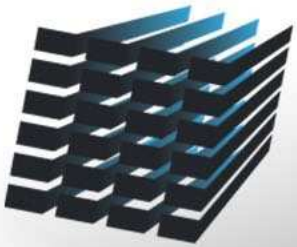


muse
multi unit spectroscopic explorer

Probing the cold circum-galactic gas around individual high-redshift galaxies with MUSE

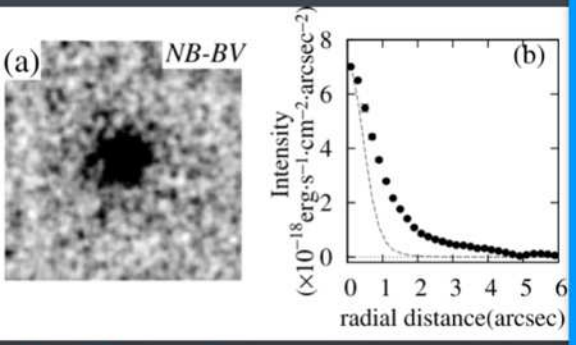
Floriane Leclercq,
CRAL, Lyon - France

R. Bacon, L. Wisotzki, P. Mitchell, J. Blaizot, A. Verhamme, T. Garel, T. Hashimoto, S. Cantalupo, T. Contini, E. C. Herenz, J. Richard, M. Maseda, J. Schaye, H. Inami, R. A. Marino, and M. Akhlaghi
and the **MUSE collaboration**

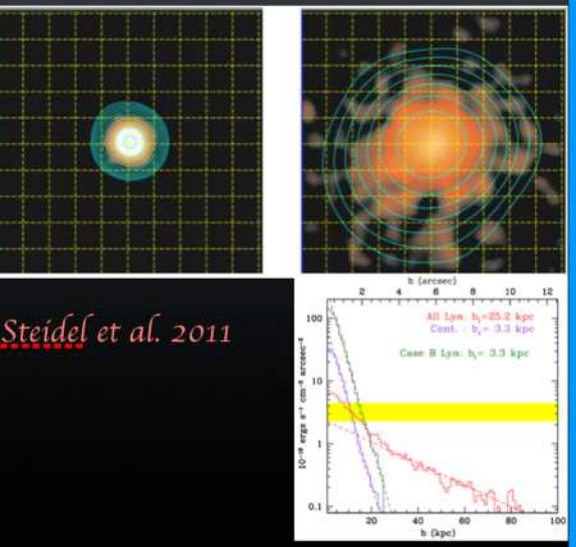
Journées du PNCG - November 2017

Detection methods of Lyα halos for high-z galaxies

Stacking

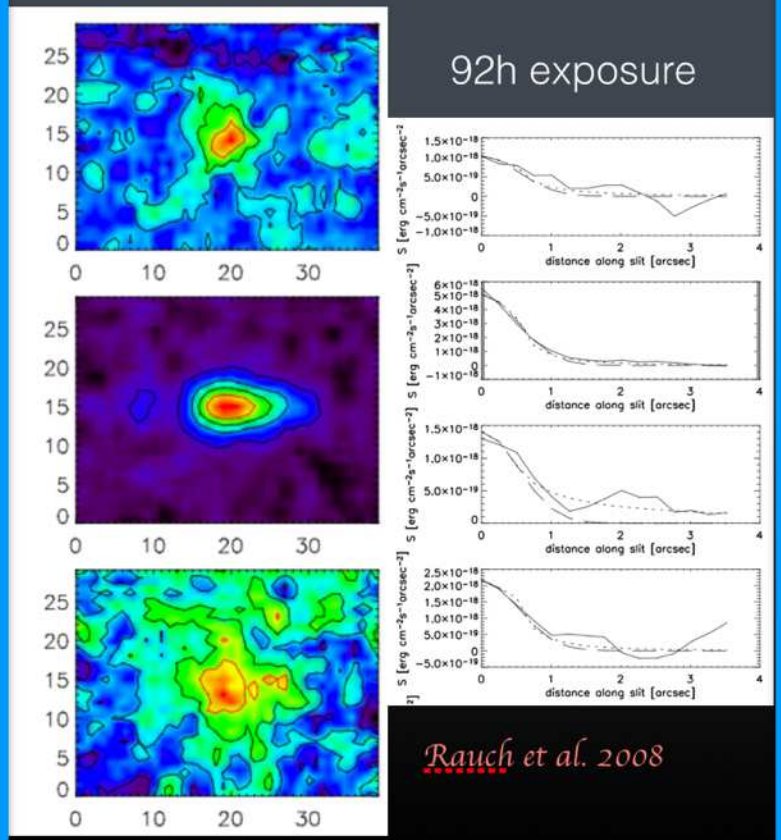


Hayashino et al. 2004



Steidel et al. 2011

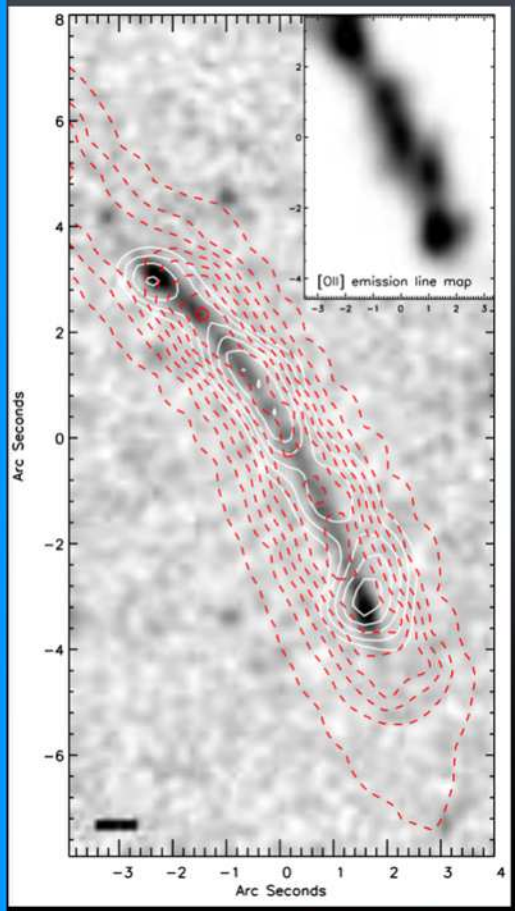
Long-slit detection



92h exposure

Rauch et al. 2008

Lensing detection



Swinbank et al. 2007

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First individual haloes detection

MUSE detection

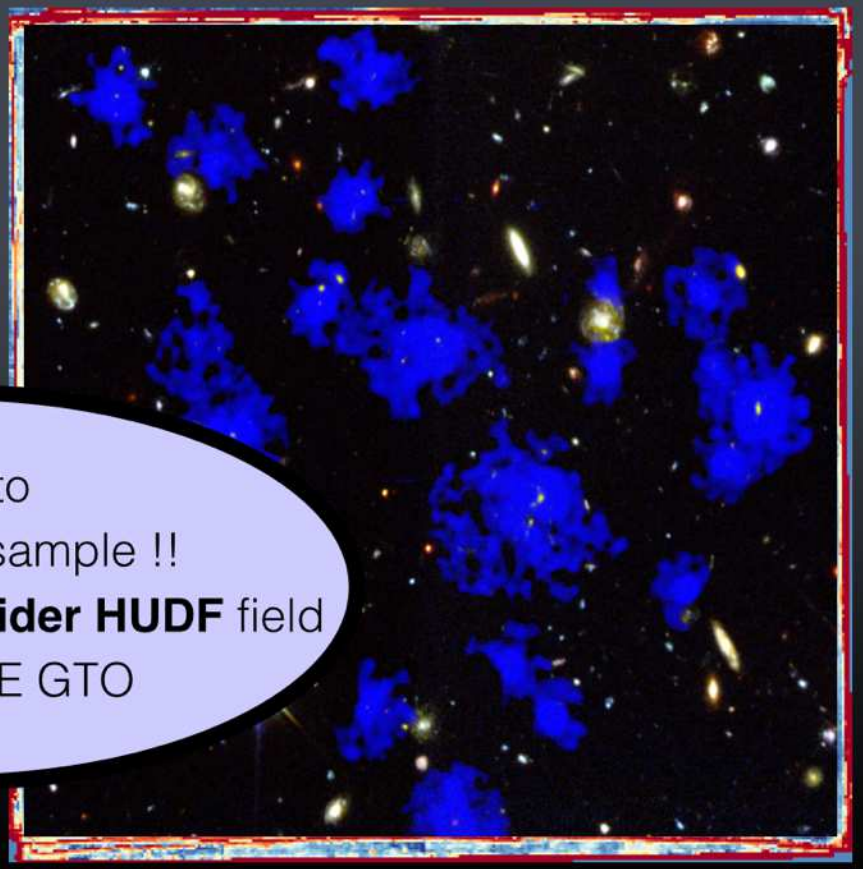
Wisotzki et al. 2016

Detections of spatially extended Lyα emission around **21 individual/non-AGN** high-z galaxies ($2.96 \leq z \leq 6.28$)

Need to
increase the sample !!
Lya haloes in the wider HUDF field
under MUSE GTO

HDFS - 27h

SBlim(1σ) ~ 1×10^{-19} erg s^{-1} cm^{-2} $arcsec^{-2}$



1'

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The Hubble Ultra Deep Field seen by MUSE

Lya haloes in the MUSE UDF

Leclercq et al. 2017

The MUSE Hubble Ultra Deep Field Survey

Astronomy&Astrophysics

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The Hubble Ultra Deep Field seen by MUSE

MUSE catalogues *Inami+17* :

775 LAEs

Sample of
252 Lyman-alpha emitters

10 x
W16 sample

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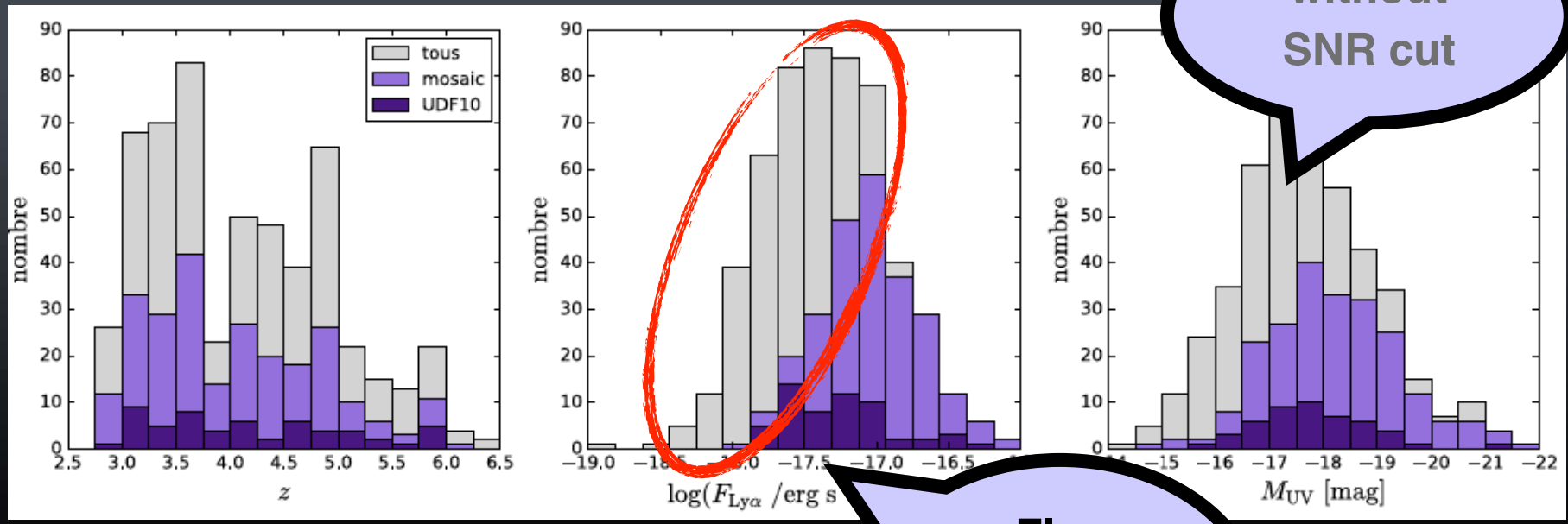
Lya haloes in the UDF

Leclercq et al. 2017

Sample of **252 LAEs**



$2.9 \leq z \leq 6.0$ $10^{-18} \lesssim F_{lya}$ [erg/s/($\geq M_{UV} \geq -22$

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Lya haloes in the UDF

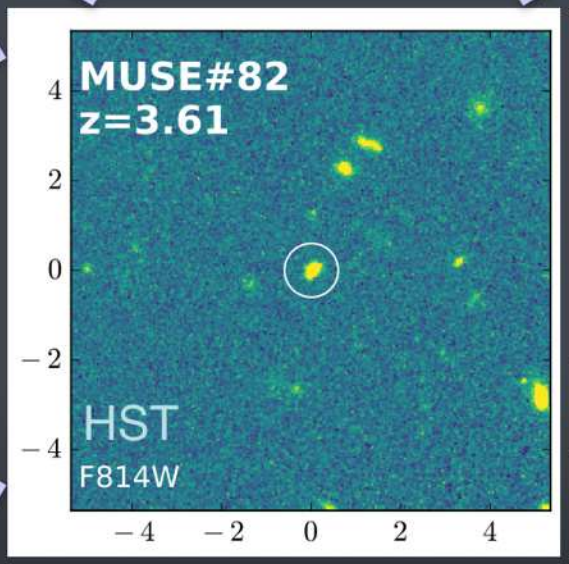
Leclercq et al. 2017

Is the Lya emission
extended ?

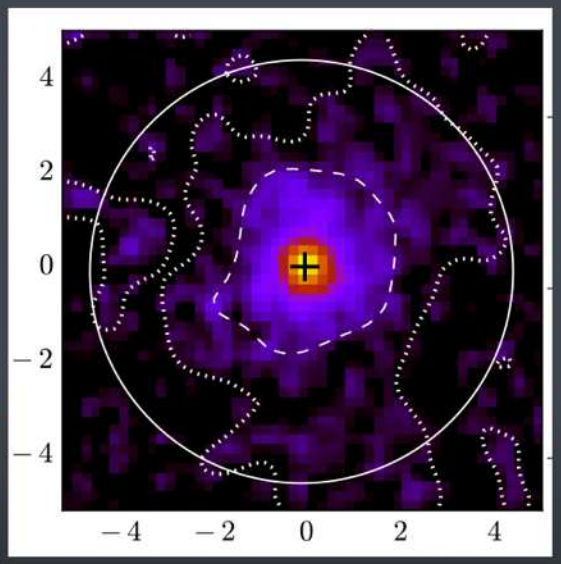
Visual inspection…

Lya haloes in the UDF

Leclercq et al. 2017



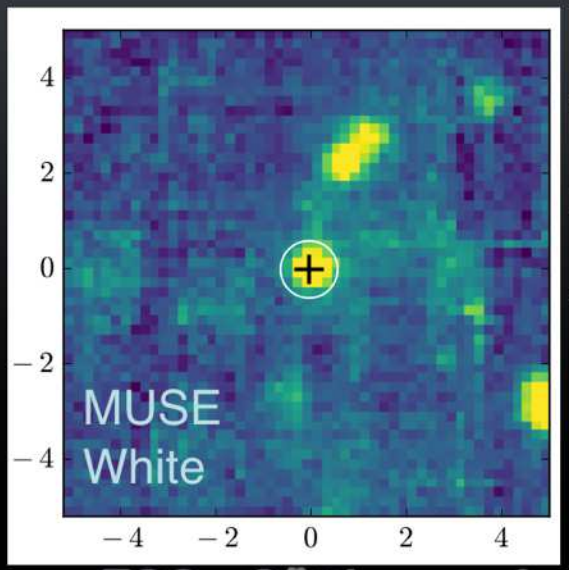
Lya NB

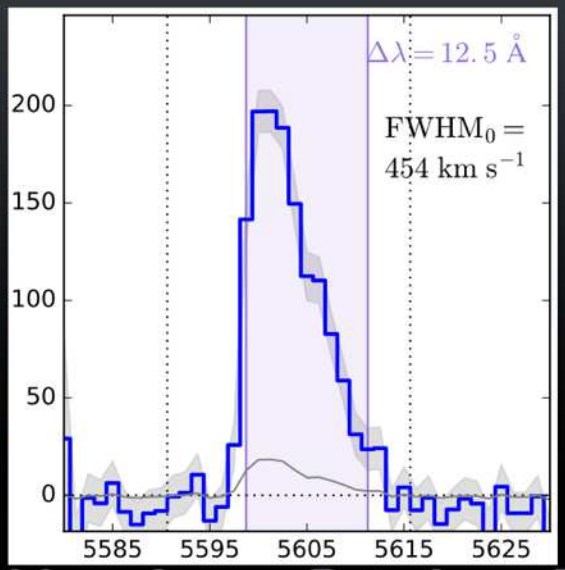


SB contours :

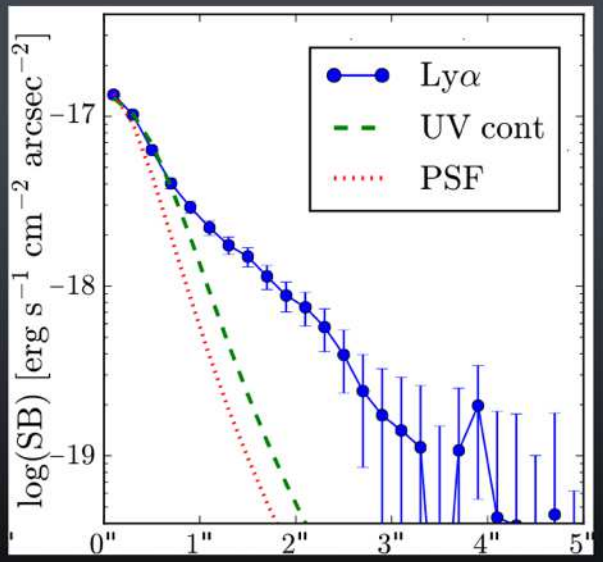
---- 10^{-18} cgs arcsec^{-1}

..... 10^{-19} cgs arcsec^{-1}





Lya line



SB radial profile

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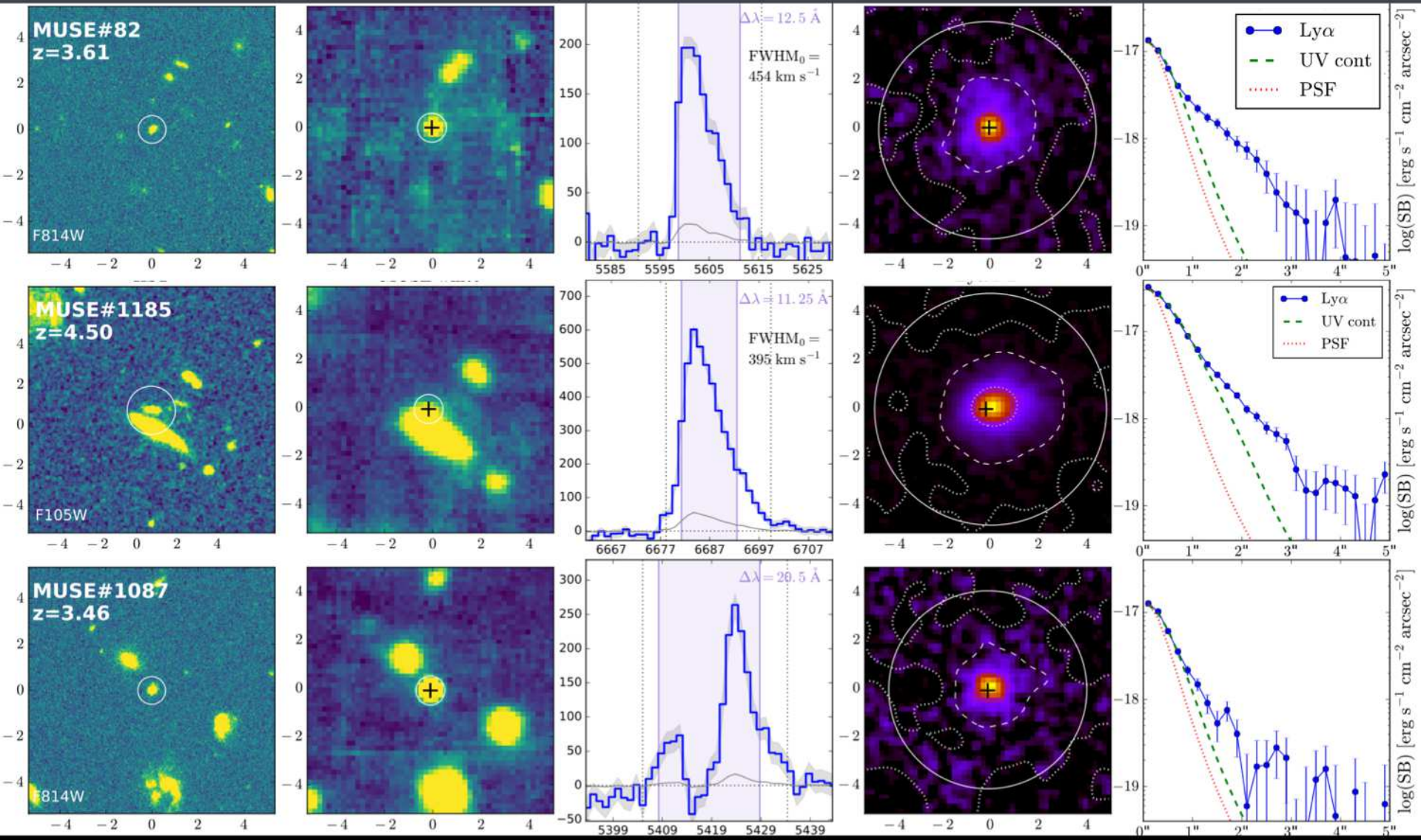
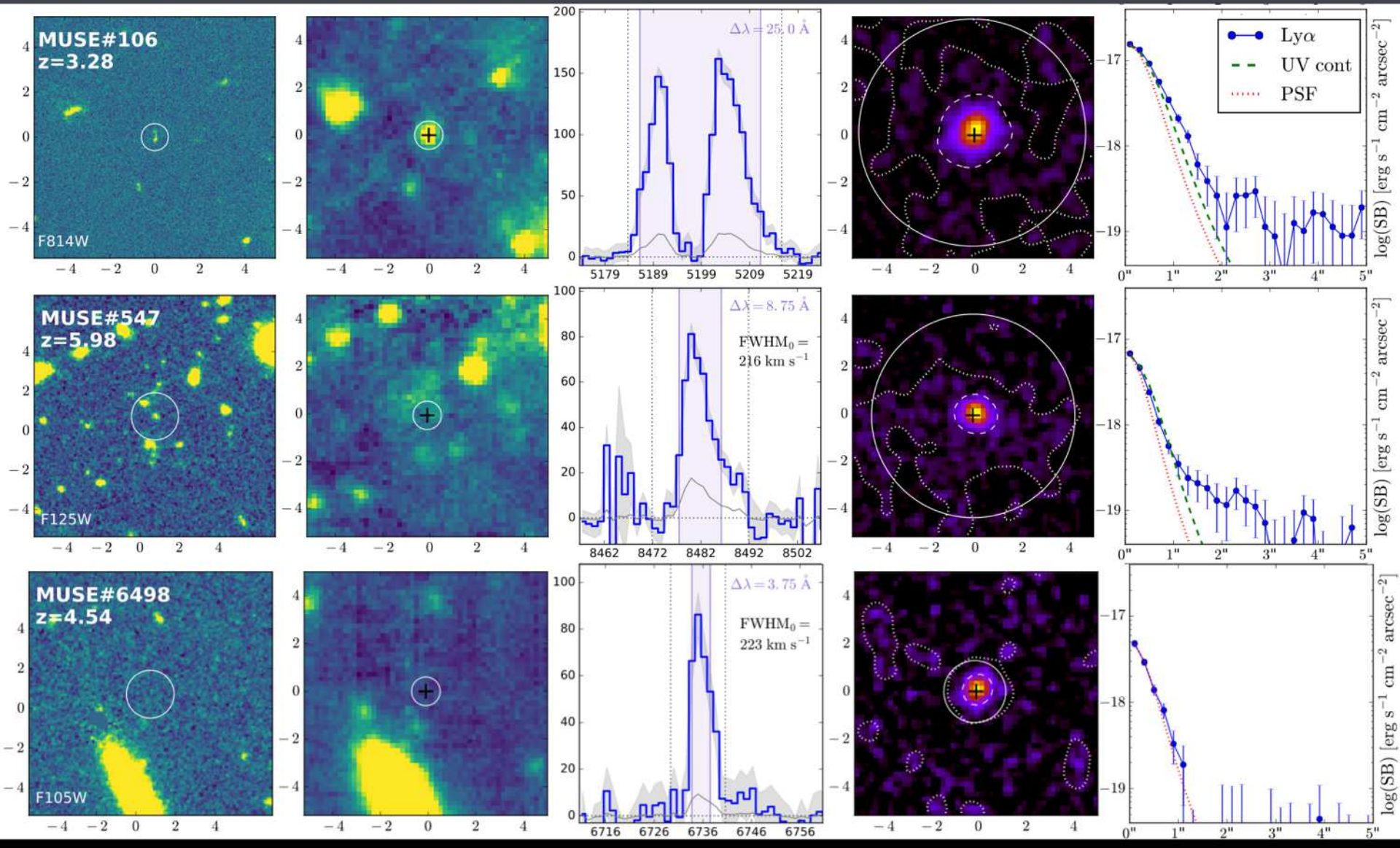
Lya haloes in the UDF

Leclercq et al. 2017



Lya haloes in the UDF

Leclercq et al. 2017



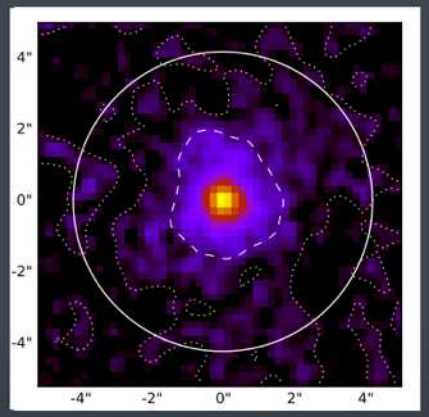
Leclercq et al. 2017

Lya emission
fitting

Lya haloes in the UDF

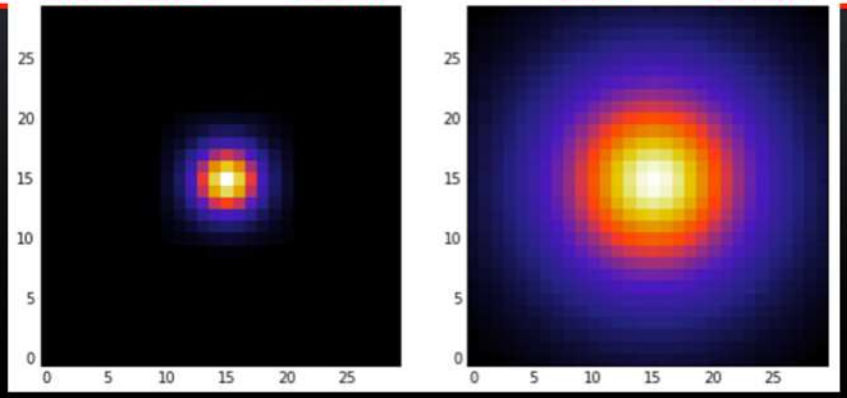
Leclercq et al. 2017

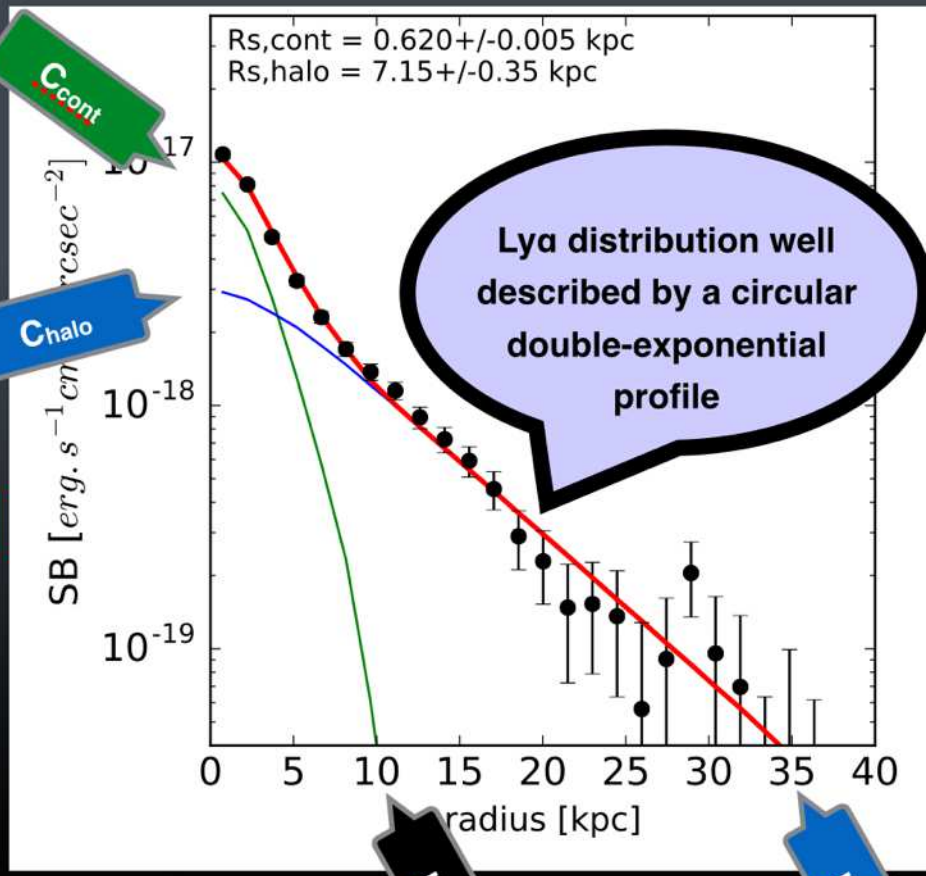
Circular 2D 2-components fitting



PSF convolved

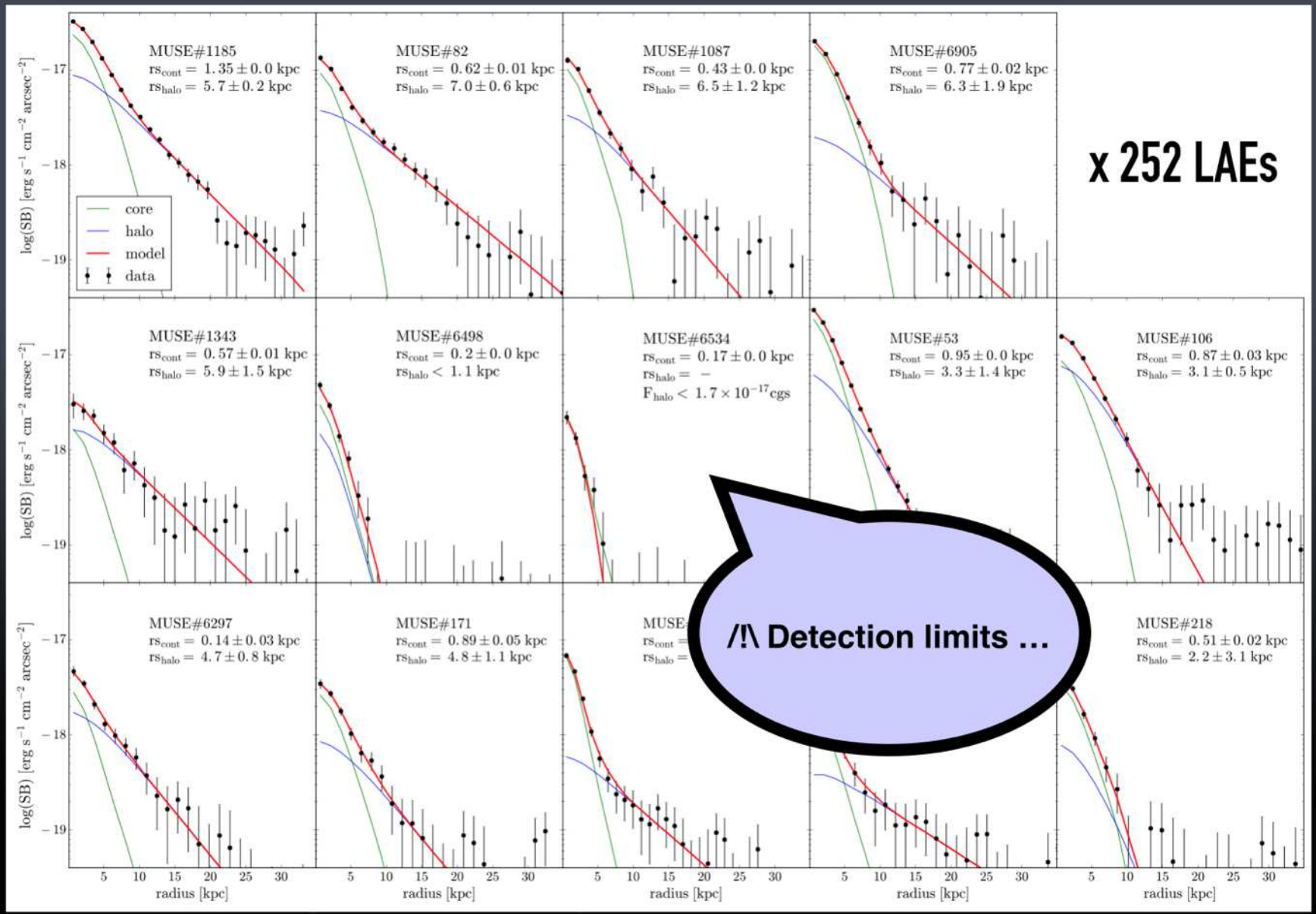
$C_{cont}\ exp(-r / rs_{cont}) + C_{halo}\ exp(-r / rs_{halo})$





Lya haloes in the UDF

Leclercq et al. in prep.



Lya haloes in the UDF

Leclercq et al. in prep.

- Detection limits -

Halo size limit
- depends on PSF (λ-depe
- upper limit on halo size

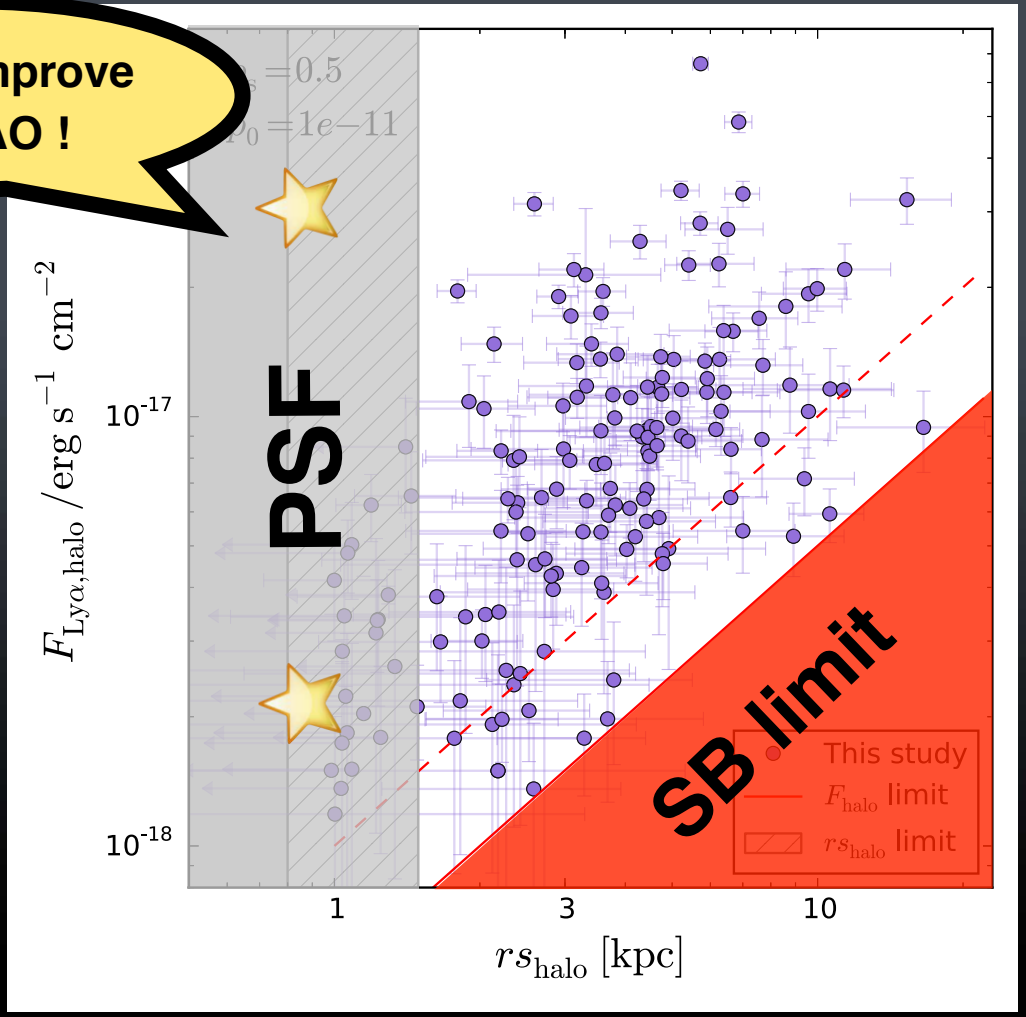
=> 18 objects

Halo flux limit
- depends on rs_{halo}

=> 68 objects

will be improve with AO !

184 LAEs with reliable measurements



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Lya haloes in the UDF

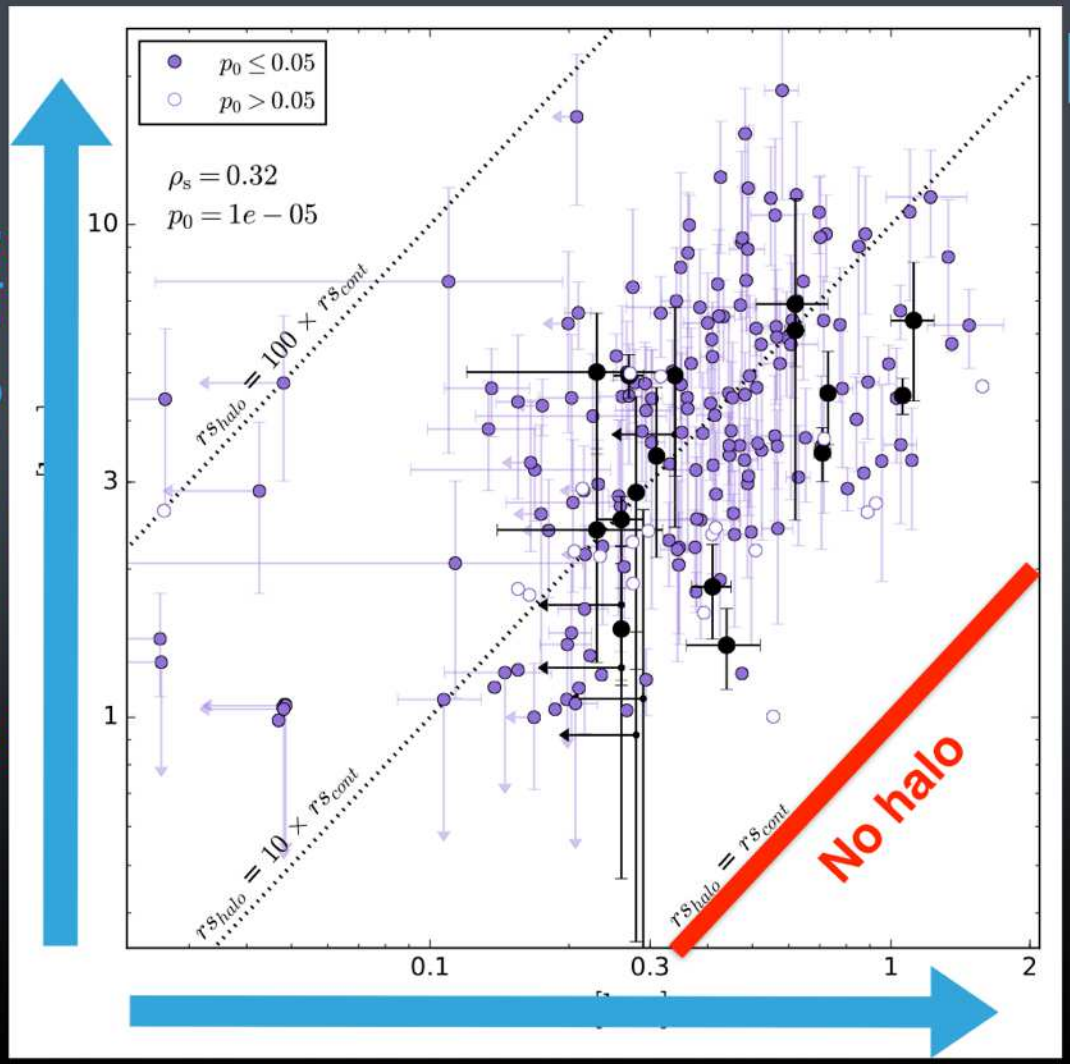
Leclercq et al. 2017

Lya haloes **detection**

Lya / UV scale length comparison

Lyα haloes in the UDF

Leclercq et al. 2017



Statistical test of the halo detections :

$H_0 : rs_{halo} = rs_{cont}$

p_0 : probability that there is no halo

p_0 < 0.05 : halo detected

145 Lyα haloes are statistically significant !

~ 80% of the tested galaxies have a Lyα halo !

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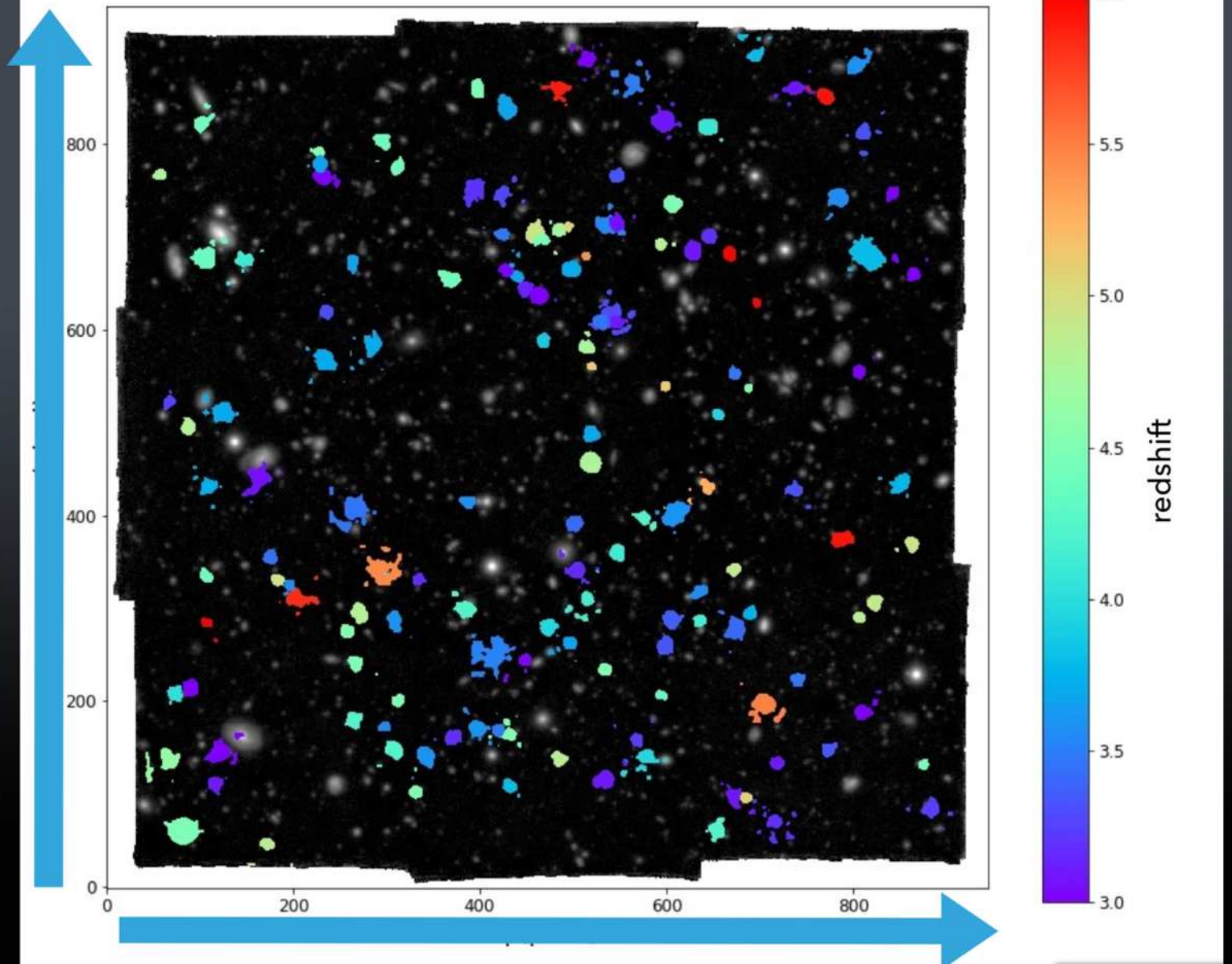
Lya haloes in the UDF

Leclercq et al. 2017



3′x 3′

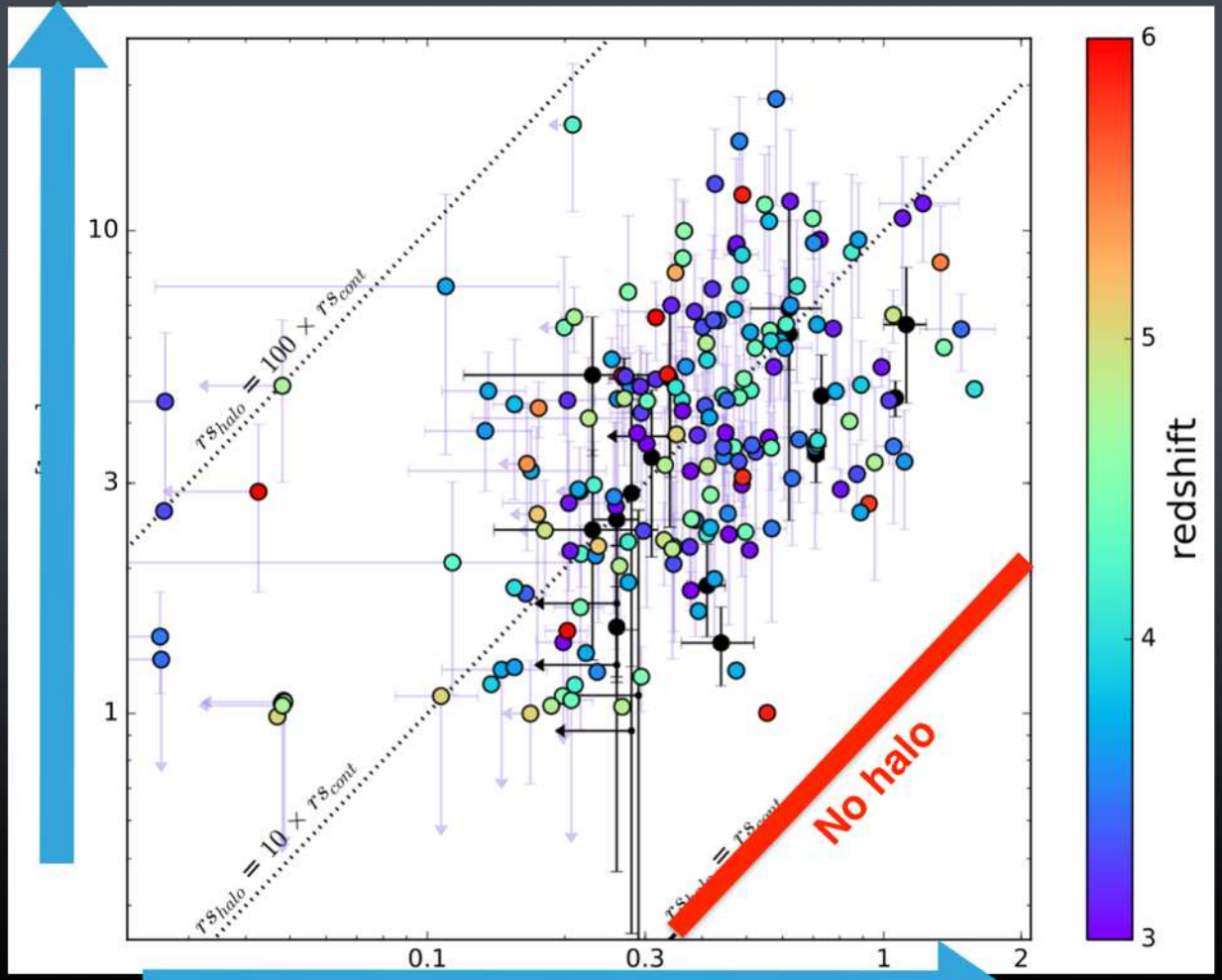
Lya haloes in the UDF

Leclercq et al. 2017

Lya haloes
properties

Lya haloes in the UDF

Leclercq et al. 2017



- $1 < rs_{halo}$ (kpc) < 20
  median : 4.5 kpc
- $4 < rs_{halo} / rs_{cont} < 30$
  median : 11
- Correlation between rs_{halo} et rs_{cont}
- No evolution between z = 3-6

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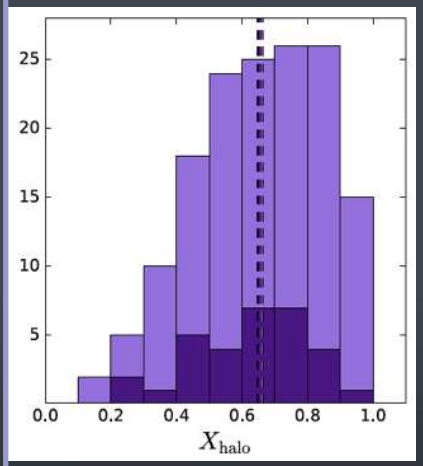
Lya haloes in the UDF

Leclercq et al. 2017



$$X_{\rm halo} = \frac{F_{\rm halo}}{F_{\rm cont} + F_{\rm halo}}$$

65% of the Lya flux comes from the halo component in average

Extended emission has to be taken into account !

Galaxy/ Lya halo link is not obvious !

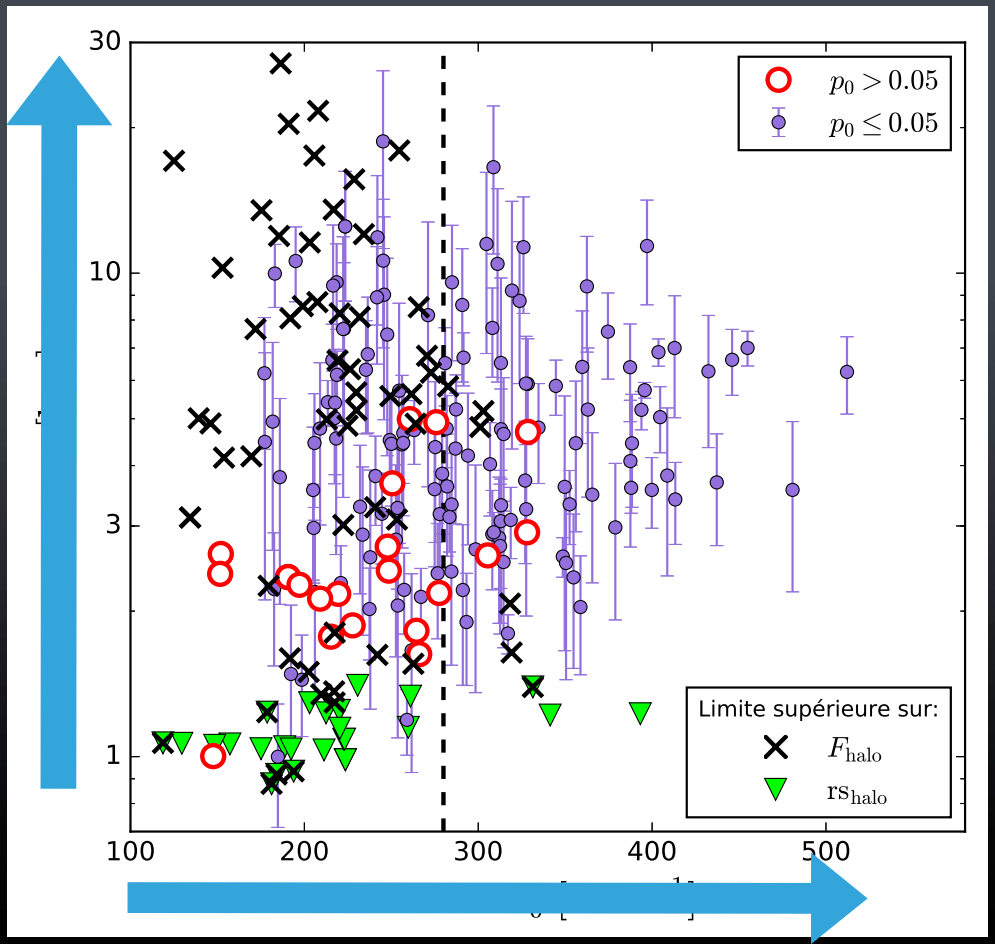
Galaxy/Lya Halo relation

correlation?	rs_{halo}	X_{halo}
rs_{galaxy}	✅	❌
$M_{UV\ galaxy}$	🔶	❌
β	❌	❌
$L_{Lya\ total}$	🔶	❌
$EW_{Lya\ total}$	❌	❌

Lya haloes in the UDF

Leclercq et al. 2017

Spatial / spectral relation ?



- Objects with large Lya lines (>350 km/s) have large haloes (>3 kpc)
- « Compact » objects have rather narrow lines (<300 km/s)

Other results… cf. paper

Lya haloes in the UDF

Leclercq et al. 2017

Summary & perspectives

Summary / perspectives

Leclercq et al. 2017

MUSE allows the cold circum-galactic gas to be observed !

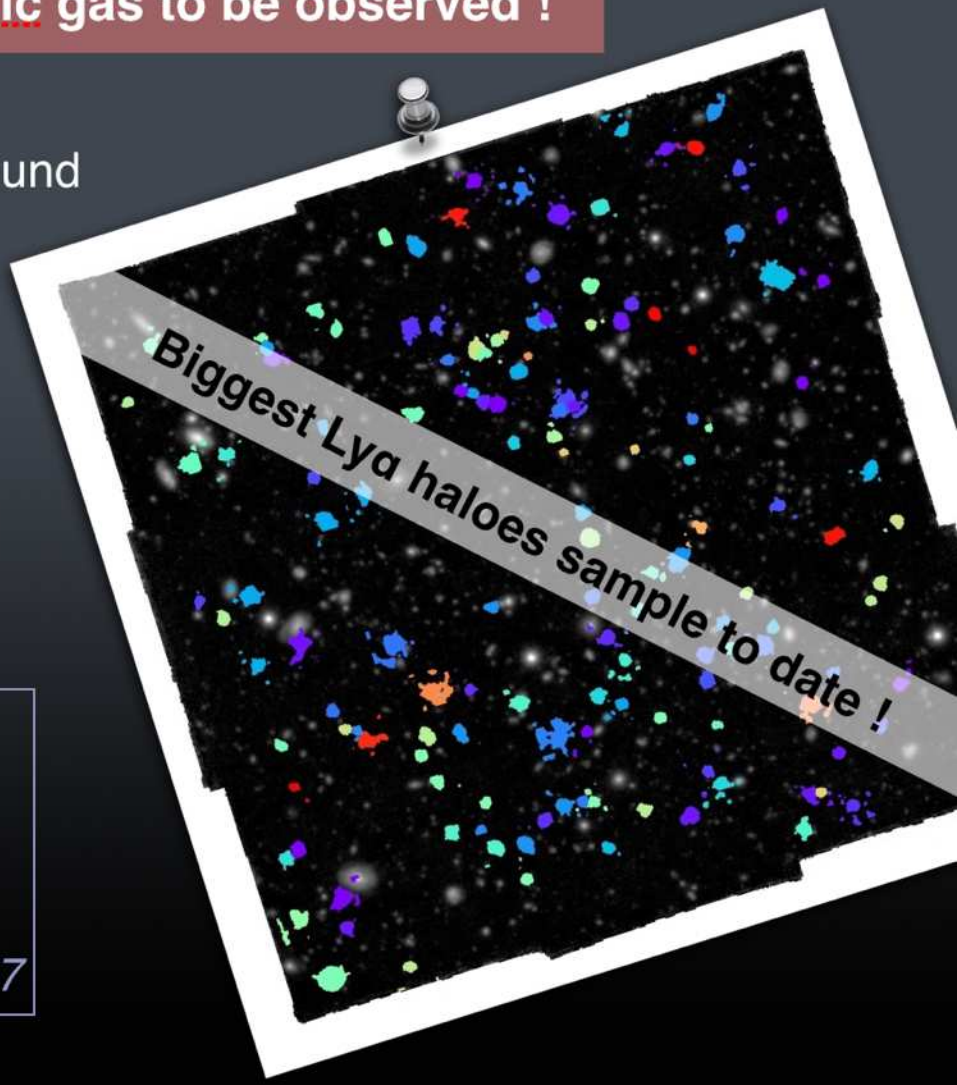
- ★ Lya haloes appear to be **ubiquitous** around high-z low-mass star-forming galaxies
- ★ ~65% of the Lya flux is in the halo
- ★ No size evolution at z = 3—6
- ★ Galaxy / Lya halo relation is not obvious

...

Origin of the Lya haloes ?

star formation, fluorescence, cooling radiation, satellite galaxies ?

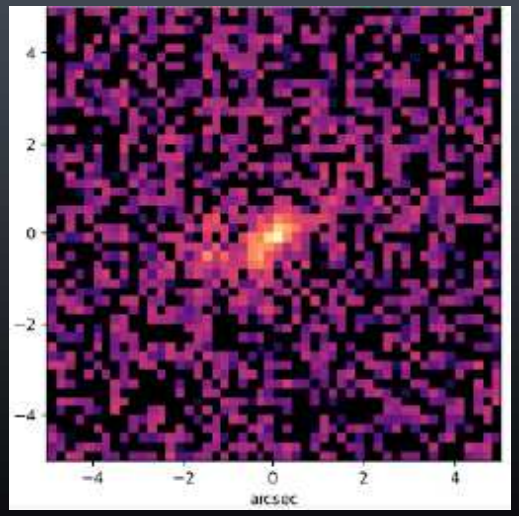
cf. Leclercq+17



Summary / perspectives

Comparison with simulations

RAMSES-RT + RASCAS

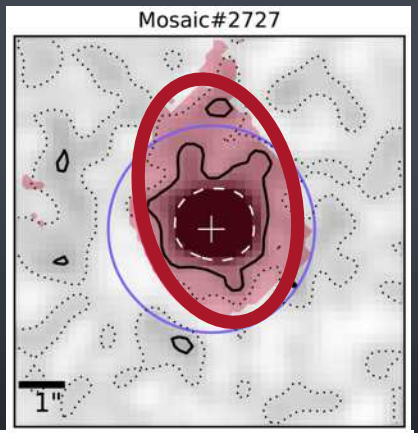


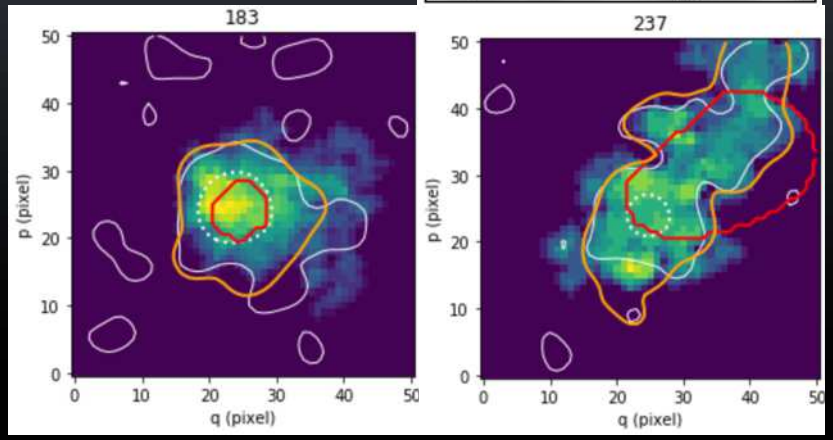
MUSE mock image

cf. Jérémy Blaizot's talk

CGM Morphological analysis

Go beyond the circular analysis …





Léo Michel-dansac
Jérémy Blaizot
Thibault Garel
Anne Verhamme

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