and published papers, as documented in the data tables. If a user believes they have discovered an error in these sensitivities, they are requested to contact Jane.Rigby@nasa.gov.

Poster in Foyer, # M8.

Plots online, google "JWST sensitivity".

Galaxy Assembly with Gravitational Lensing and with JWST

Jane Rigby

JWST Deputy Project Scientist for Operations
NASA Goddard Space Flight Center

RCS0327 iJH

z=1.70

F390, 814, 160

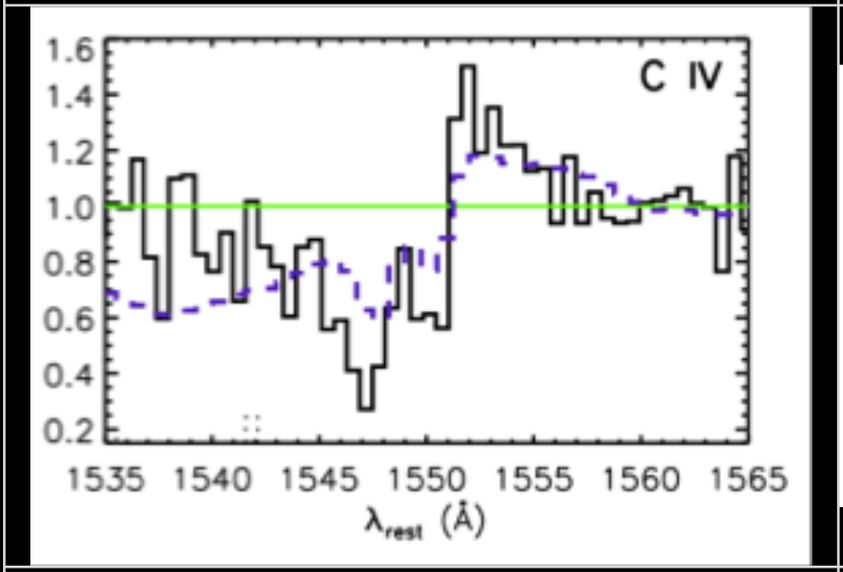
Source reconstruction

8.5 kpc = 1”

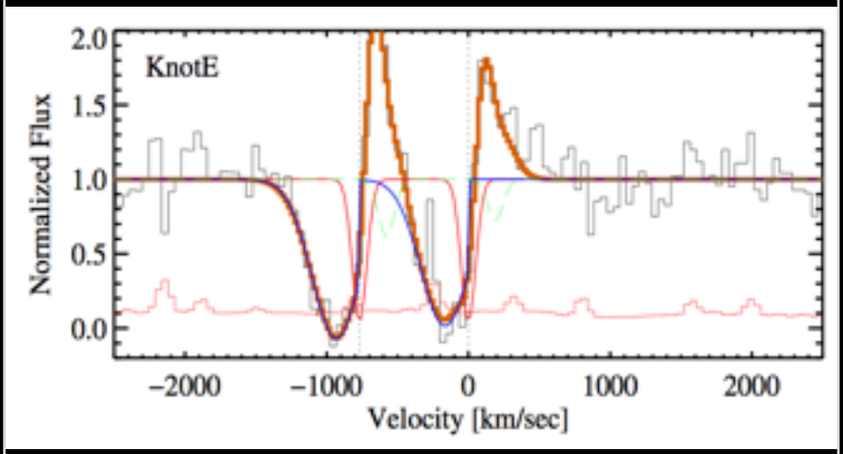
RCS 0327 at z=1.70; Sharon, Gladders, Rigby, Wuyts et al. 2012

For lensed galaxies, we are using JWST diagnostics now.

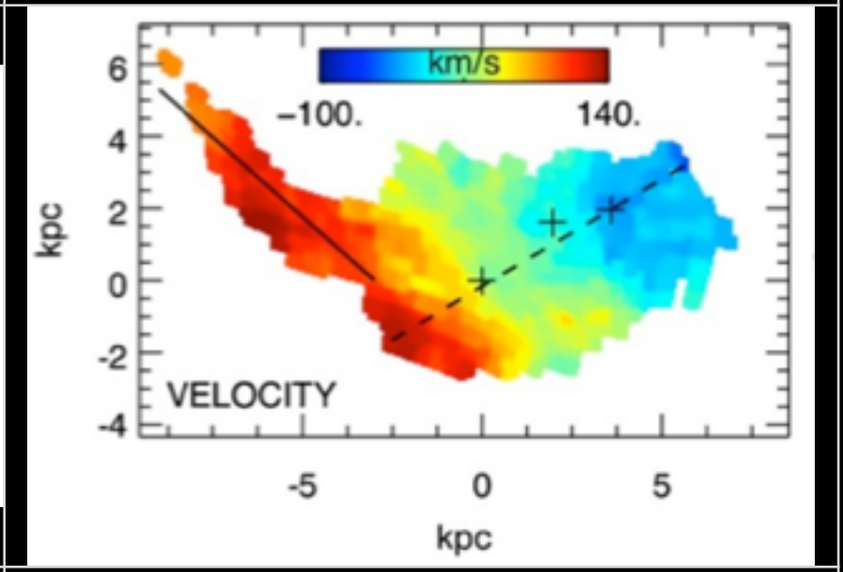
Hot stars: C IV, He II
Bayliss et al. 2014



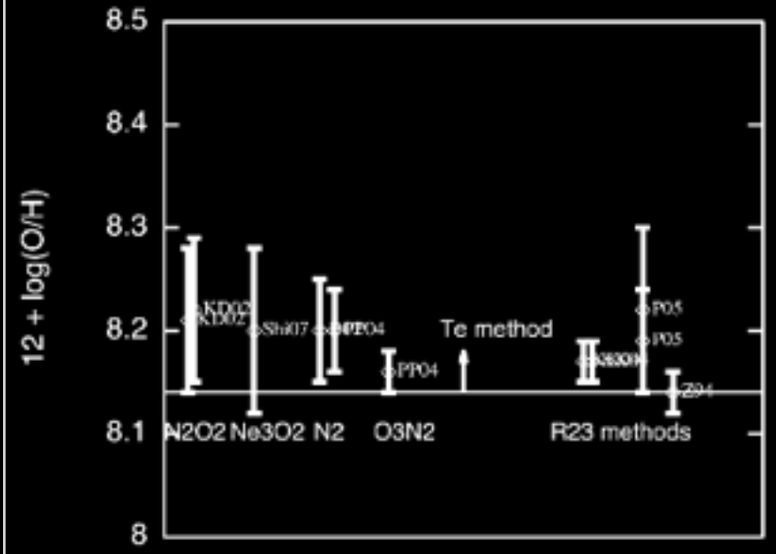
Outflows: Mg II and Fe II*
Rigby+ 2014; Bordoloi+ 2015



Kinematics: H alpha
Wuyts et al. 2014



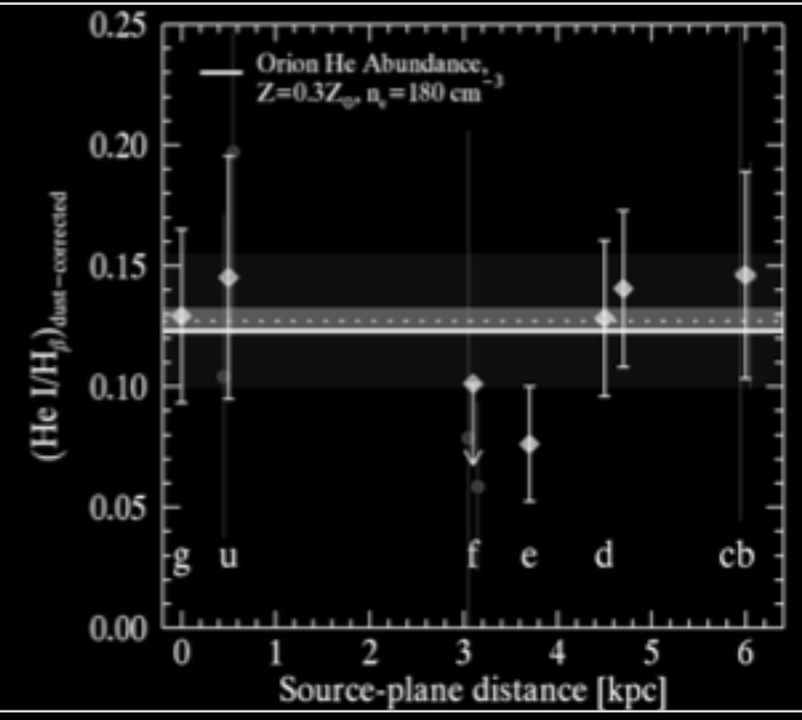
Metallicity
Rigby et al. 2011



Physical conditions:
Rigby et al. 2011

n_e = 180 ± 30 cm^{-3}
logU = -2.79 ± 0.06 ± 0.1
T_e = 1.1-1.2 10^4 K
12 + log(O/H) > 8.17 ± 0.03
[N/O] = -0.9 ± 0.04 ± 0.1
[Ne/O] = 0.0 ± 0.09 ± 0.1
[Ar/O] = 0.0 ± 0.18 ± 0.13

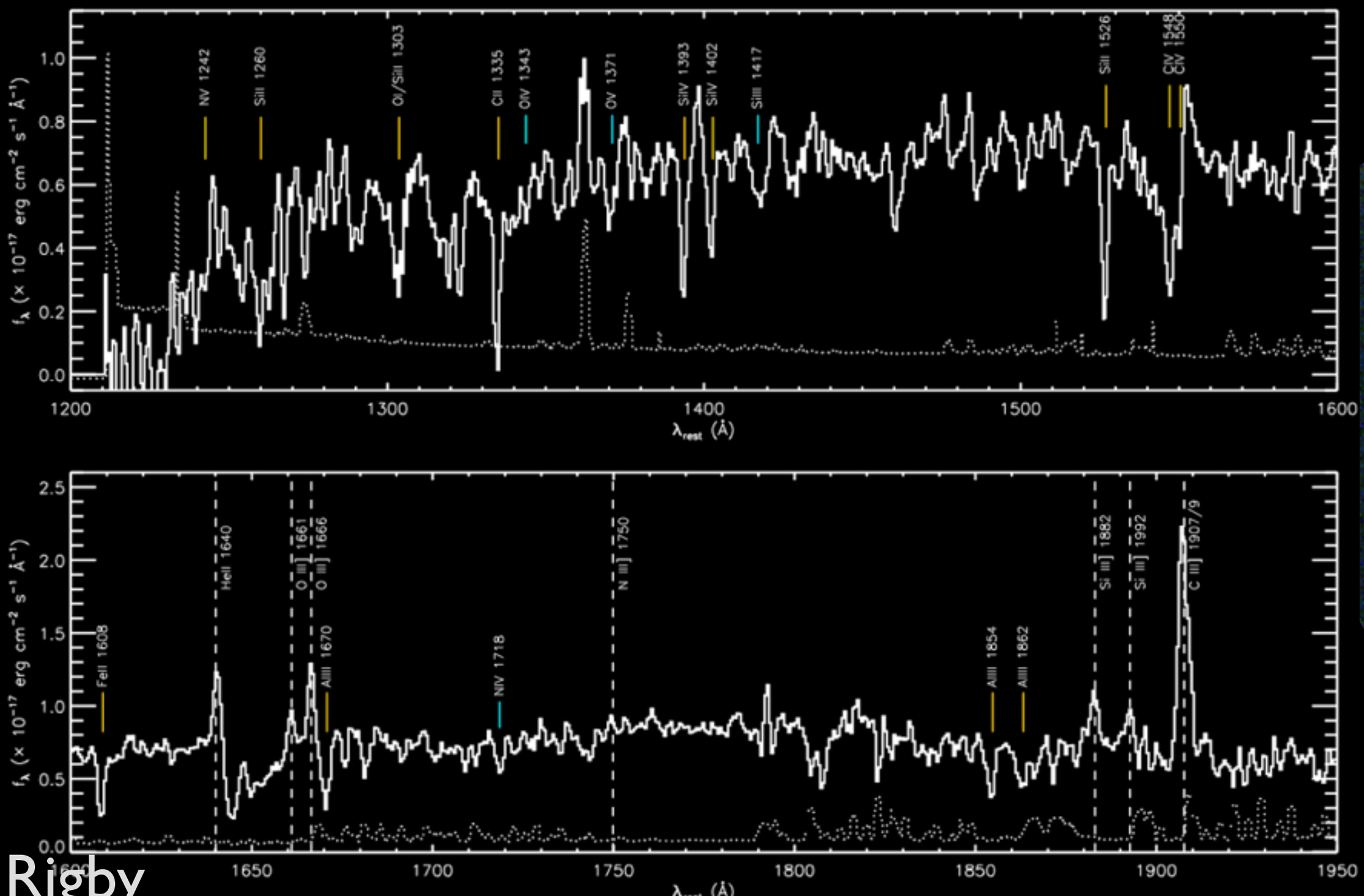
Excitation: He I/H I
Whitaker et al. 2014

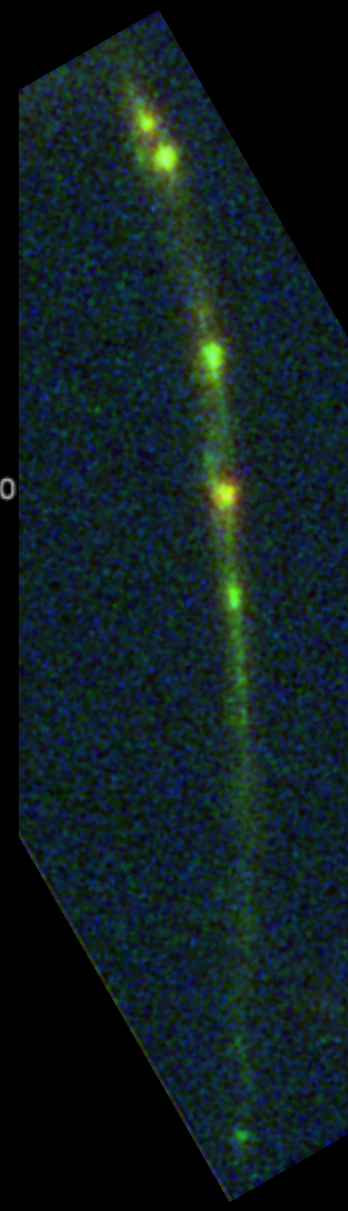


Rigby

Abundances in high-redshift galaxies: rest-frame UV lines

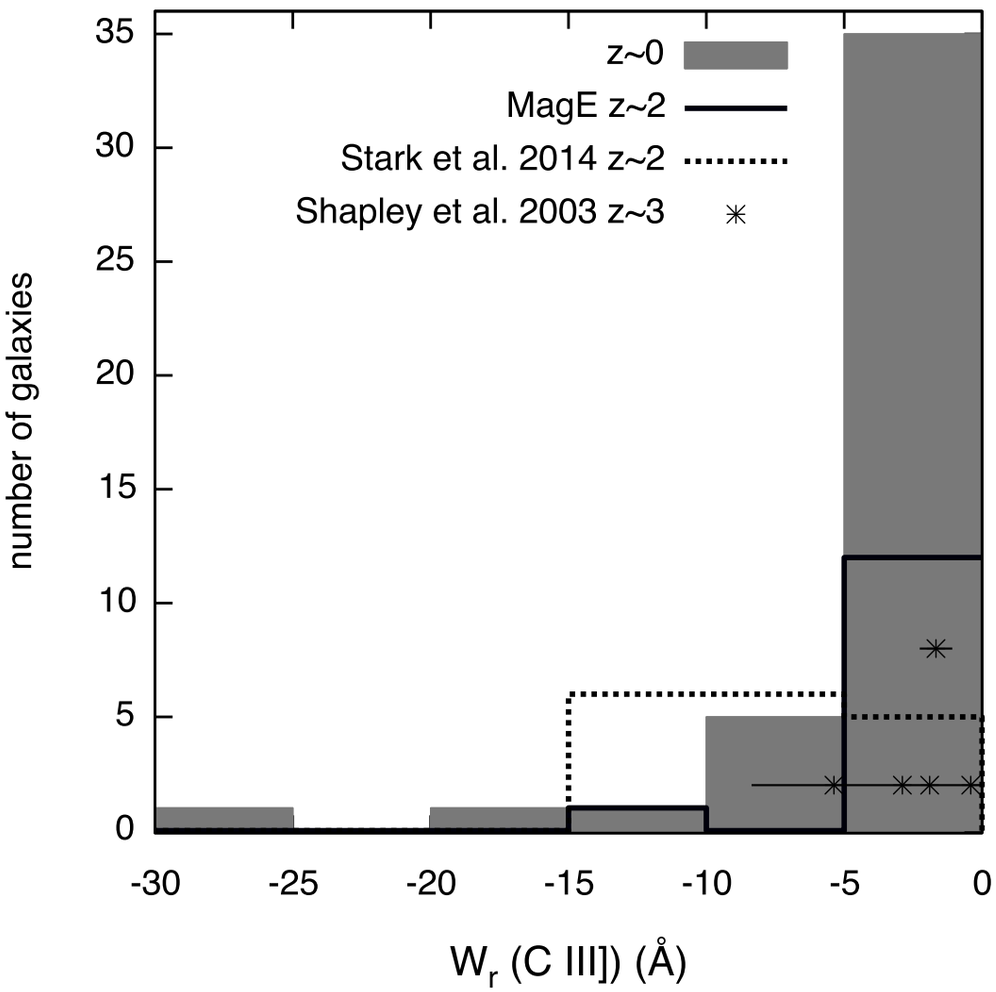
Two hours on Gemini. SGAS 1050+0017, arc z=3.625.
Bayliss, Rigby et al. 2014

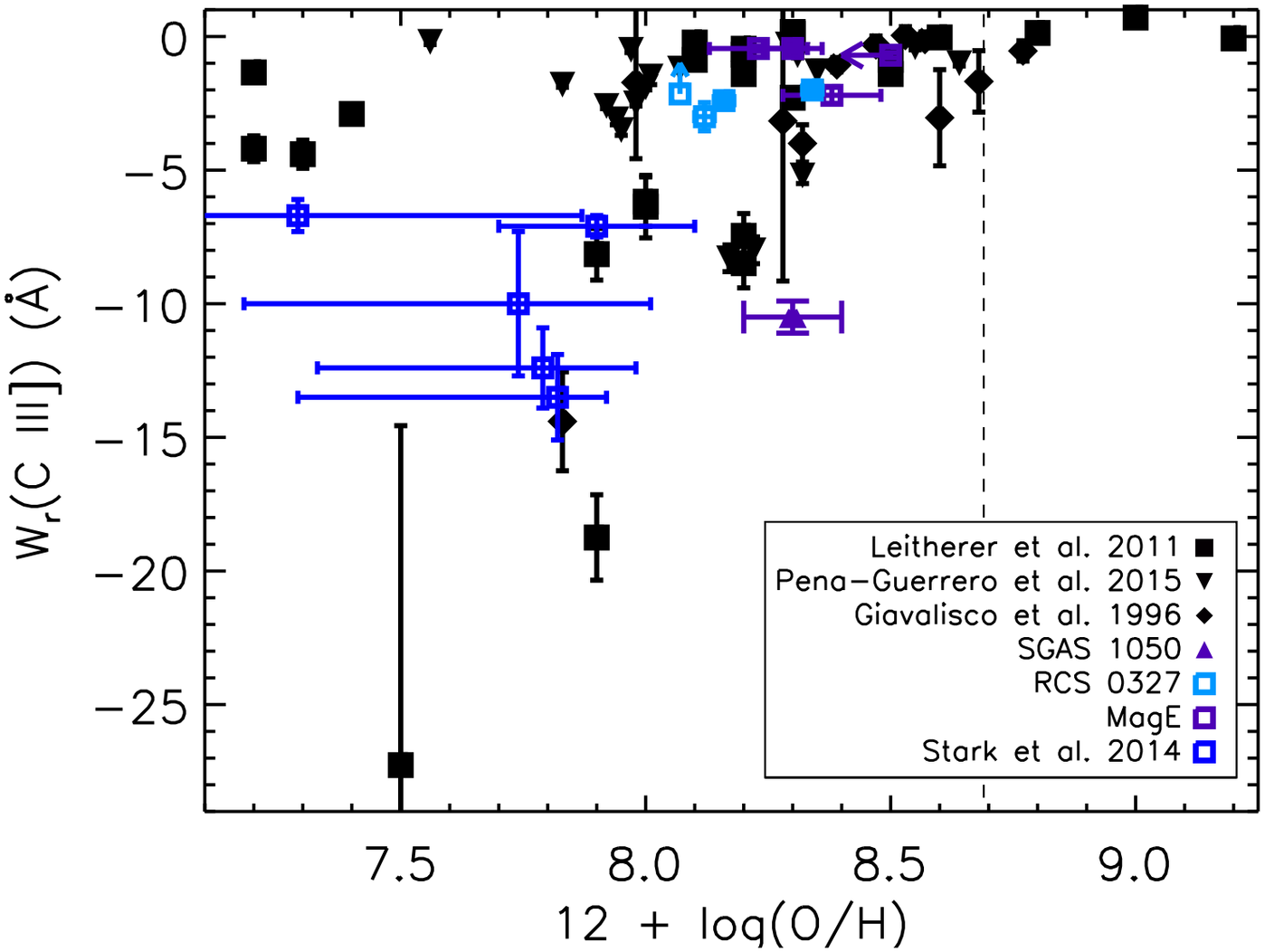




Rigby

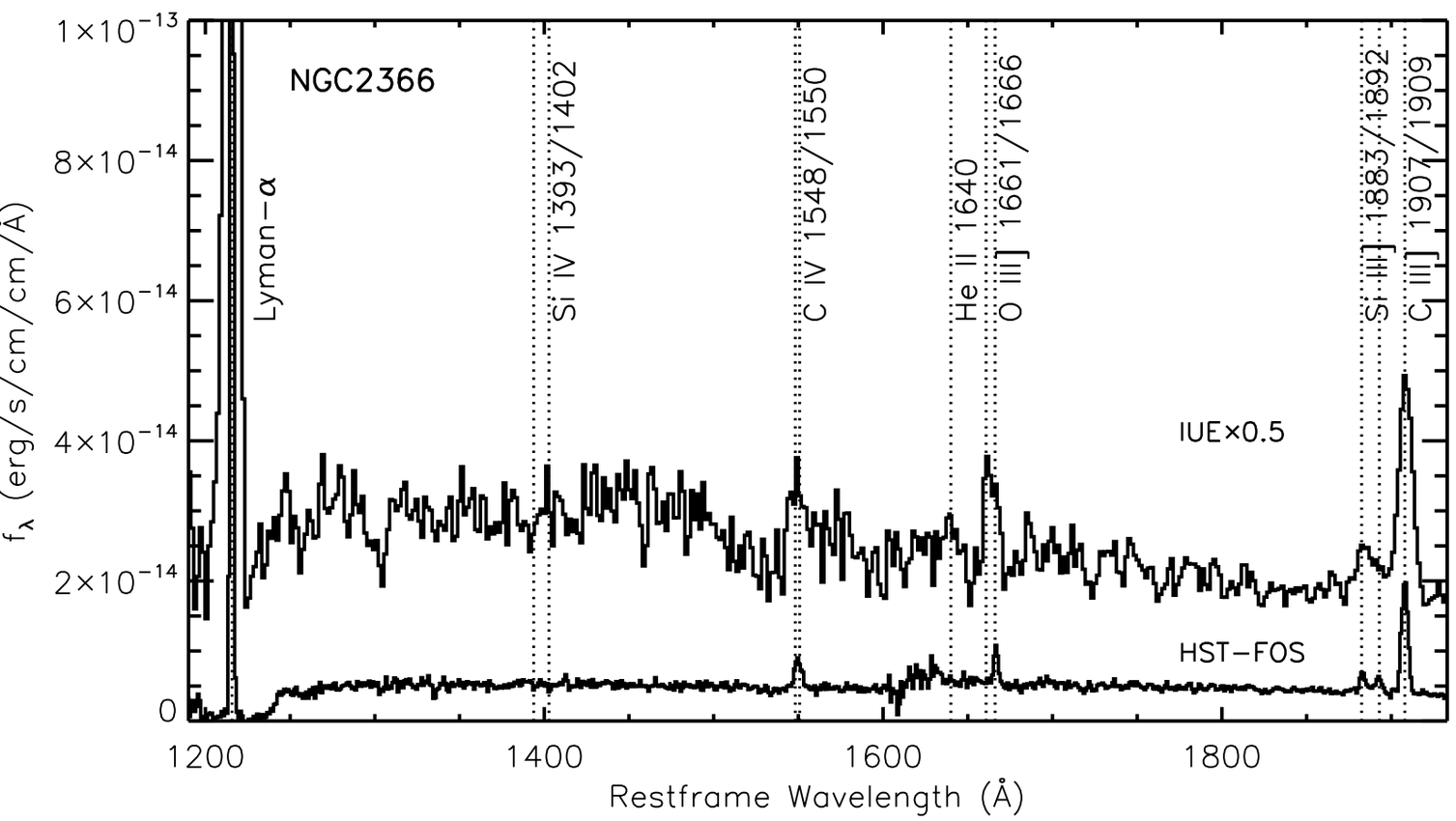
C III] emission in high-redshift galaxies

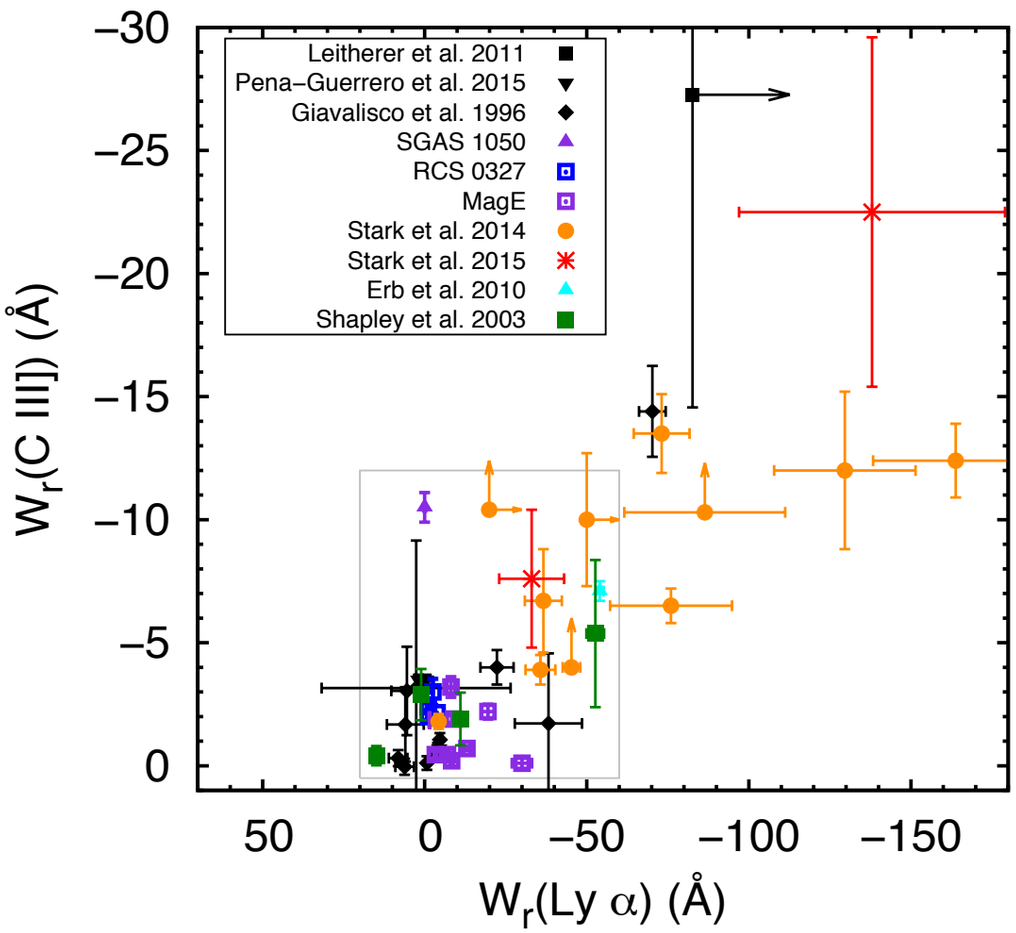




Rigby

C III] emission in high-redshift galaxies

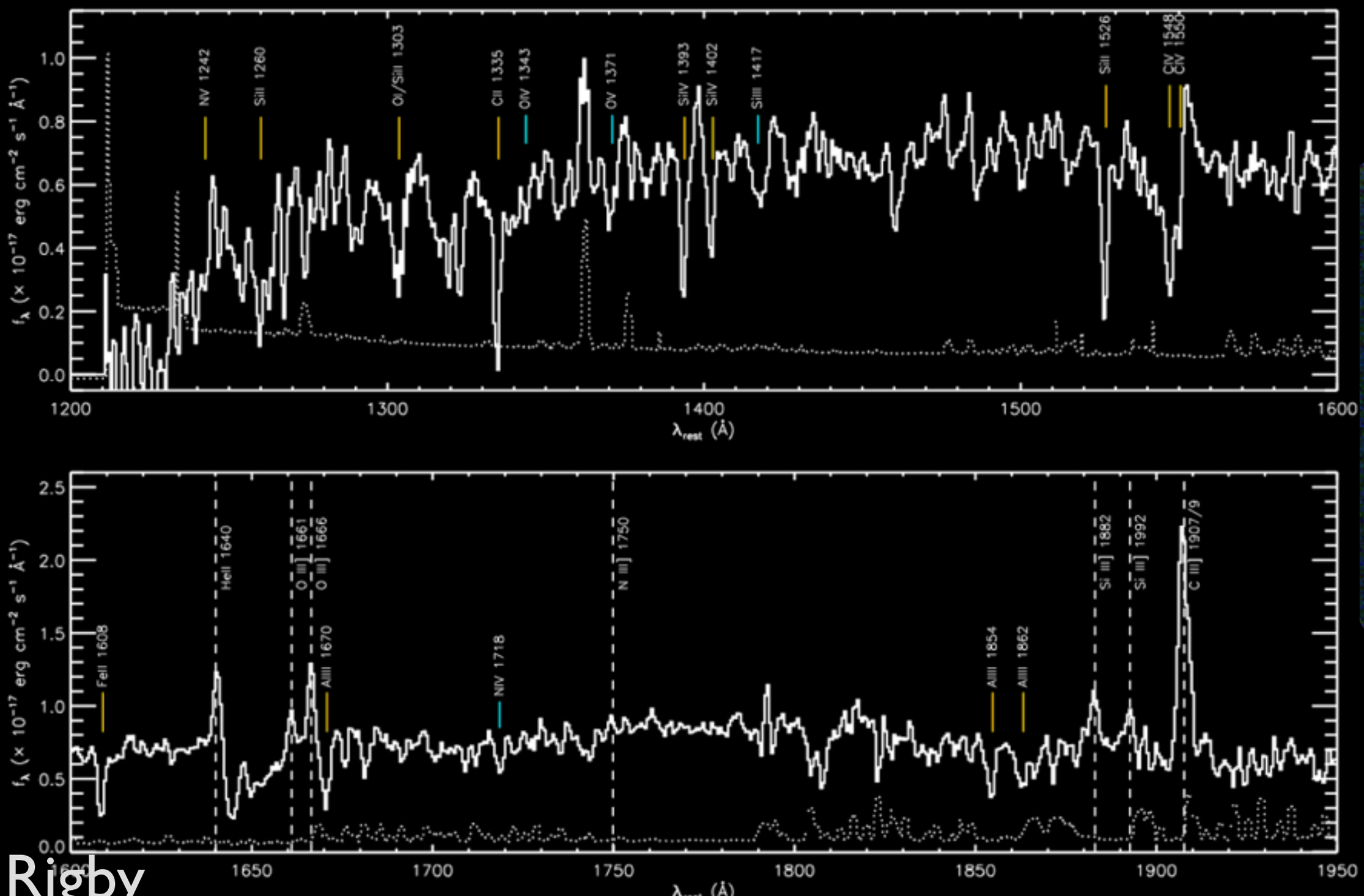


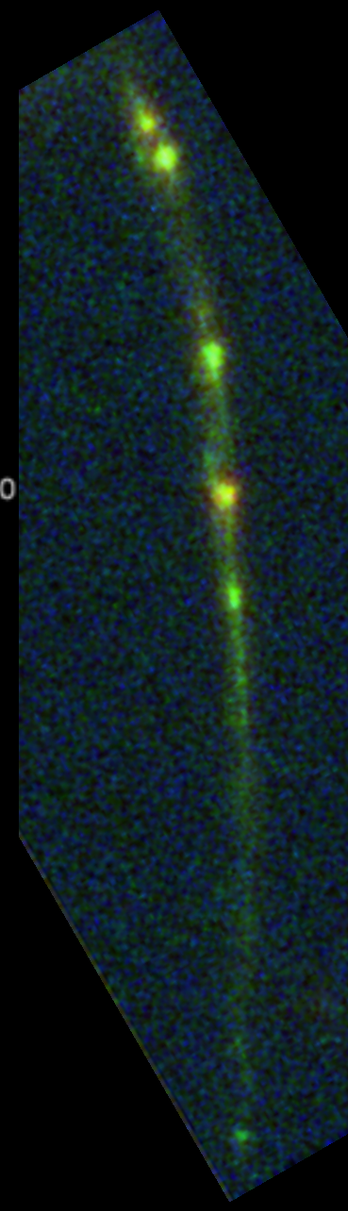


Rigby

Abundances in high-redshift galaxies: rest-frame UV lines

Two hours on Gemini. SGAS 1050+0017, arc z=3.625.
Bayliss, Rigby et al. 2014

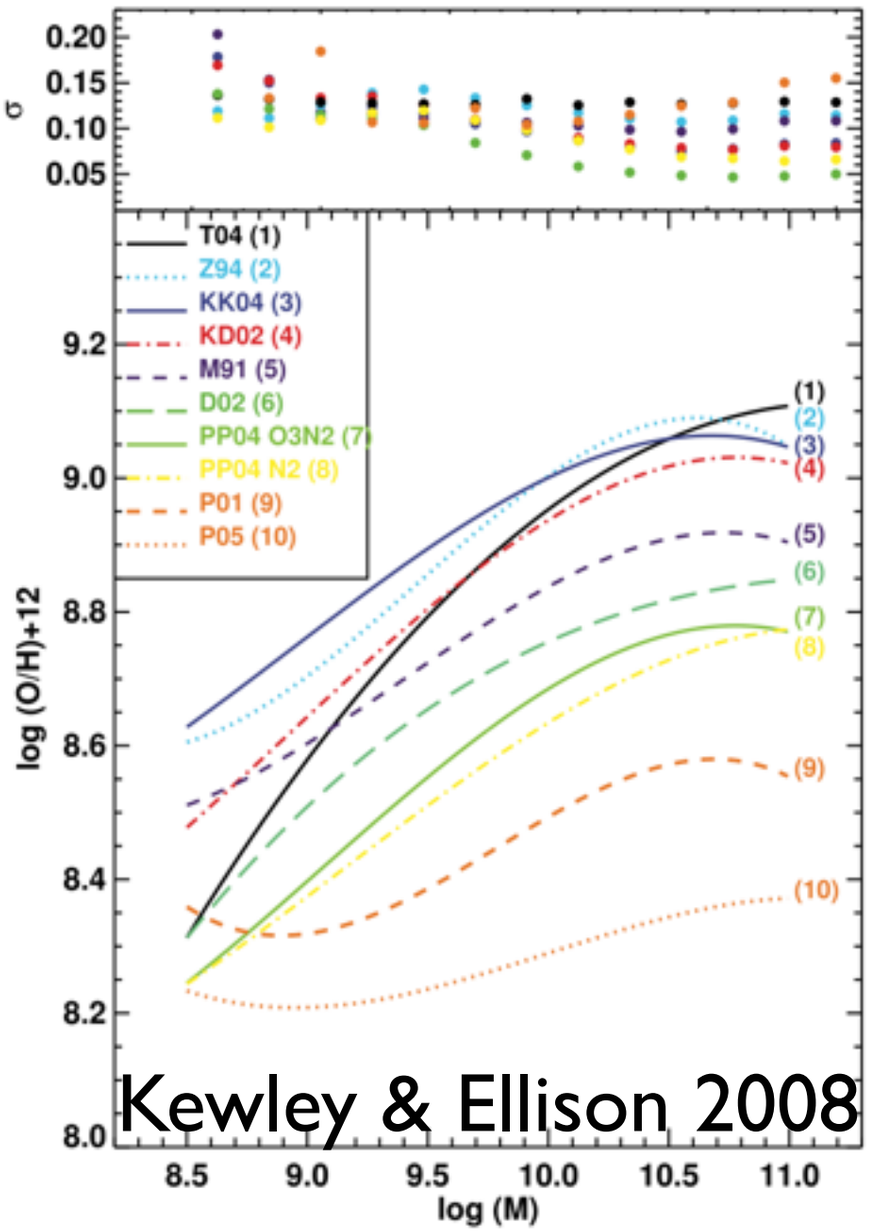




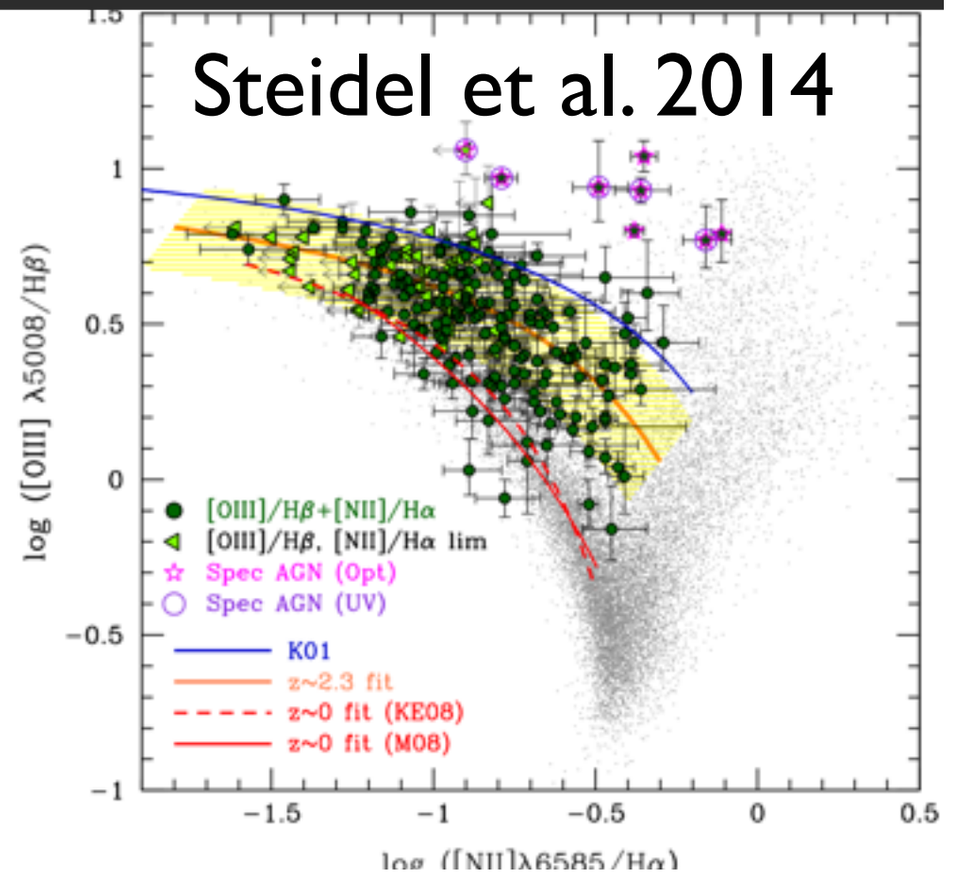
Rigby

Abundances in high-redshift galaxies: rest-frame optical lines

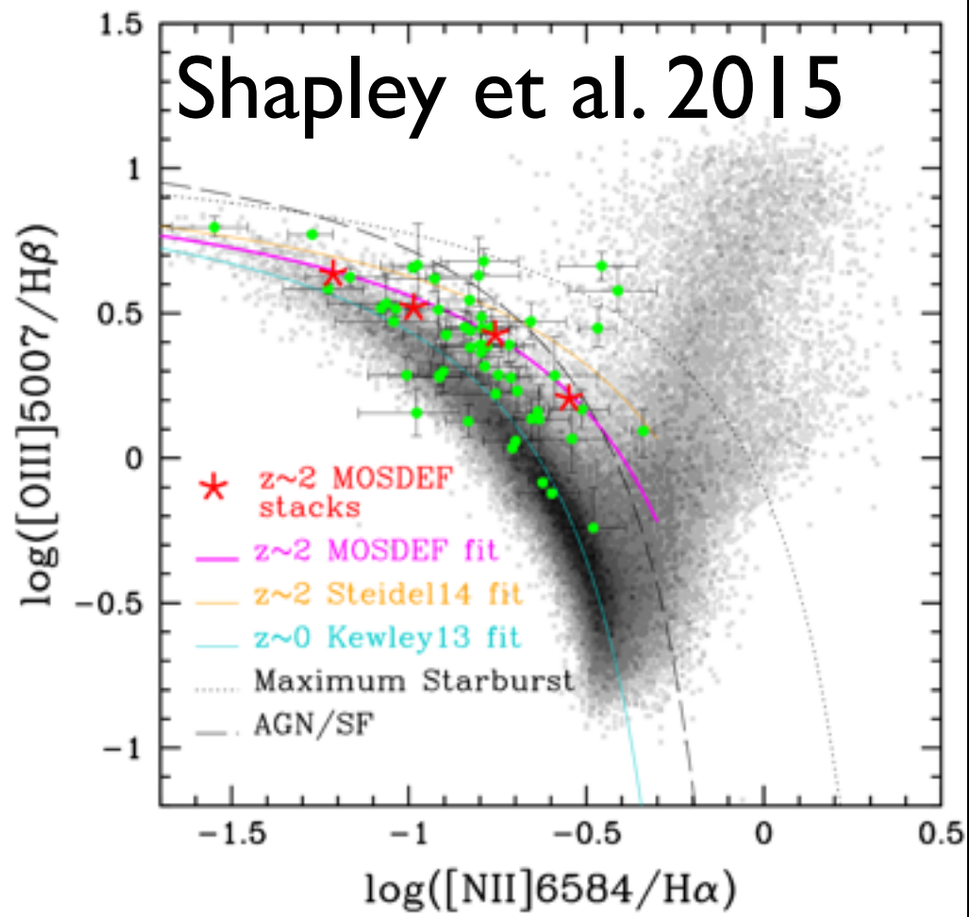
"There is great chaos under heaven, and the situation is excellent."
-Mao, on metallicity diagnostics



Kewley & Ellison 2008

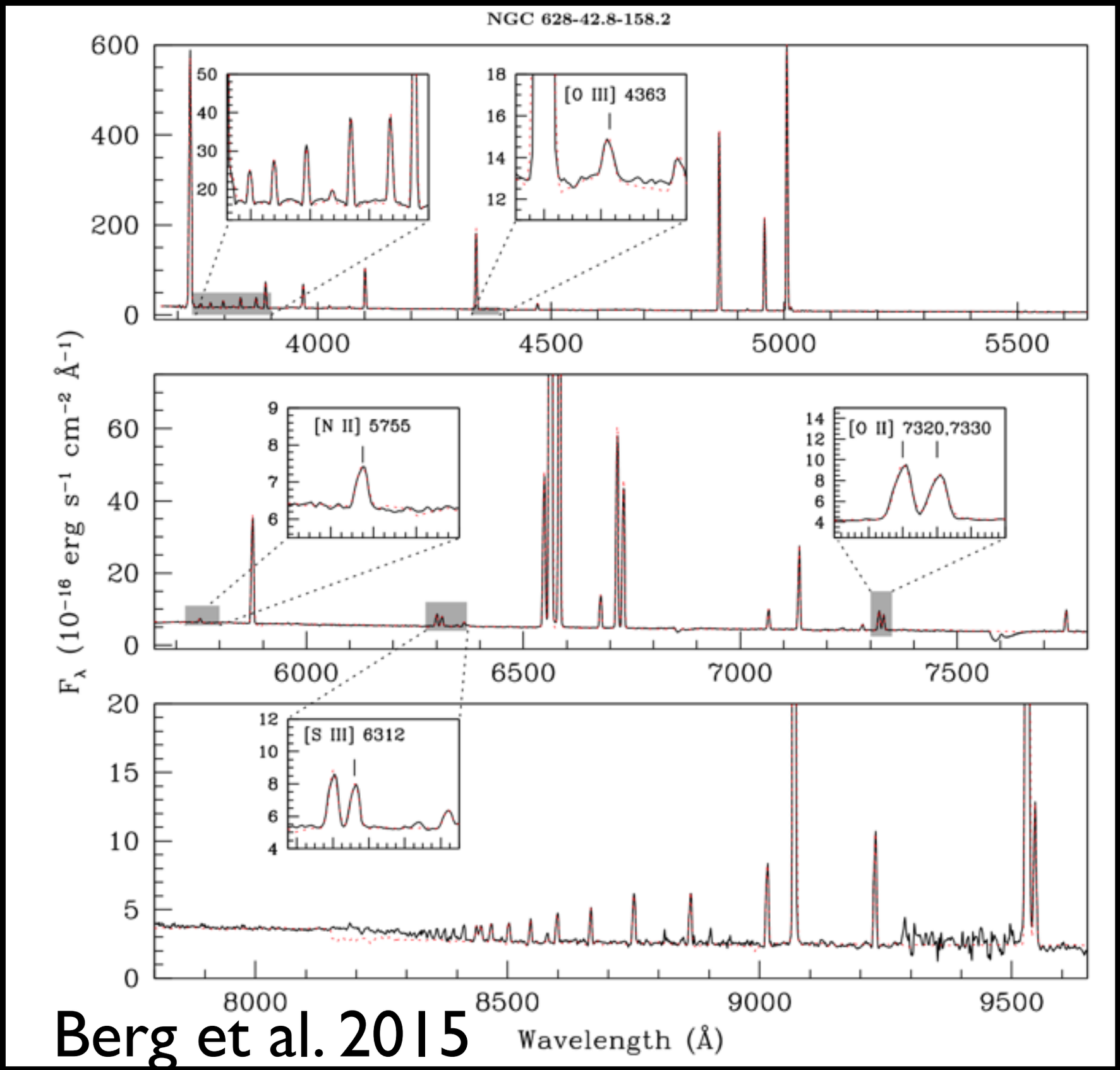


Steidel et al. 2014



Shapley et al. 2015

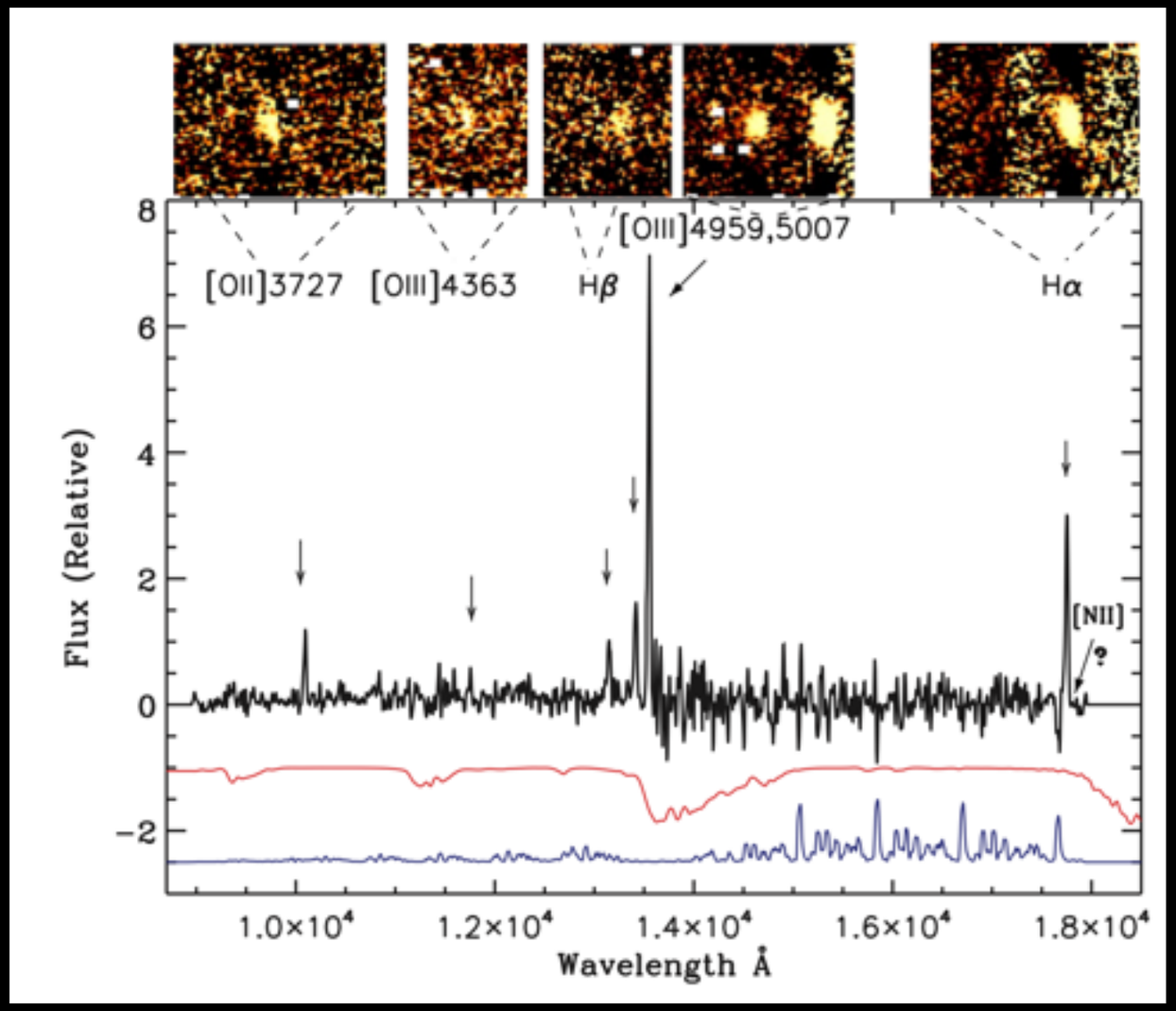
Abundances in high-redshift galaxies: rest-frame optical lines



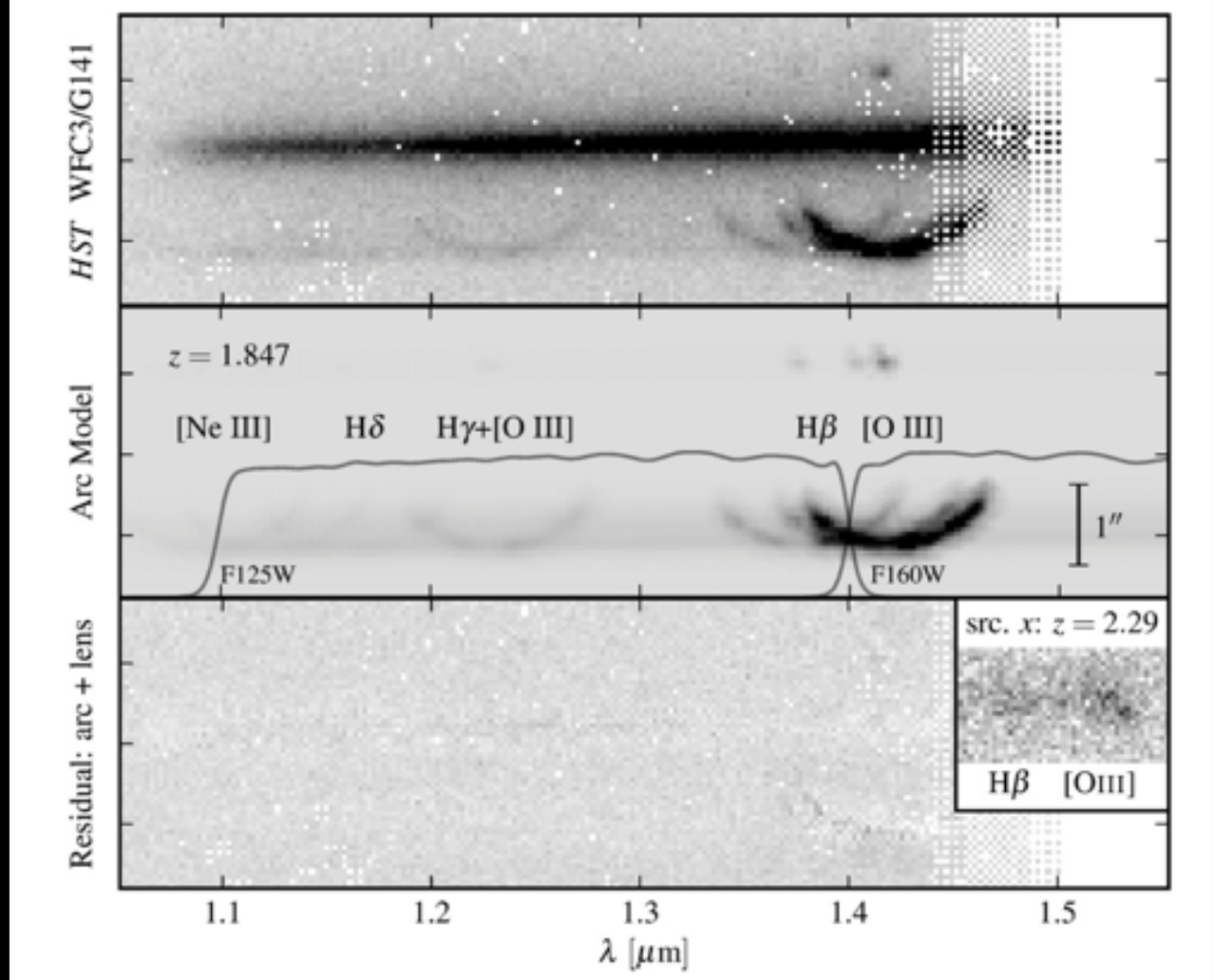
Berg et al. 2015

Rigby

Abundances in high-redshift galaxies: rest-frame optical lines



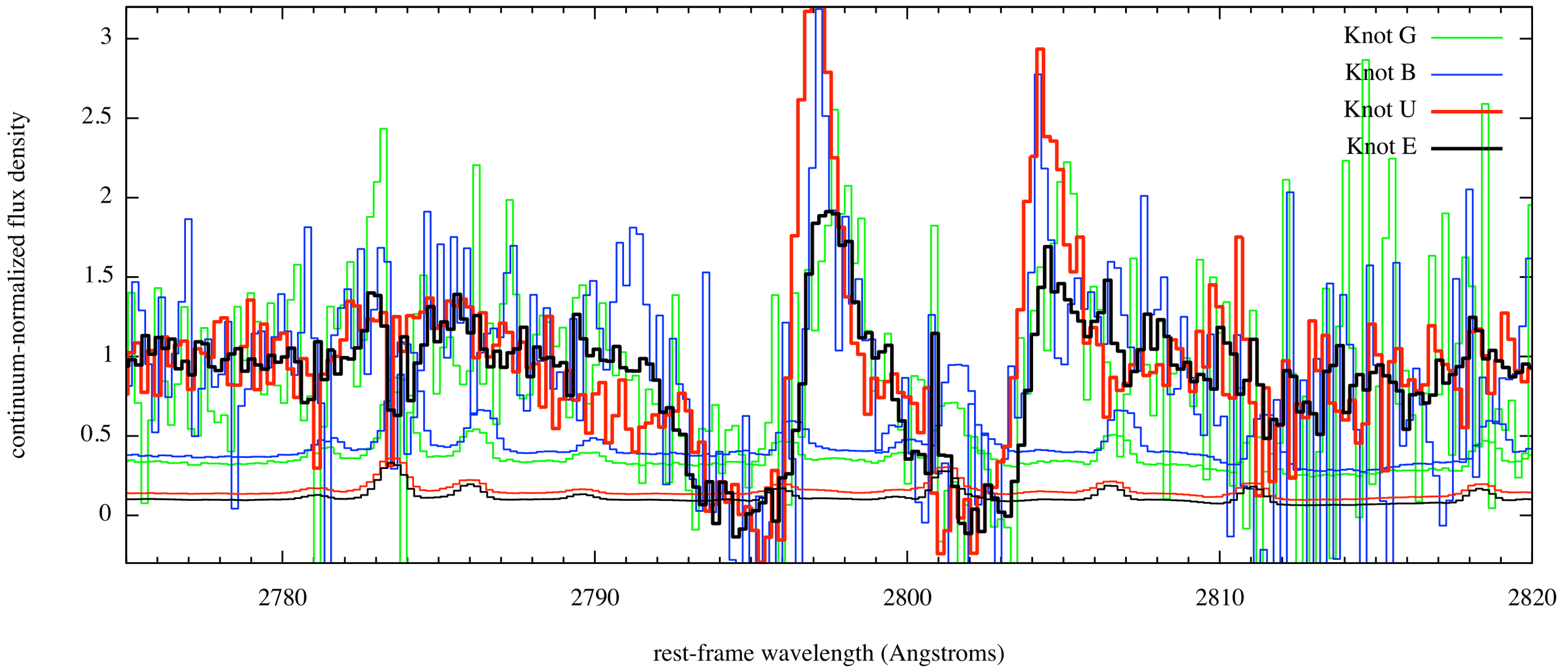
Yuan & Kewley 2009

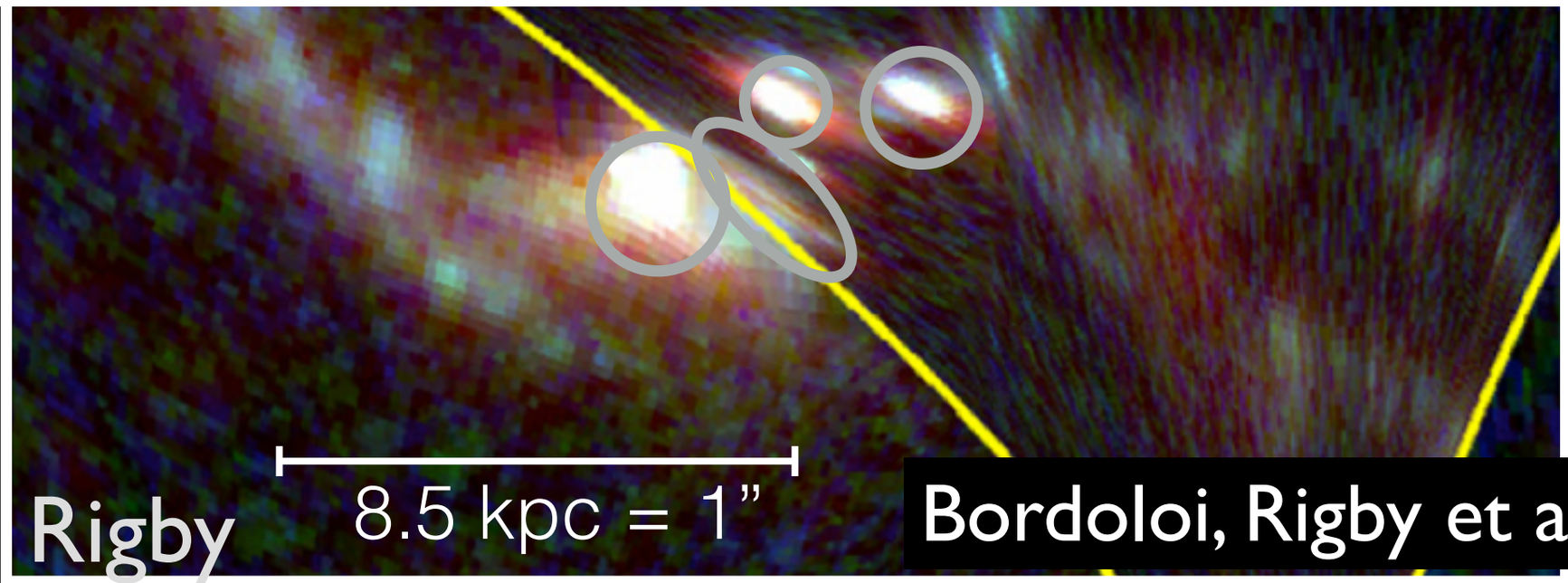


Brammer et al. 2012

Rigby

Mg II 2796, 2803 emission

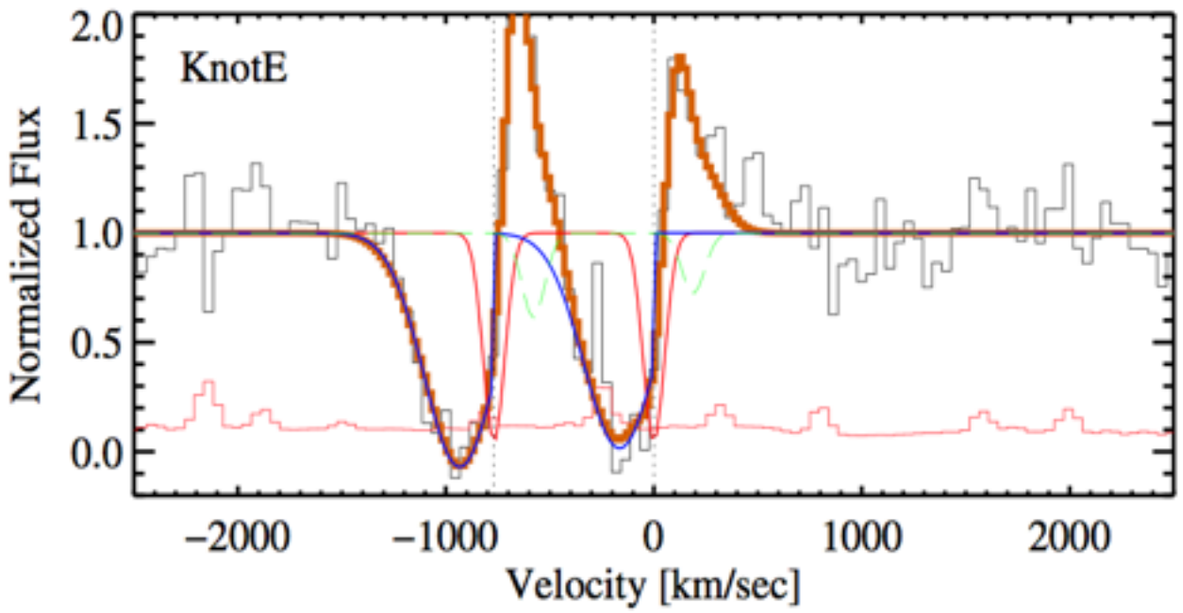


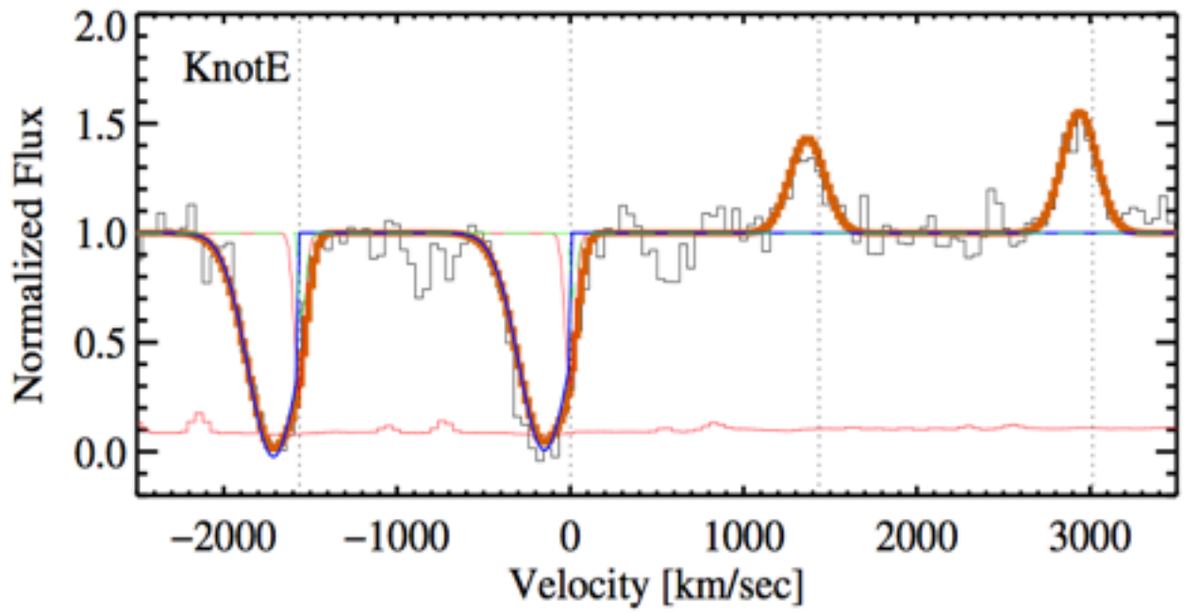


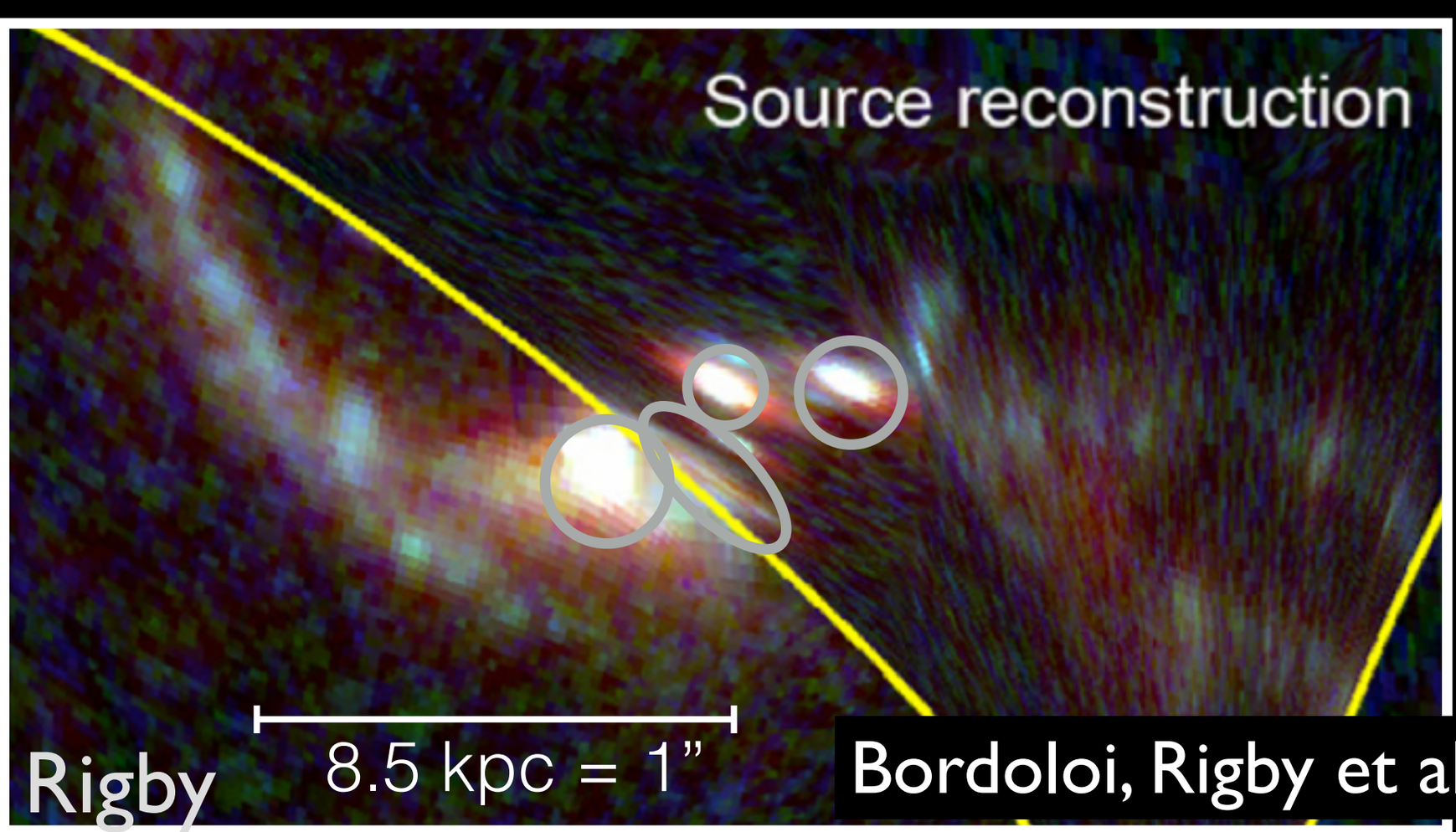
Rigby

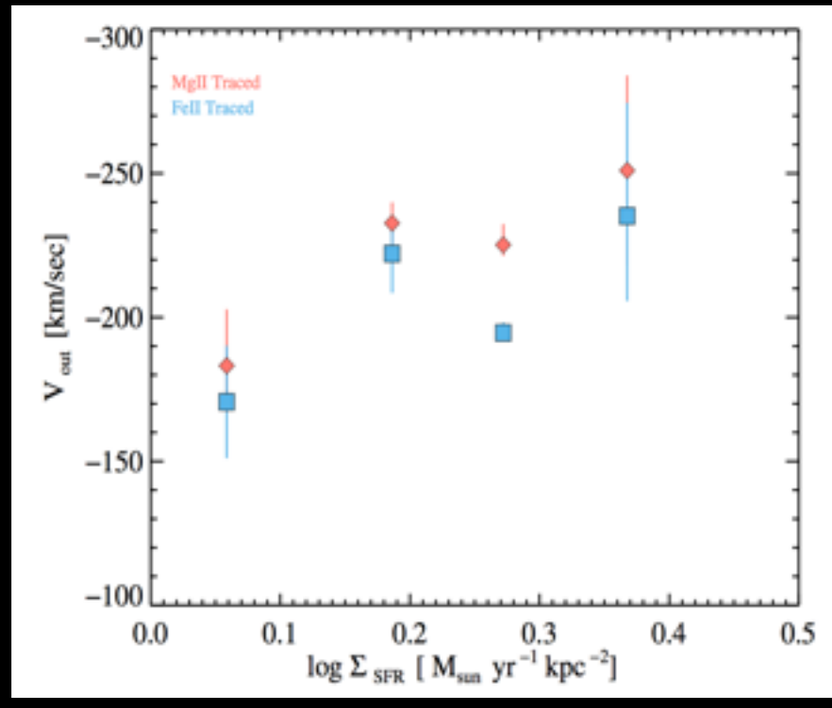
Bordoloi, Rigby et al. submitted to MNRAS

Mg II 2796, 2803 emission





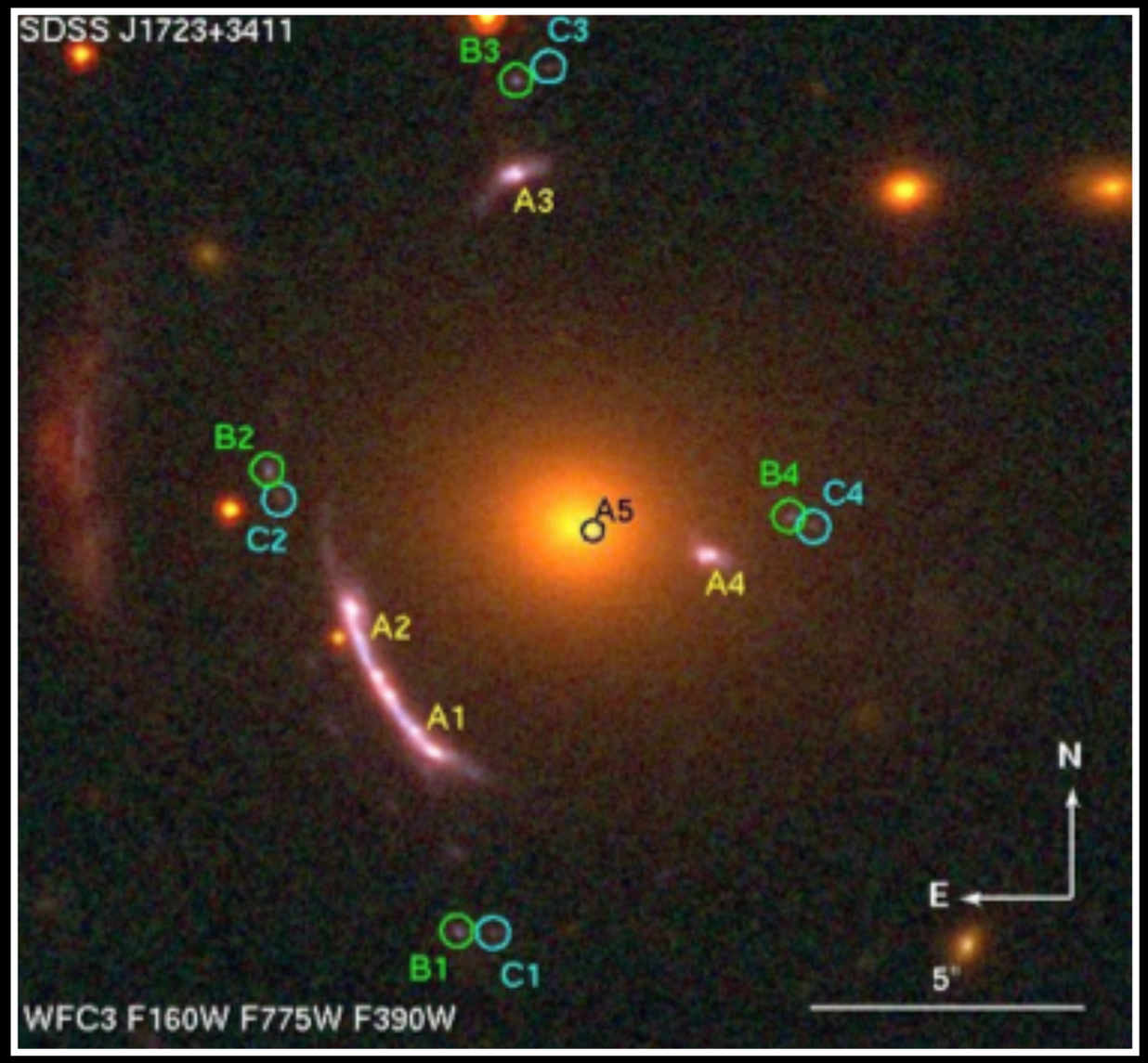


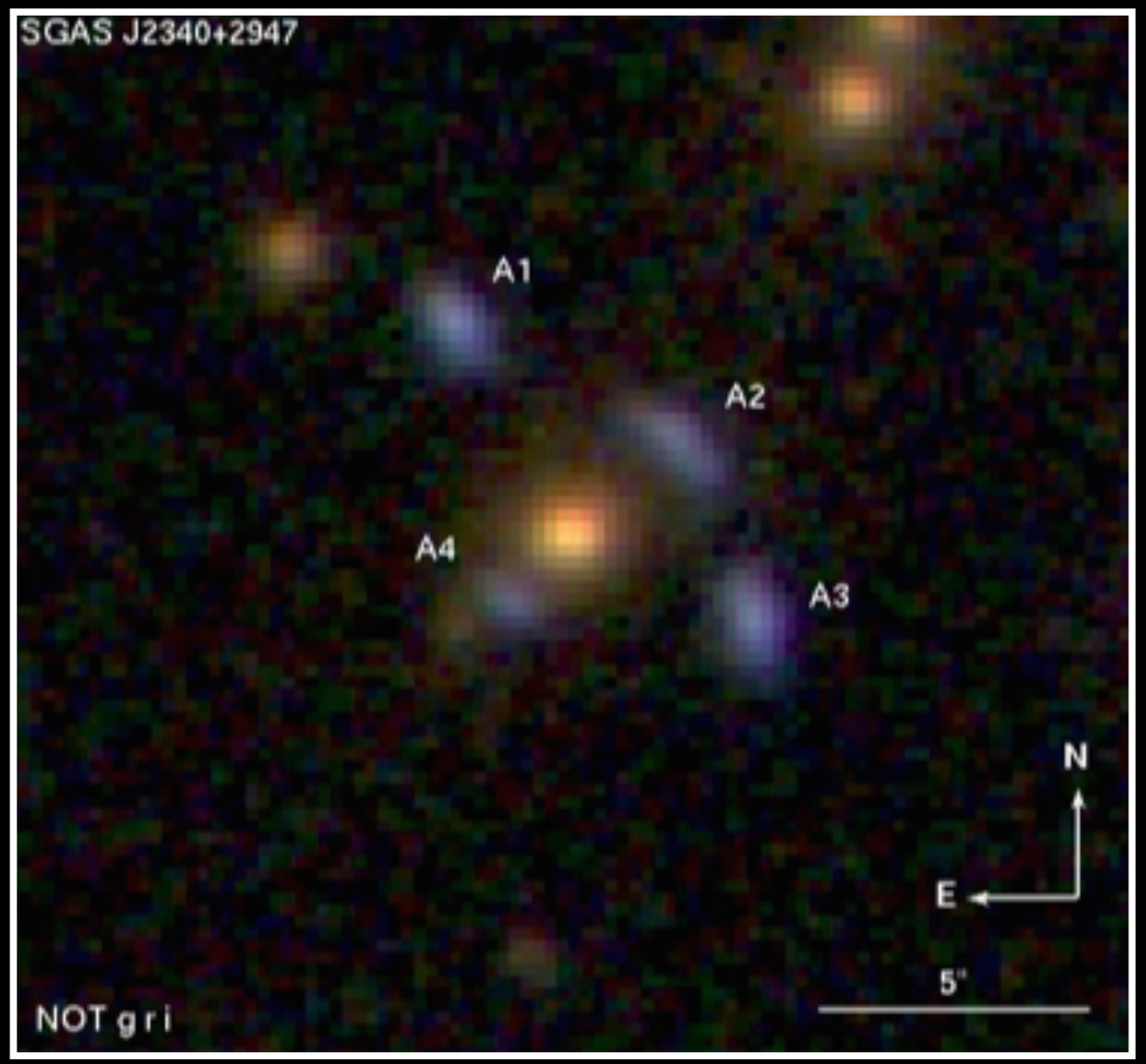


Rigby

Bordoloi, Rigby et al. submitted to MNRAS

New program in HST Cycle 23

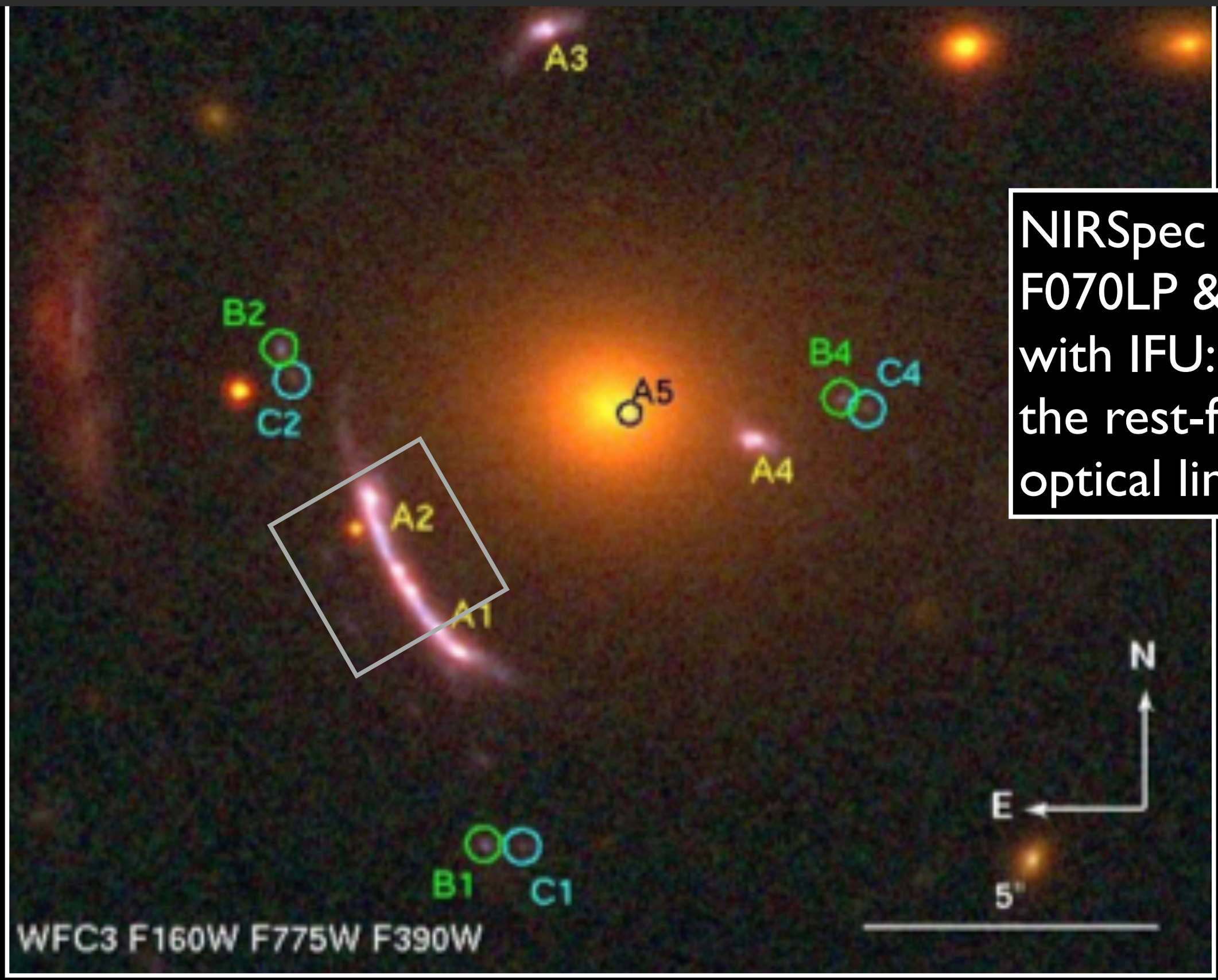




- 20 orbits (PI Rigby)
- Two targets at z=1.329 and z=1.420
- G102 + G141 grism
- Every emission line diagnostic from [O II] 3727 to [S II] 6731
- Diagnostics of SFR, logU, Z, E(B-V), spectral hardness, shocks

Rigby

From WFC3/HST to NIRSpec IFU



NIRSpec G140H + F070LP & F100LP with IFU: cover all the rest-frame optical lines.

Rigby

- JWST will bring a powerful toolbox of spectral diagnostics.
- Physical conditions, kinematics and outflows, C/N/O/Si abundances, and re-calibration of metallicity diagnostics.
- With lensed galaxy spectra, we can test that toolbox now.

C III] emission	Rigby, Bayliss et al. 2015, ApJ Letters in press
C,N,O, Si abundance at z=3.6	Bayliss, Rigby et al. 2014, ApJ
Outflows from Mg II, Fe II	Bordoloi, Rigby et al. 2015 subm. to MNRAS; Rigby, Bayliss et al. 2014
Outflows, kinematics of Hα	Wuyts, Rigby et al. 2014, ApJ
Excitation from He I / H I	Whitaker, Rigby et al. 2014, ApJ
Physical conditions	Rigby, Wuyts et al. 2011