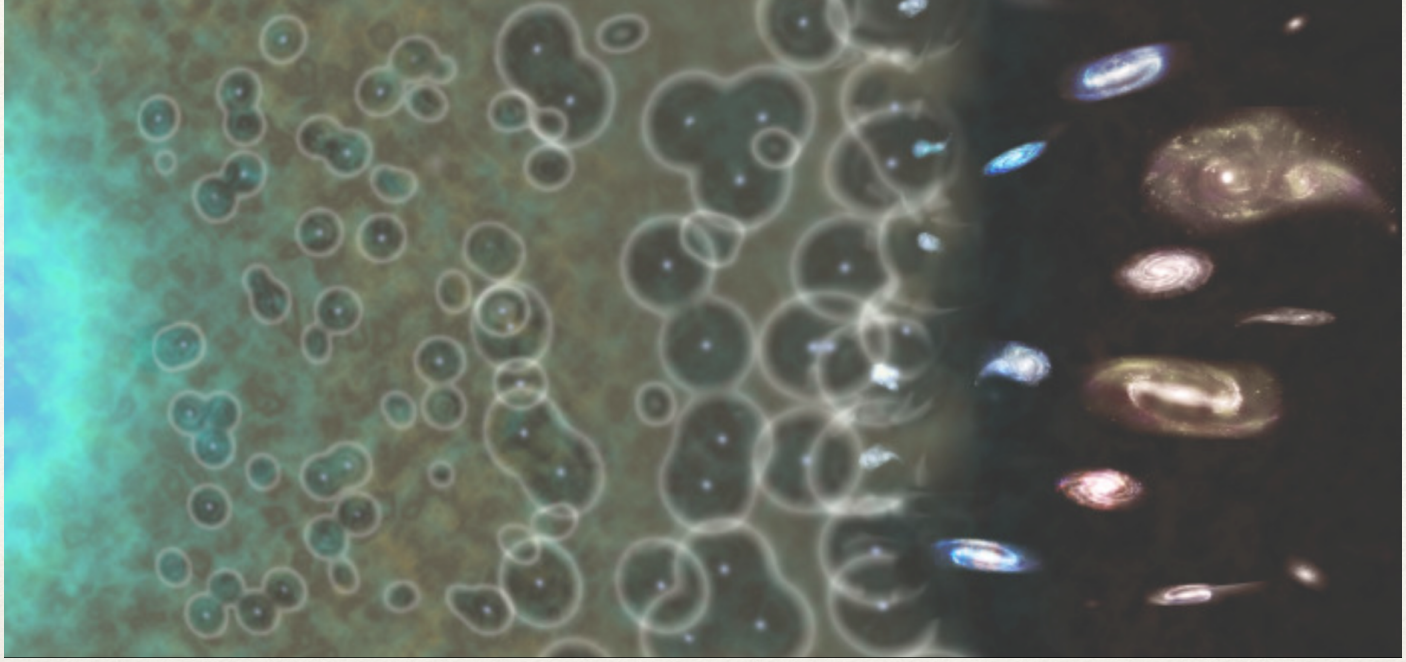


Observing galaxies across the EoR boundary

Adriano Fontana,
Marco Castellano,
Laura Pentericci,
Eros Vanzella, et al..

Goal: to characterize the transition from neutral to ionized.

1) The evolution of the Lyα visibility: what is telling us?

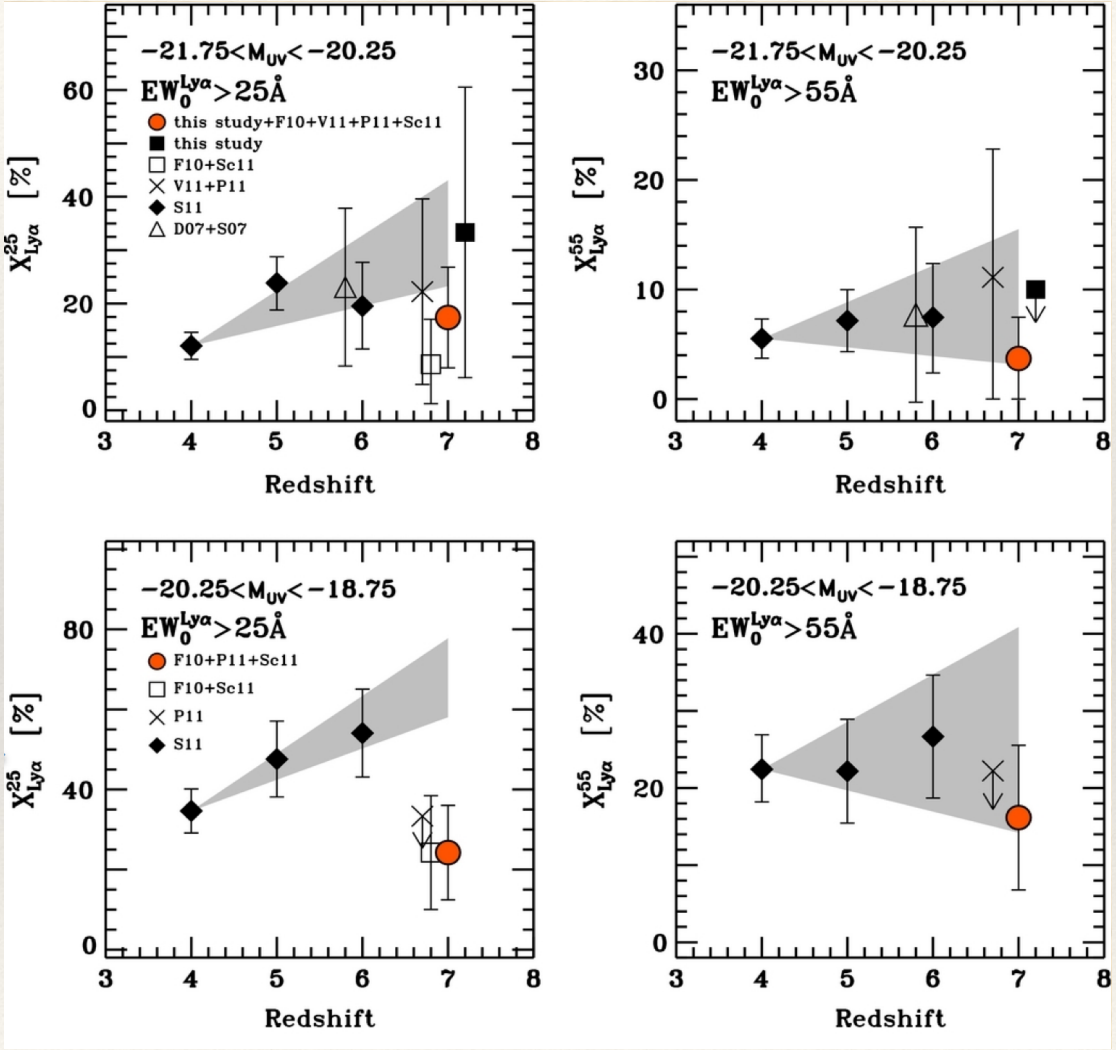
2) What is the topology of reionization? Is it patch? Which are the sources?

Lack of Lyα emission as a tracer of increasingly neutral IGM/CGM

Since the beginning interpreted as an

increased IGM absorption -> onset of re-ionization

(Stark+10, Fontana+10, Pentericci+11, Ono+12, Treu+12, 13 ,Schenker+12, 14)



Ono+12

What does it mean?

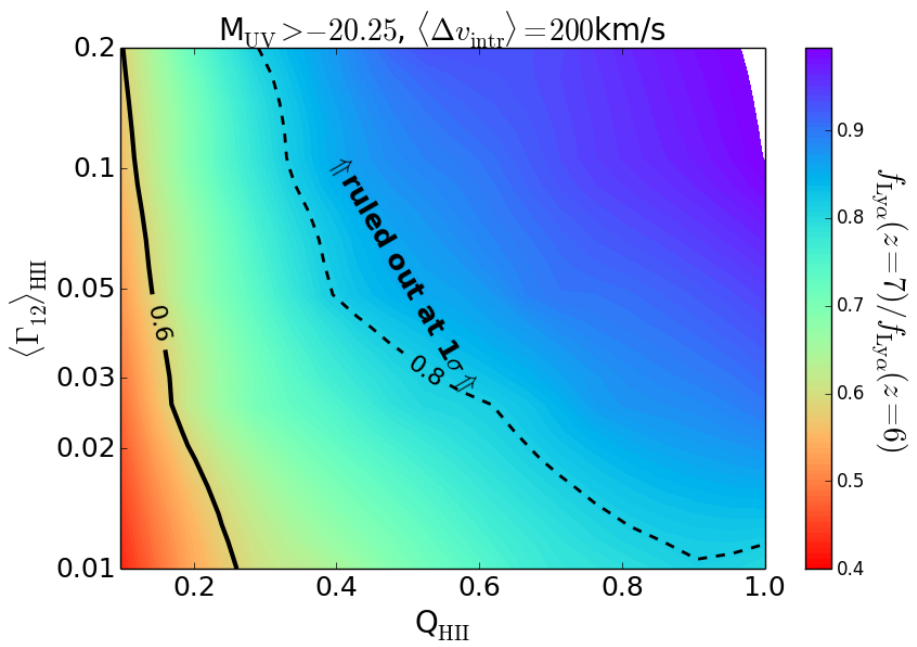
Modelling the reionization process is complicated.

Dijkstra+11, Jensen+13, Bolton&Haenhelt 13, Mesinger+15, Choudhury+15, Kakiichi+16

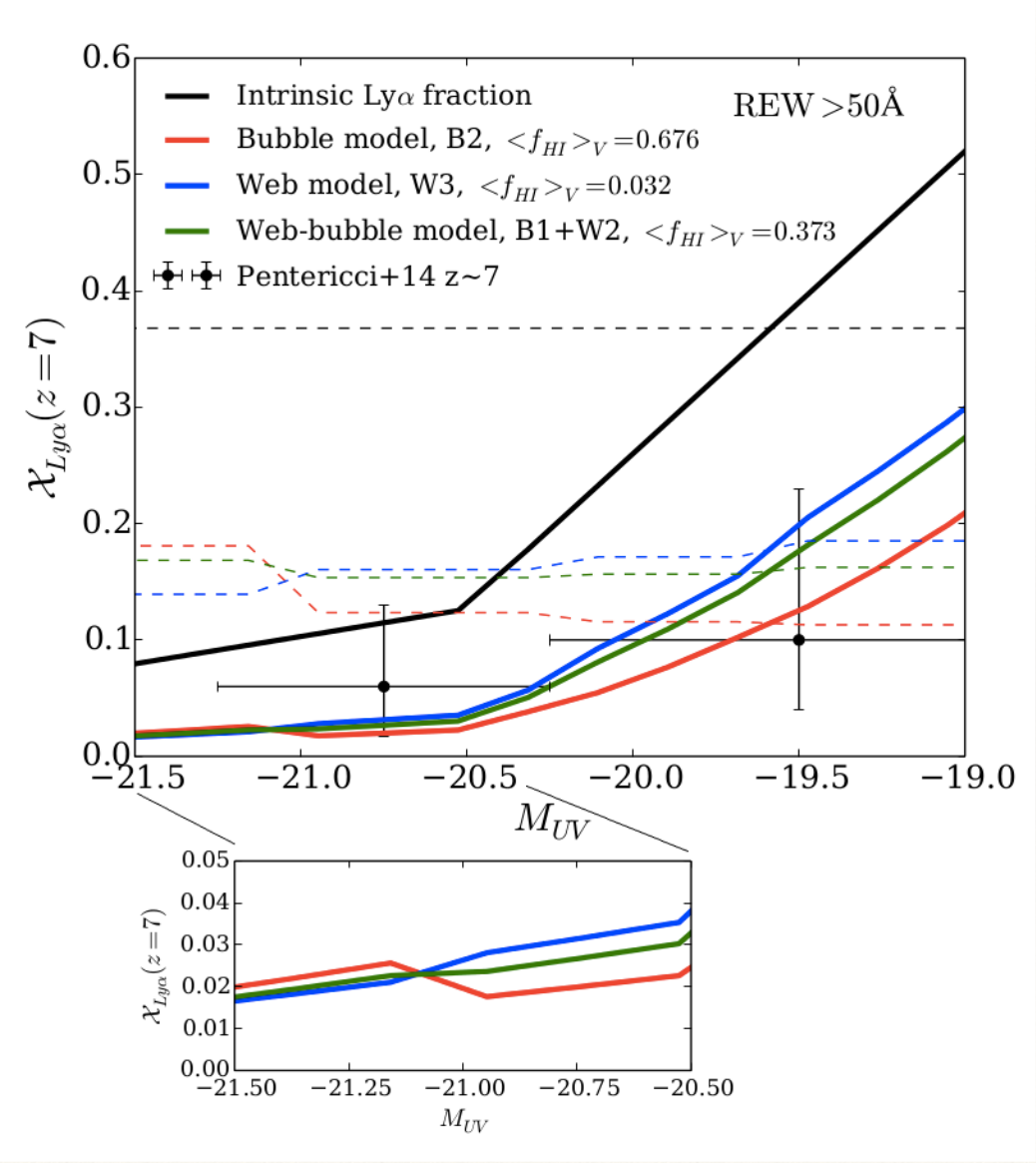
- **Small scale - Web (damped-like systems)**
- **Large scale - Ionized Bubbles**
- **Web+Bubble**

The fast evolution from z=6 to z=7 may be difficult to explain: **needed also an evolution of rest-frame properties?**

(*Dijkstra+13, Meisinger+15 etc*)



Meisinger+15

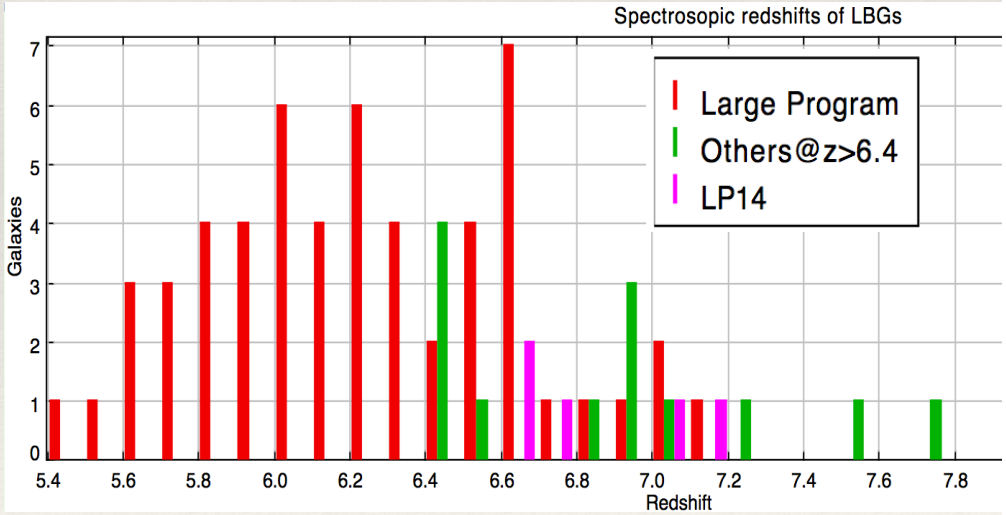


Kakiichi+16

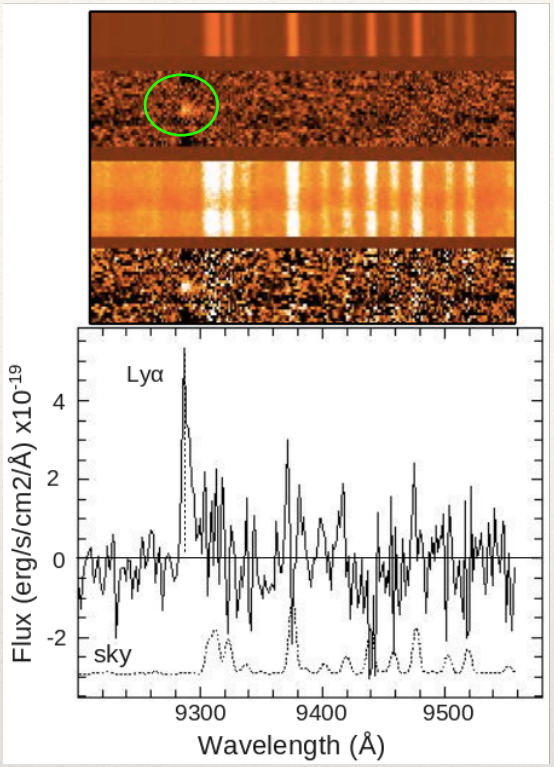
CANDELSz7: an ESO Large Program to probe the reionization epoch.

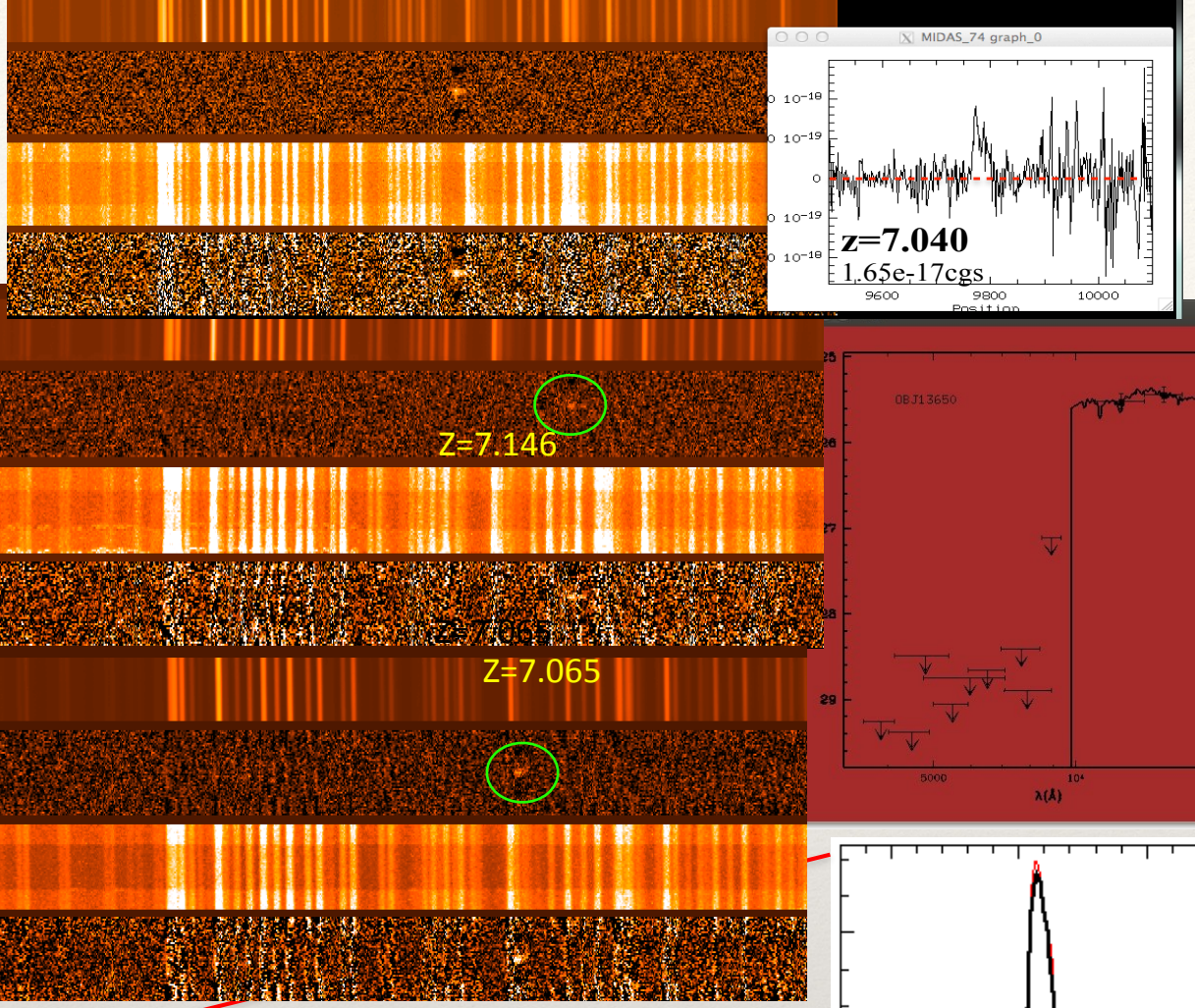
- 200 galaxies at 5.5<photo-z-<7.3; **70 z-dropout (candidate z~7)**
- COSMOS/UDS/GOODS-S
- Homogeneous color-selection criteria from CANDELS data
- H-selected - no influence of Lyα in selection
- "adaptive" integration time (15-25hr) to reach **uniform EW limit**
- **Analysis 90% complete** as of today (results are PRELIMINARY)

- 17 new galaxies at 6.5<z<7.3
- 40 new galaxies at 5.5<z<6.5 with Lyα
- several galaxies at z~6 with no Lyα

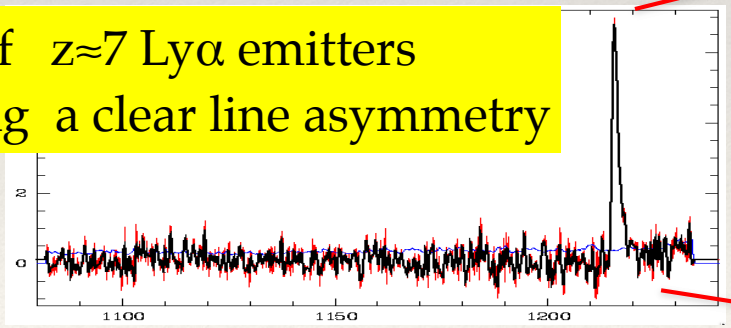


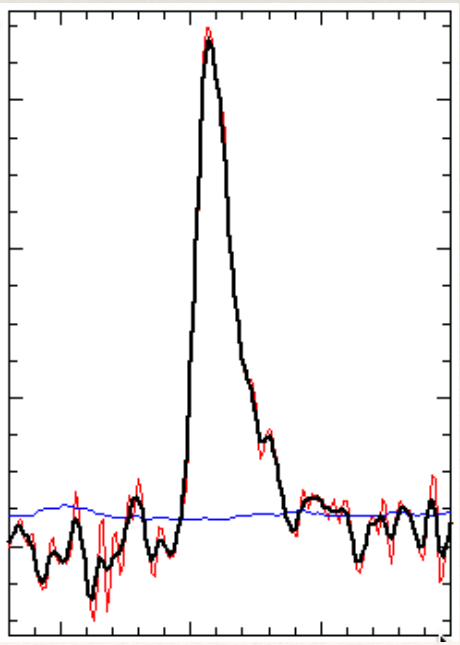
Some new z~7 galaxies





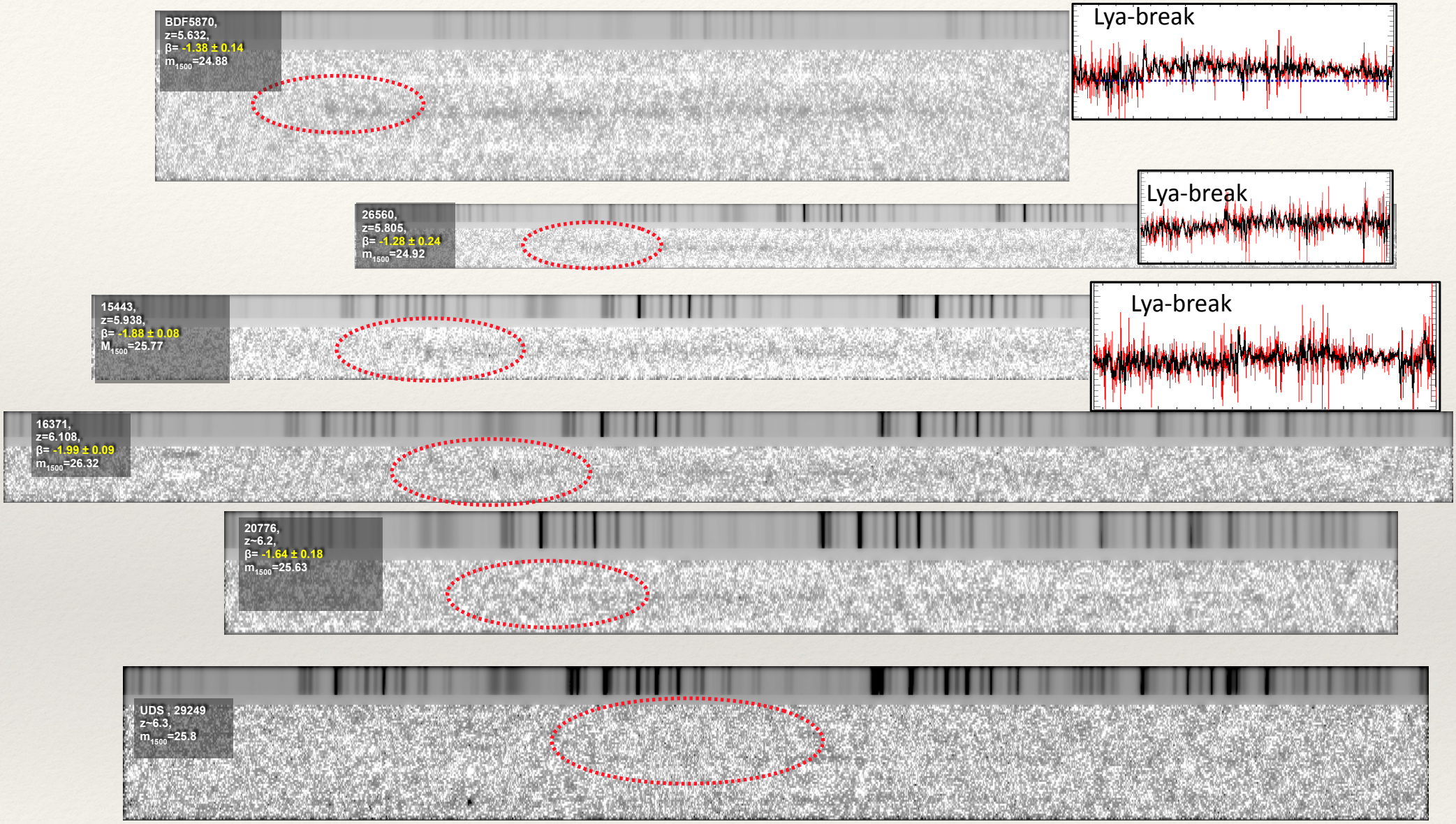
Stack of z≈7 Lyα emitters showing a clear line asymmetry





Deep spectroscopy starts to reveal faint z~6 non-Lyα emitters

Vanzella, Pentericci et al. in prep.



Confirms reliability of LBG technique at z~6 -> **corroborates evidence that the Lyα drop is not due to interlopers**

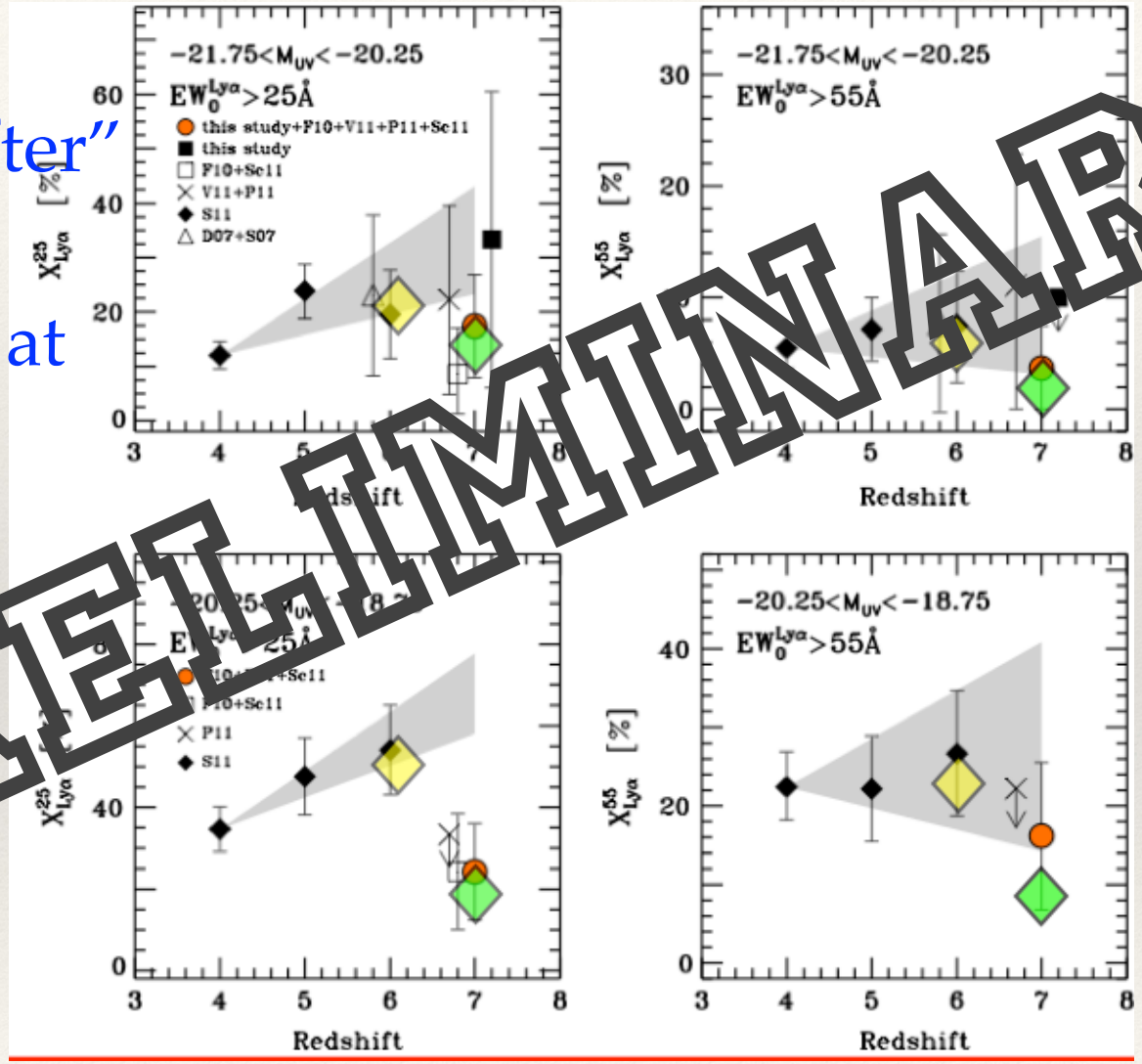
CANDELSz7 + earlier + archival observations

120 z-dropouts + 180 i-dropouts in 5 independent fields.

The largest spectroscopic sample at z>6

Lyα decline "softer" than previous estimates: starts at z~6

- new z=7 limits
- new z~6 limits



Bright galaxies (M_{UV}<-20.25)

Faint galaxies (M_{UV}>-20.25)

"Small" EW(Lyα) > 25 Å

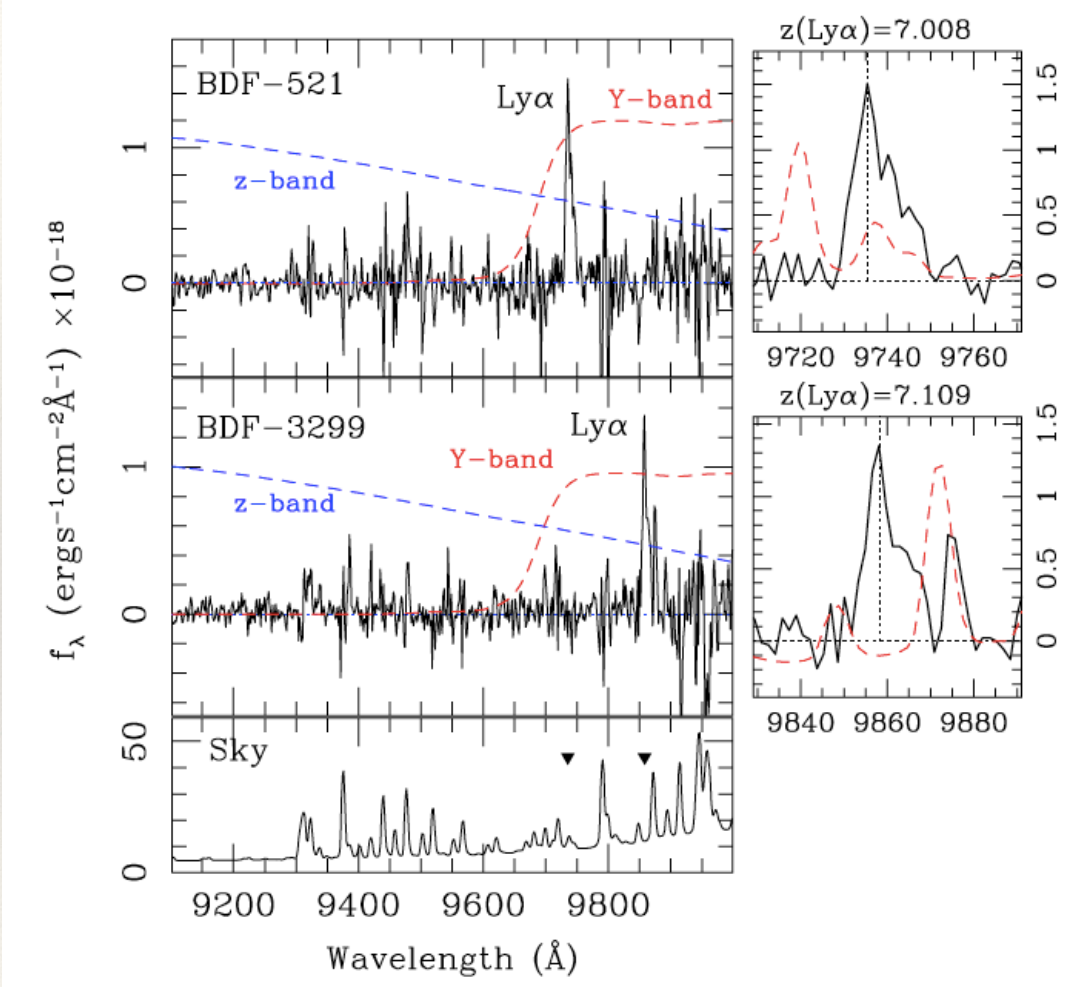
"Large" EW(Lyα) > 55 Å

A space oddity at z~7

In the overall paucity of Lyα lines, one line of sight with twin bright emitters among the 8 l.o.s. investigated in Pentericci+ 14

The BDF field hosts **two close-by (4.4 proper Mpc) EW>50Å emitters**. ***(Vanzella+11).***

A random fluctuation is unlikely.
These objects likely reside in a region of high transparency -within an ionized bubble

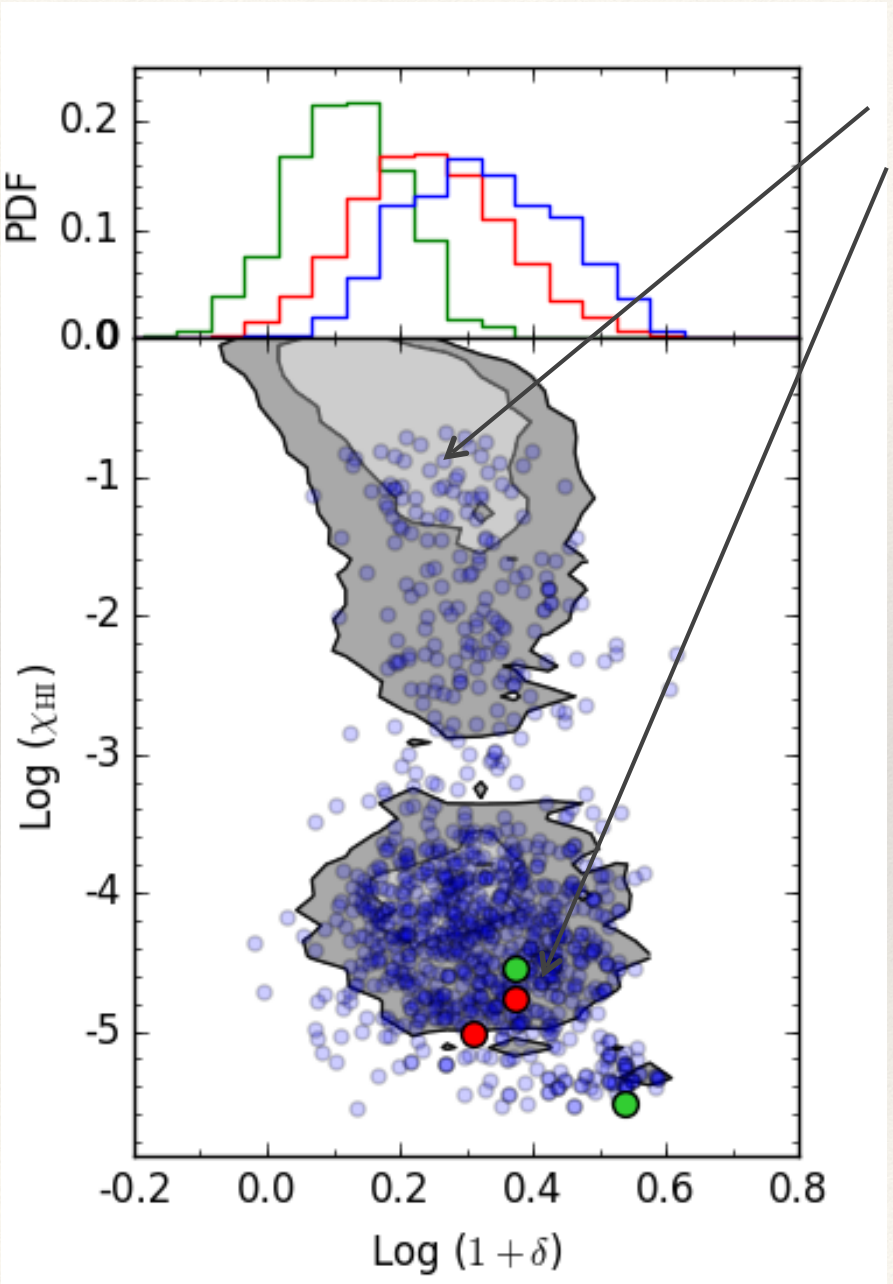


Vanzella+ 11

Galaxy density drives reionization

Castellano+16, ApJL

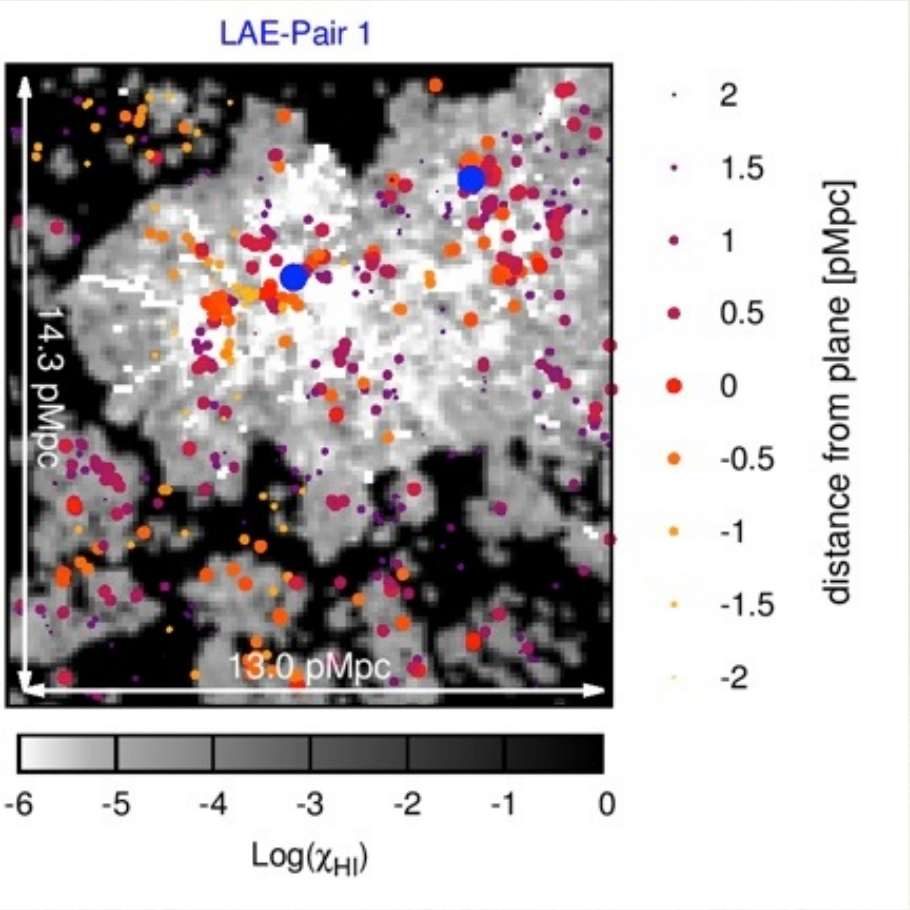
Comparison with SPH model (Hutter+14,+15).



Relation between density and HI fraction

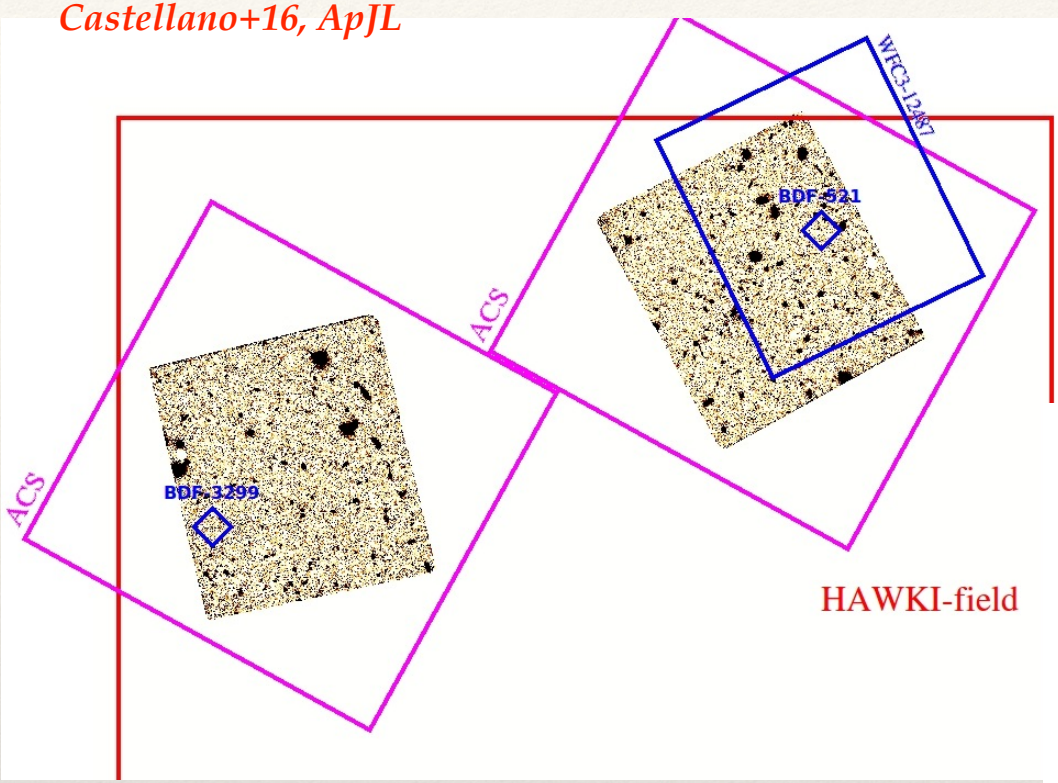
LAE pairs live in overdense regions with low HI

- analogs of BDF pairs reside in reionized, overdense bubbles



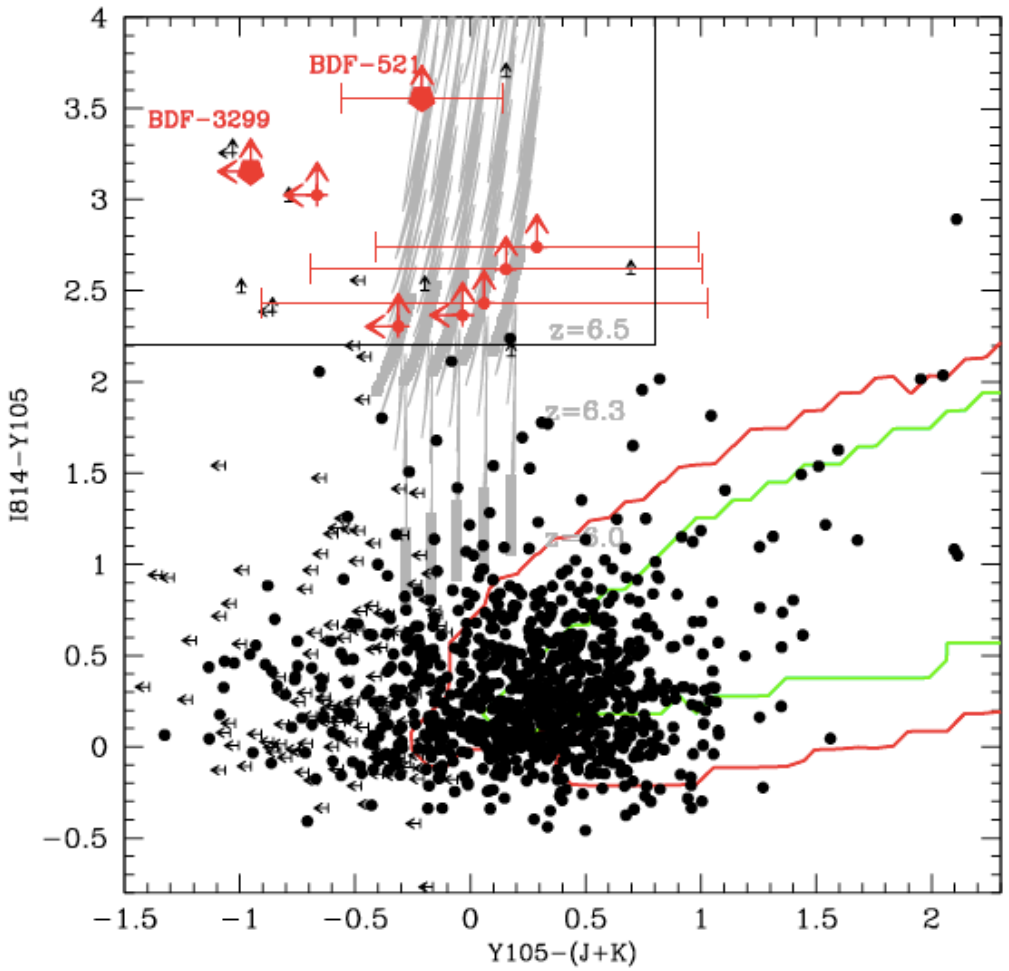
Faint z~7 LBGs in the BDF field

Castellano+16, ApJL



HST Cycle 22 program (PI MC) to look for surrounding, fainter LBGs.

14 orbits with V606, I814, Y105.



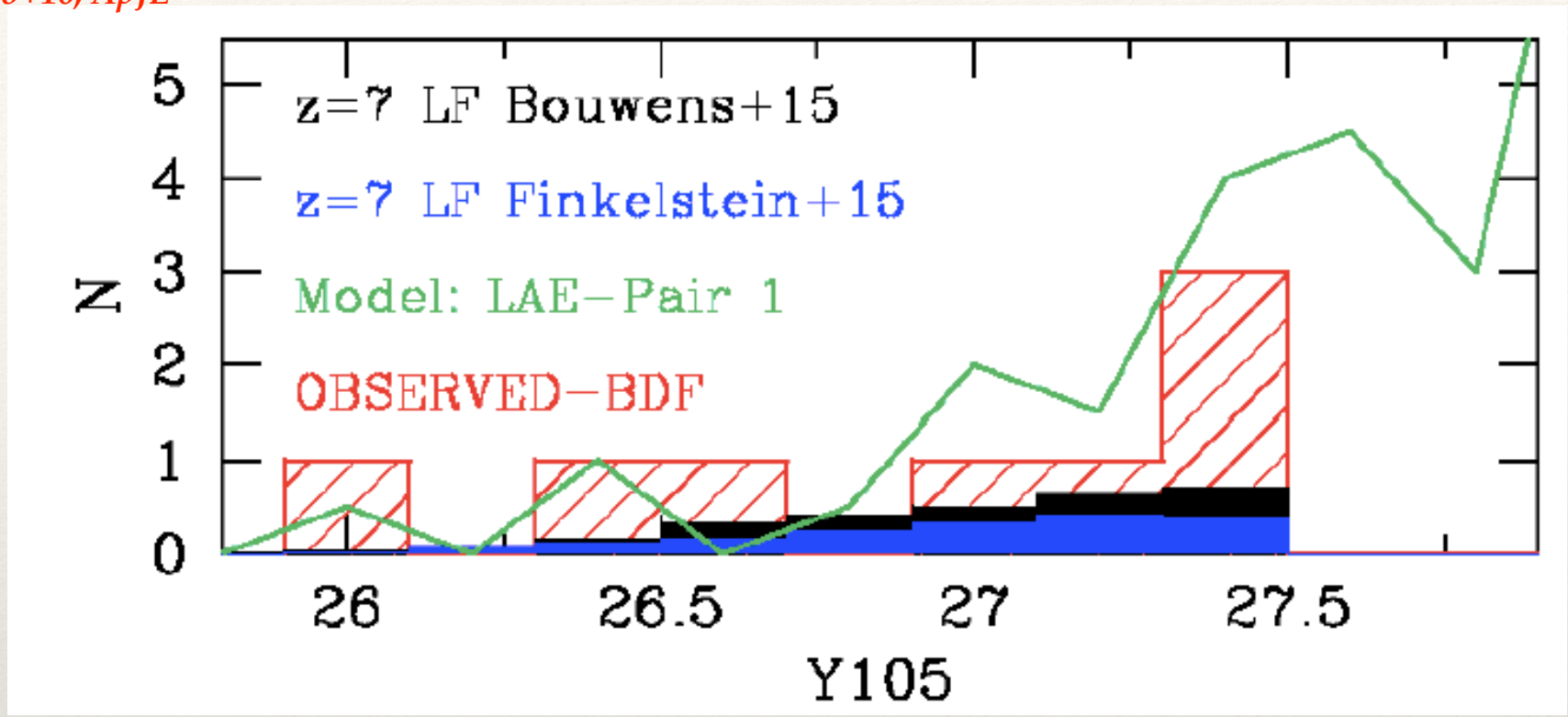
Previous Hawk-I data limited to Y~26.5.

Six new robust LBGs recovered down to Y105~27.5 (at S/N>10)

$$(S/N(I_{814}) < 1) \wedge (I_{814} - Y_{105} > 2.2)$$
$$Y_{105} - (J + K) < 0.8$$
$$(S/N(Y_{105}) > 10) \wedge (S/N(V_{606})) < 1,$$

The BDF region **is** overdense

Castellano+16, ApJL



Observed 8 objects in two pointings. Expected ~1.8-2.9 objects.

No clustering around z~7 GOODS-S galaxies (objects lacking Lyα emission).

The BDF field is 3-4x overdense wrt average: consistent with a positive relation between line visibility and galaxy density as in inside-out reionization scenarios. (e.g. McQuinn+ 07, Wyithe&Loeb 07, Dayal+ 09).

Conclusions

1) The evolution of the Lyα visibility: what is telling us?

- Lyα decline softer than previous estimates: starts at z~6
- Might eventually allow us to discriminate between reionization models - probably needed a combination of small-scale (“*web*-“)and large-scale (“*bubble*-“) absorbers.

2) Is reionization patchy? Which are the sources?

- Yes! Overdensity of faint galaxies can be connected with ionized bubbles *(Castellano + 2016, ApJL)*