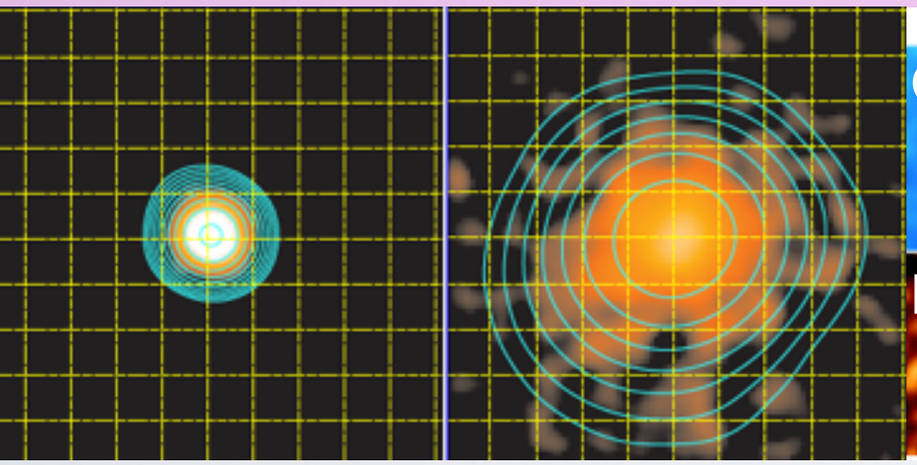
Statistical properties of diffuse Lyα haloes around star-forming galaxies at z ~ 2

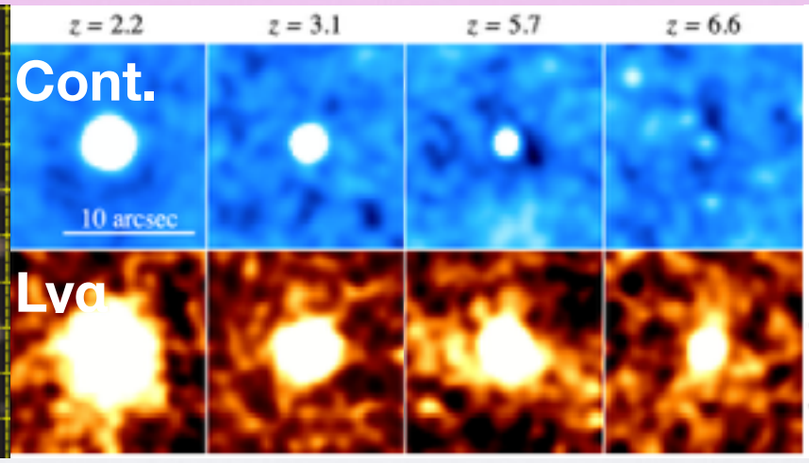
Momose+16, MNRAS, 457, 2318

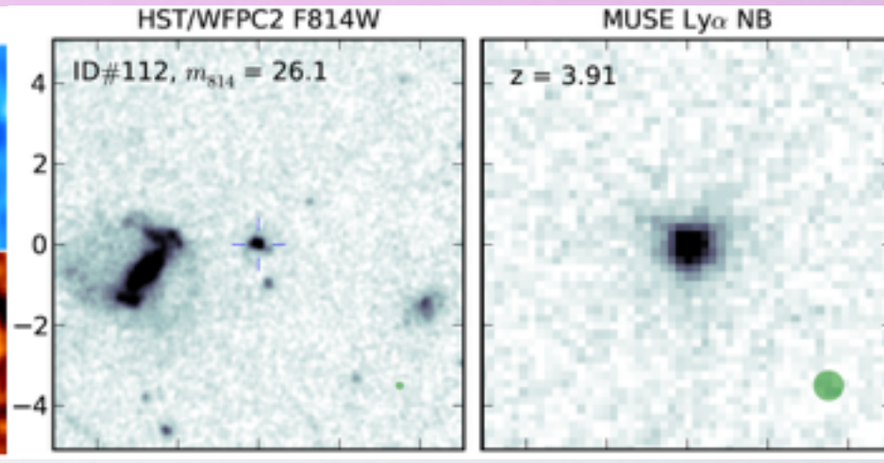
Rieko Momose（NTHU → U. Tokyo from next week）

Ouchi, M., Nakajima, K., Ono, Y., Shibuya, T., Shimasaku, K., Suraphong, Y., Mori, M., Umemura, M.

New questions for the LAHs' study



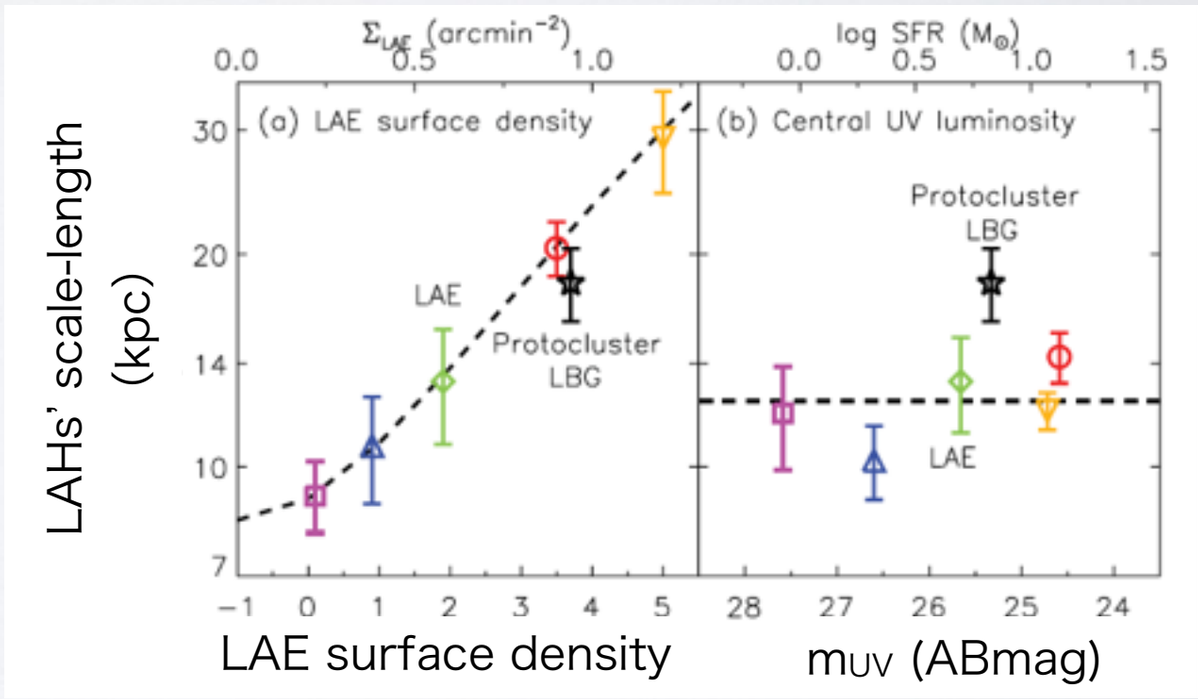




What is the origin of LAHs?

Which physical parameters of LAEs determine LAHs' size?

param.	Y	N
L_{UV}	Zheng+11, Feldmeier+13, Xue+17, Leclercq+17	Steidel+11, Matsuda+12
$L_{Ly\alpha}$	Xue+17, Zheng+11	Leclercq+17
M_{DH}	Zheng+11	
r_{s_cont}	Leclercq+17	



Steidel+11; Matsuda+12; MR+14; Wisotzki+16

Methodology of this study

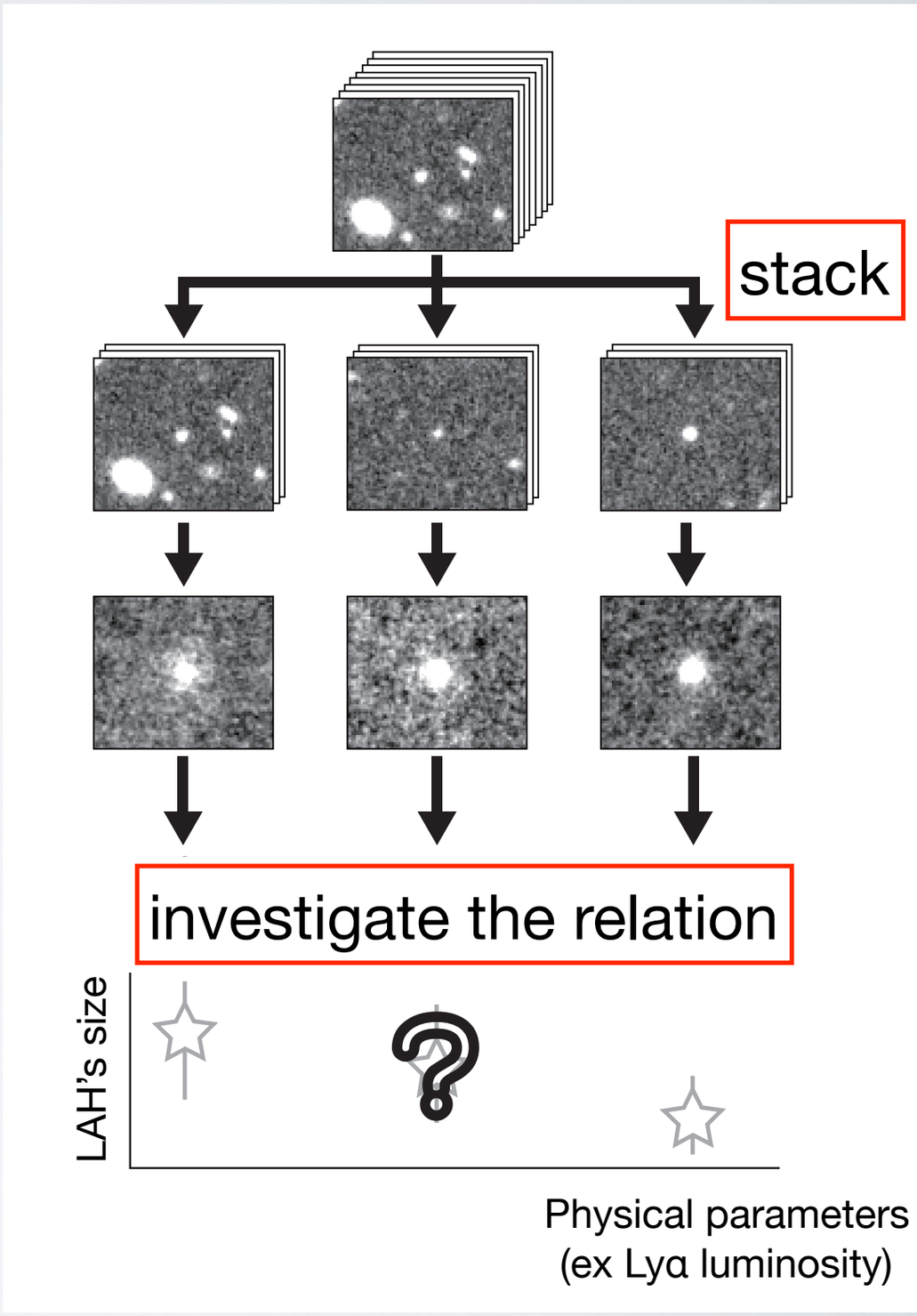
Data

~ 3,500 LAEs at z = 2.2

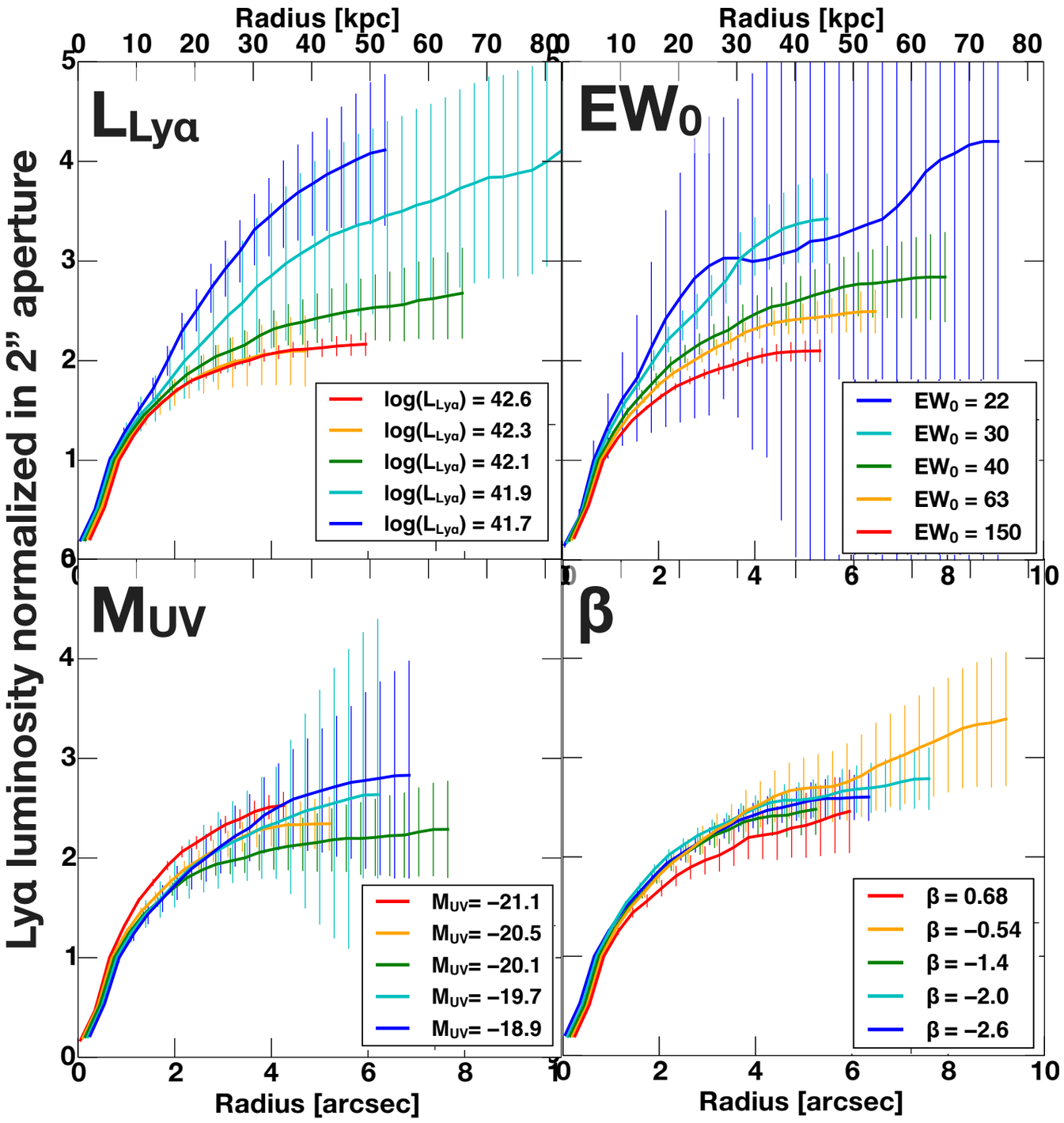
Method

Make 5 subsamples as a function of LAEs'

- Lyα luminosity
- M_{UV}
- EW_0 (Lyα)
- UV-slope β



Cumulative radial profile of $L_{Ly\alpha}$



Trend from all subsamples

$L_{Ly\alpha}$ increases in LAHs

$L_{Ly\alpha}$, EW_0

More extend in faint $L_{Ly\alpha}$ and small EW_0 subsamples

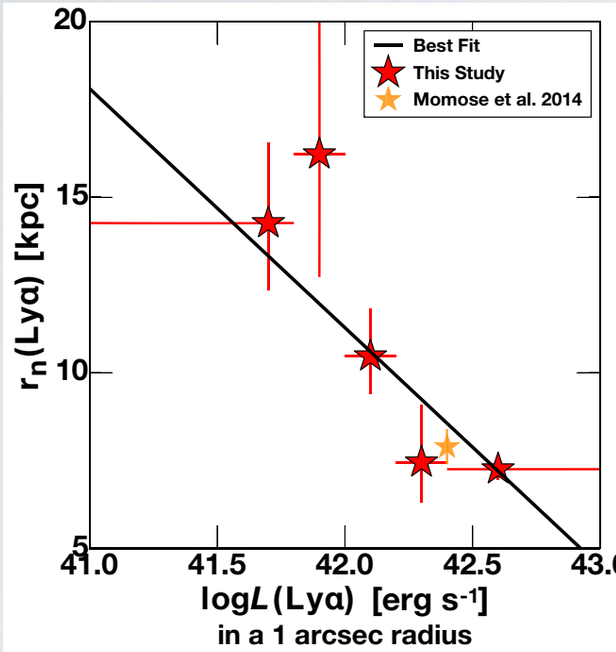
M_{UV}

More extend in bright M_{UV} (if exclude two subsamples with large error-bars)

β

No clear trend

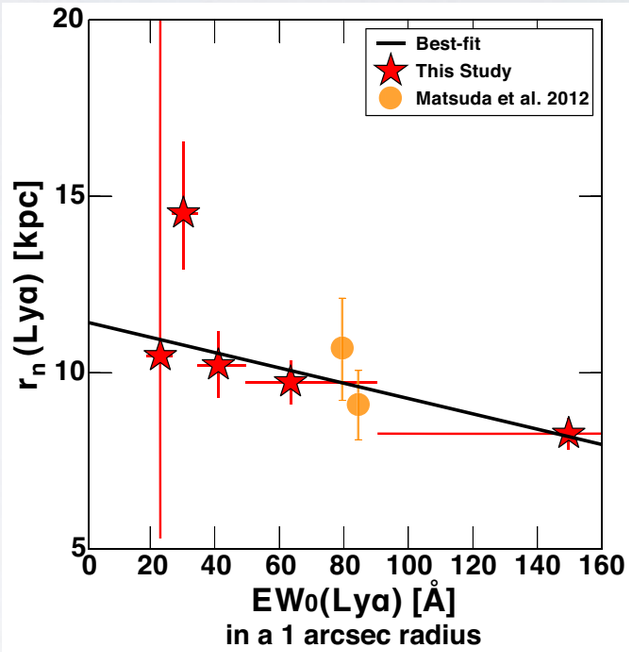
LAHs' size



$L_{Ly\alpha}$

p = –0.9 (96%)

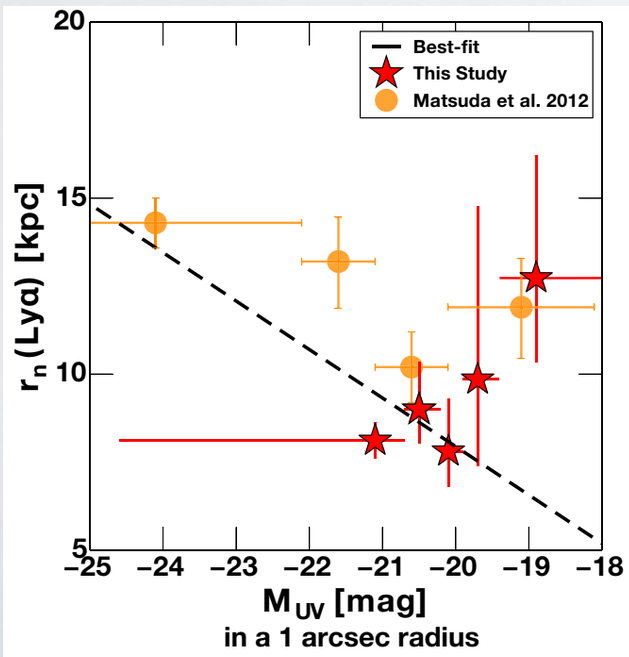
Strong Corr.



EW_0

p = –0.7 (93%)

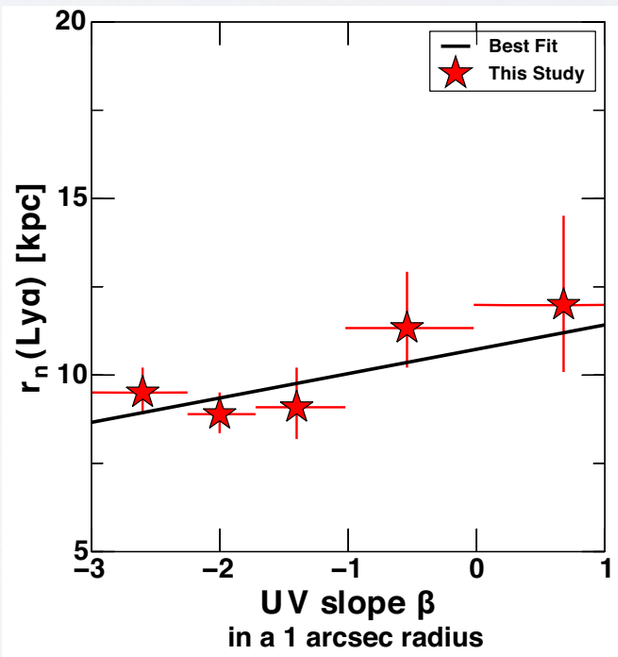
Corr.



M_{UV}

p = –0.2 (45%)

No clear Corr.

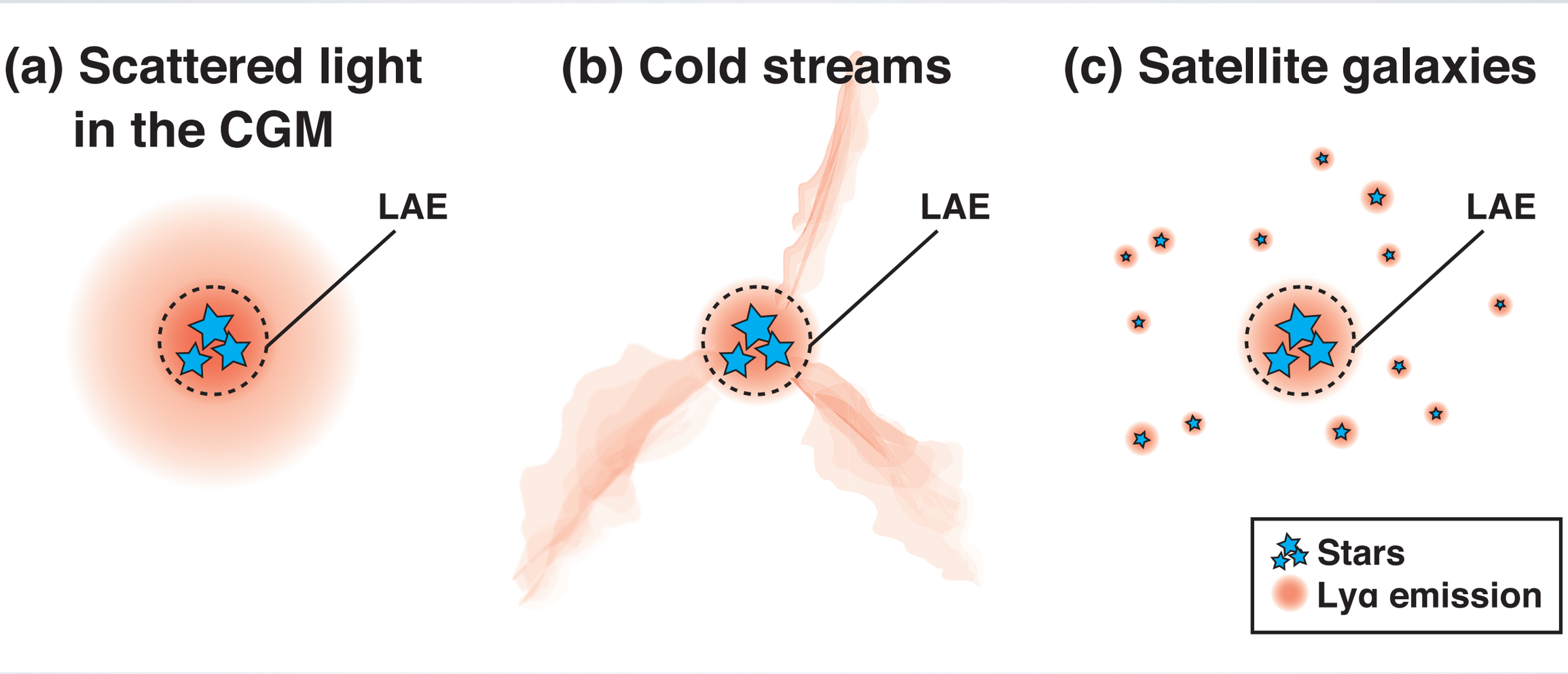


β

p = 0.7 (81%)

Corr.

Origin of LAHs

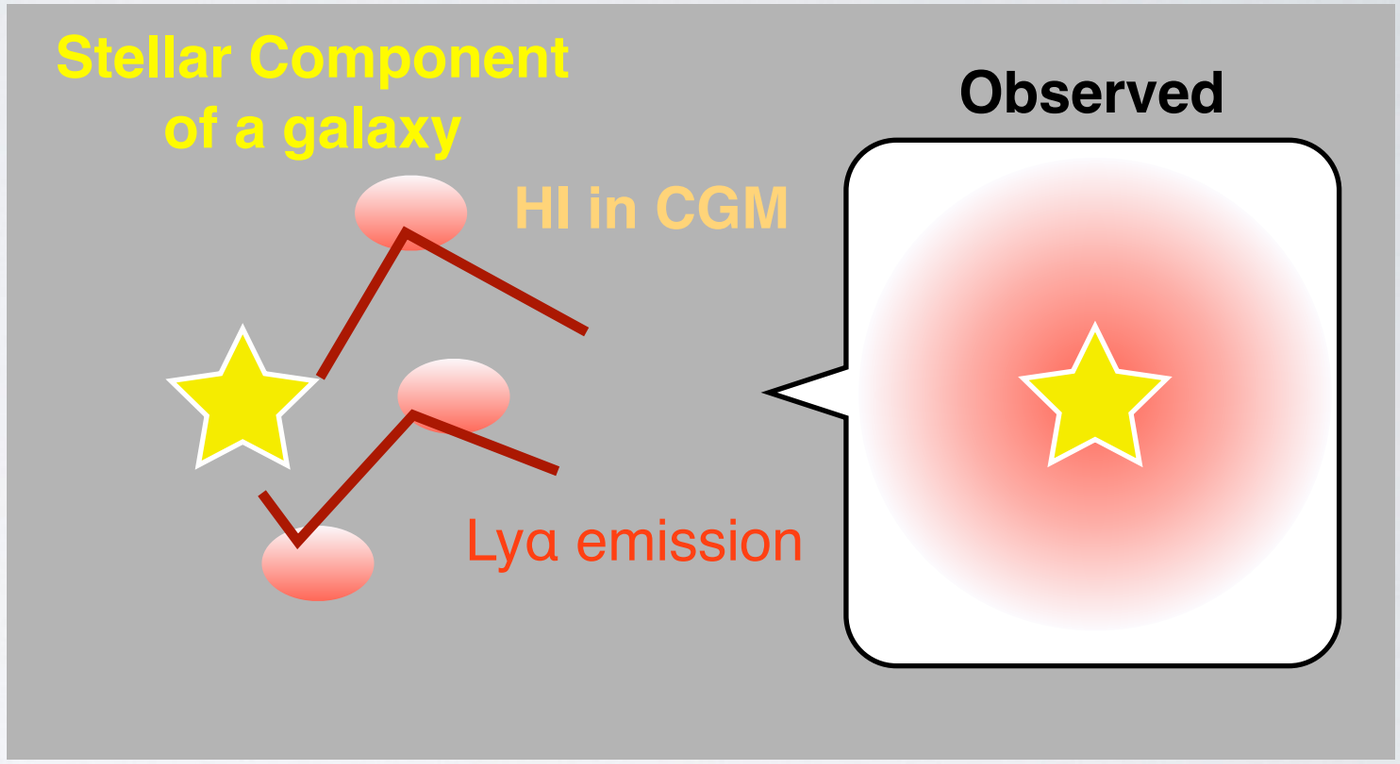


(a) Scattered light in the CGM

Origin of Lyα photons

- Produced in SF regions and/ or AGNs
- Lyα escape mechanisms
  - outflow
  - clumpy clouds
  - low column density

e.g. Neufeld 91, Verhamme+06, Dijkstra+12



Observational evidences

- Spectroscopic observations have shown the evidence
  - outflow
  - low column density
- We cannot examine spectra or gas distribution from our data

We cannot rule out this scenario.

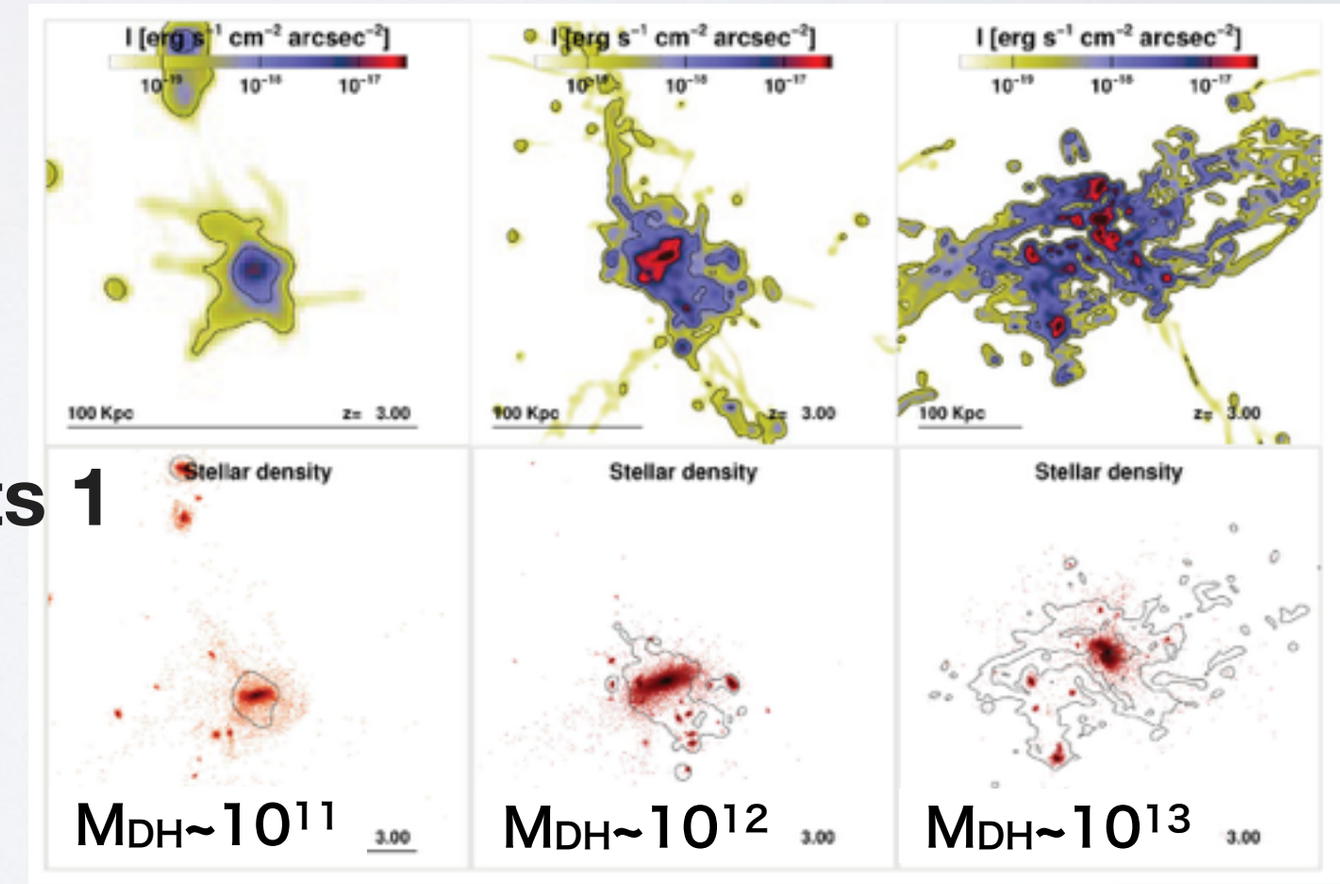
(b) Cold streams

Origin of Lyα photons

- Dense and clod gas (10^4 K) can emit in Lyα
- Produce an extended Lyα nebula around a galaxy
  - size of the nebula depends on the dark halo mass M_{DH}
  - widely extend with
    $M_{DH} > 10^{12}\ M_\odot$
  - extend r ~ 20 kpc with
    $M_{DH} \sim 10^{11}\ M_\odot$

Comparison with our results 1

- M_{UV} correlates with M_{DH}
  - Large LAHs are found in UV luminous LAEs => **consistent**



Rosdahl & Blaizot 12

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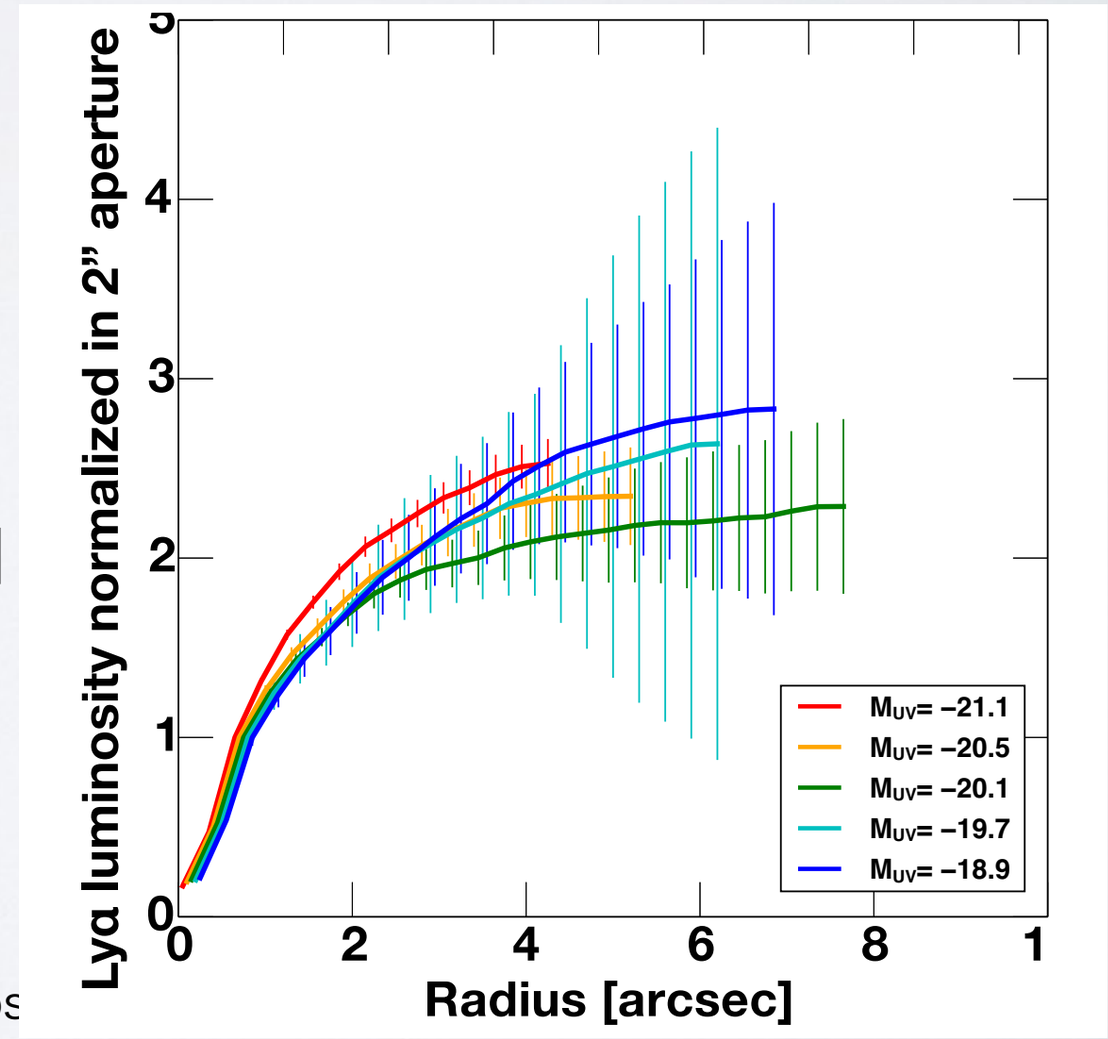

Comparison with our results 1

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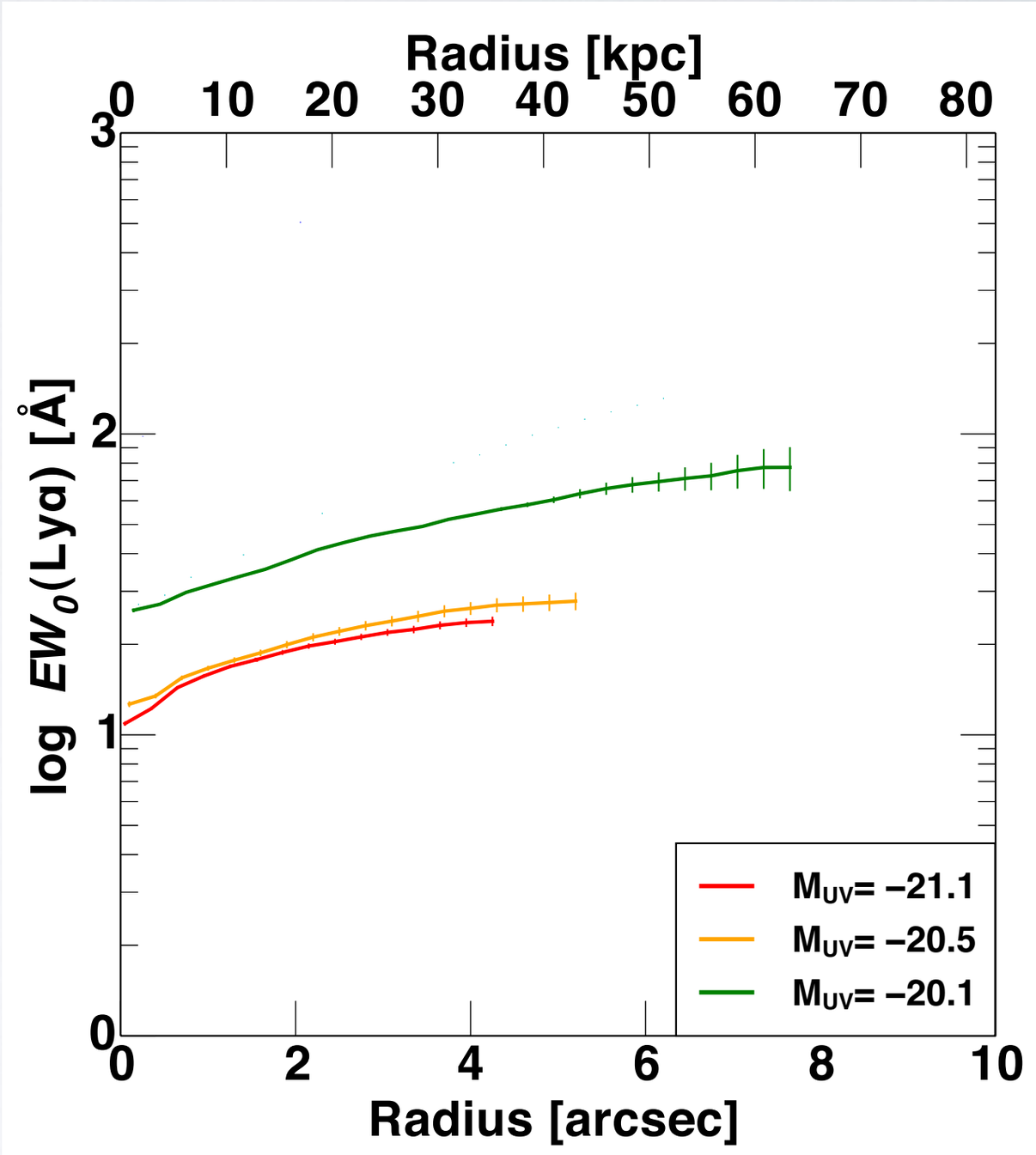
(b) Cold streams

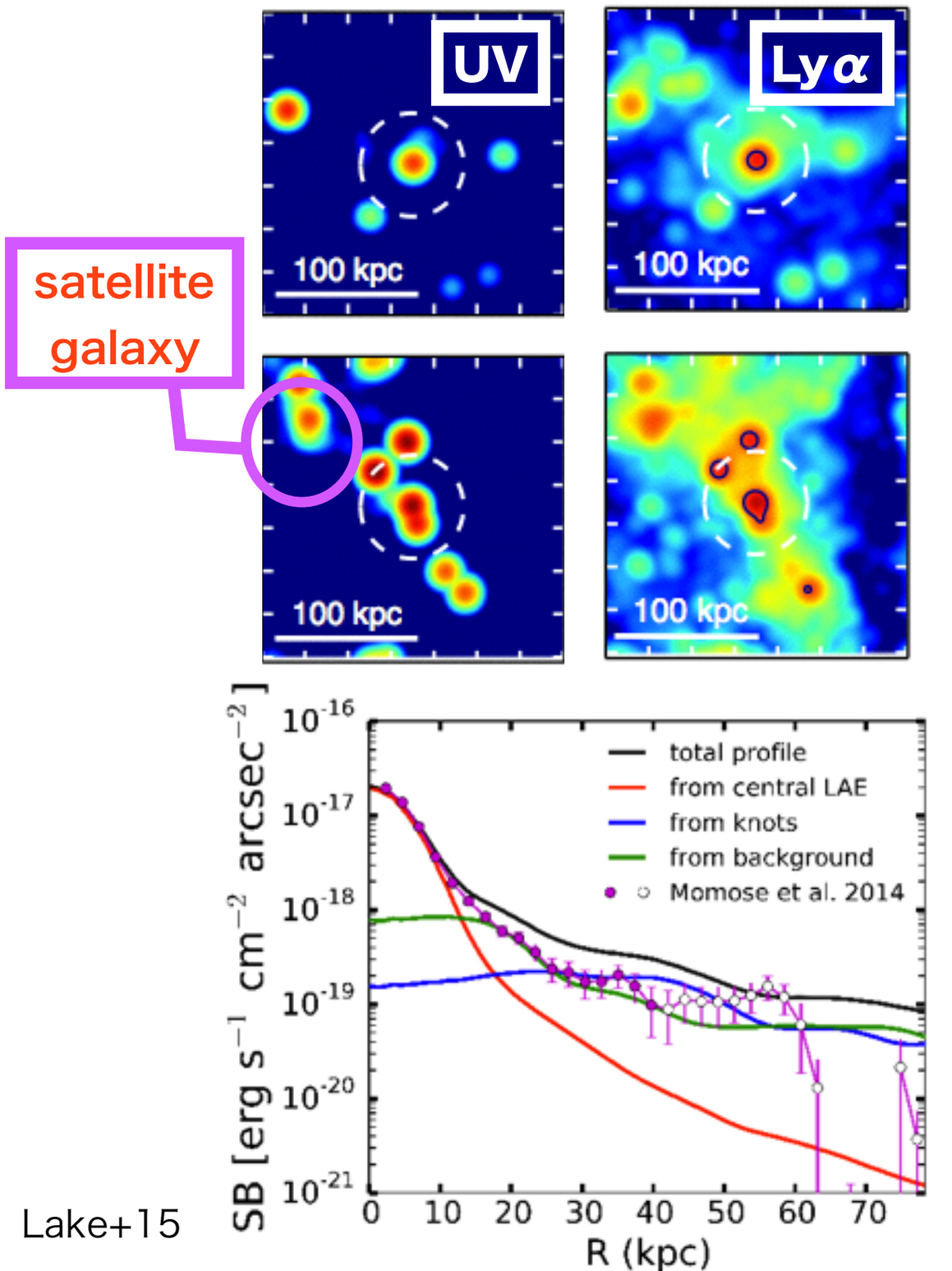
Comparison with our results 2

- EW_0 of our M_{UV} subsamples are lower than 77 Å => **inconsistent**
  - maximum value for EW_0 originating from popII star formation is 240 Å
- if cold streams contributes LAHs, EW_0 at large radii should be larger than 240 Å

Our LAHs are not produced by cold streams.



(c) Satellite galaxies



Lake+15

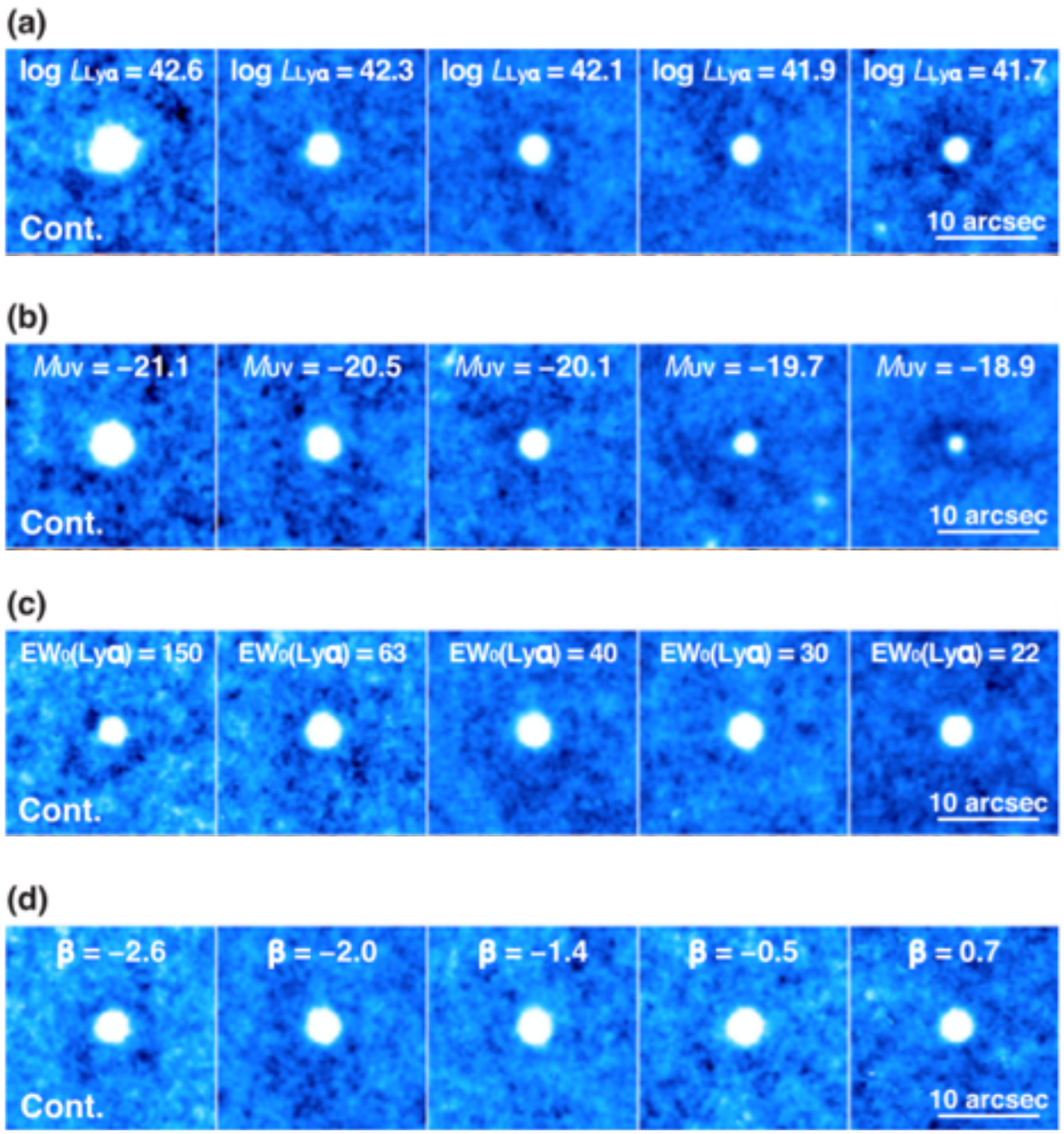
Origin of Lyα photons

- Star forming regions in satellite galaxies around LAEs
- If total radiation from satellite galaxies is strong, they would produce extended Lyα emission

Comparison with our results

- If there are satellite galaxies, extended UV emission should also exist in our stacked UV images
- Our stacked UV images suffer from sky-over subtraction
  - It may cancel out the evidence of satellite galaxies

(c) Satellite galaxies



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We cannot rule out this scenario

Summary

Physical parameters of LAEs to determine LAHs' size

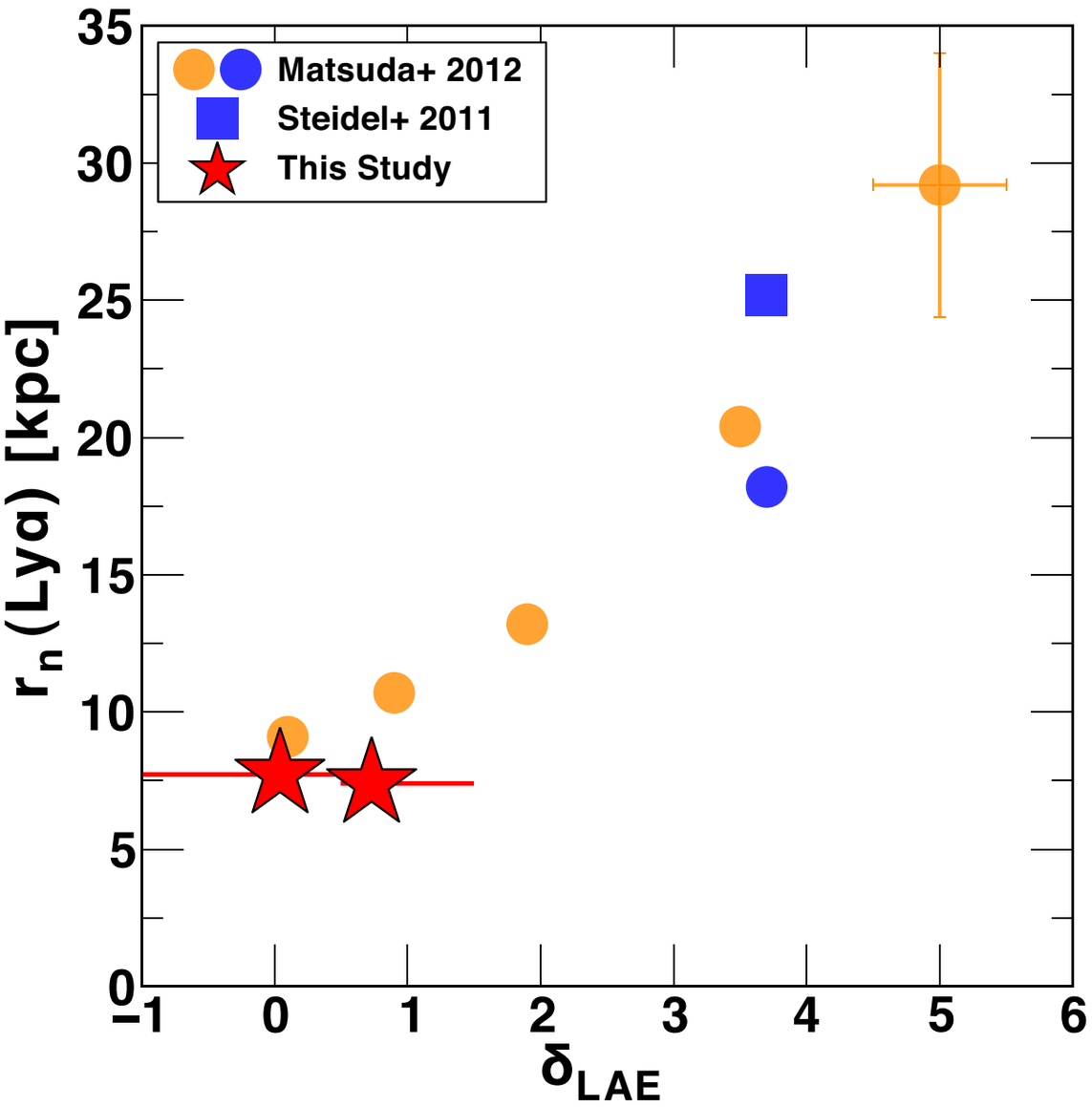
LAHs' sizes tend to be large with

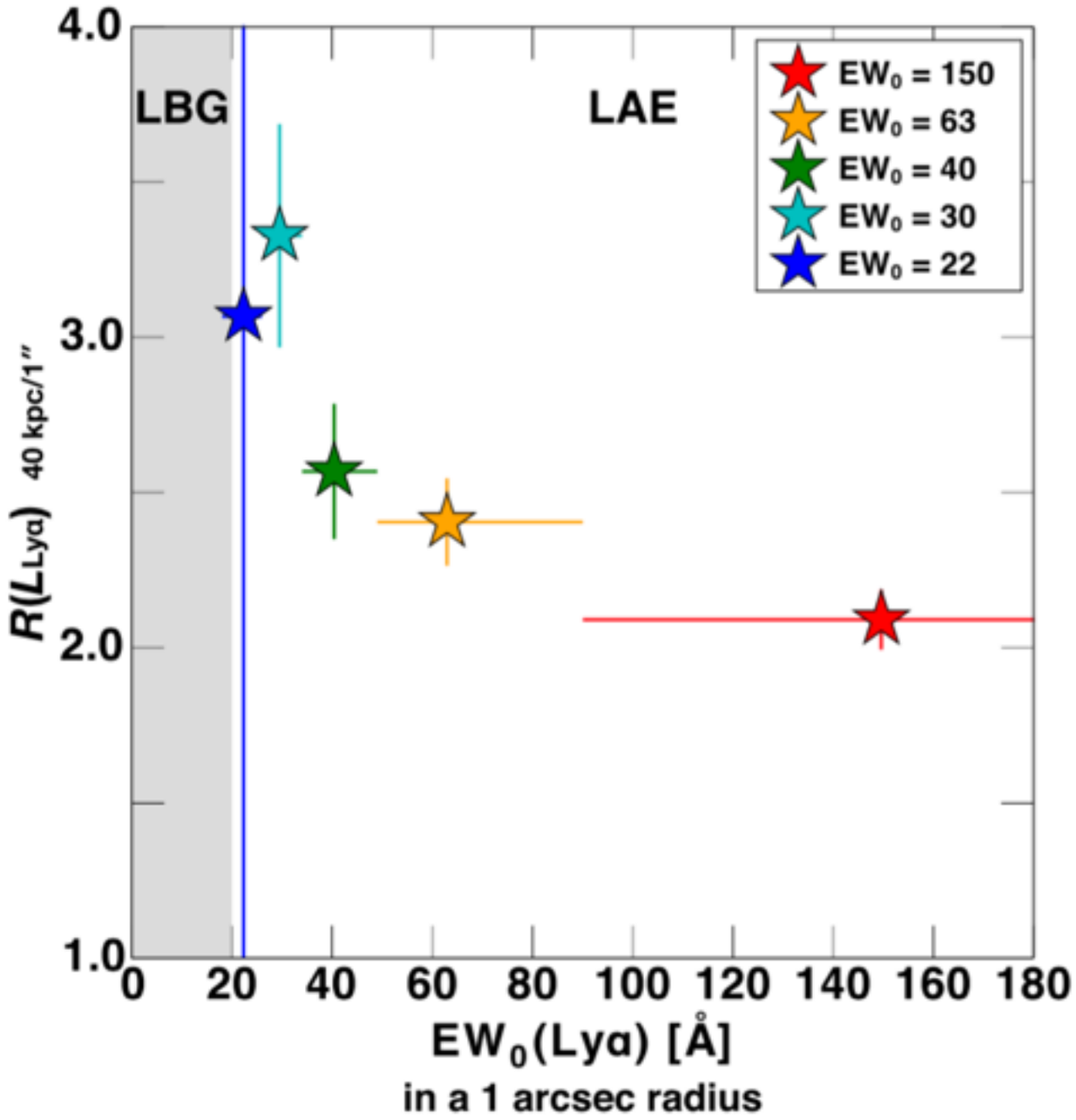
- fainter in $L_{Ly\alpha}$
- smaller in EW_0
- brighter in M_{UV}

Origin of LAHs

(a) Scattered light in the CGM ==> we cannot rule out
(b) Cold streams ==> not the major contributor of our LAHs
(c) Satellite galaxies ==> we cannot rule out

→ **Haruka will discuss more details in her talk!**


Matsuda+ 2012
Steidel+ 2011
This Study
r_n(Lyα) [kpc]
δ_{LAE}
0
5
10
15
20
25
30
35
−1
0
1
2
3
4
5
6


LBG
LAE
EW_0 = 150
EW_0 = 63
EW_0 = 40
EW_0 = 30
EW_0 = 22
$R(L_{Lyα})$ 40 kpc/1″
EW_0(Lyα) [Å]
in a 1 arcsec radius
1.0
2.0
3.0
4.0
0
20
40
60
80
100
120
140
160
180