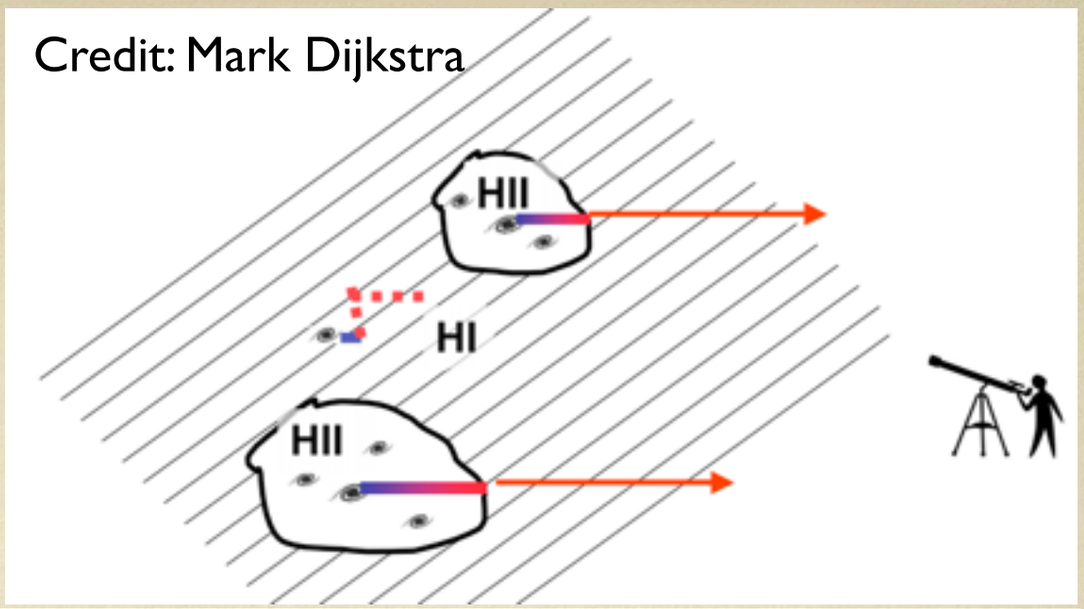
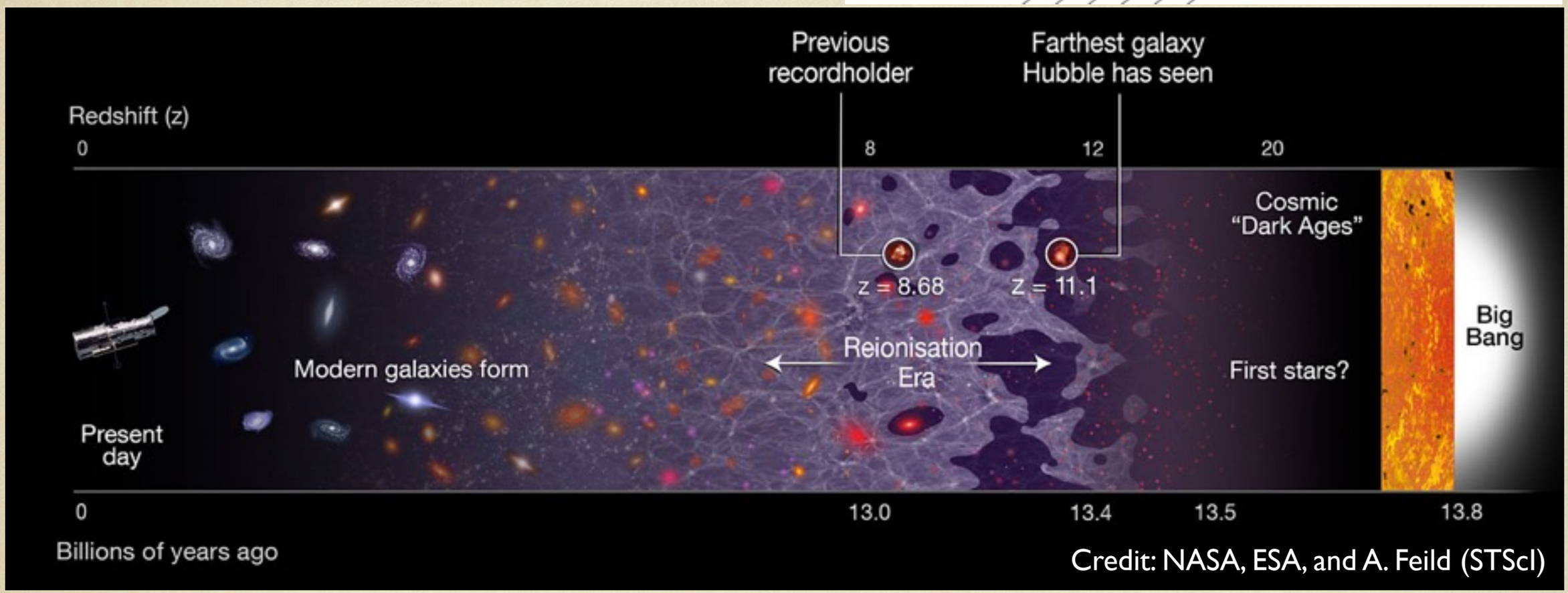
Insights into Lyα and CIV emission from strongly lensed galaxies observed with MUSE

Renske Smit

Durham University

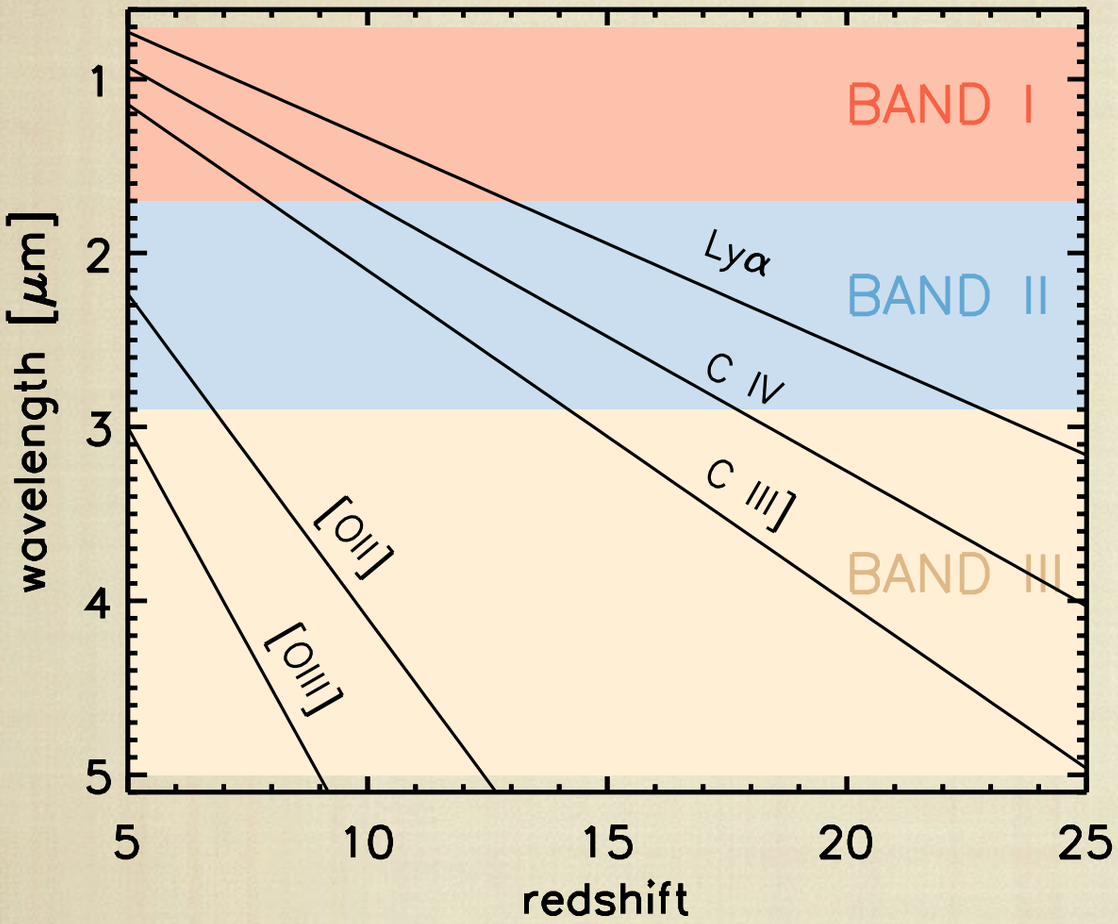
Reionisation studies





Lyα escape - i.e. spatial and frequency distribution - influences prevalence of the line in the reionisation epoch

First galaxies with JWST: Spectroscopic tracers

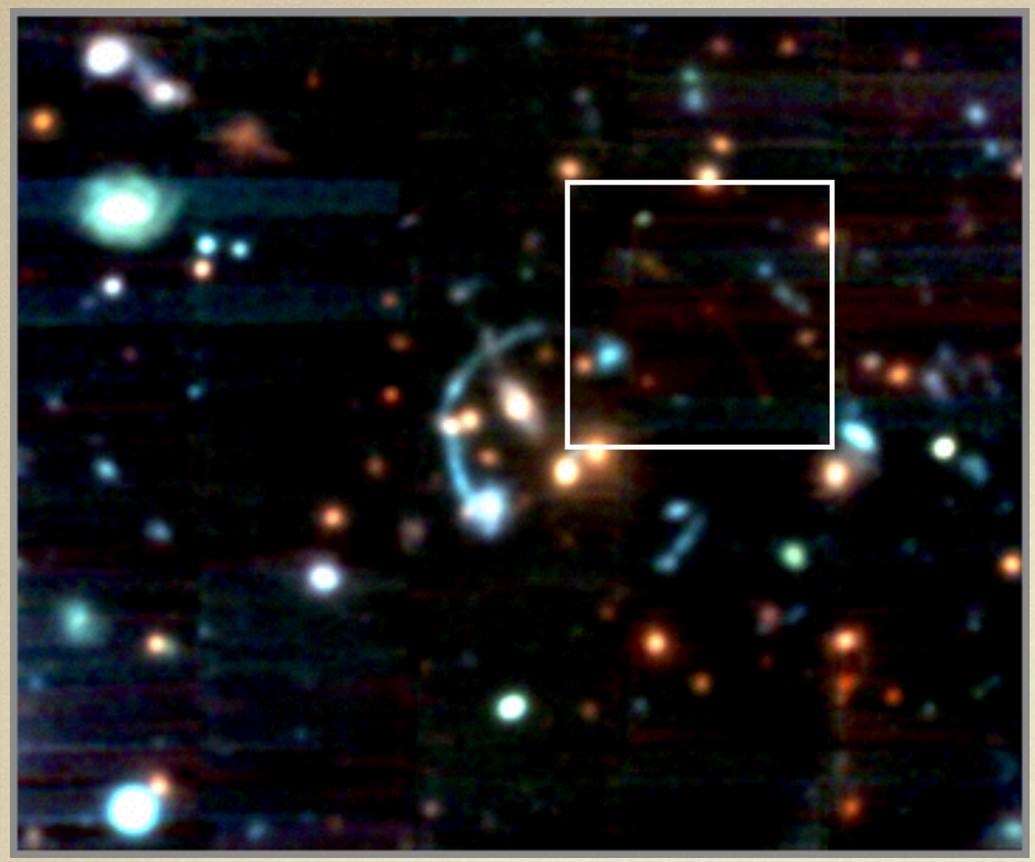


JWST/NIRSpec

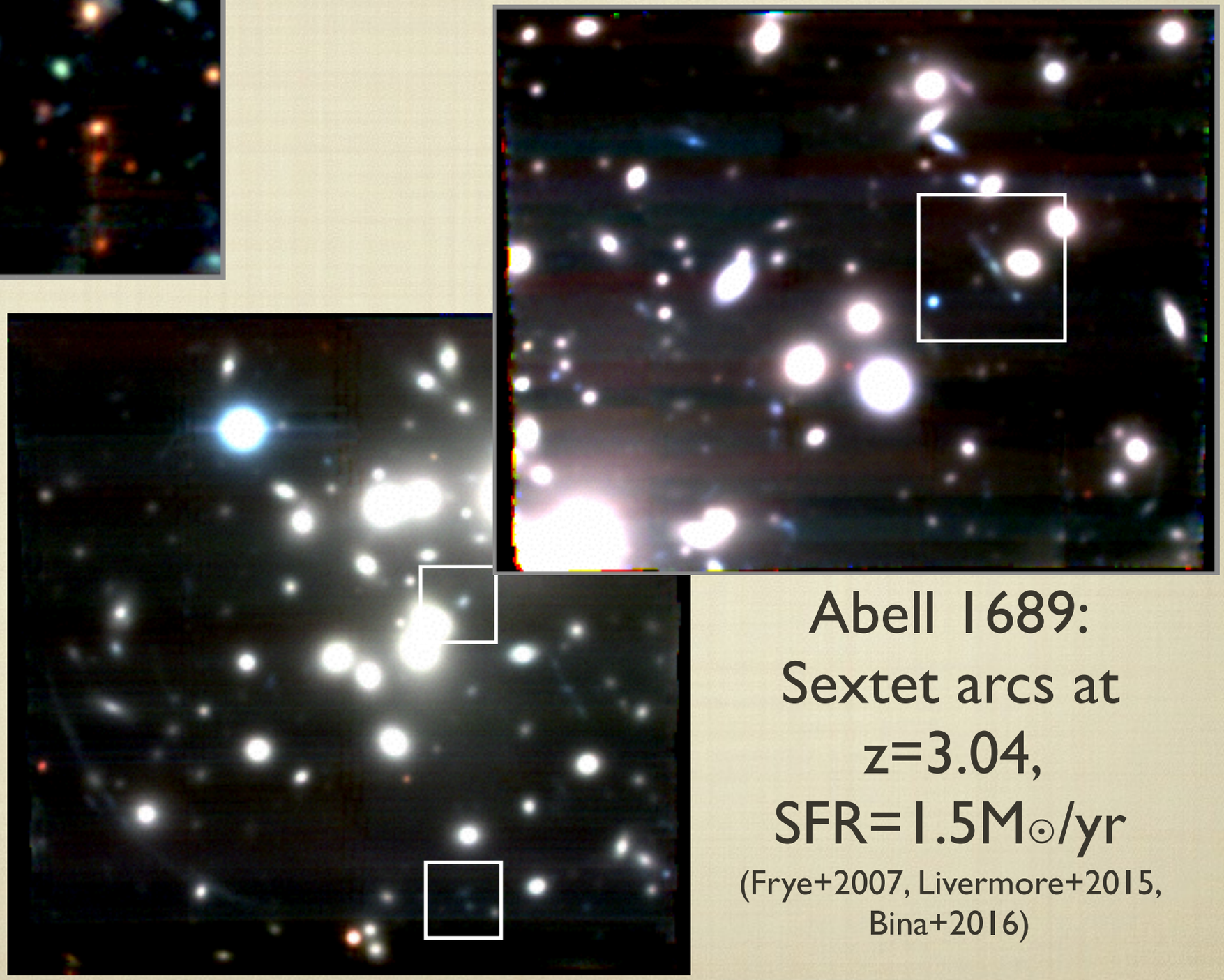
We will rely on nebular lines such as C IV and C III] for galaxy identifications beyond z>12 (or z>9) (e.g. Stark+2015,2016)

Are UV nebular lines commonly produced in low-metallicity star-forming galaxies?

MUSE spectroscopy

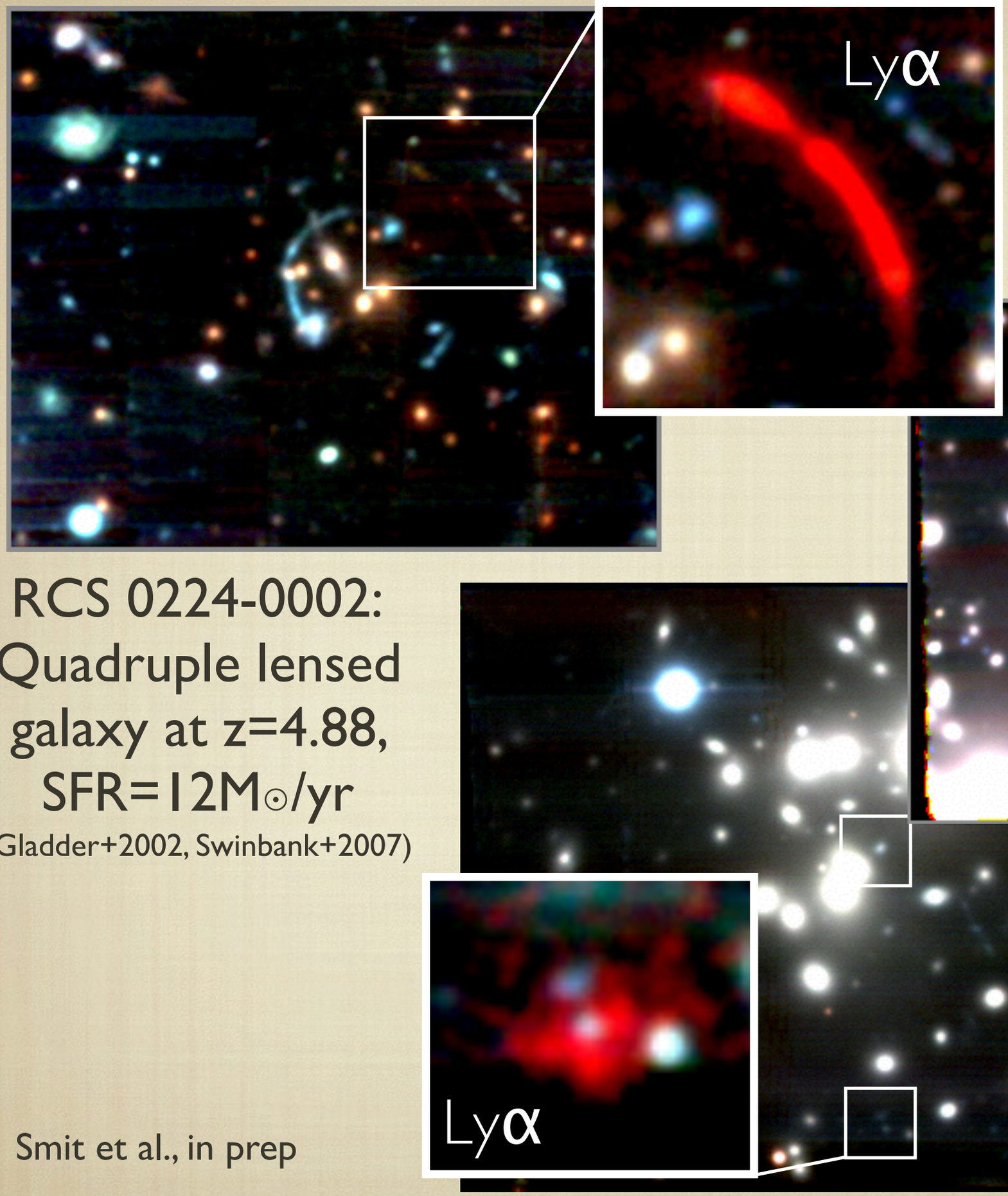


RCS 0224-0002:
Quadruple lensed galaxy at z=4.88, SFR=12M⊙/yr
(Gladder+2002, Swinbank+2007)



Abell 1689:
Sextet arcs at z=3.04, SFR=1.5M⊙/yr
(Frye+2007, Livermore+2015, Bina+2016)

Smit et al., in prep



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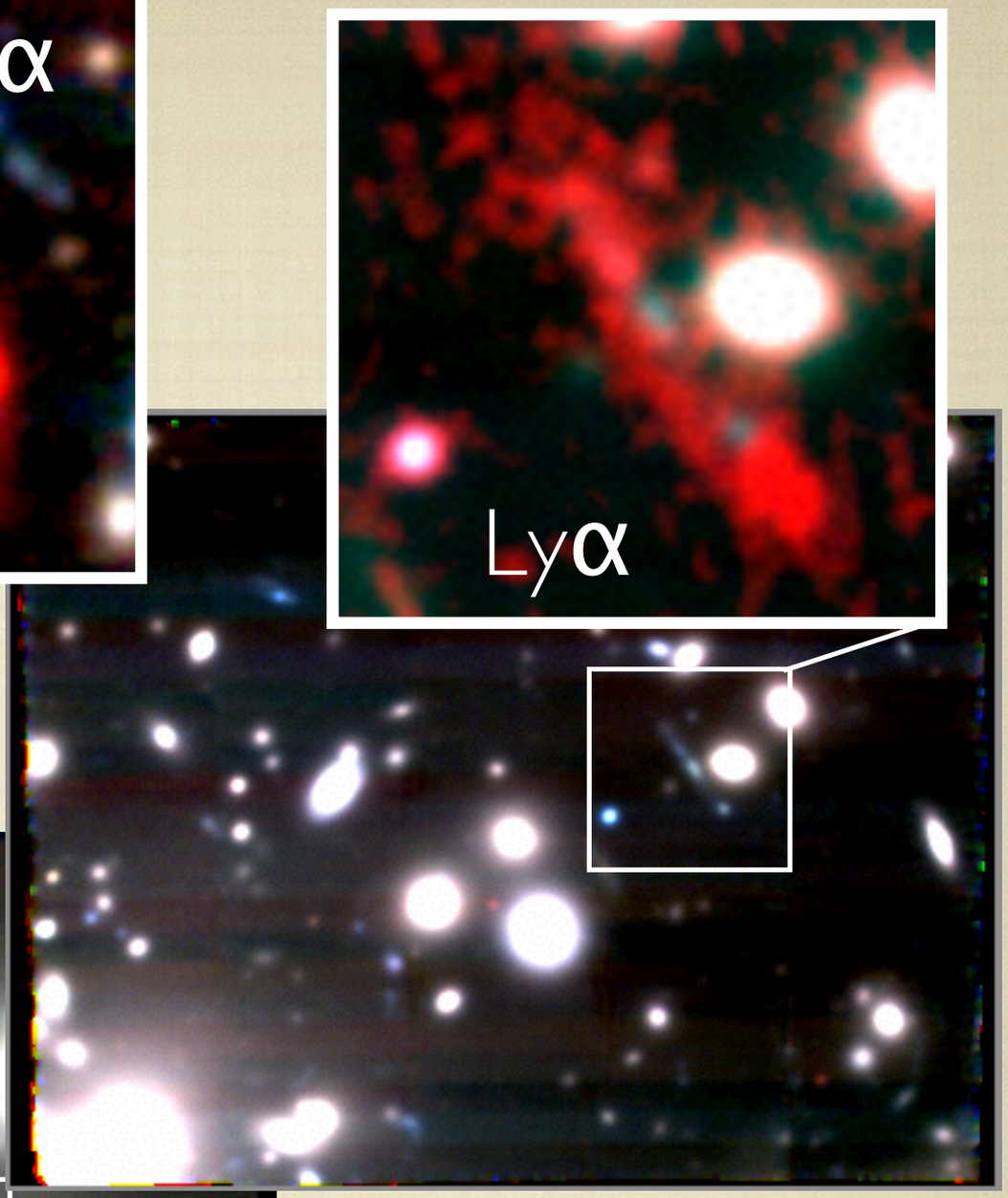

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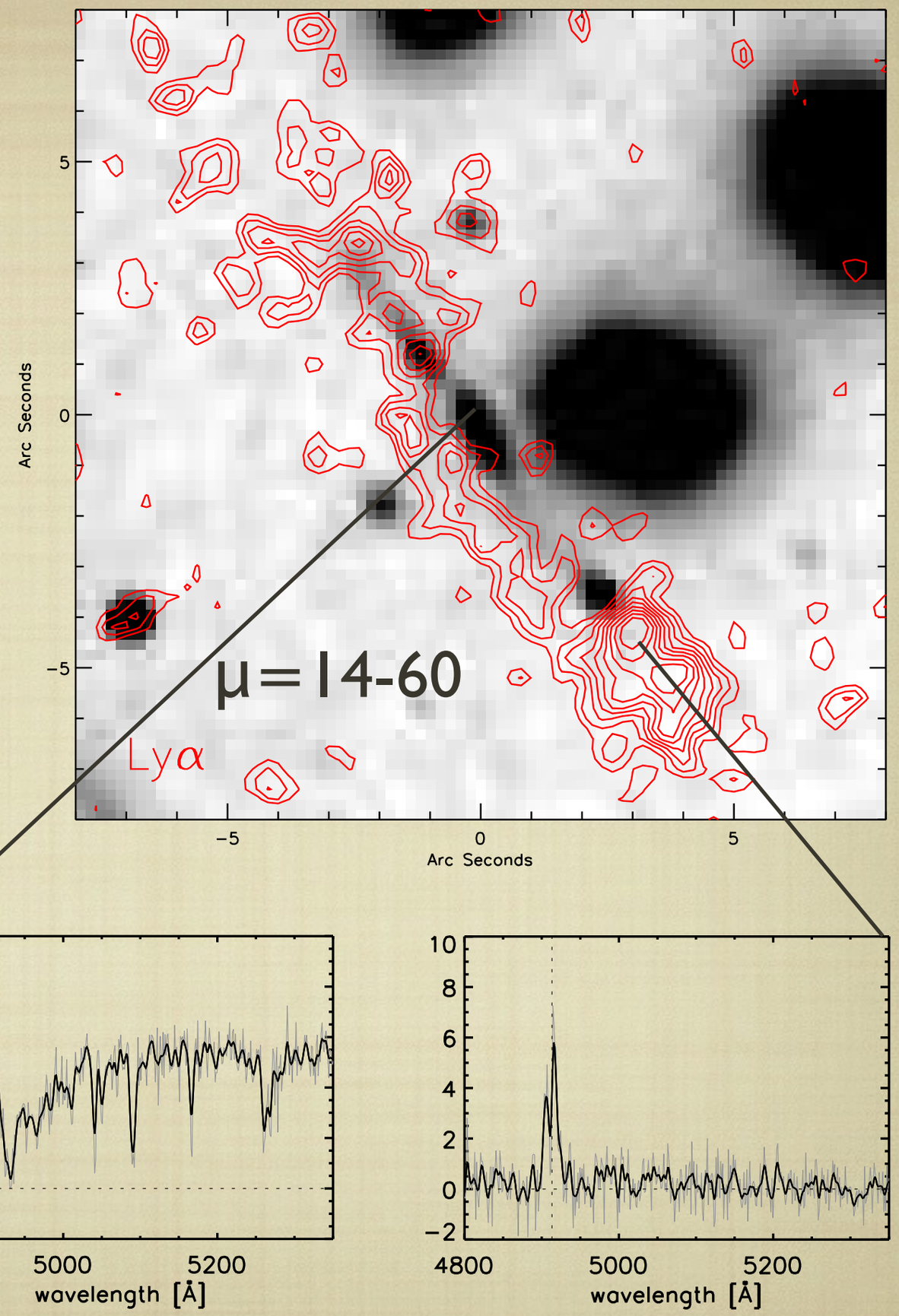
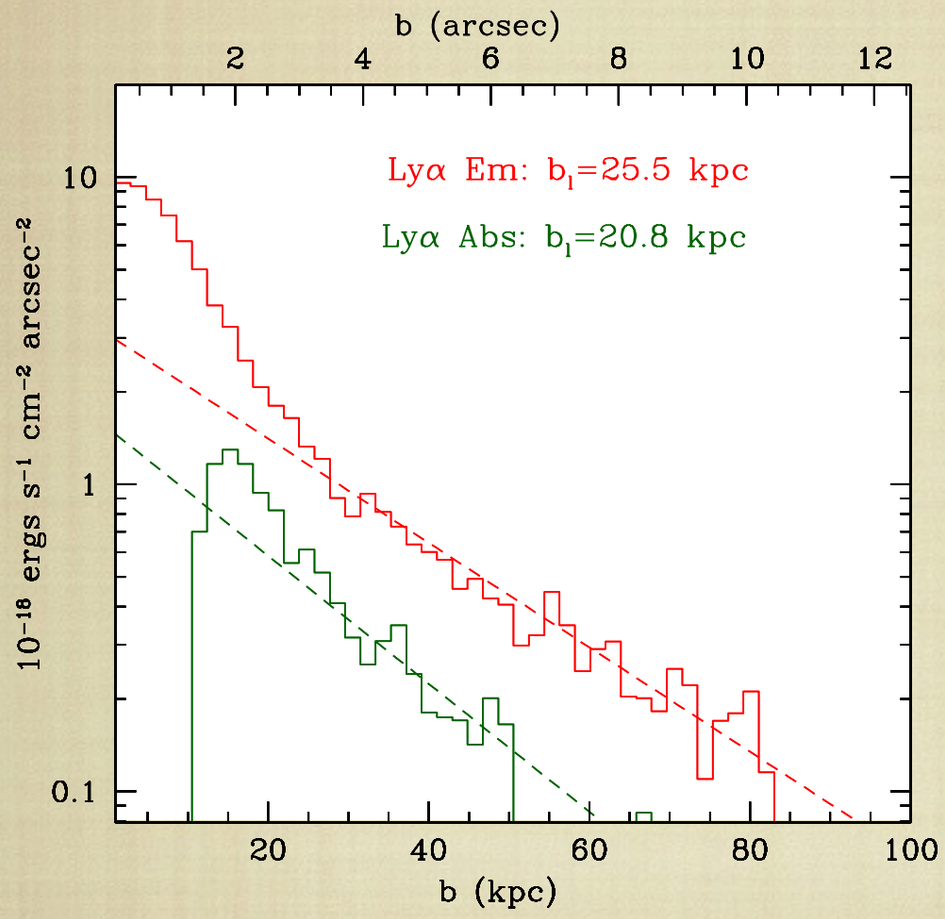
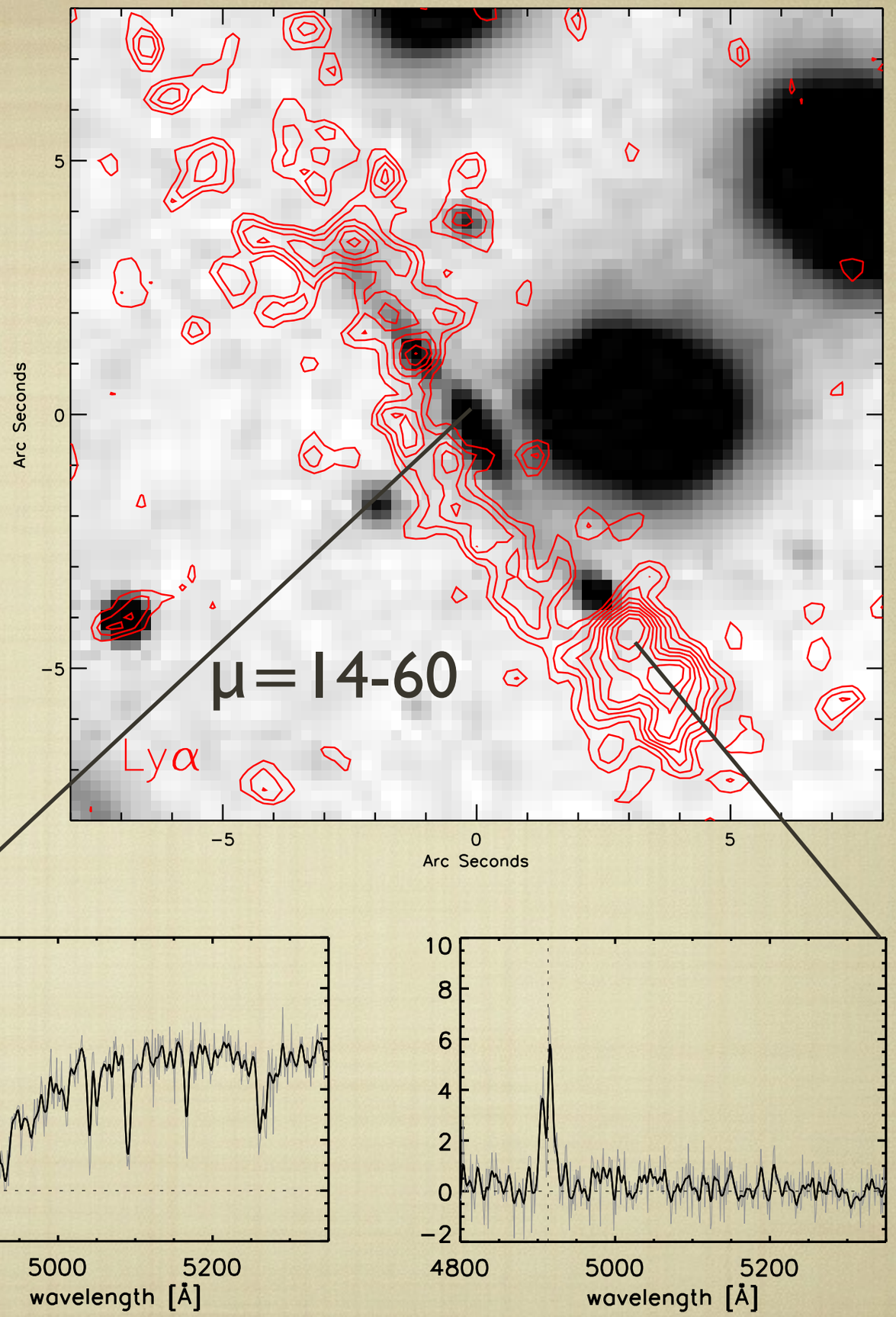
A1689: resonantly scattered Lyα



Lyα absorbers are Lyα emitters on large scales

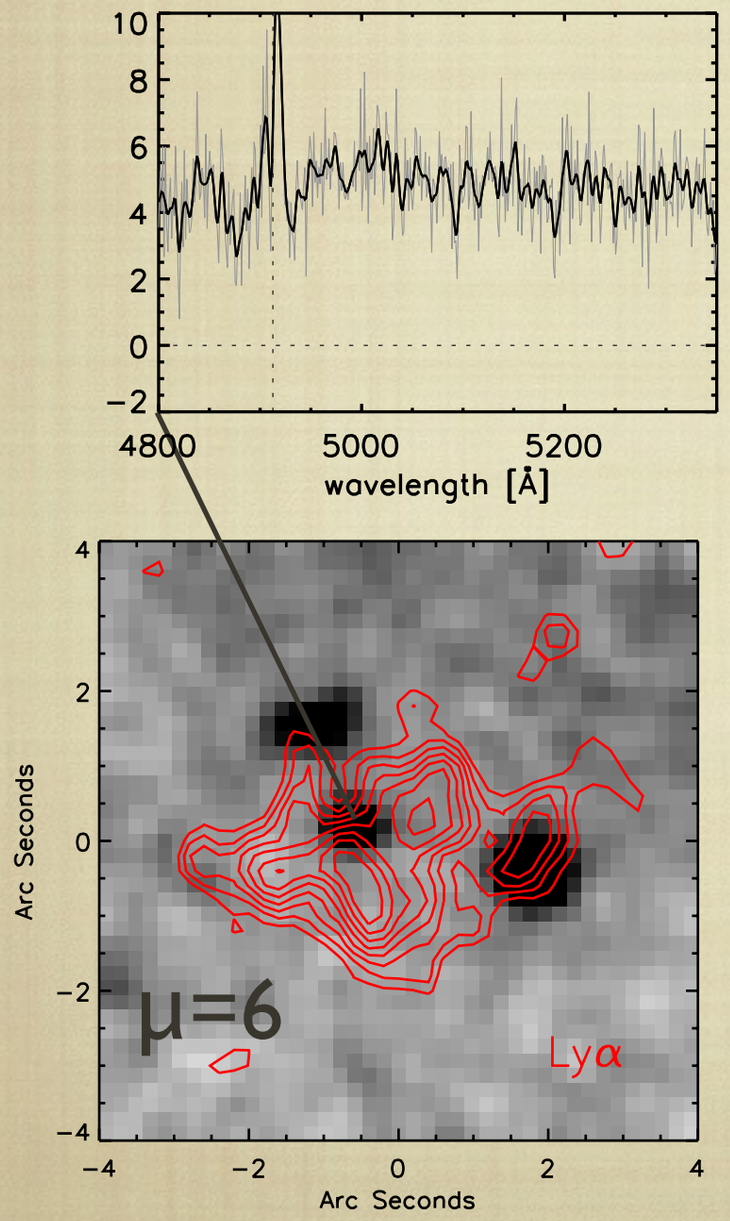


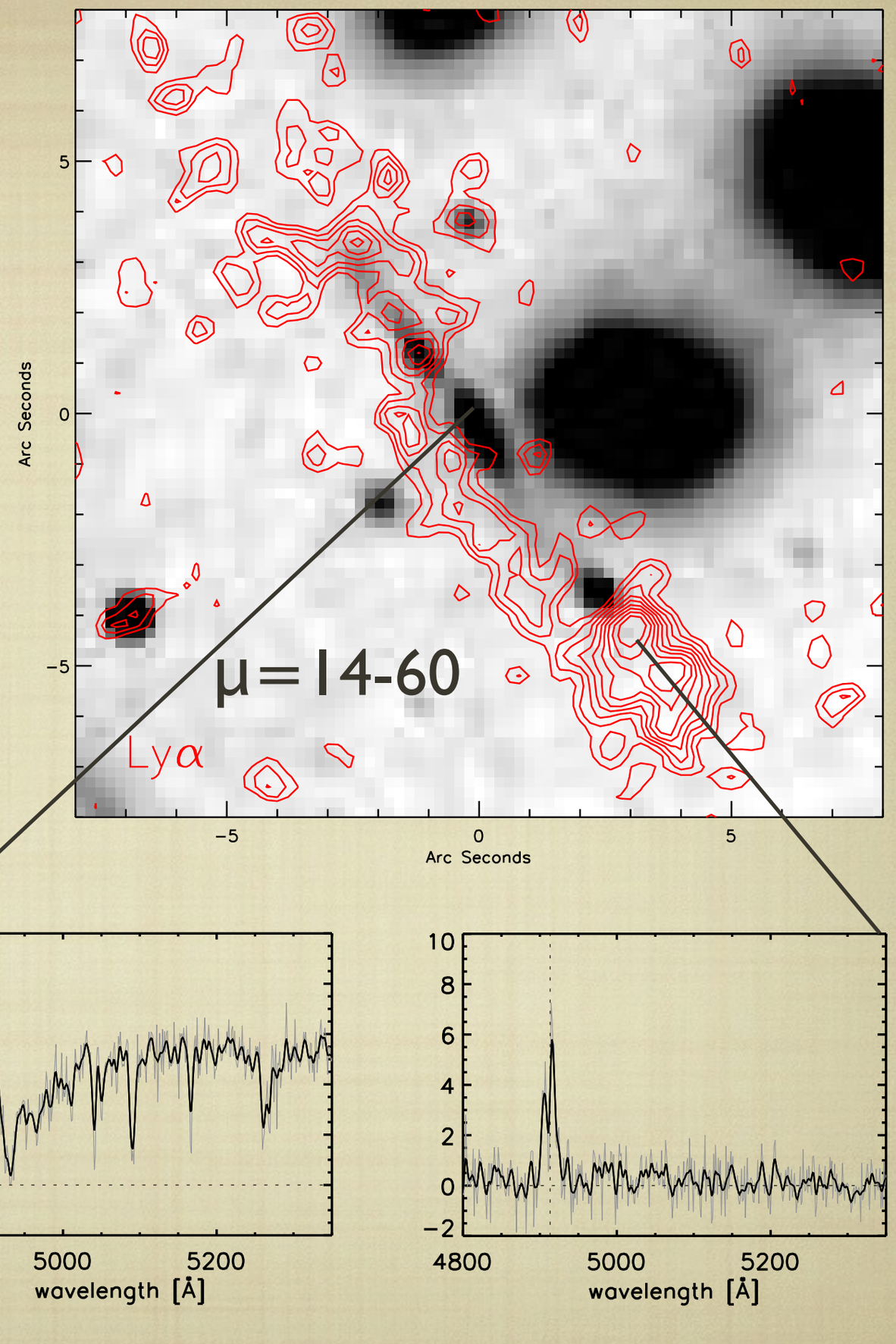
Steidel at al. 2011



~~Lyα absorbers are Lyα emitters on large scales~~

Lyα emitters can be Lyα absorbers at high spatial resolution





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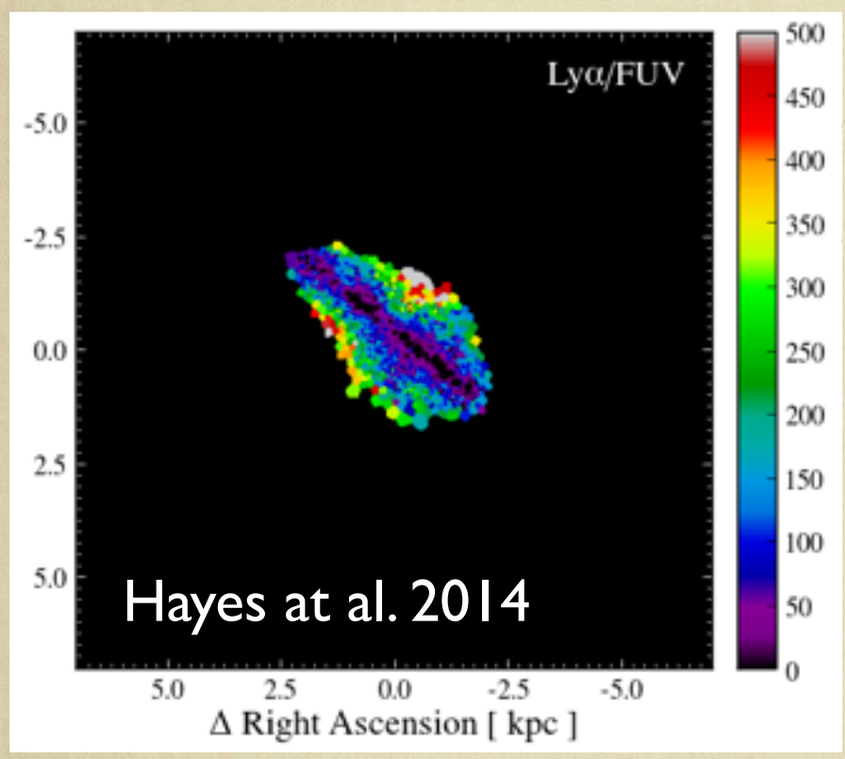
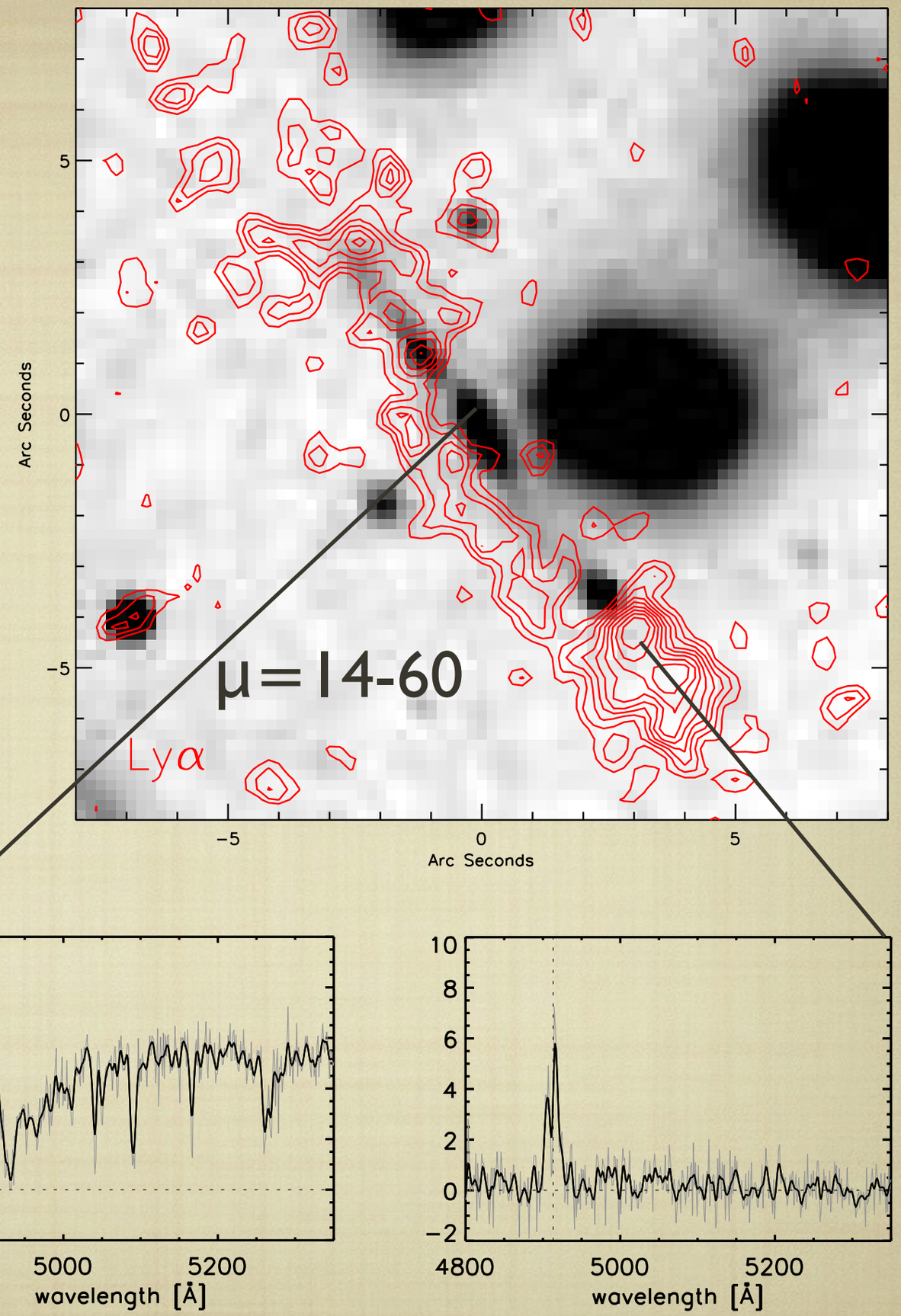
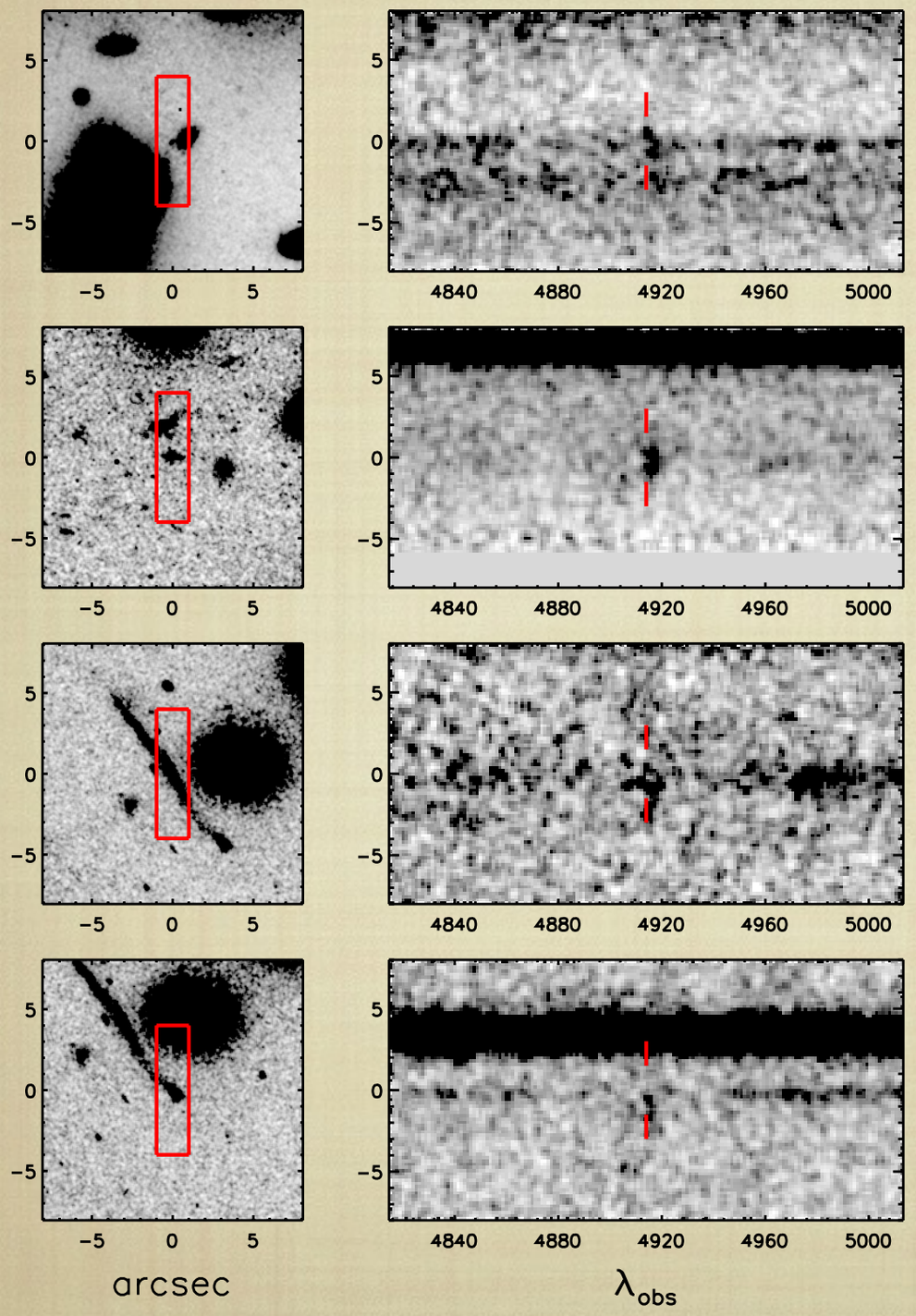


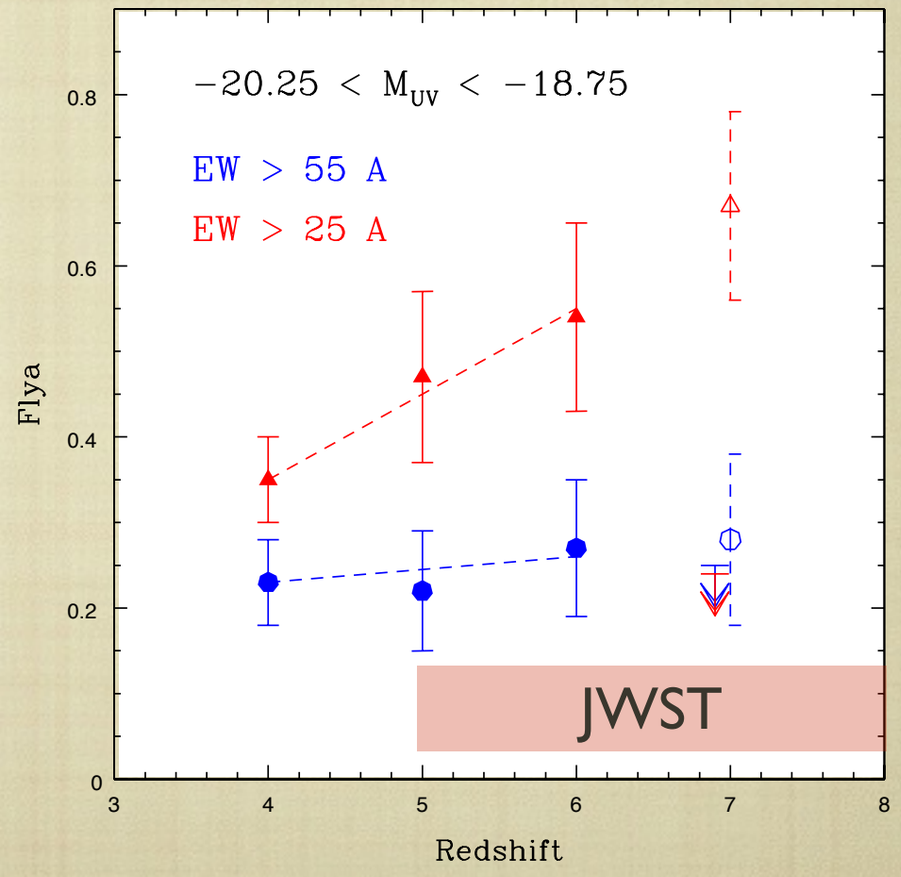
Redshift z~0 analogs show similar effect in *all* Lyα emitters



Implications for Lyα studies

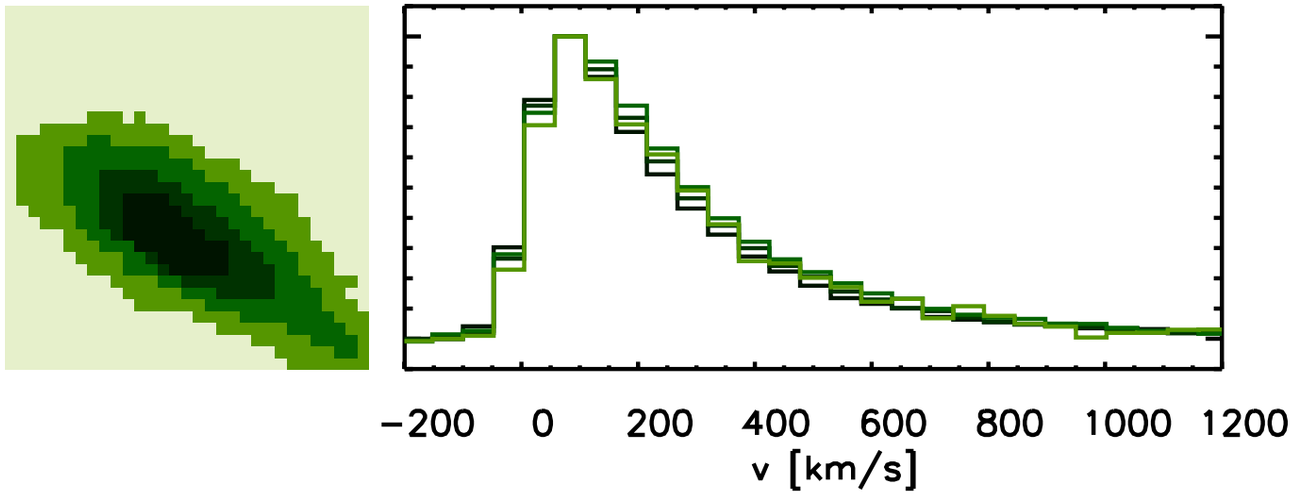


Will Lyα prevalence drop due to JWST spatial resolution?



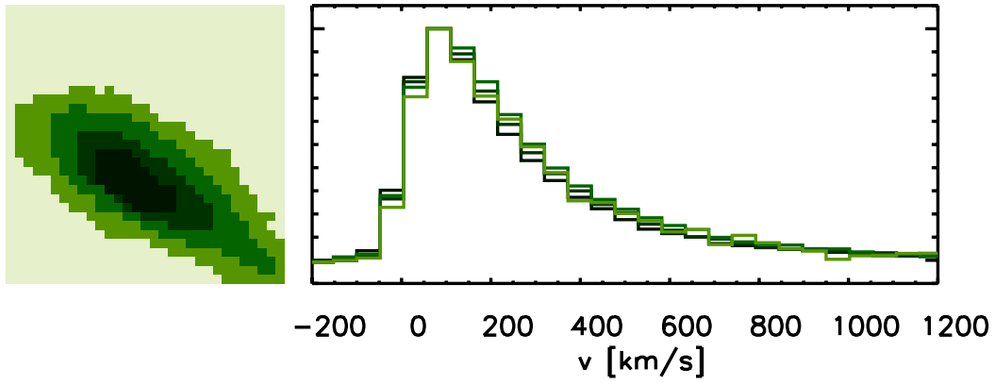
Pentericci at al. 2011

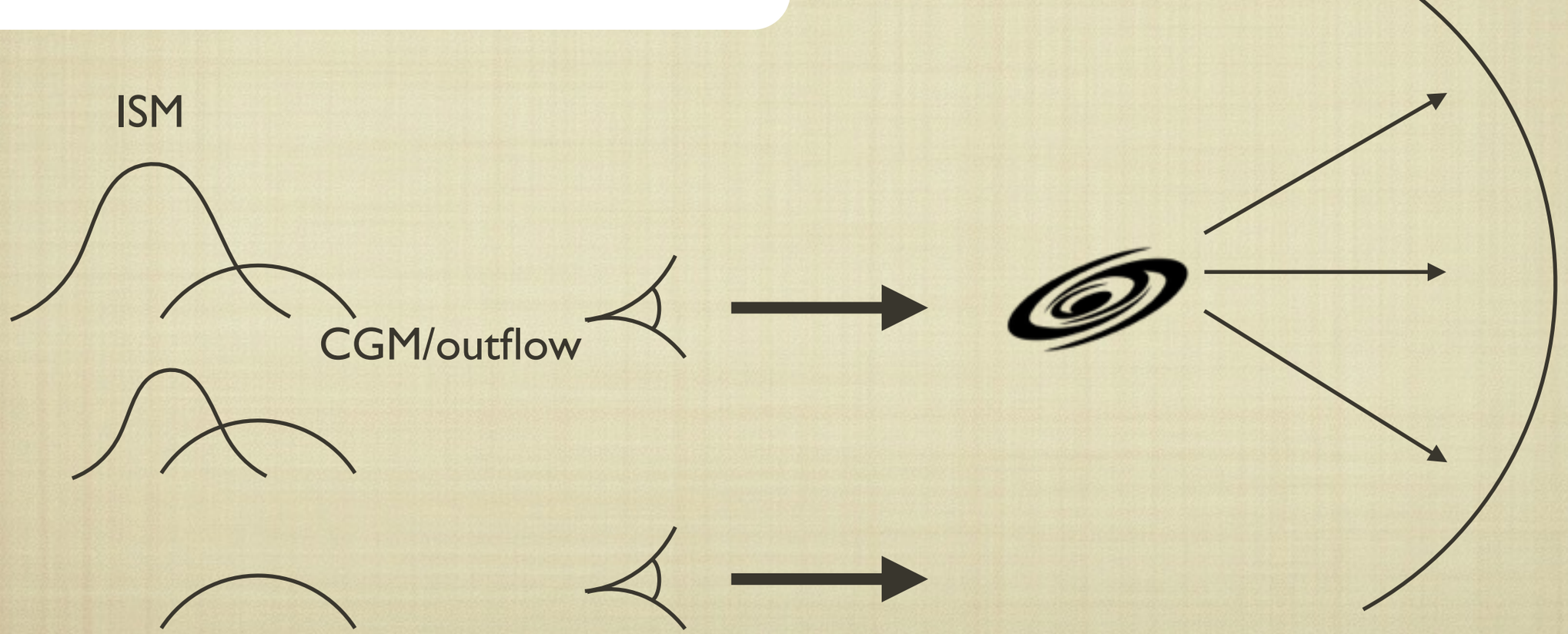
RCS0224: Spatially invariant Lyα velocity profile



Variation is Lyα peak as a function of radius is <60 km/s

RCS0224: Spatially invariant Lyα velocity profile





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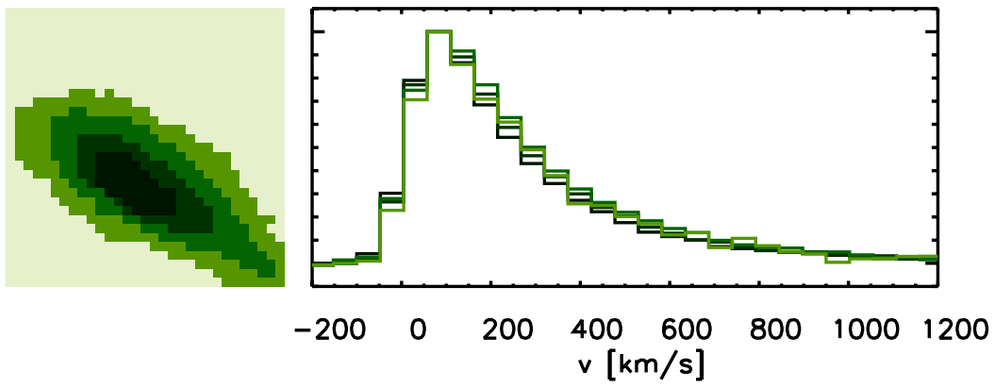
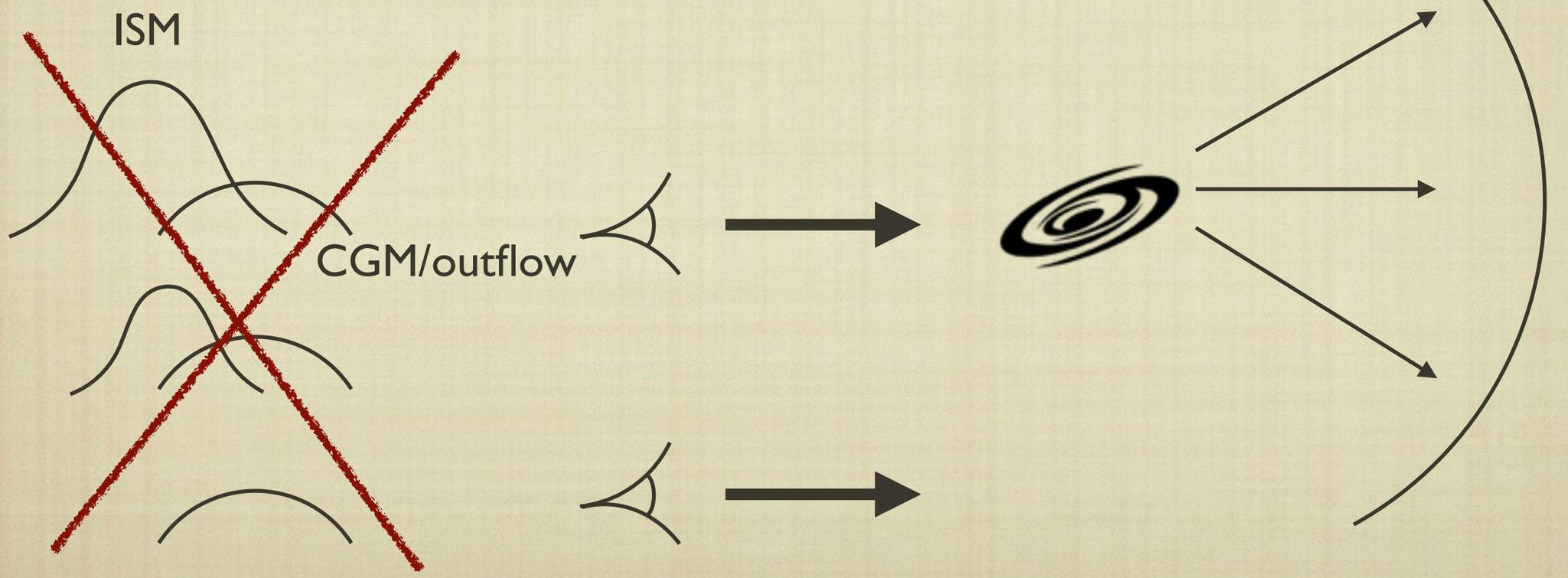
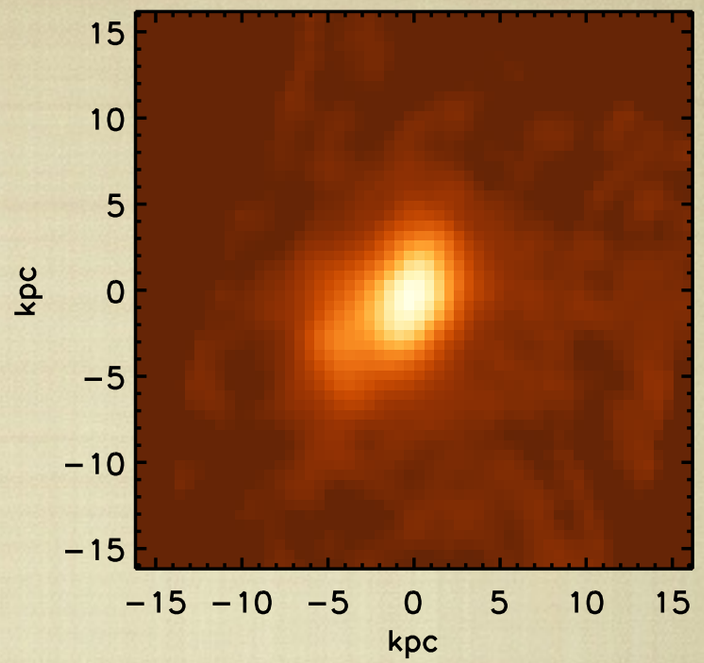


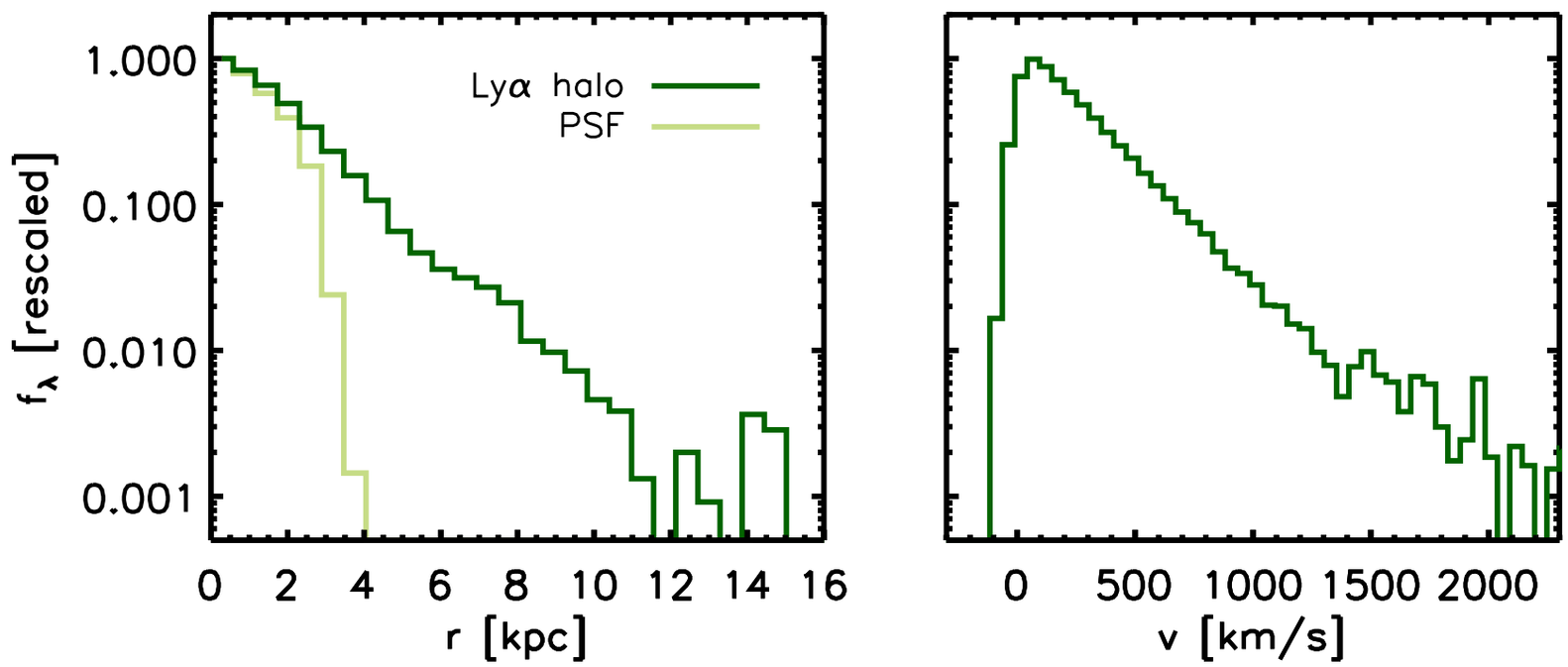
Is Lyα here also dominated by CGM emission?



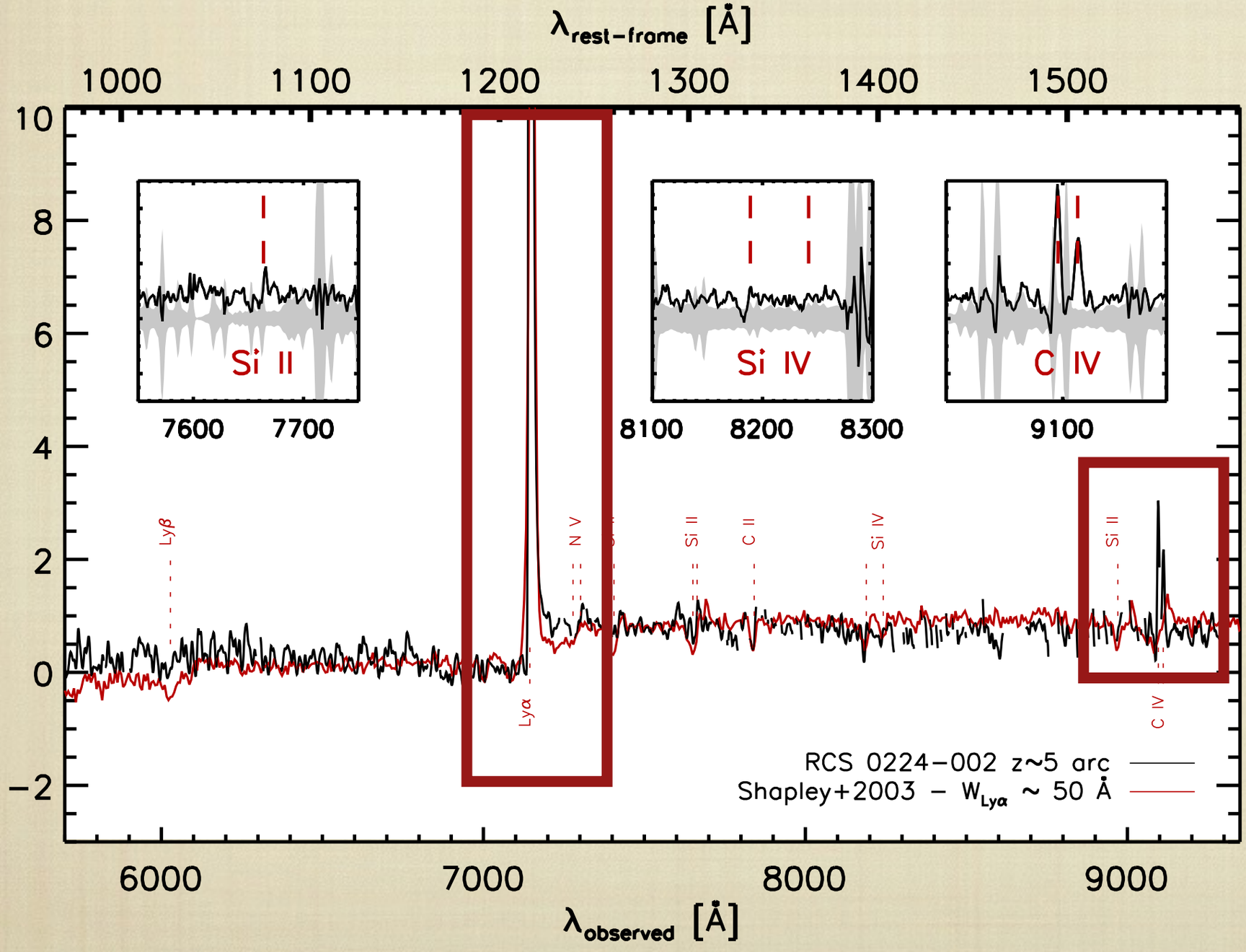
The exponential shape of the Ly**α** halo

Lyα emission is best describe by an exponential profile **both** spatially and in velocity space - smooth red tail that was previously not detected





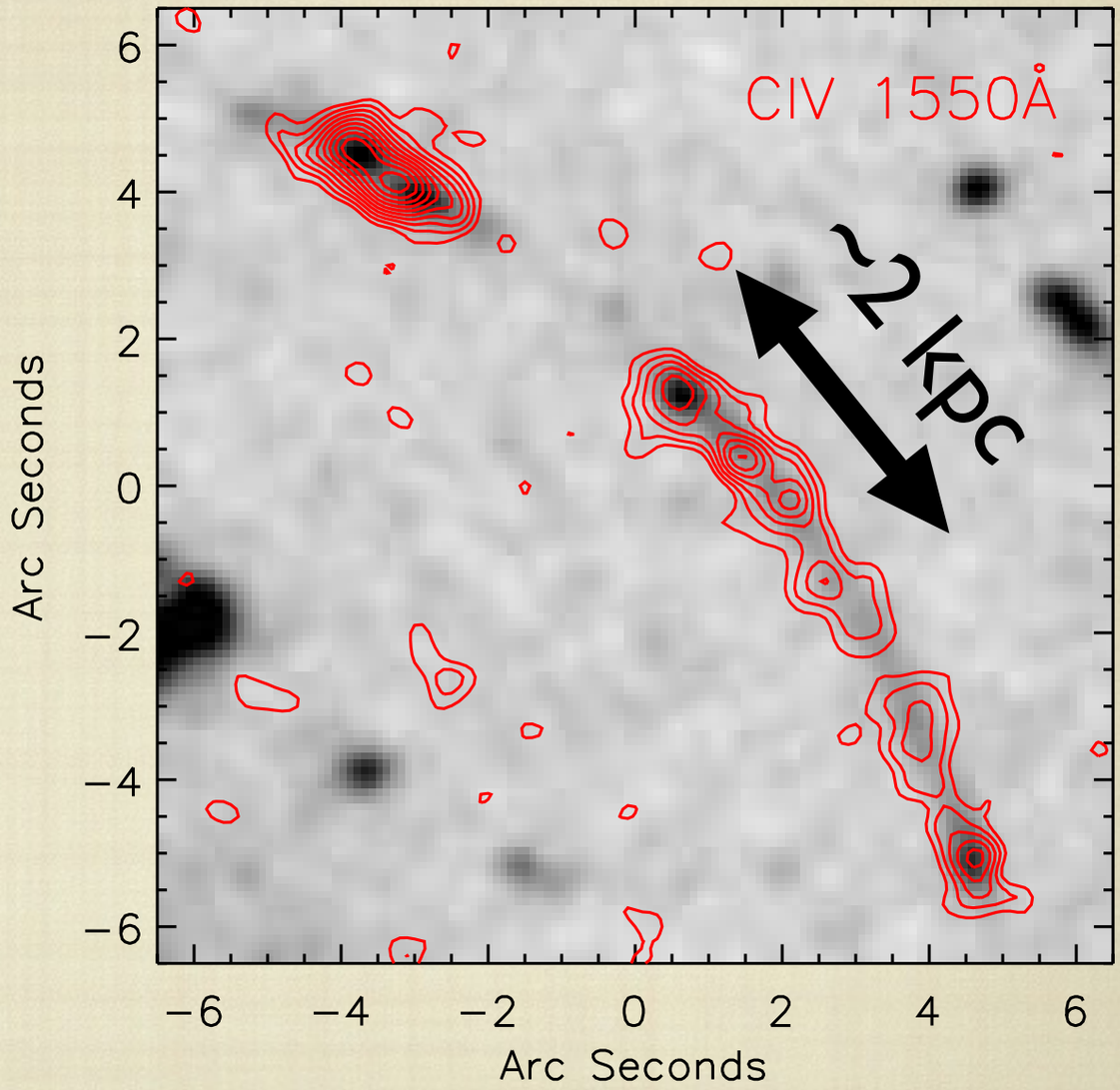
RCS 0224 z=4.88 arc: discovery of a strong CIV doublet



CIV emission requires significant flux of radiation at >40-50 eV

Spatial distribution of CIV

- We can resolve star-forming regions with ~300 pc resolution and find extended CIV emission over ~4 massive star-forming clumps



Spatial distribution of CIV

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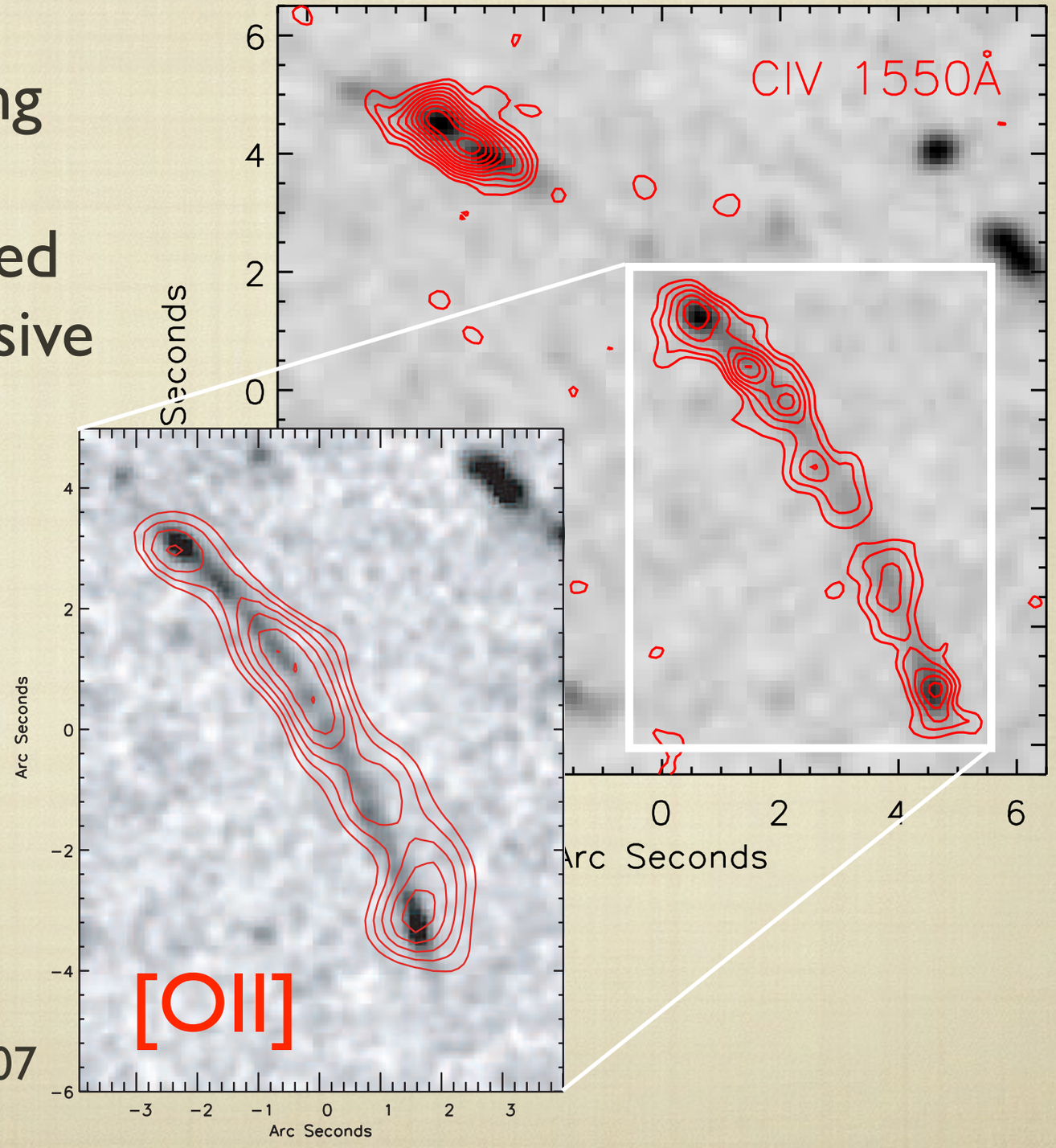
- CIV follows the spatial distribution of [OII], with $z_{CIV} \sim z_{OII} \sim 4.875$ and $\sigma_{CIV} \sim \sigma_{OII} \sim 50$ km/s

Swinbank et al. 2007



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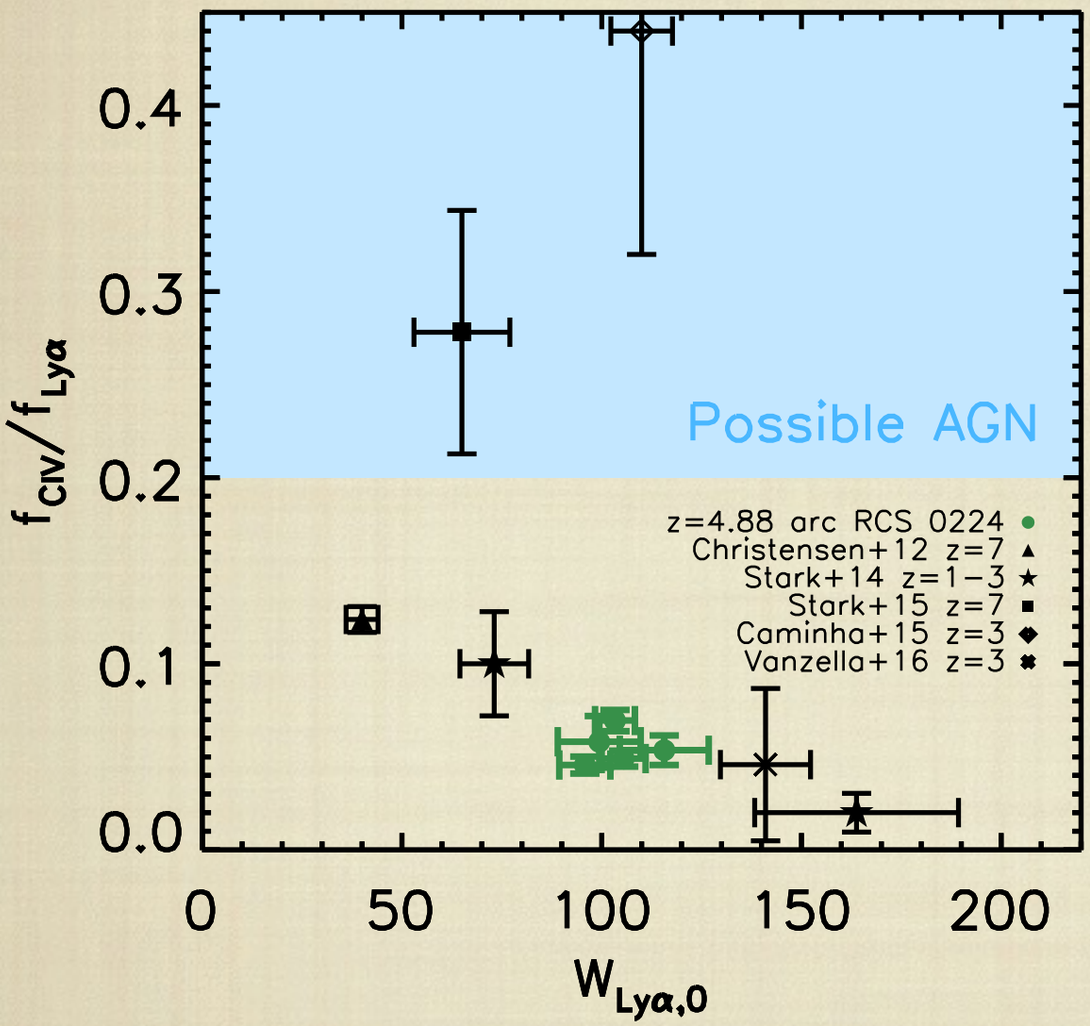
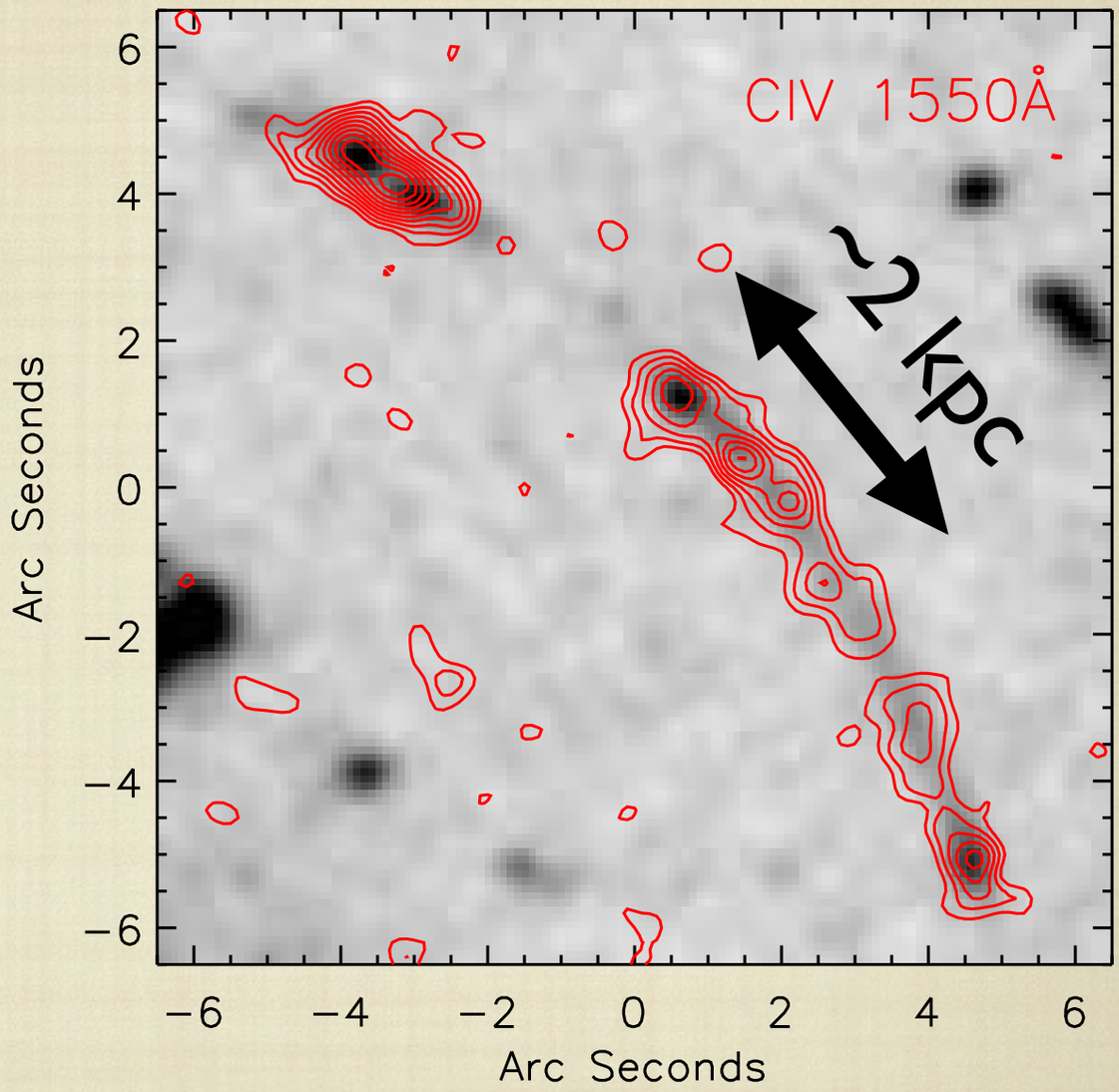
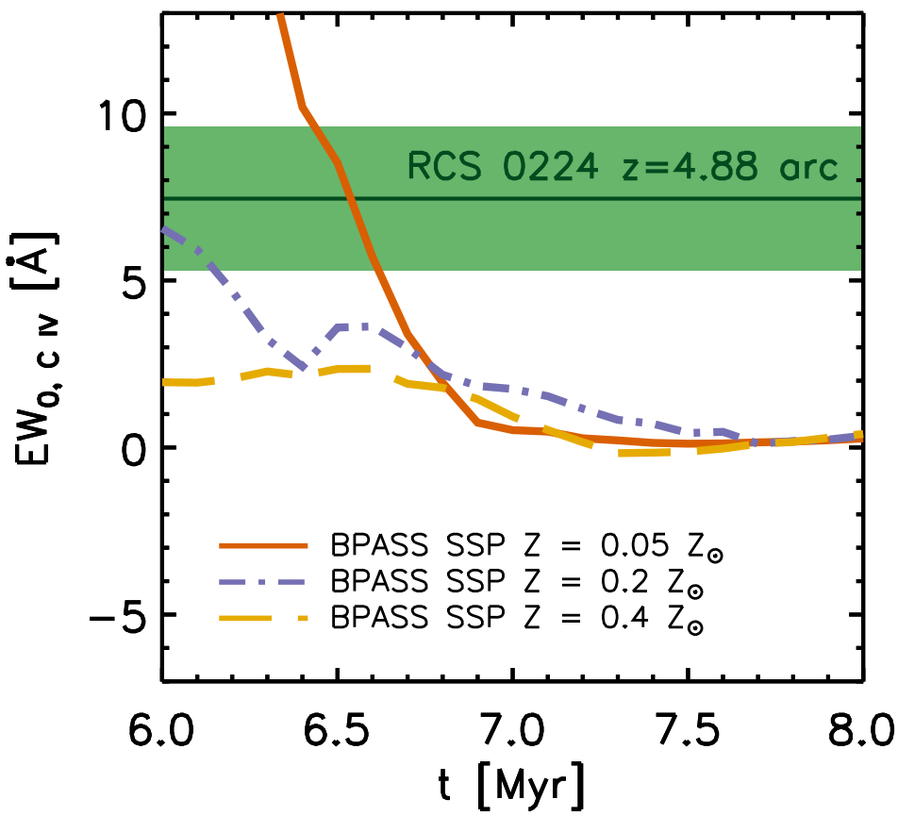


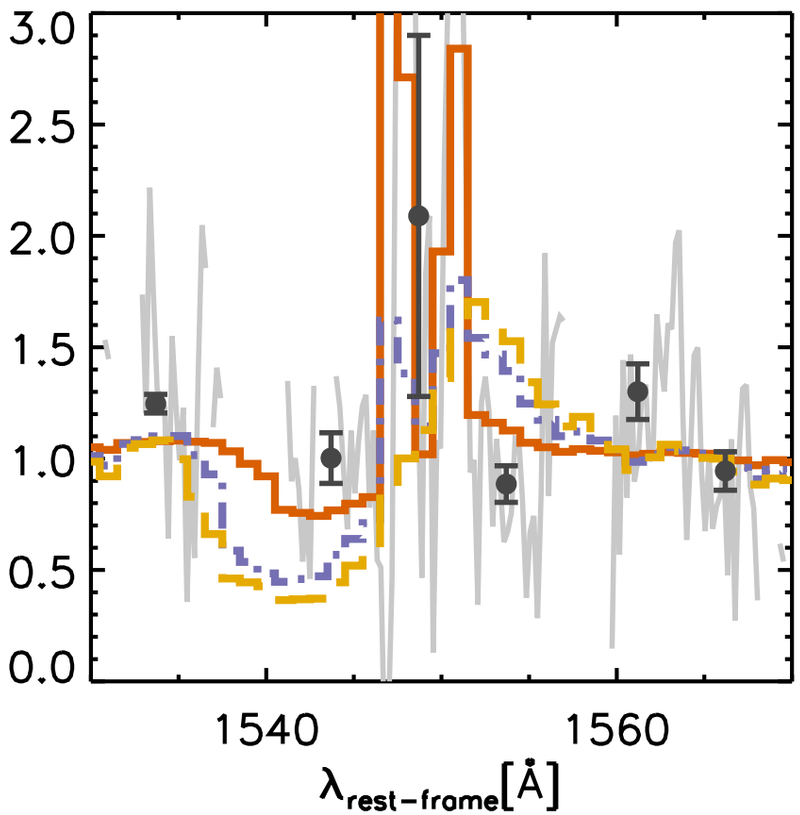


More soon; incoming HST/WFC3,
potentially He II1640, CIII] 1909 spectroscopy

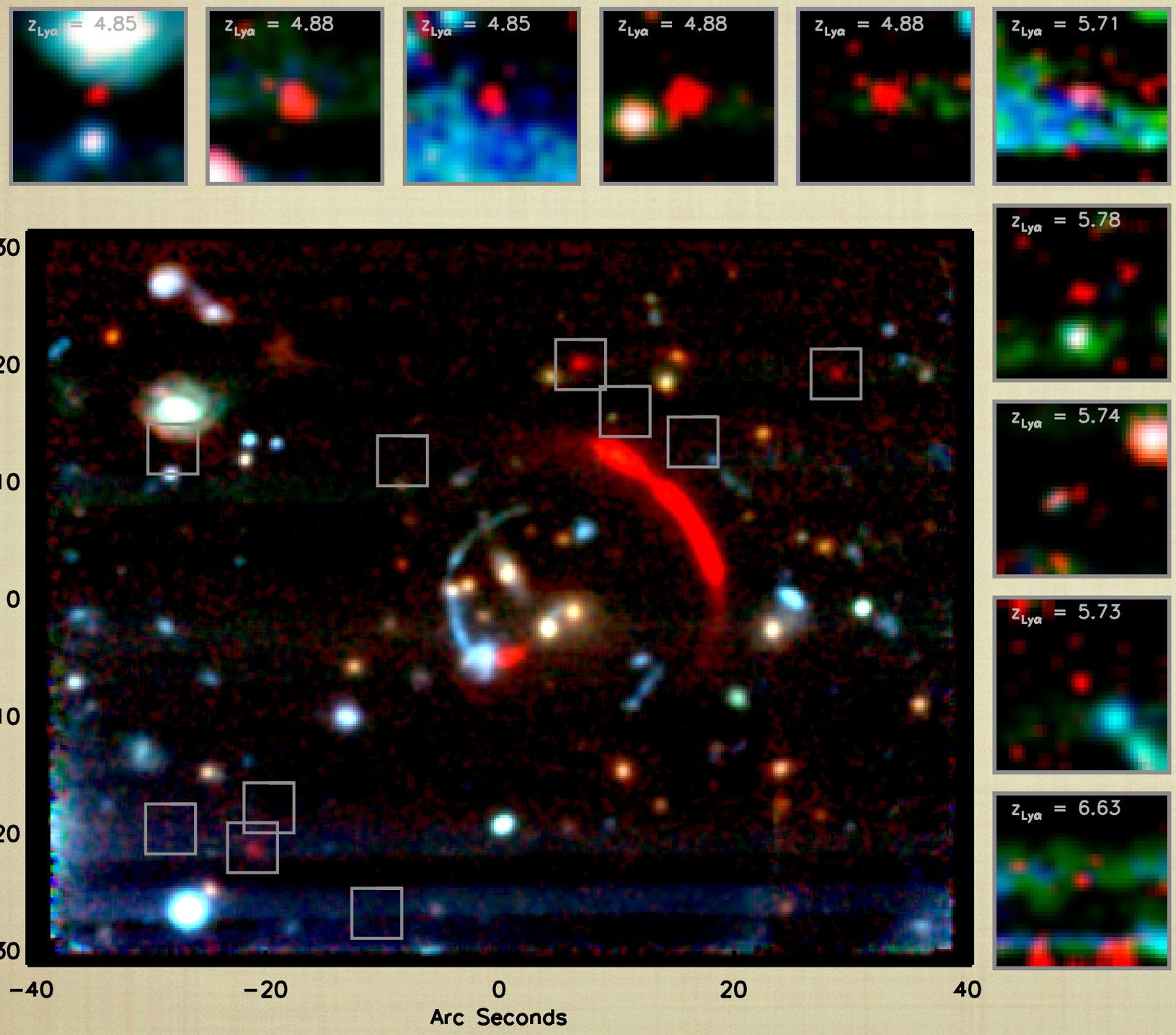
Stellar population models

- Low metallicity stellar population (<5% solar) needed for high CIV EW
- No evidence for stellar lines: CIV 'clean' measurement of nebular emission





Search for Lyα candidates z=4.8-6.6



Deep MUSE observations (27hr) over HDF-S have revealed m_{UV}>30 mag sources (Bacon+2015)

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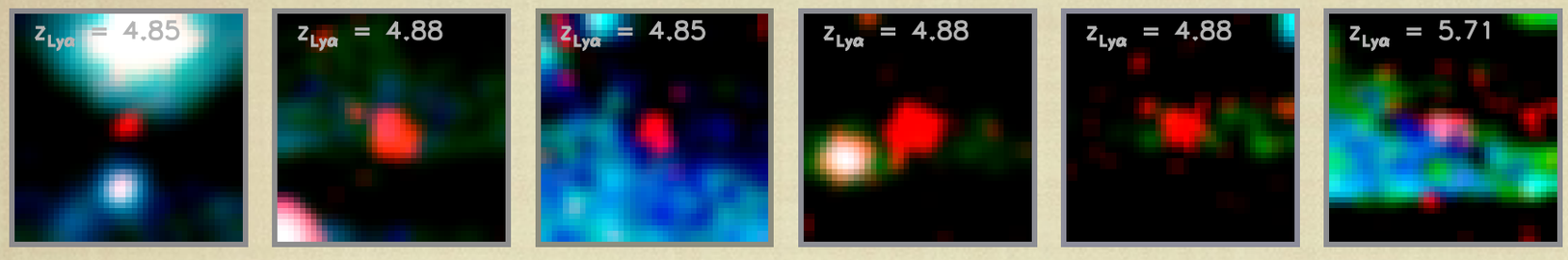
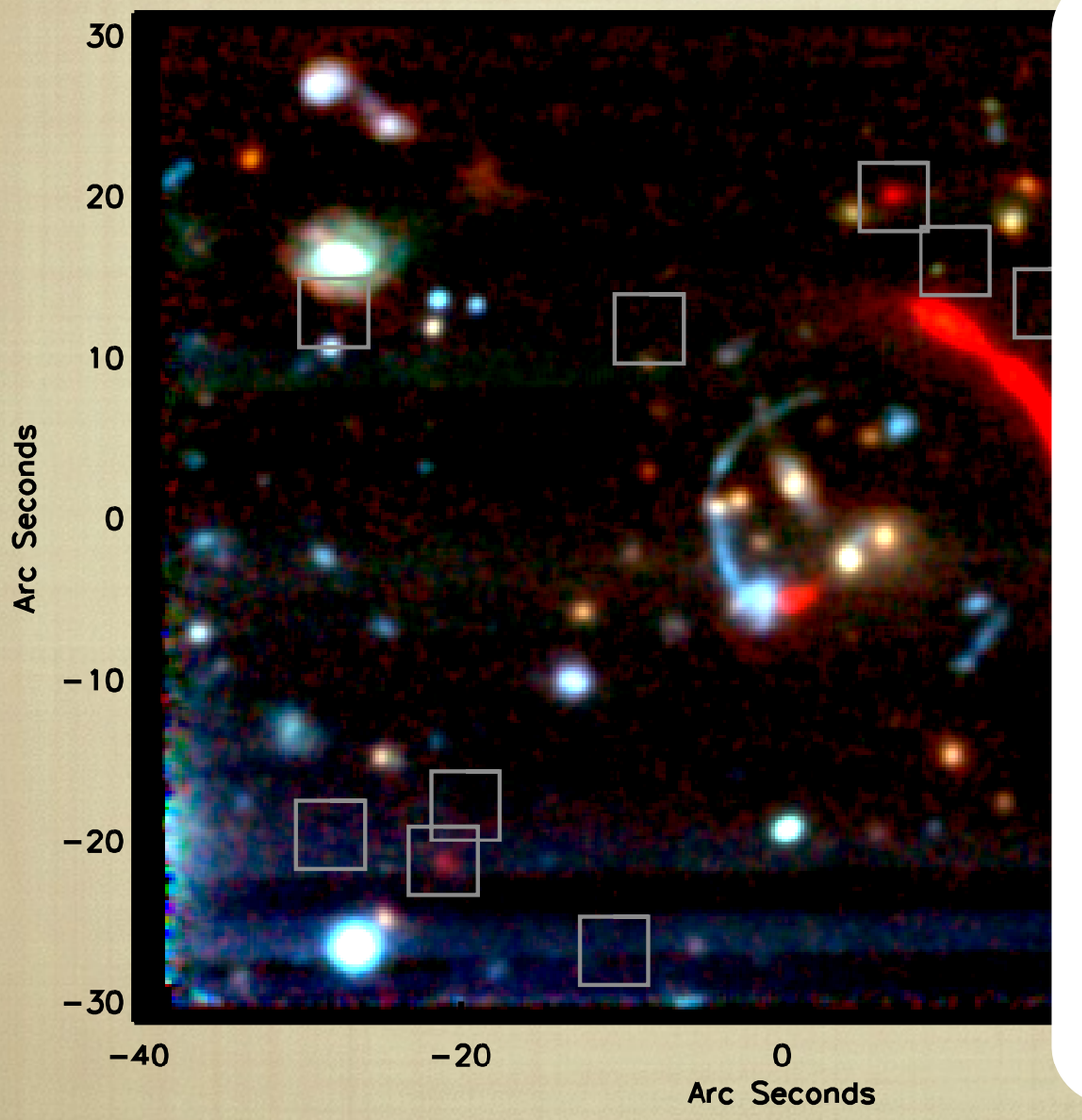
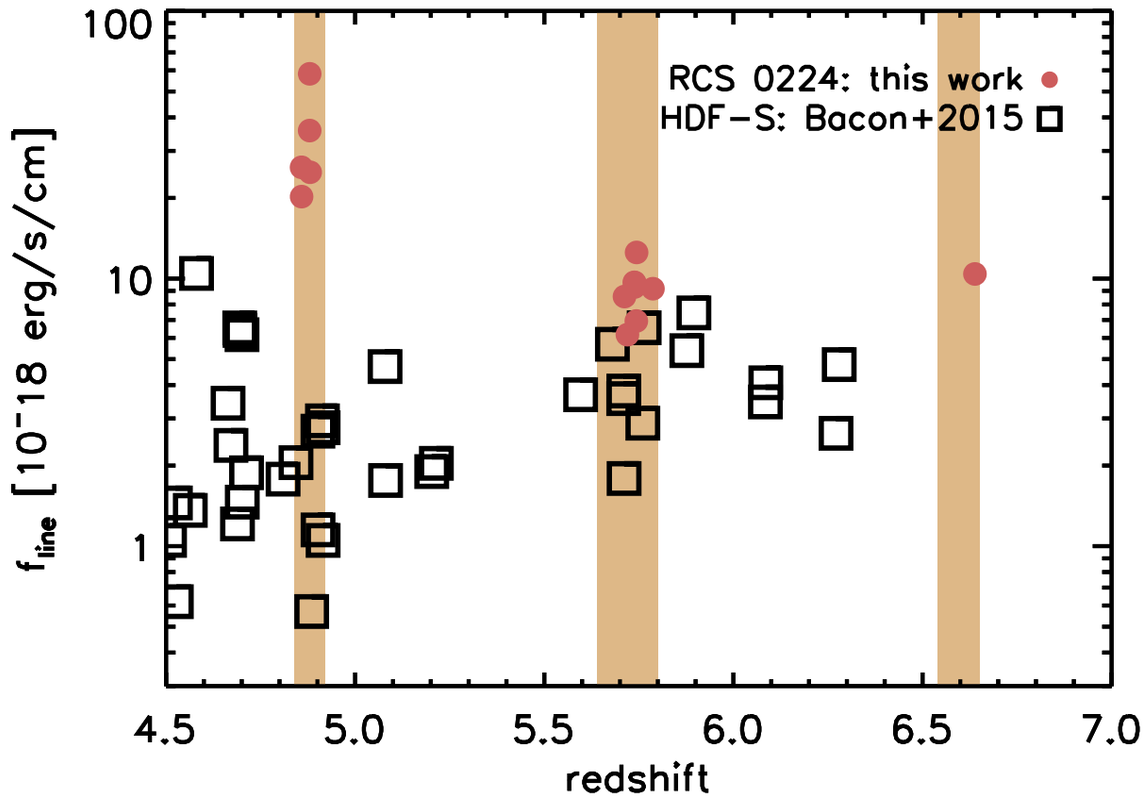
what about lensing fields?

Search for Lyα candidates z=4.8-6.6





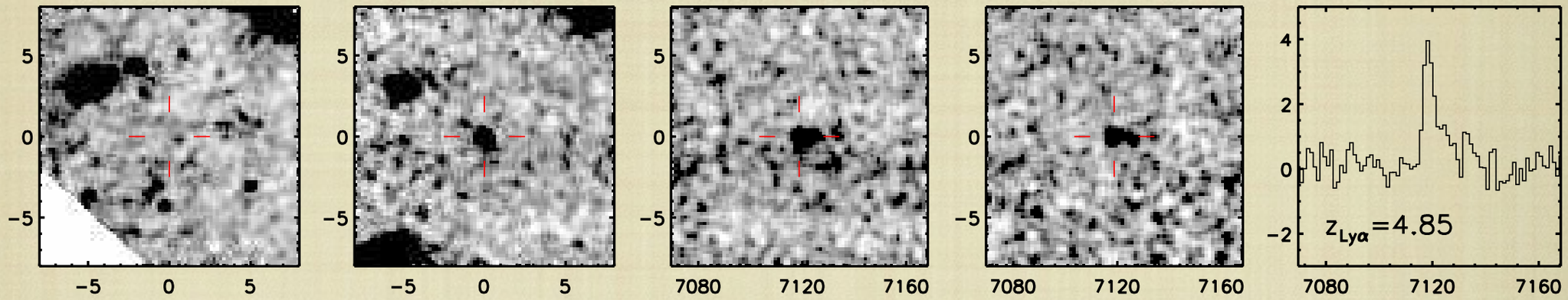
Efficient search for Lyα without ~30hr integration (see also Bina+2016)



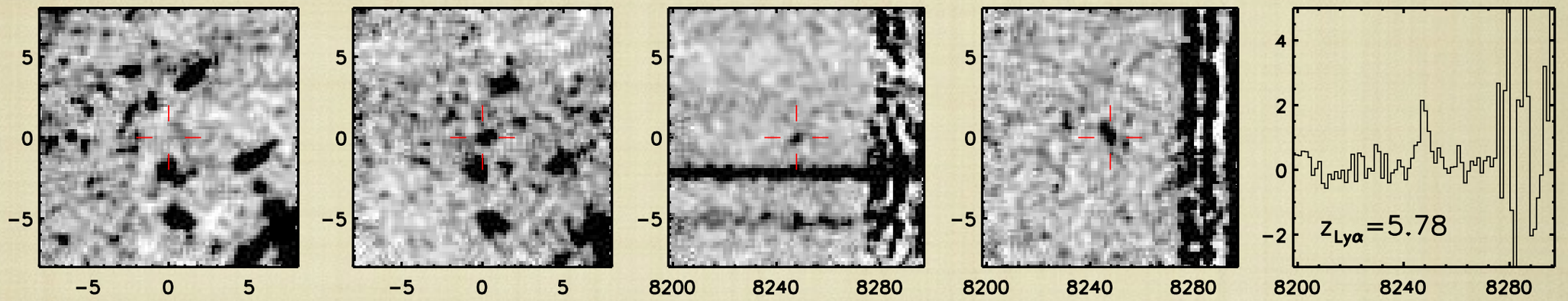
No HST counterparts

HST — MUSE

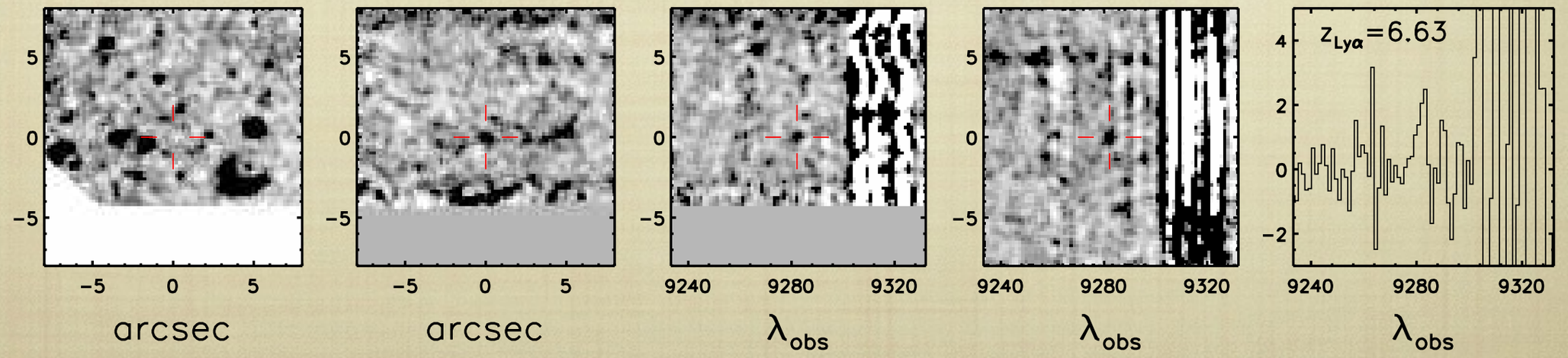
z=4.8



z=5.7



z=6.6



Summary

Lyα

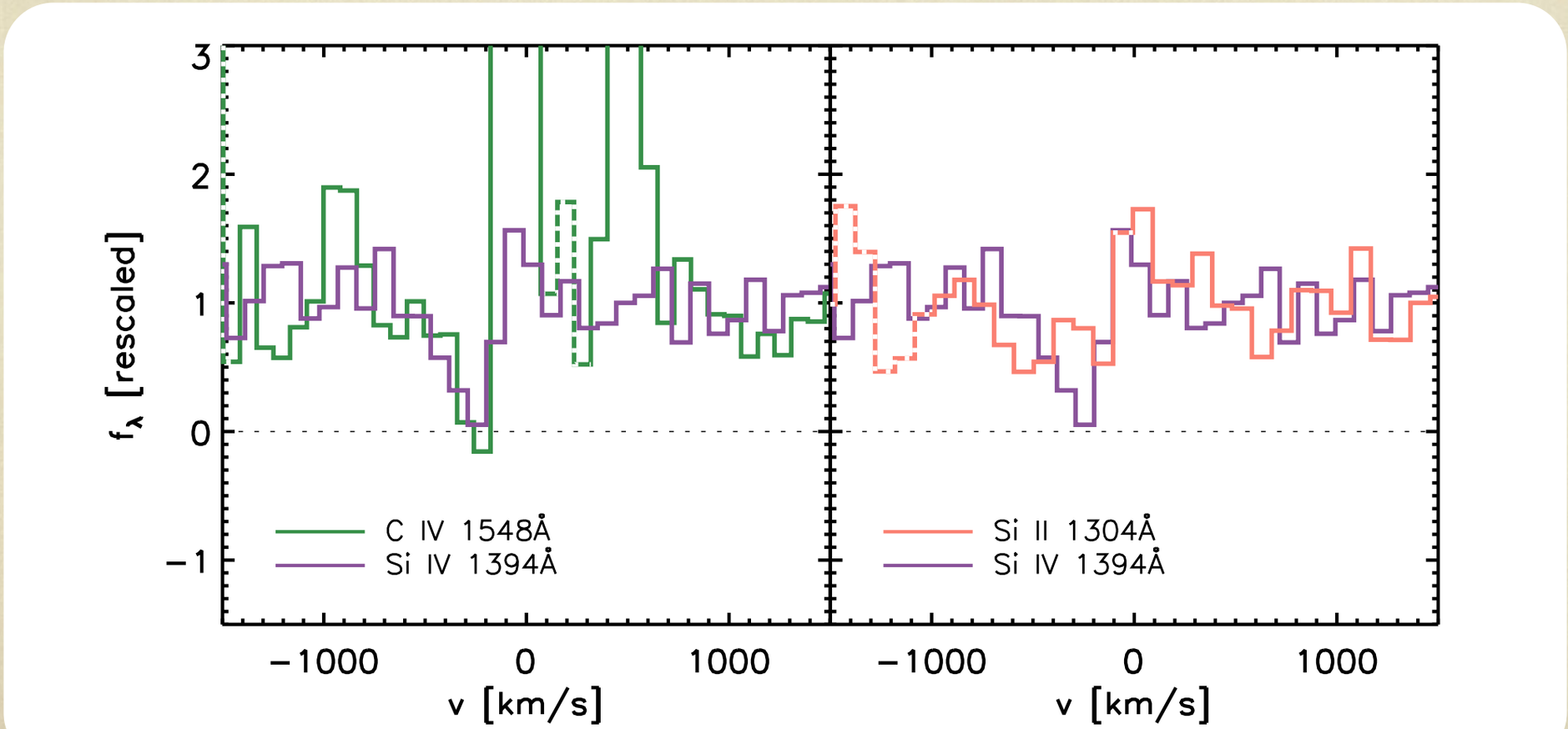
- Lyα appears dominated by a CGM/outer disk component: implications for Lyα prevalence with JWST
- Extremely faint sources can be efficiently found over strong lensing clusters using ‘blind’ line searches

CIV

- Spatially resolved strong emission in RCS 0224 indicates widespread SF as a powering source
- Absence of P-Cygni profiles and high nebular EW is an indicator of very low stellar metallicities

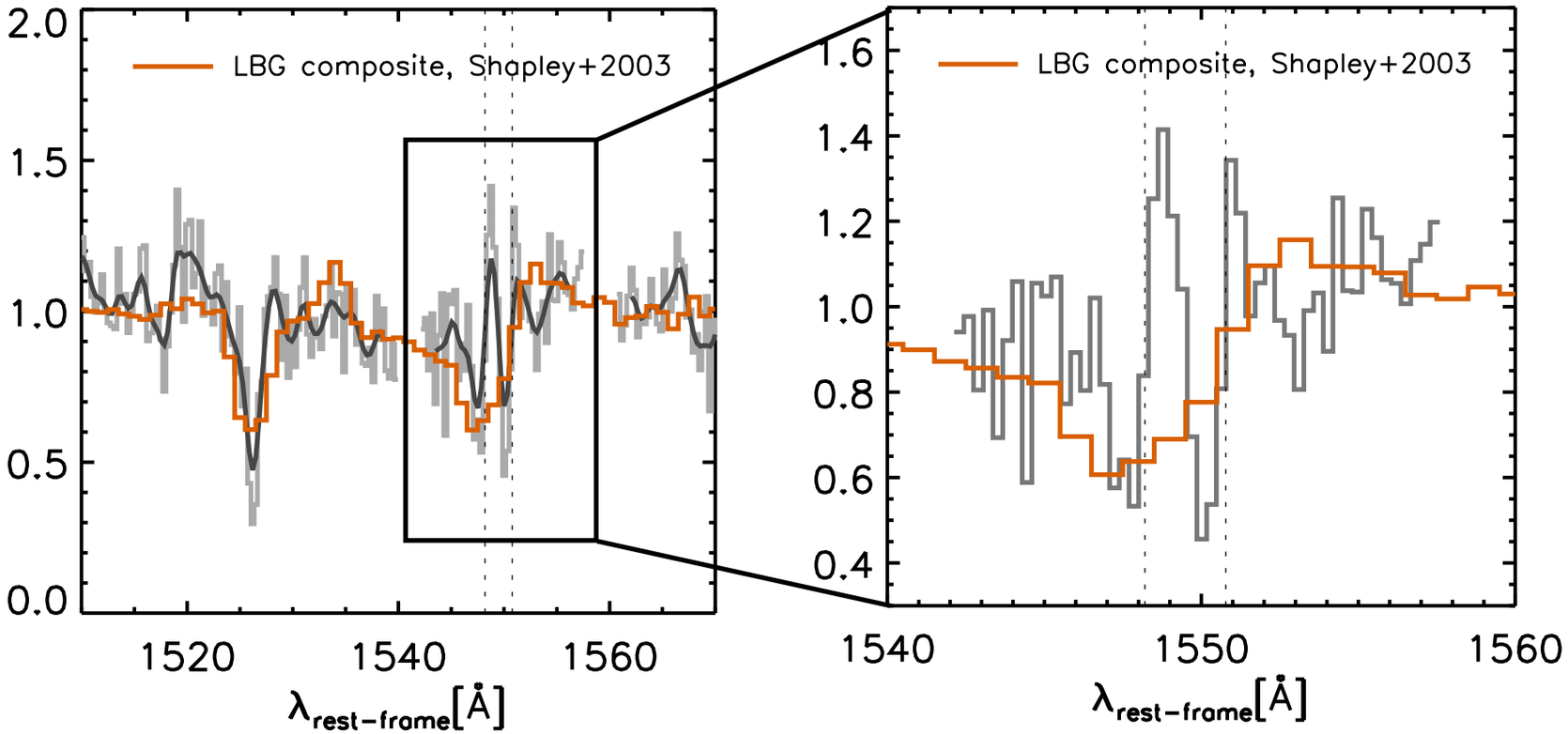
High-ionisation absorption lines

- Narrow blue-shifted absorption is present, but not at the systemic velocity
- Has the starburst in this galaxy efficiently expelled the ISM gas?



A1689: weak P-Cygni profile

- Similar to RCS 0224: nebular emission and ISM/ CGM absorption, but no evidence for stellar lines
- High ionisation nebular emission indicates recent SF - but stars need to be metal-poor to not drive winds



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