Cosmic Dawn and Reionization

The priority science objectives chosen by the survey committee for the decade 2012-2021 are

- searching for the first stars, galaxies, and black holes;
- seeking nearby habitable planets; and
- Advancing understanding of the fundamental physics of the universe.

Ways to Study Reionization

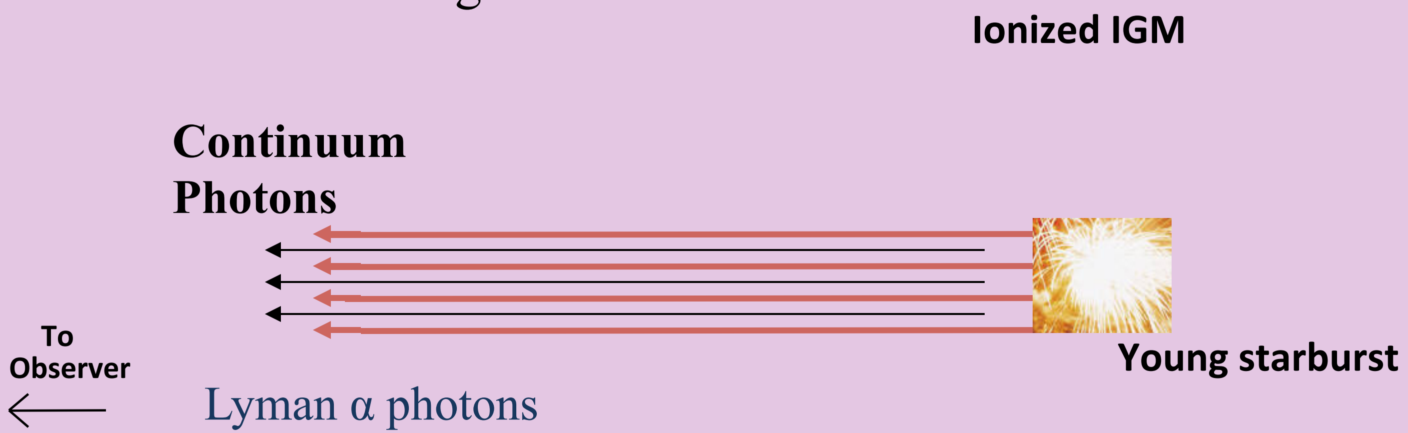
- Look for the ionizing sources, estimate L_{ion}, and compare to requirements for (re)ionization
  - Uncertainties: f_{esc}, clumping, IMF, dust, etc.

- Look for evidence of neutral gas and/or evidence of free electrons
  - More direct.

- WFIRST can do both!

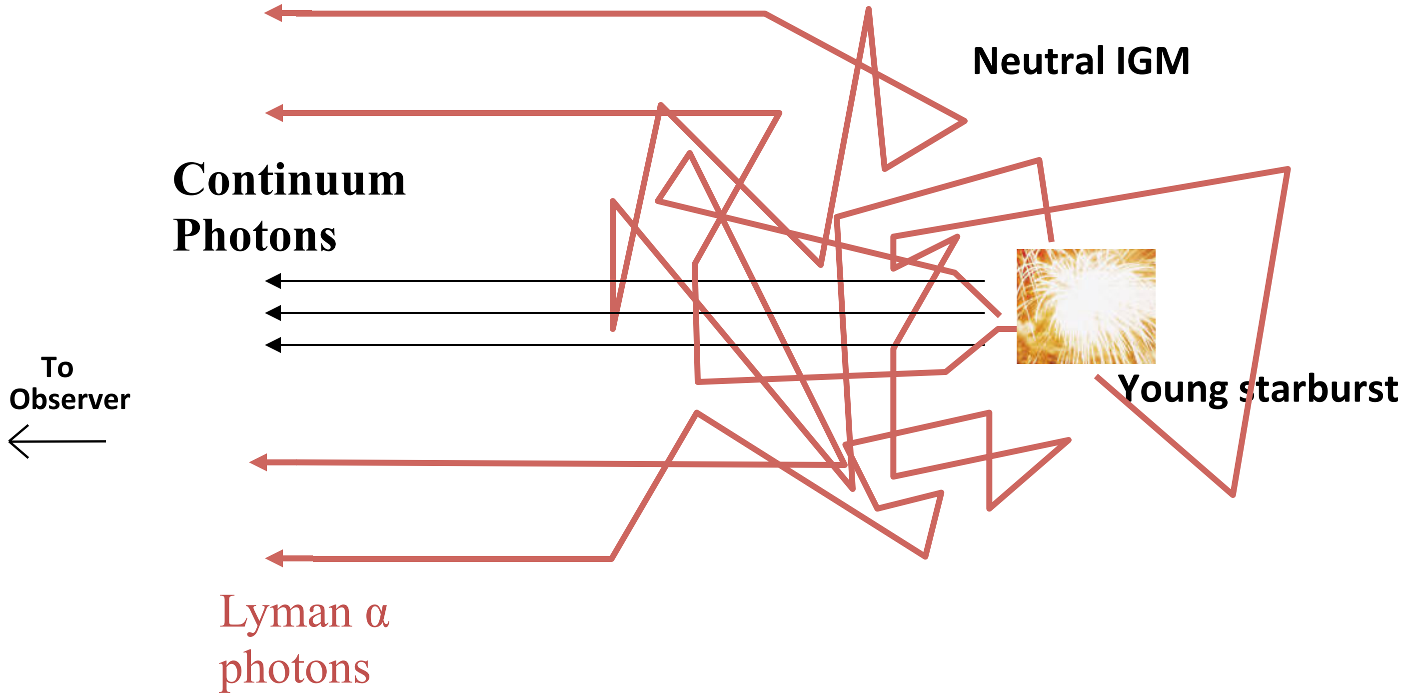
Lyman-α in an Ionized IGM

Radiative transfer of Lyman-α and continuum photons in an ionized intergalactic medium.

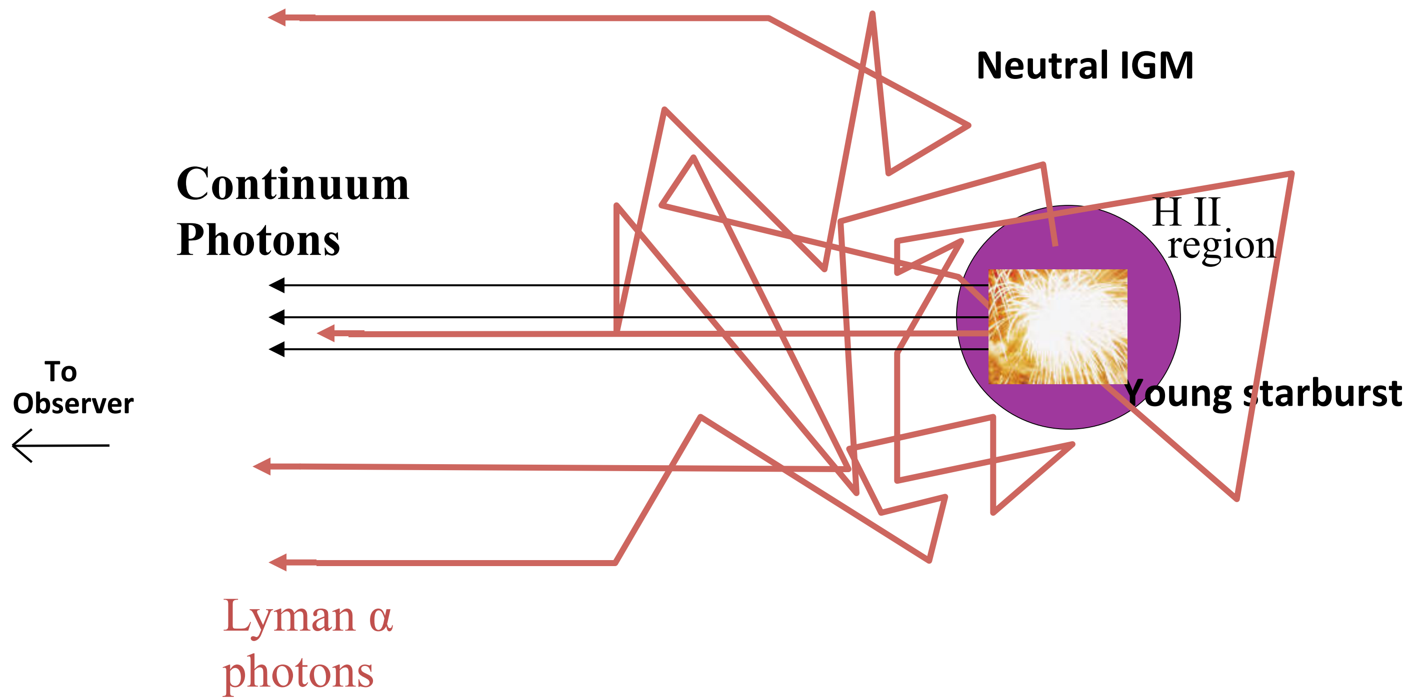


Lyman-α in a Neutral IGM

Radiative transfer of Lyman-α and continuum photons in a neutral intergalactic medium.

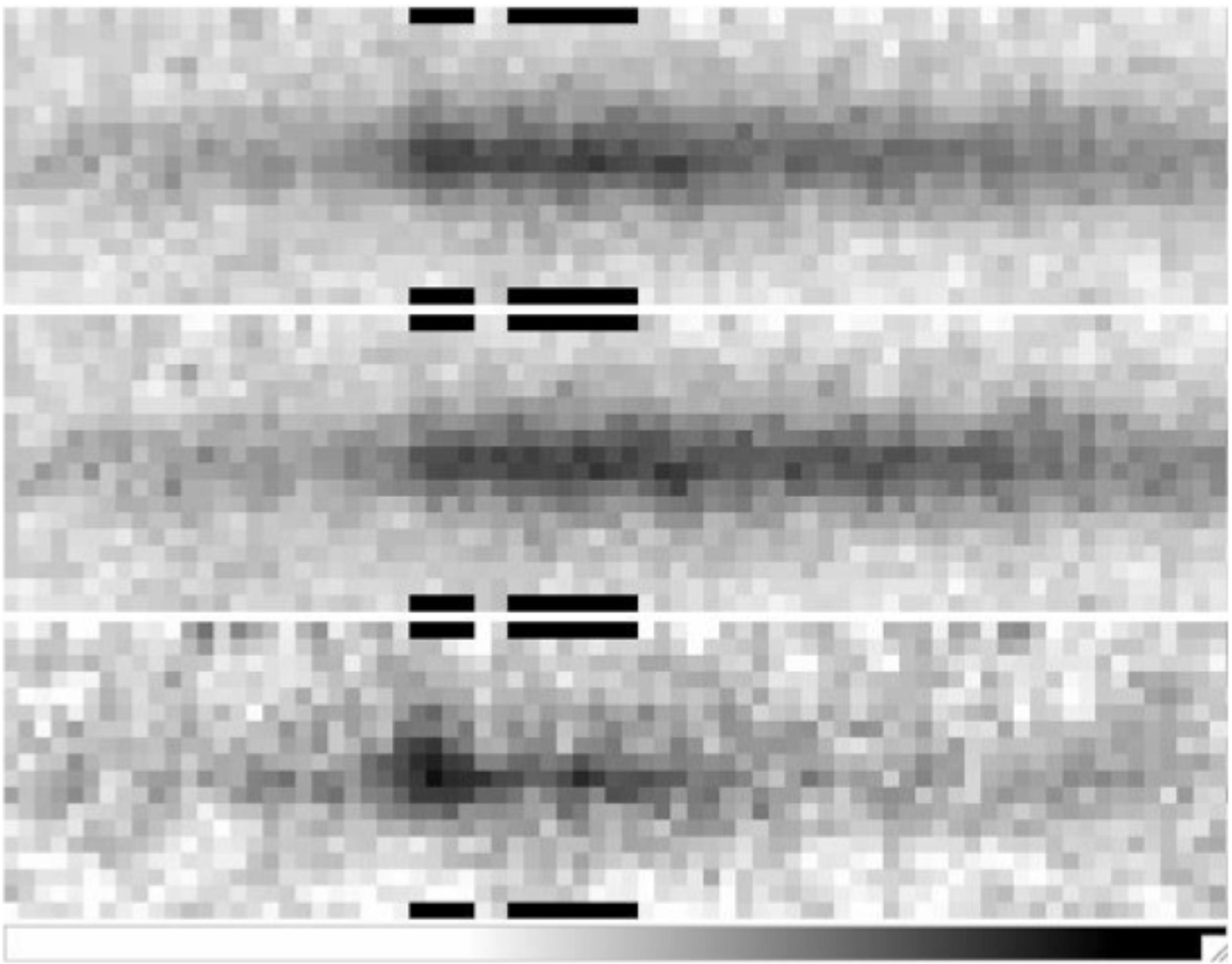


Lyman α : Neutral IGM + Ionized Bubble



• Due to a local HII bubble around galaxies, and due to gas motions inside the galaxy, not all of the Lya photons are scattered.

Slitless surveys will spectroscopically identify galaxies with or without Ly-a line



Rhoads et al. 2009. (GRAPES treasury program)

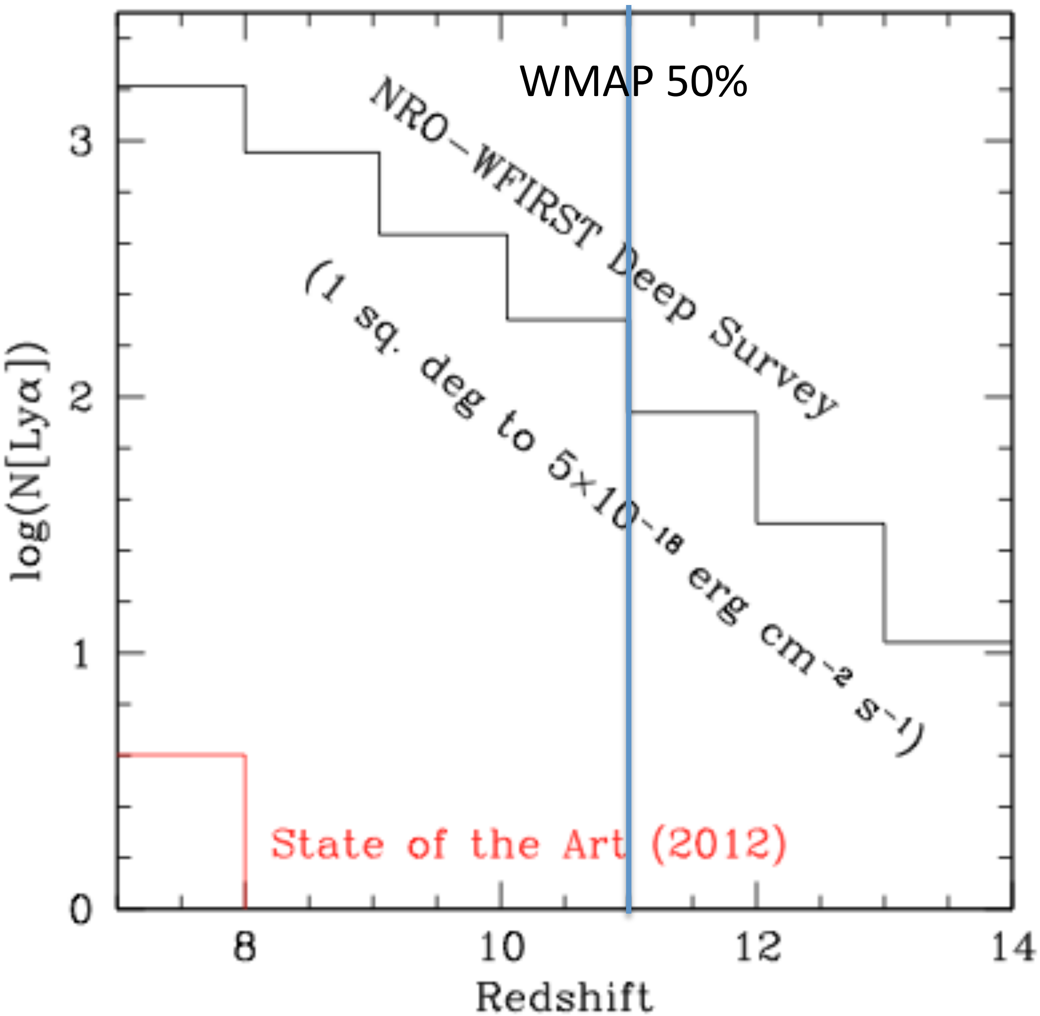
What can WFIRST do?

- Blind slitless search for Lyman alpha:
  - Sensitive for $11 < z < 15$ or so
  - Redshift range of greatest interest 8-12 or so.

    (can we shift the grism blueward to 1.10 microns?)
  - Strawman: 1 sq. degree, ~ 200-300 hours of integration with grism …
  - Expect ~ 900 Lyman α galaxies at $8<z<9$ per square degree

This could either be a large GO program, or a set of calibration fields re-observed throughout BAO survey.

Lyman-α Tests with WFIRST

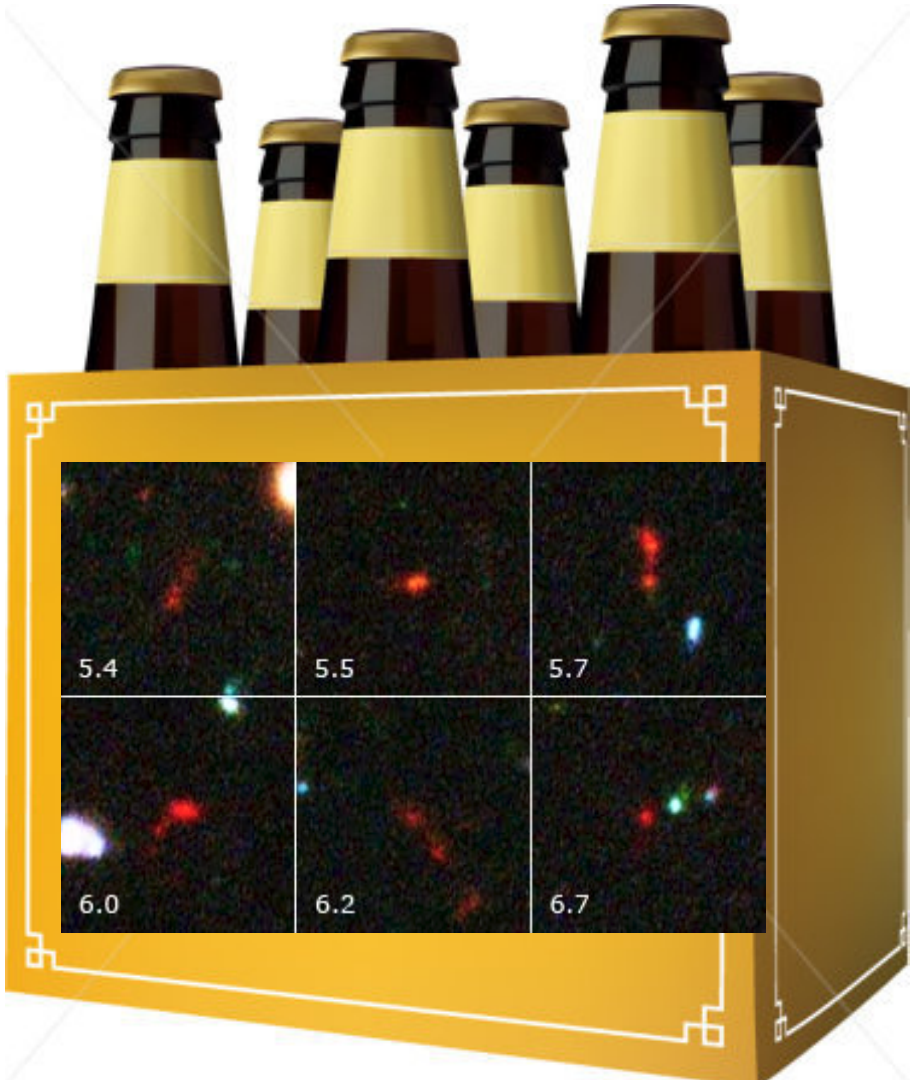


- Based on Ouchi 2010 LF at z=6.5.

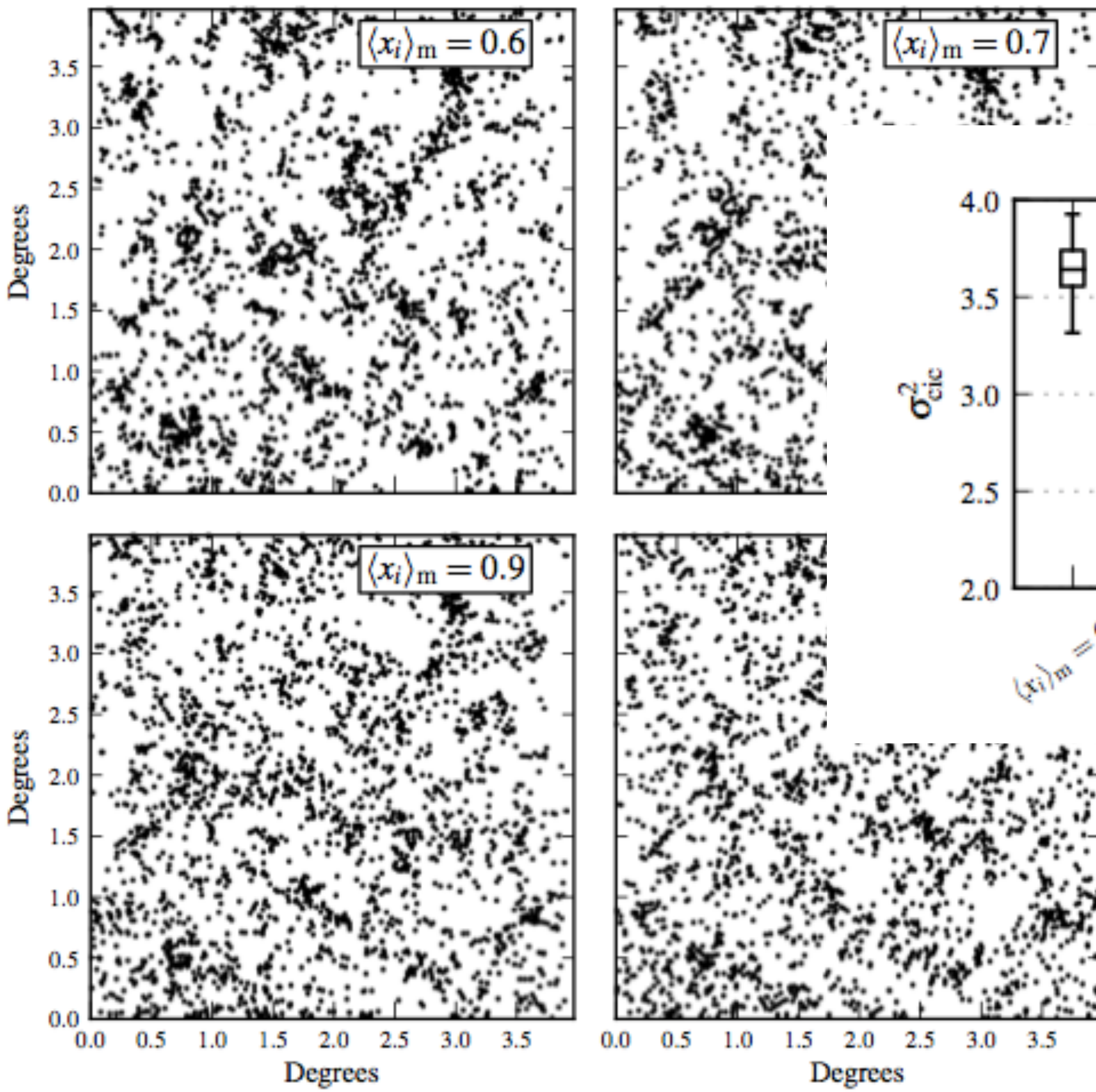
(Kashikawa et al 11 similar; Hu et al 10 slightly below)

- The neutral IGM should ~~truncate~~ modify this someplace.

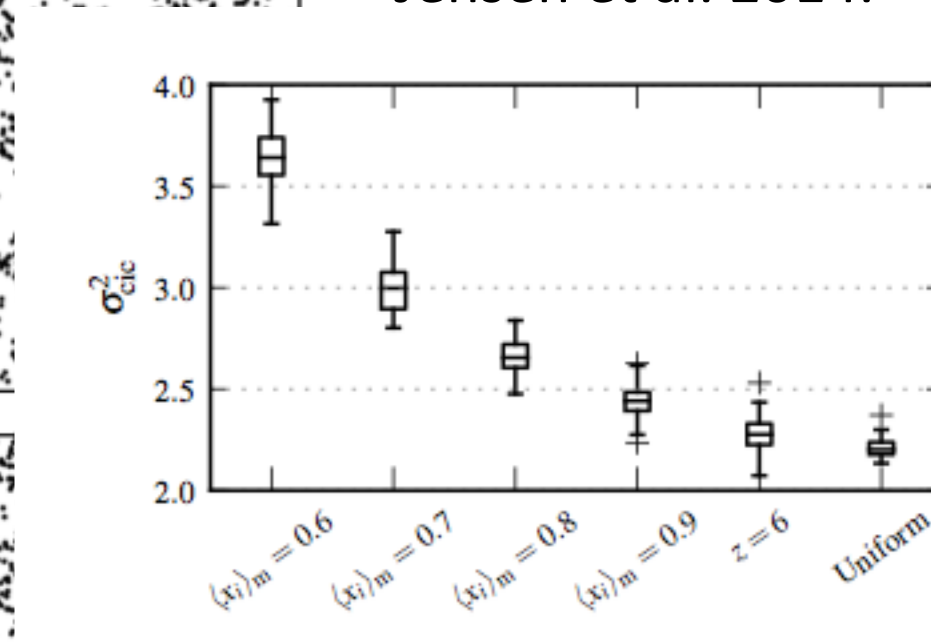
So far the galaxies at high-z have been coming in small numbers.



Topology of Reionization:



Simulations by Jensen et al. 2014.

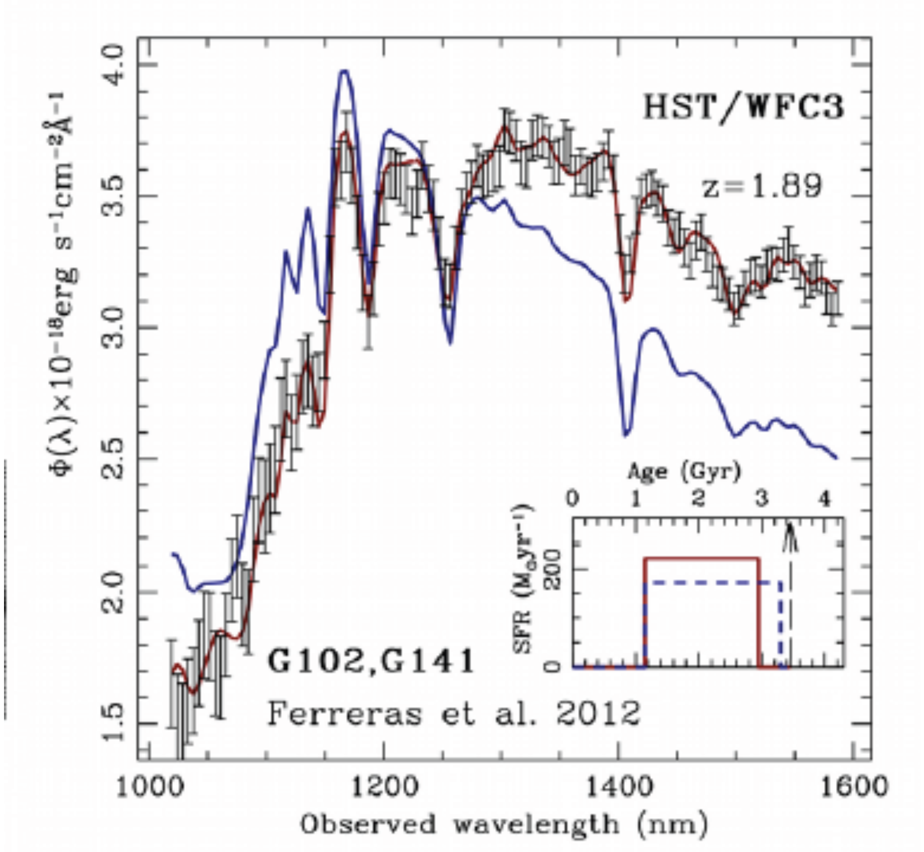


Synergies with LOFAR, MWA studies of 21 cm.

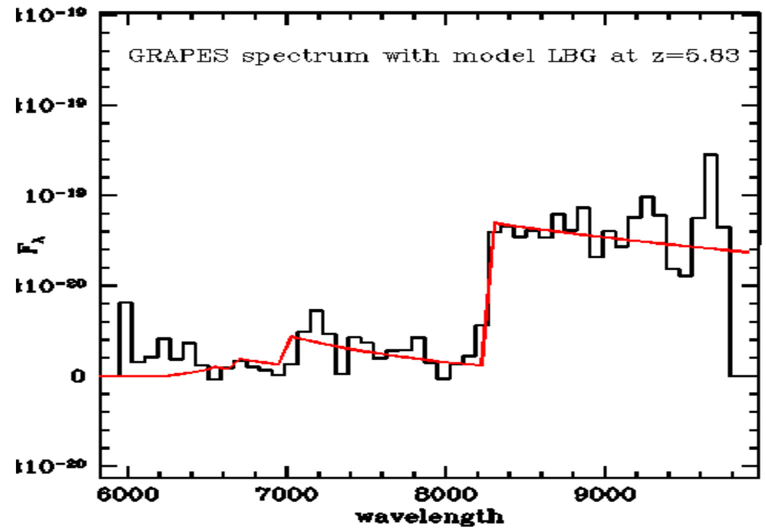
Faint Infrared Grism Survey (FIGS)

WFC3-IR grism observations of 4 fields at 40 orbits depth each (Cycle 22).

1. LBGs and Lyman-alpha galaxies.
2. Massive (evolved) galaxies at z > 2 (See poster by Nor Pirzkal.)
3. Emission line galaxies at z=0.3-2.2
4. unbiased continuum up to 26th magnitude AB.



Follows the successful design of grism programs with the ACS grism.



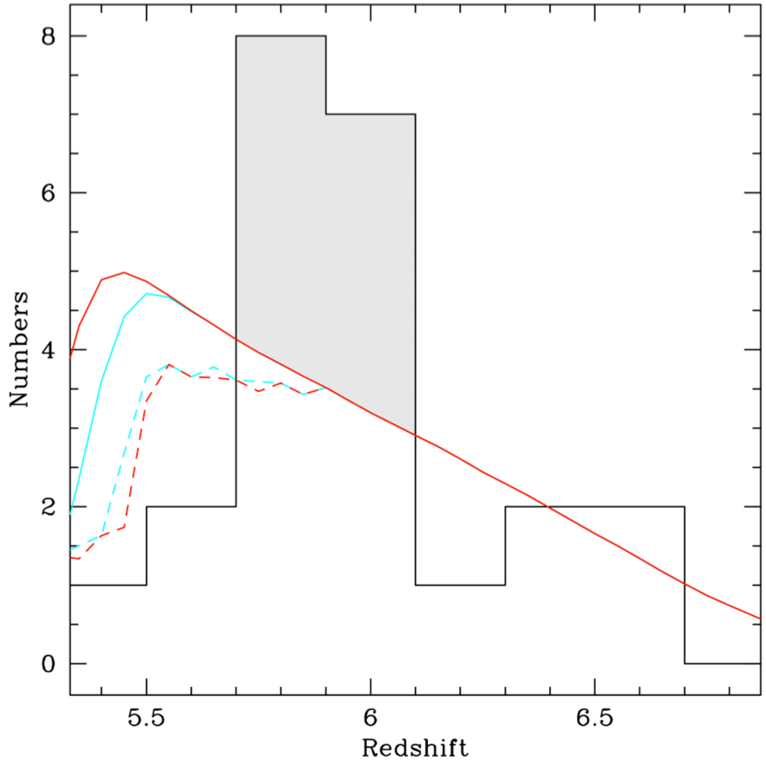
1. GRAPES
2. PEARS

   HUDF + 8 surrounding fields

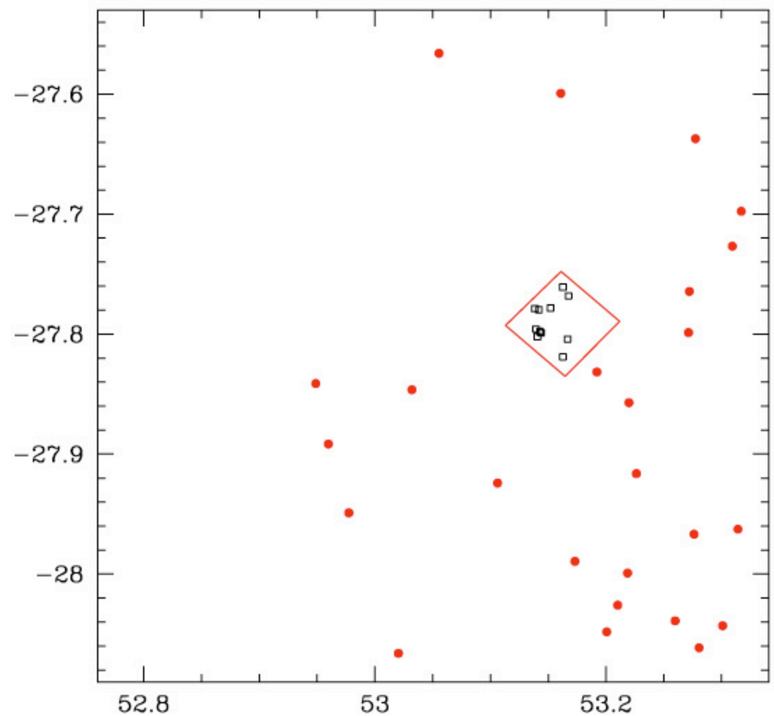
   40 – 20 orbits

   multiple position angles.

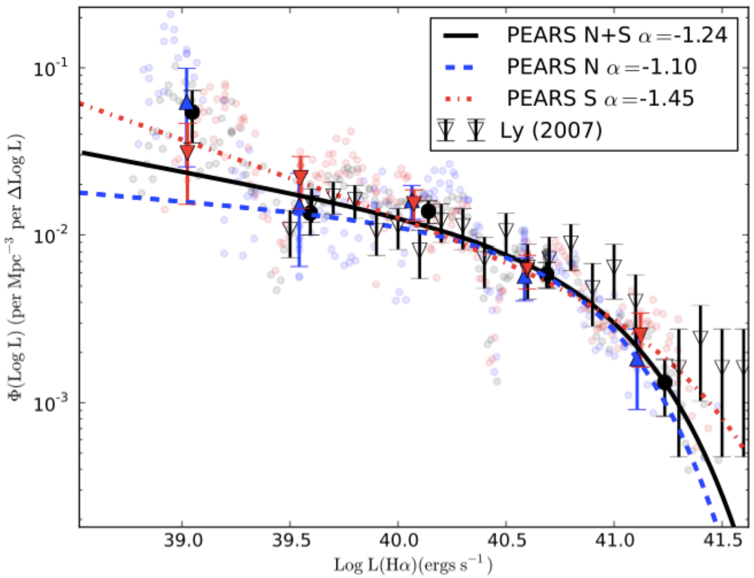
Ionizing sources (Malhotra 2005)

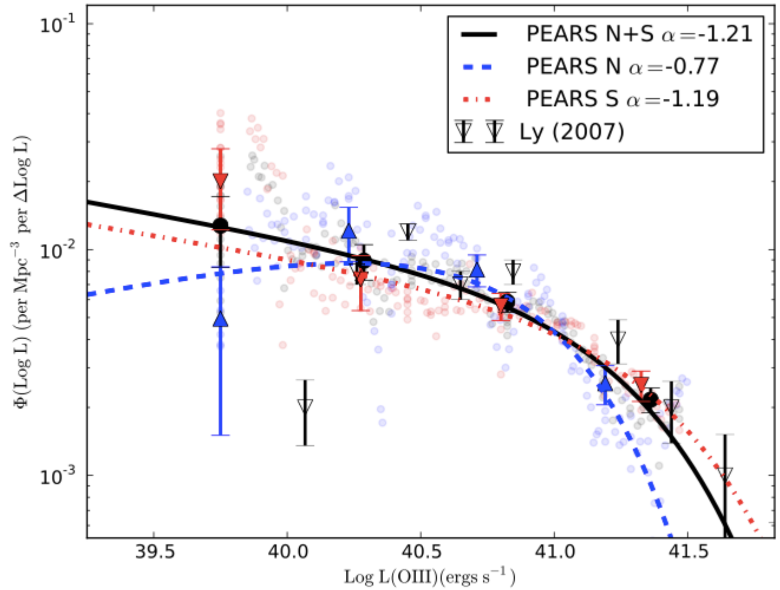


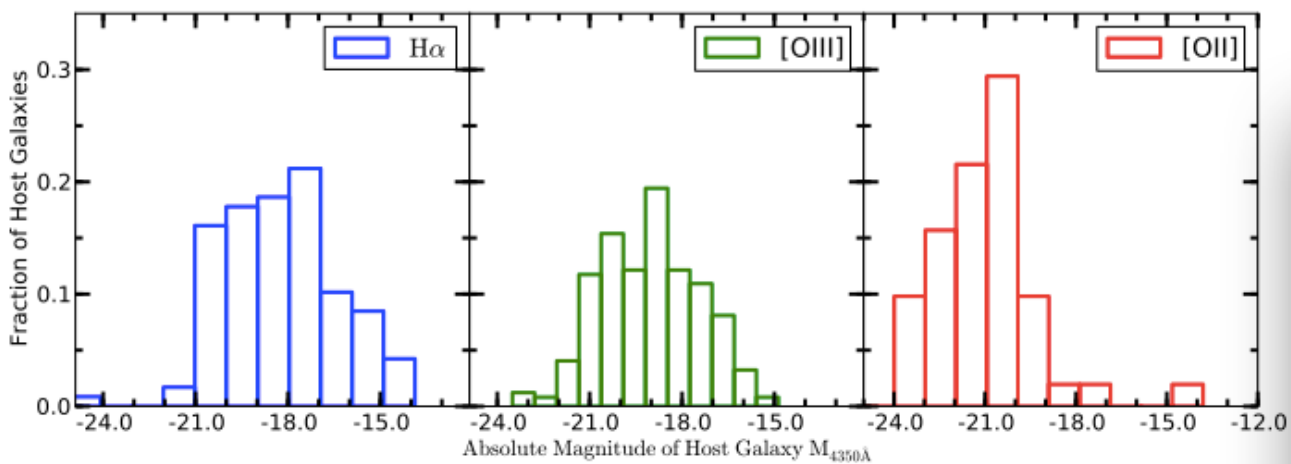
Overdensity > 4 at z=5.8



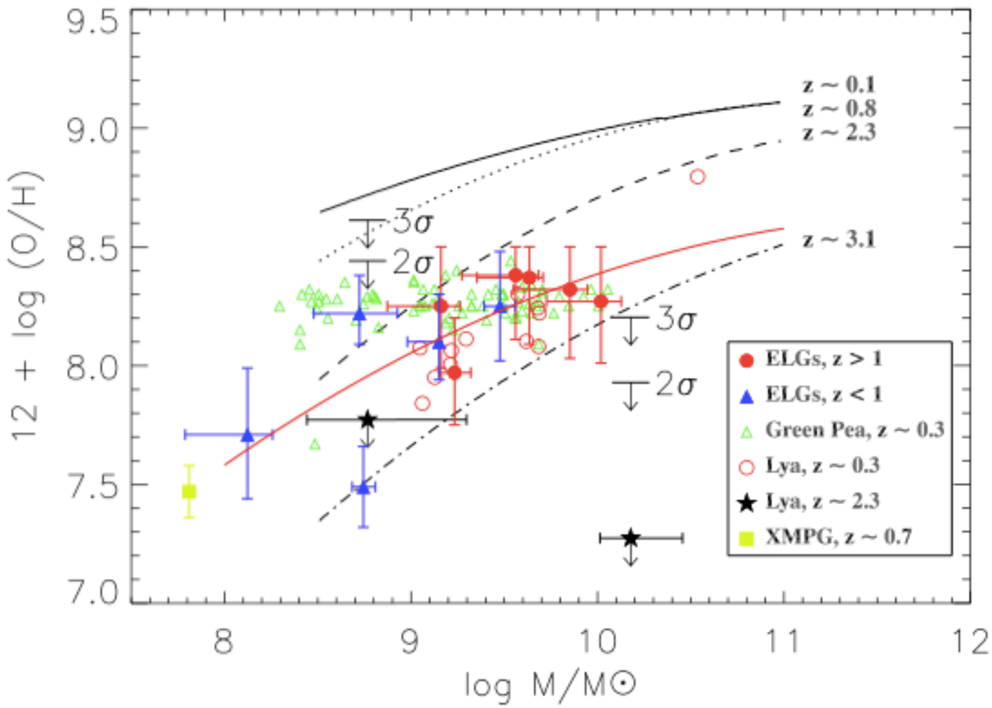
Line and continuum luminosities:
(Pirzkal et al. 2013)



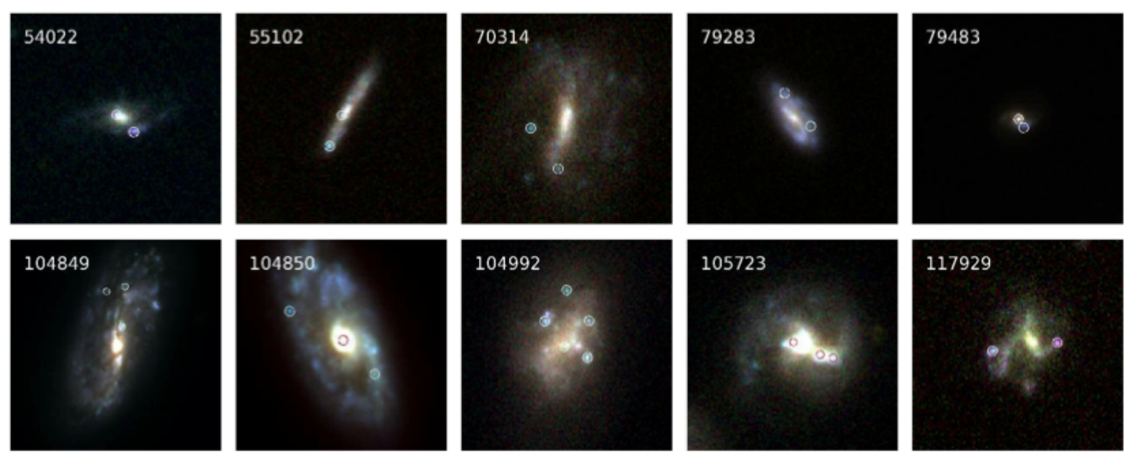




Emission line galaxies:

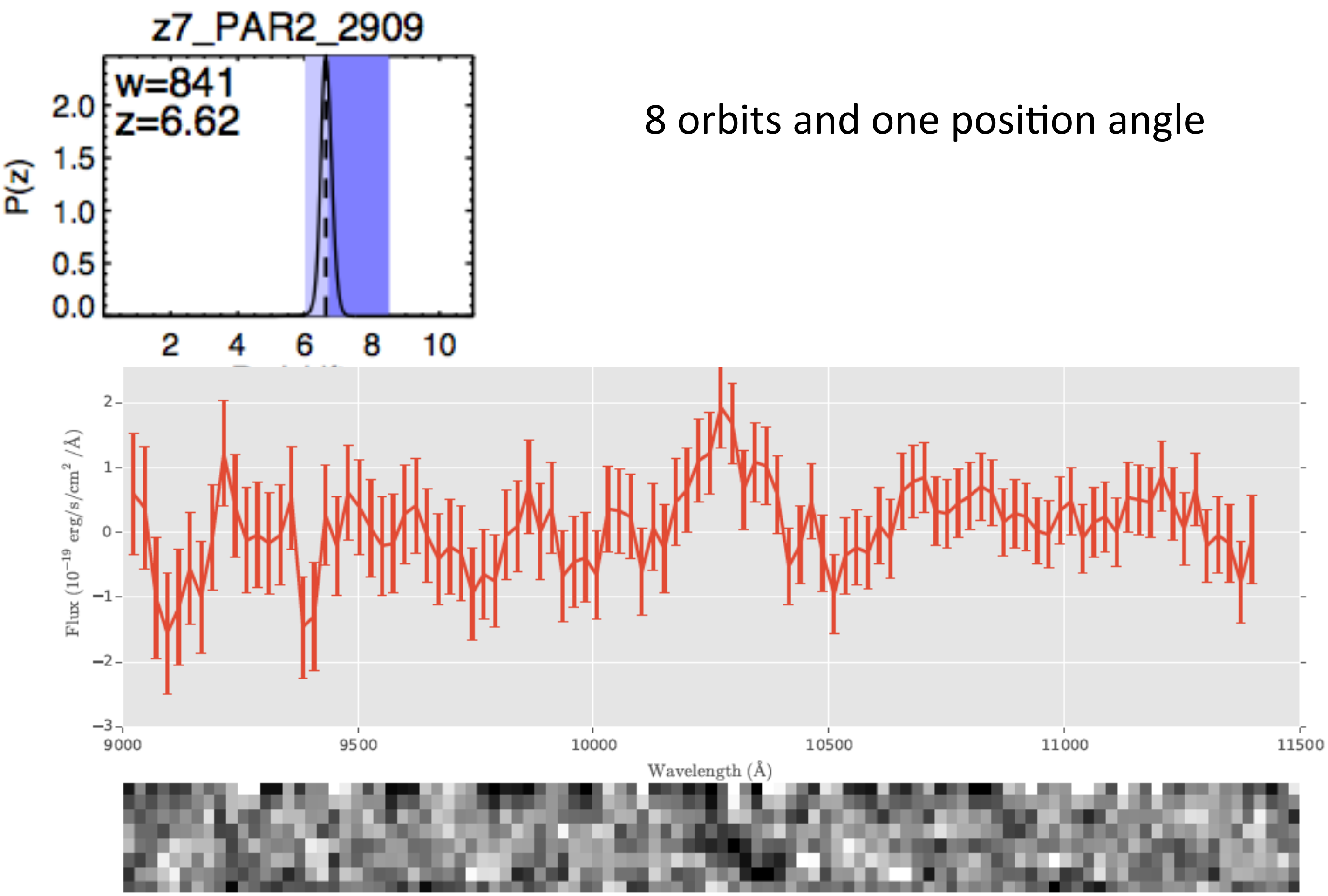


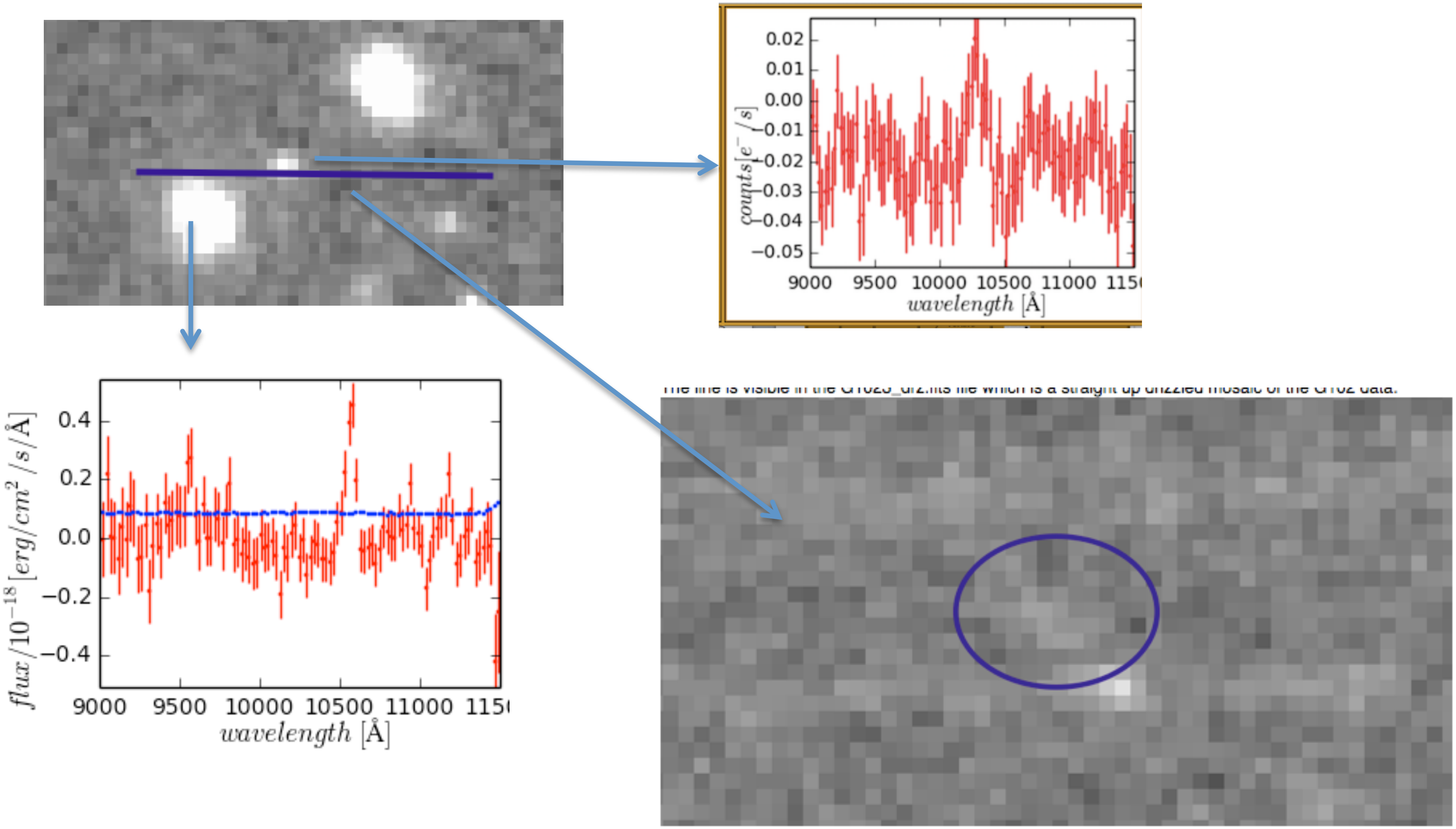
Xia et al. 2012.



Lets talk FIGS

8 orbits and one position angle

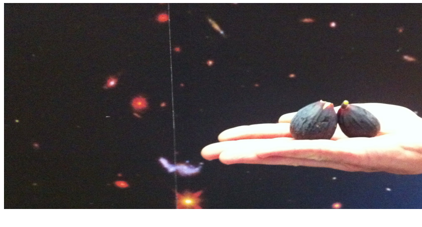




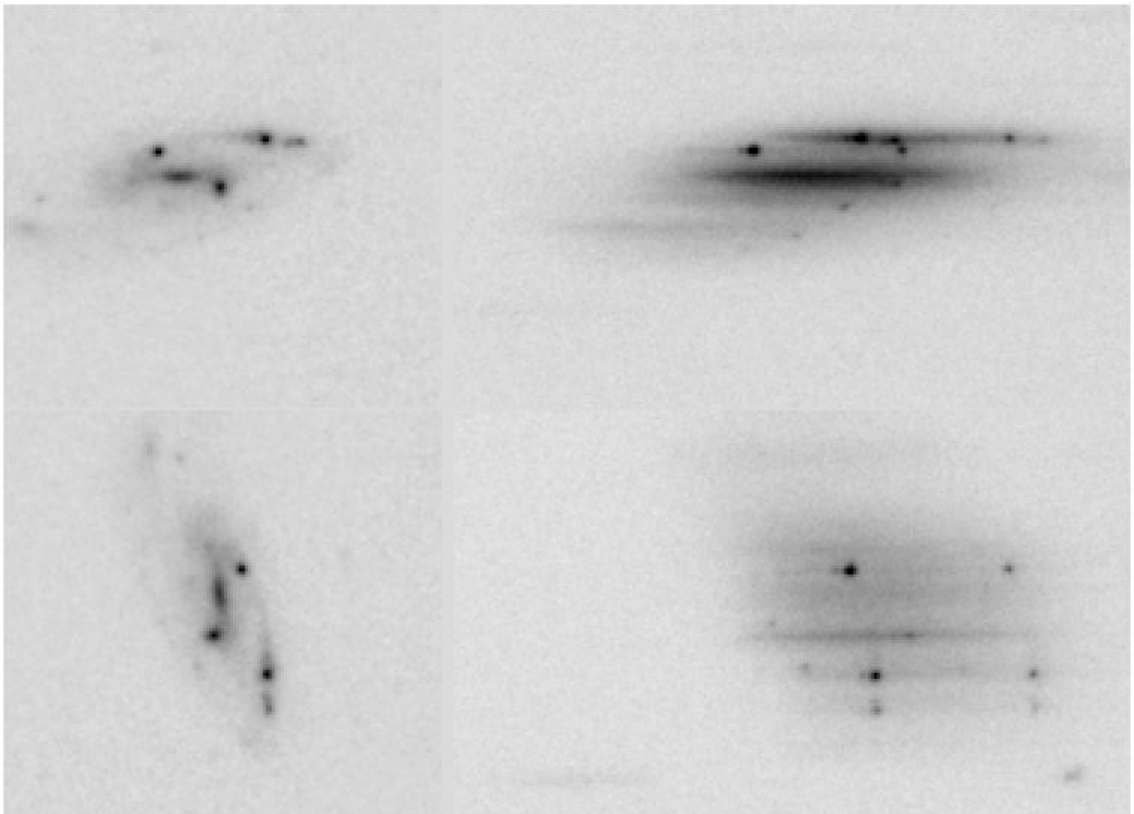
Moral of the story: don’t trust a single PA.

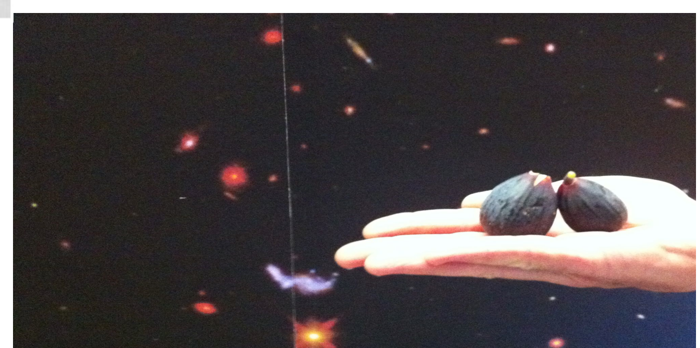
(1) bad news: may not be high-z lya.

(2) Good news: may be seeing outflows.



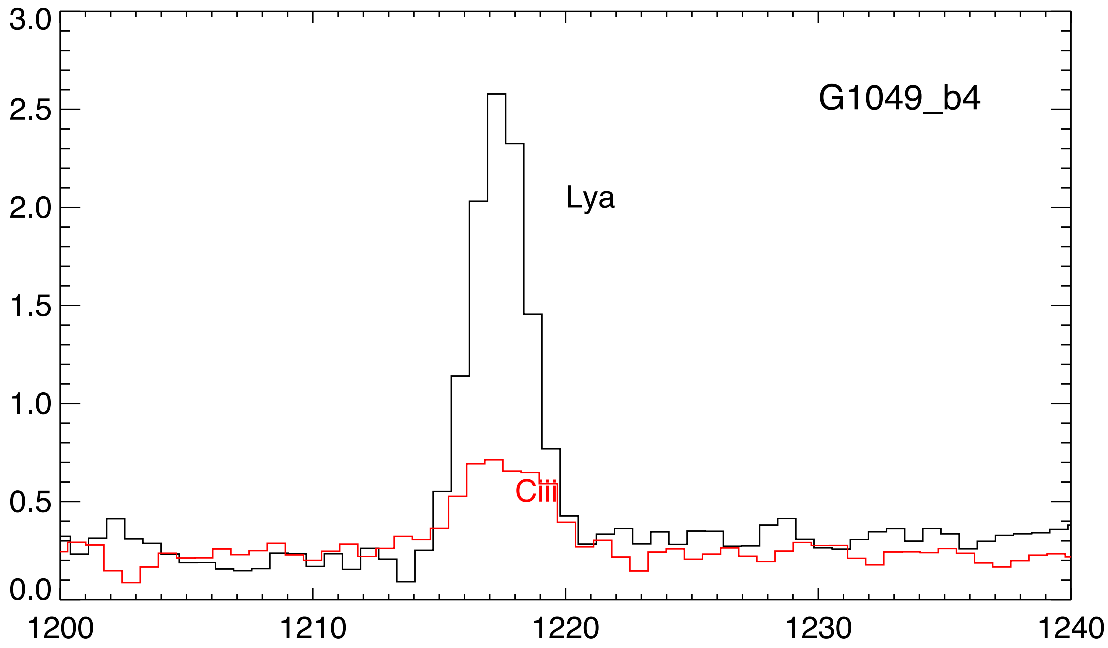
Multiple PAs also improve systematics





Q: When was the last time your typical baryon did something exciting? – James Rhoads

A: Reionization.



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