Subaru Users meeting 2026

F470N for H α

Subaru meets JWST : Direct measurement of the Ly α escape fraction at z~6.2

NB872 for Ly α

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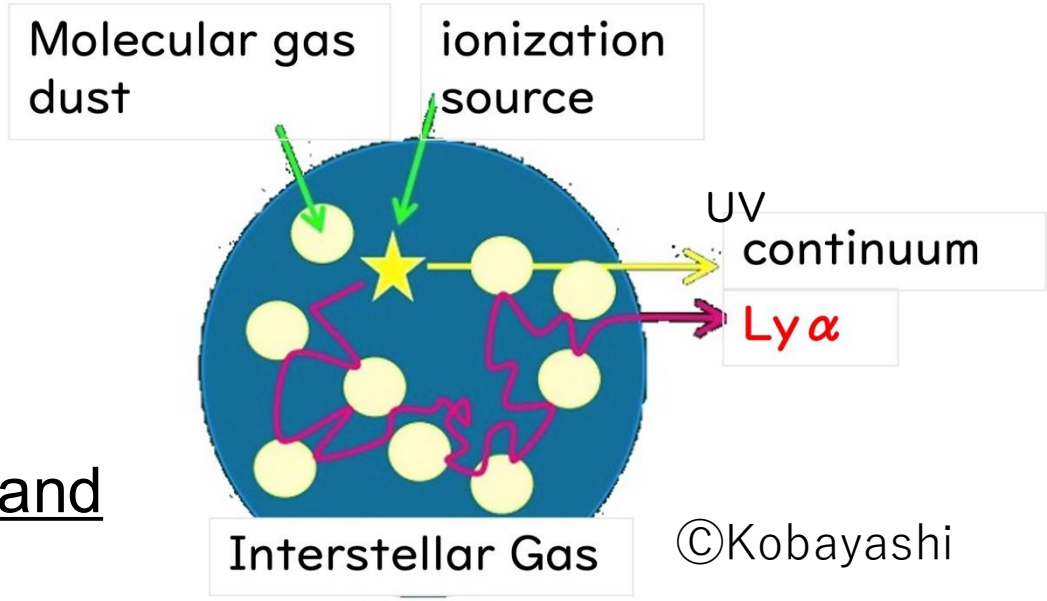
UTokyo

Credit:NAOJ, NASA

Ly α emission

Lyα is one of the strongest emission line
・sensitive to HI and dust in galaxies
and gas kinematics

→ Lyα escape fraction ($f_{\rm esc}^{\rm Ly\alpha}$) is crucial to understand the mechanisms behind Lyα escape



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The robust way to directly measure $f_{\rm esc}^{\rm Ly\alpha}$
→compare Lyα with Hα lines (rest 6563Å),
not subject to resonant scattering

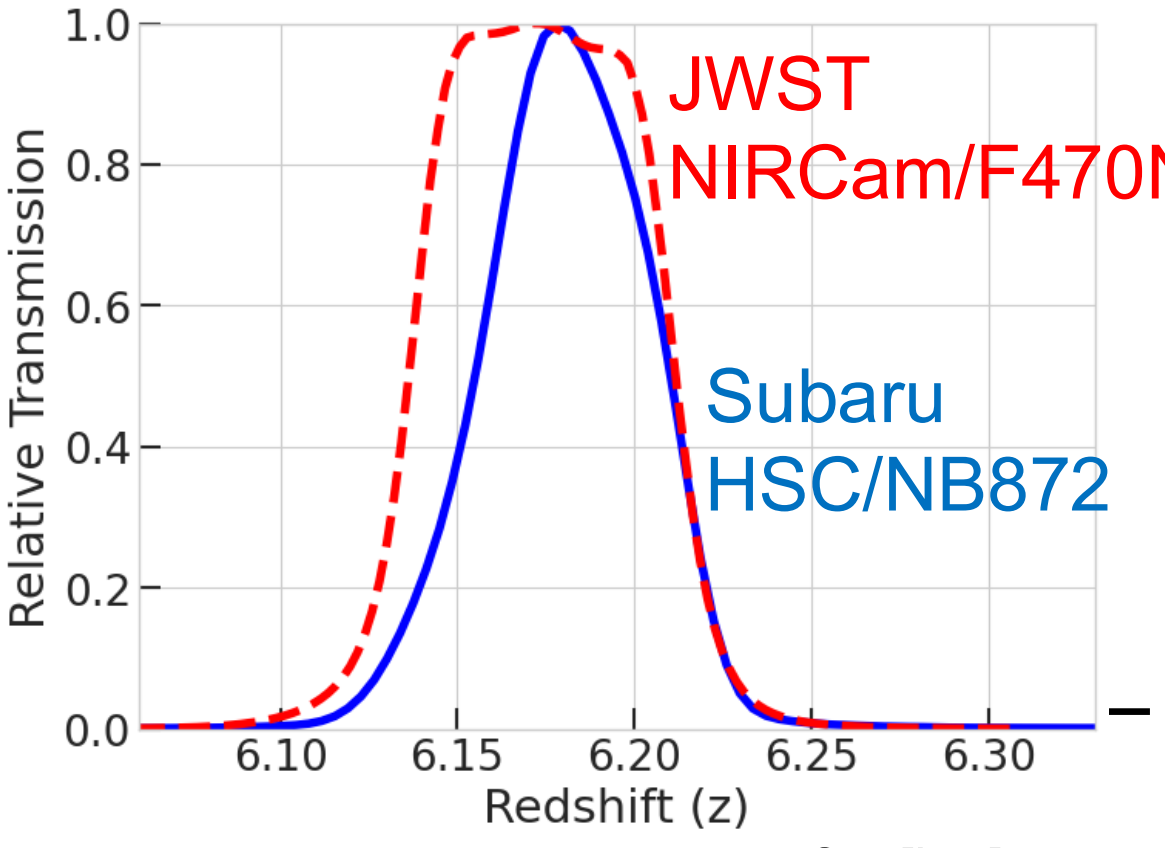
$$f_{\rm esc}^{\rm Ly\alpha} = \frac{F_{\rm Ly\alpha,obs}}{8.7 F_{\rm H\alpha,int}}$$

* Assuming Case B recombination

This Work

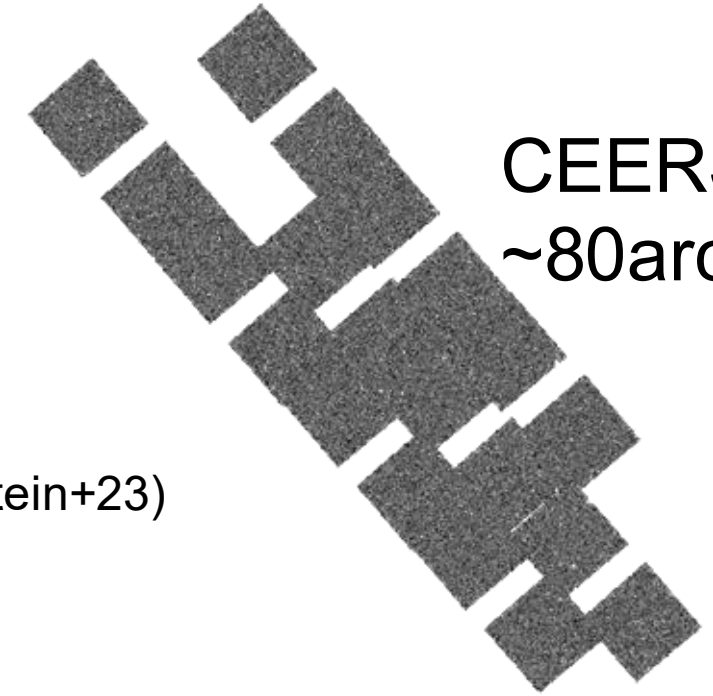
Unique combination of NB filters
・JWST F470N
→capture Hα emission at z = 6.2

・Subaru NB872 (Lyα emission)
→capture Lyα at the same redshift



We apply this dual NB method to the z>6 for the first time
→ measure median $f_{\mathrm{esc}}^{\mathrm{Ly}\alpha}$ at z = 6.2

Data



JWST data : F470N (λ_c=4.71μm)

F470N archive data (GO:2234) at CEERS field (Finkelstein+23)

Subaru data : NB872 (λ_c=0.872μm)

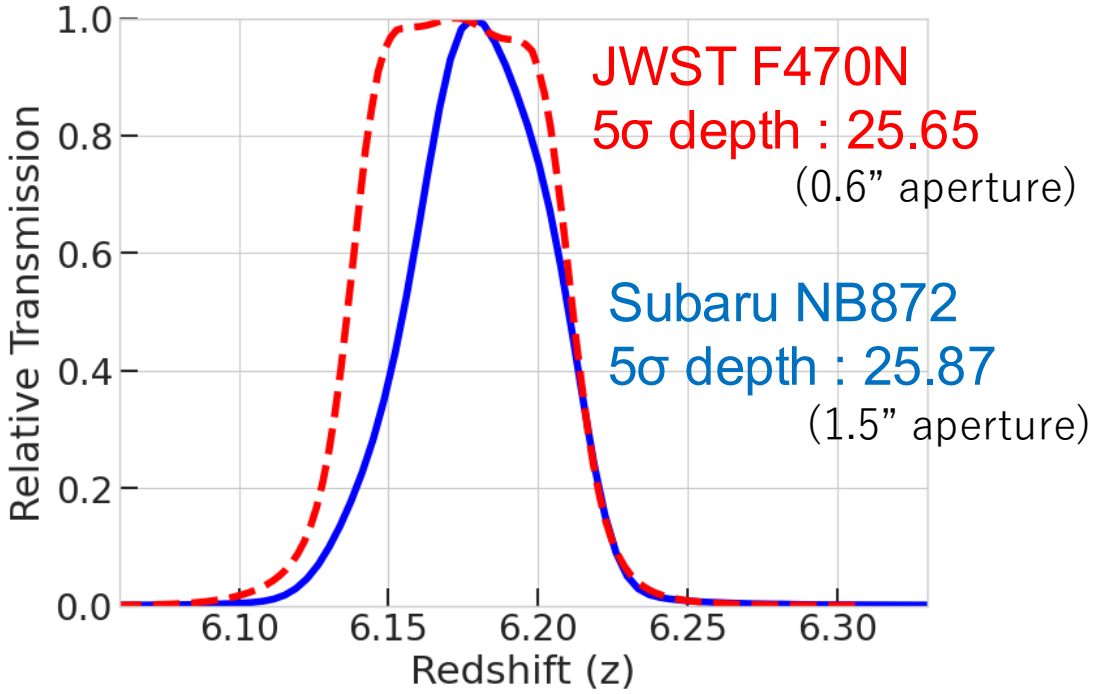
HSC/NB872 imaging

S23B (PI: N.Kashikawa)

and S24B, S25A (PI: S.Shimizu)

Total integration ~20 hours

※ The COSMOS field has also been observed with both filters, but small FoV; F470N ~40arcmin²



Sample

Detect Hα emitters (HAEs) based on F470N excess over the broadband

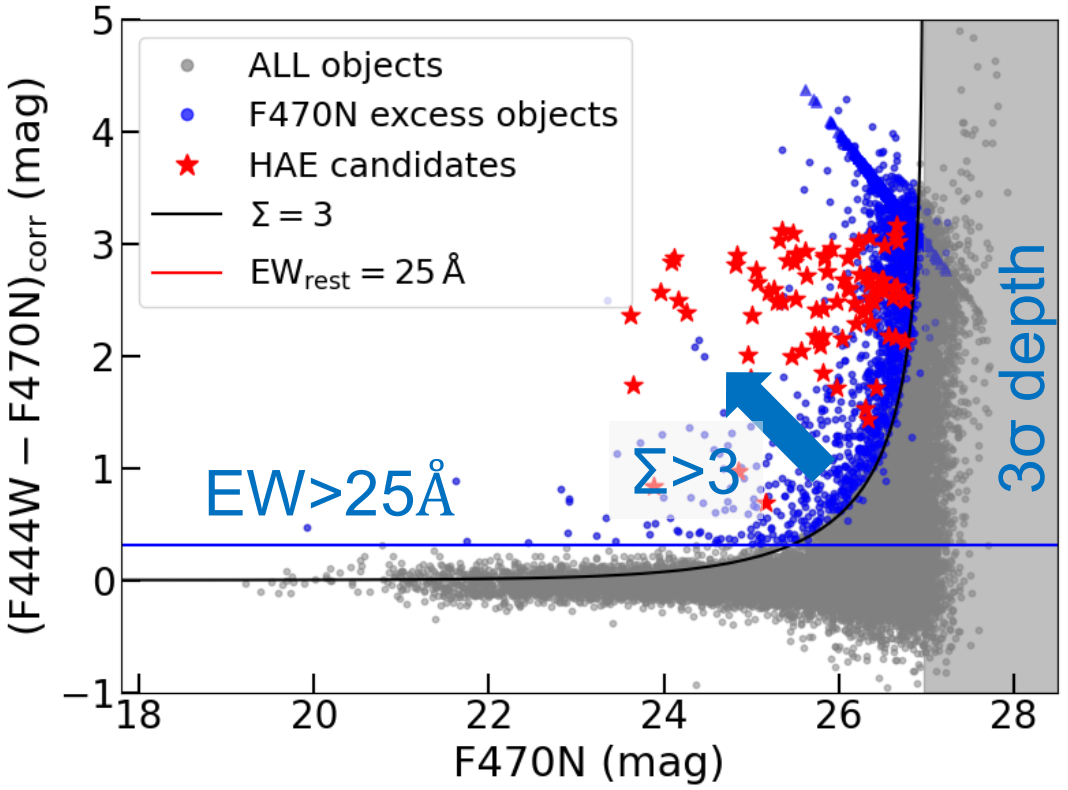
Selection criteria

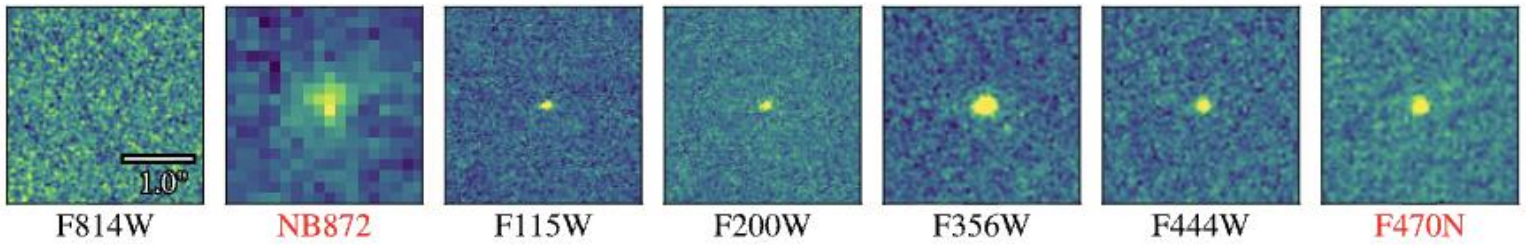
(1) F470N< $F470N_{3\sigma}$, (2) Σ>3, (3) $EW^0_{H\alpha}$ >25Å

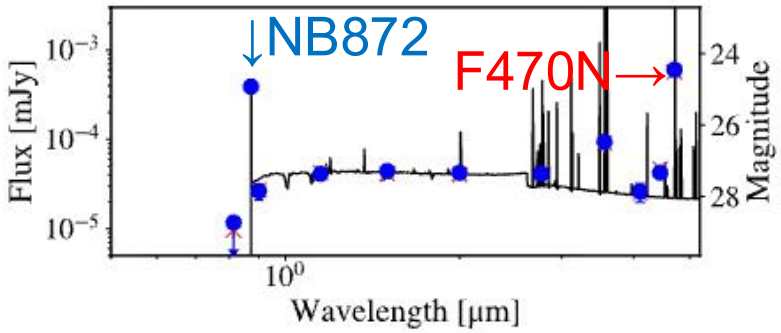
→Using EAZY to estimate photo-z (Brammer+08)

Final HAE sample : 80 (AGN/LRD excluded)

- 53 HAEs with reliable NB872 photometry
- 19 HAEs detected in Lyα at > 2σ

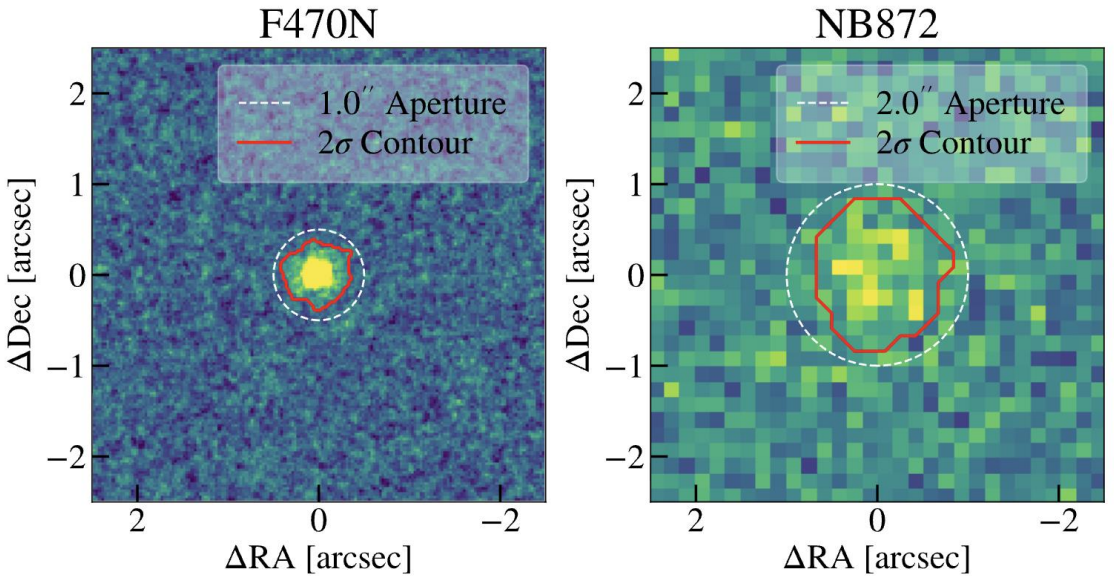






Method

Derive the median $f_{\rm esc}^{\rm Ly\alpha}$ of SFGs
by median stacking of 53 HAEs



Stacked images
- F470N: Hα + optical cont.
- NB872: Lyα + UV cont.
- JWST/F444W, F115W: for opt, UV cont.

$$f_{\rm esc}^{\rm Ly\alpha} = \frac{F_{\rm Ly\alpha,obs}}{8.7 F_{\rm H\alpha,int}}$$

$F_{\rm Ly\alpha,obs}$ ⟵ NB872 – F115W

$F_{\rm H\alpha,int}$ ⟵ F470N – F444W and correct dust attenuation using median E(B-V) ~0.08

Median $f_{\rm esc}^{\rm Ly\alpha}$

$$f_{\rm esc,med}^{\rm Ly\alpha} = 0.101^{+0.090}_{-0.042}$$ (weighted)

・Consistent with luminosity function (LF) based results and JWST results at z~6

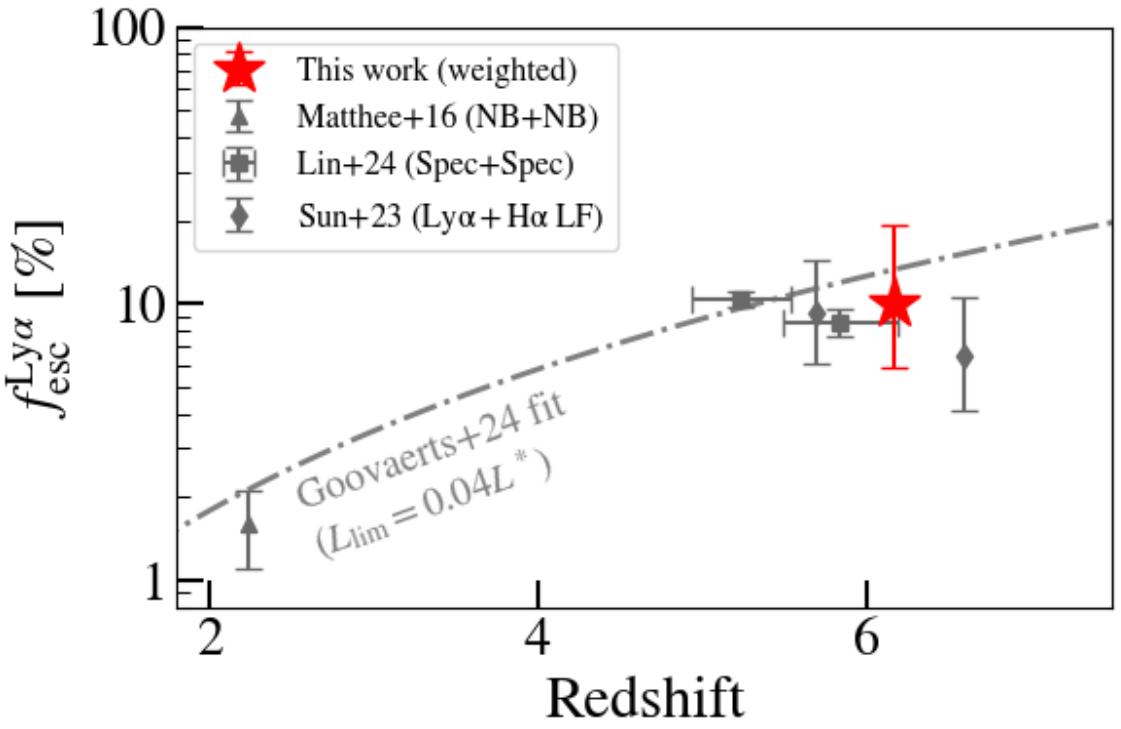
・higher than the dual NB results at z~2 (Matthee+16)

Possible interpretation

・less dusty and bluer galaxies

・clumpy HI/dust distribution

・low-density channels for Lyα escape



Individual $f_{\mathrm{esc}}^{\mathrm{Ly\alpha}}$

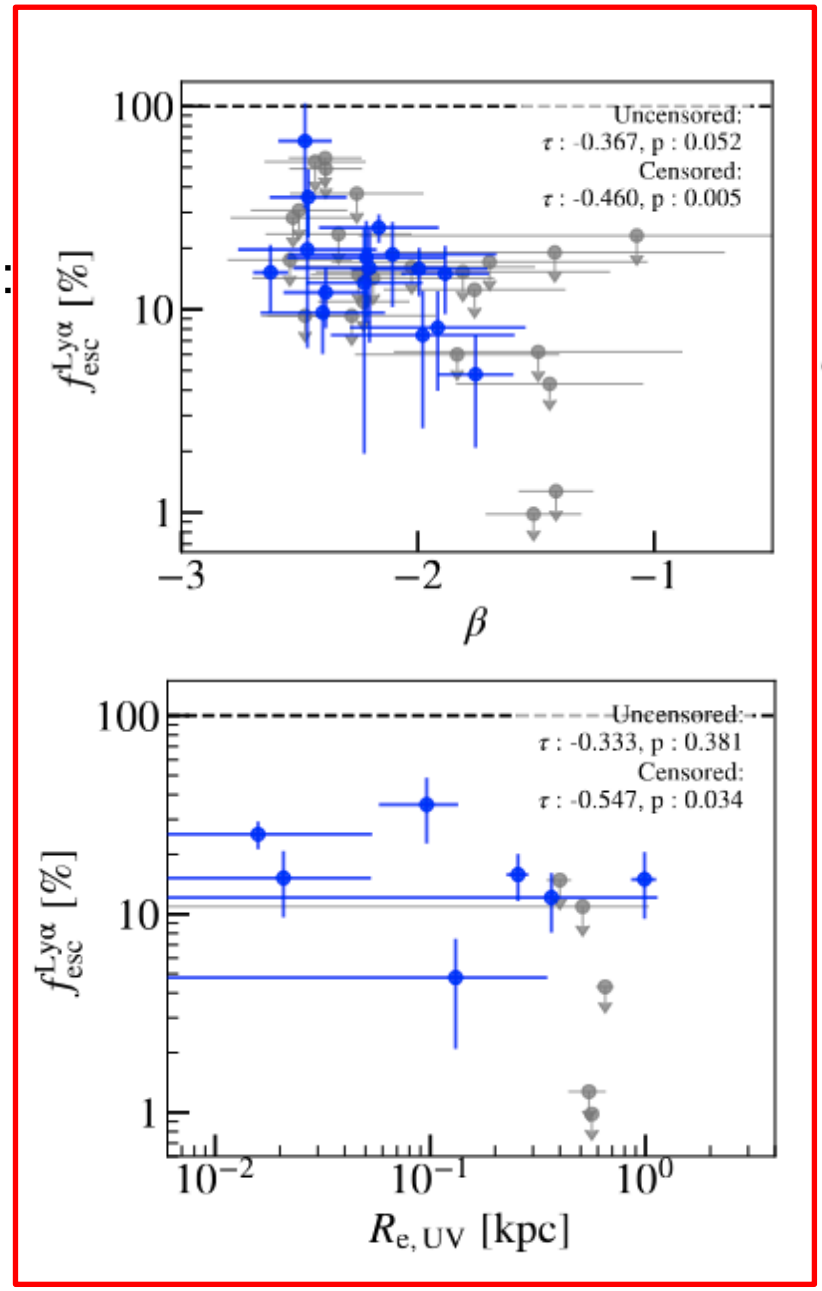
SED fitting using CIGALE
→Correlation test (with upper limits): censored Kendall's τ

Significant (p<0.05)
UV slope β, UV size

No significant
$E(B\text{-}V)_{\mathrm{SED}}$, optical size

⇨Lyα escape may depend on local ISM/dust structure, not the whole galaxy

p<0.05

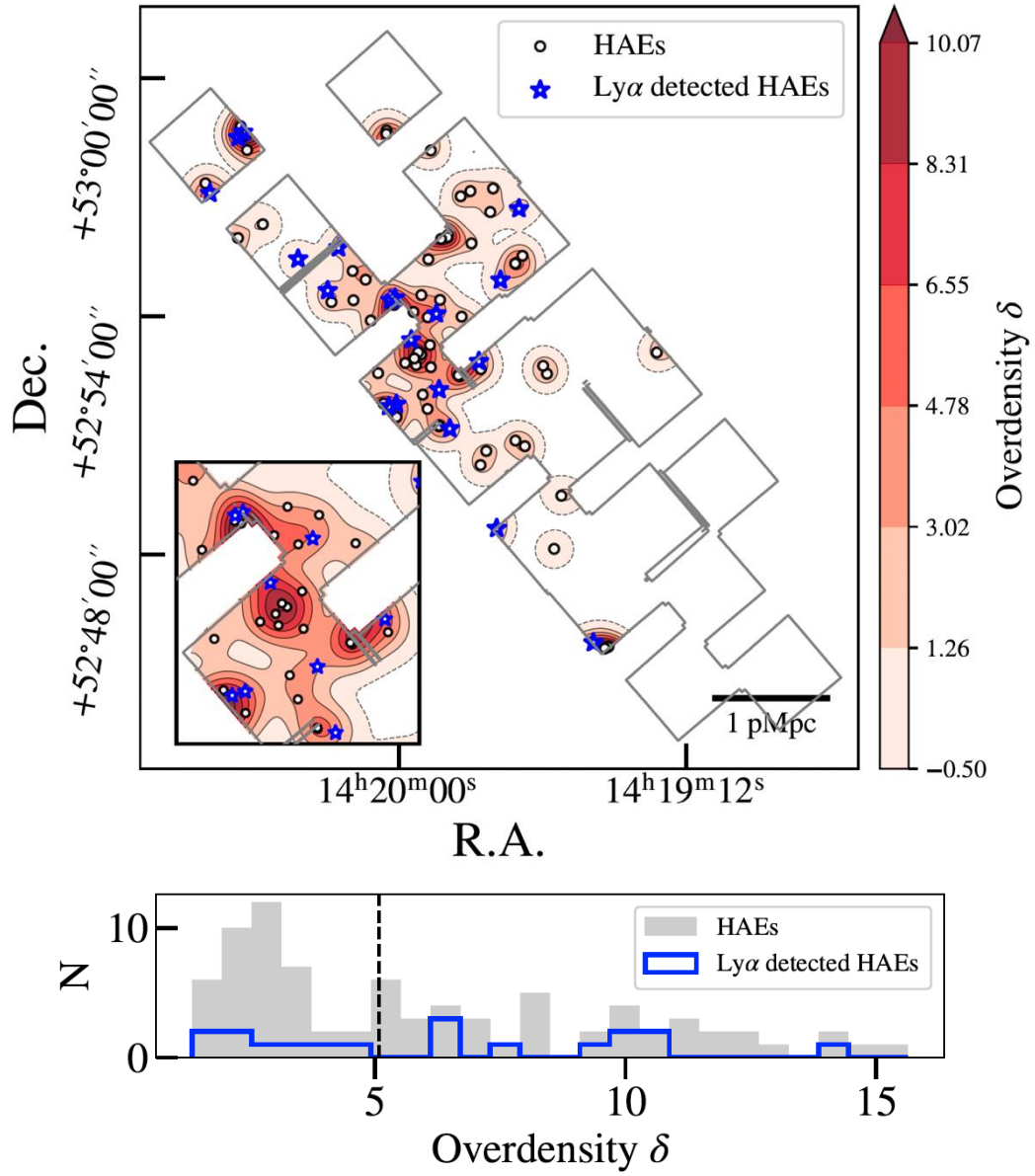


Ly α visibility

Density map from Gaussian KDE
→a non-uniform distribution of HAEs

Overdensity increases ionizing output,
but also raises HI gas (e.g. Qiong+25)
→Lyα visibility is uncertain

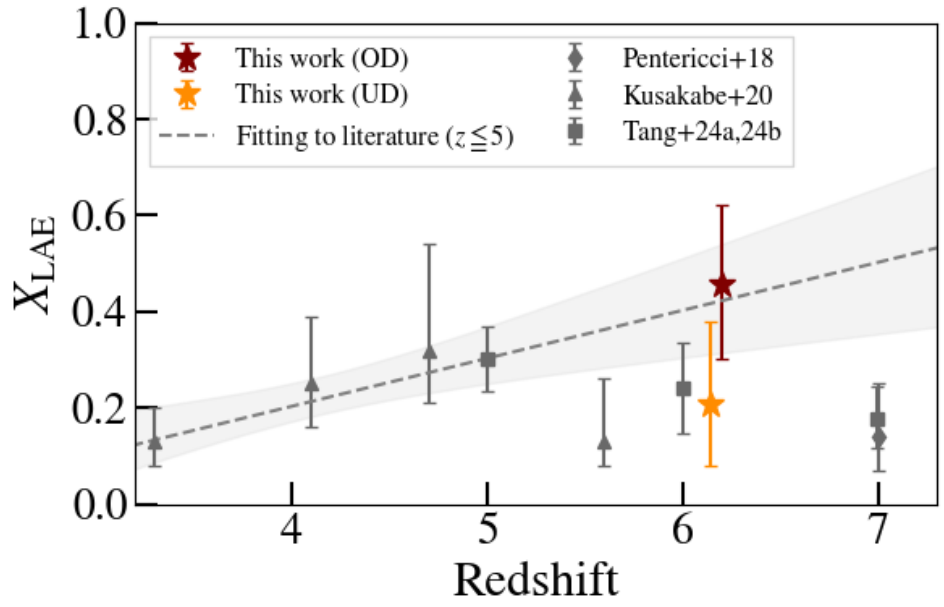
split the sample into
overdensity (OD) vs underdensity (UD)
→Compare $X_{\rm LAE}$ (LAE fraction) and $f_{\rm esc}^{\rm Ly\alpha}$
(limit to -18.75 >$M_{\rm UV}$ >-20.25)

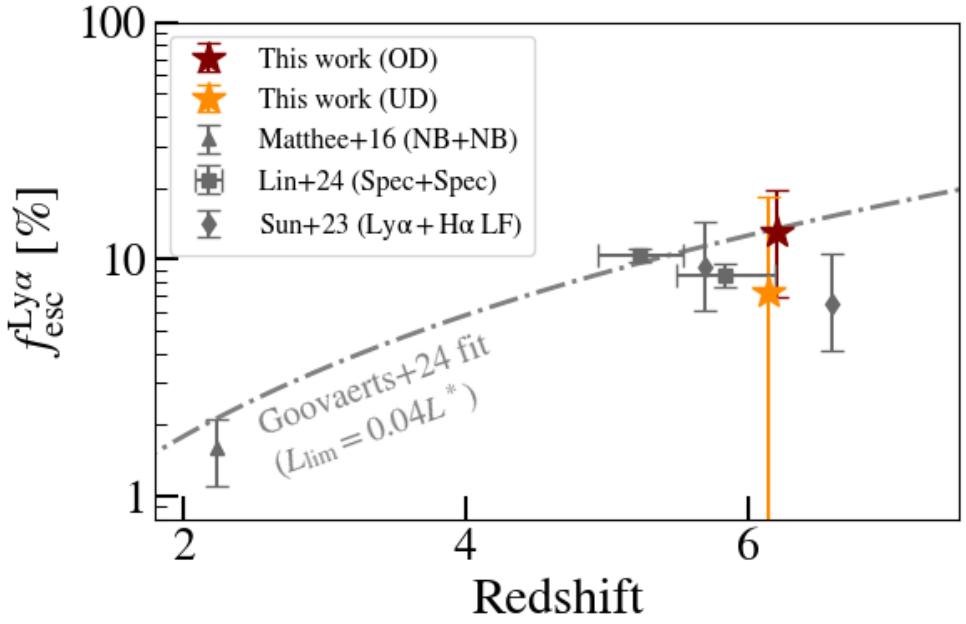


Ly α visibility

X_{LAE} is significantly higher in the OD than UD and previous studies.
($f_{\mathrm{esc}}^{\mathrm{Ly}\alpha}$ is not statistically significant)

→suggest OD galaxies make local ionized bubbles, thereby enhancing the escape and visibility of Lyα photons.





Summary

- Unique NB combination of JWST/F470N and Subaru/NB872
  → median $f_{\rm esc}^{\rm Ly\alpha}$ at z=6.2; $f_{\rm esc,med}^{\rm Ly\alpha} = 0.101^{+0.090}_{-0.042}$.
- Individual HAEs suggest that Lyα escape is linked to blue UV-emitting star-forming regions.
- the higher $X_{\rm LAE}$ in overdense suggest local ionized bubbles enhancing Lyα visibility.

Future work

We observed HAEs at z=6.2 with Keck/DEIMOS
⇦ to confirm and characterize ionized bubble
from such as Lyα velocity offset ($\Delta v_{\rm peak}$)

- only 2 hours due to bad weather... in analysis.

Thank you for the on-site observation opportunity and the Student PI Program !

Special thanks to Takashi Hattori