

Census of Ly α , [OIII]5007, Ha, and [CII]158 μ m Line Emission with ~ 1000 LAEs at $z=4.9-7.0$ Revealed with Subaru/HSC

Harikane et al. 2018b, ApJ, 859, 84

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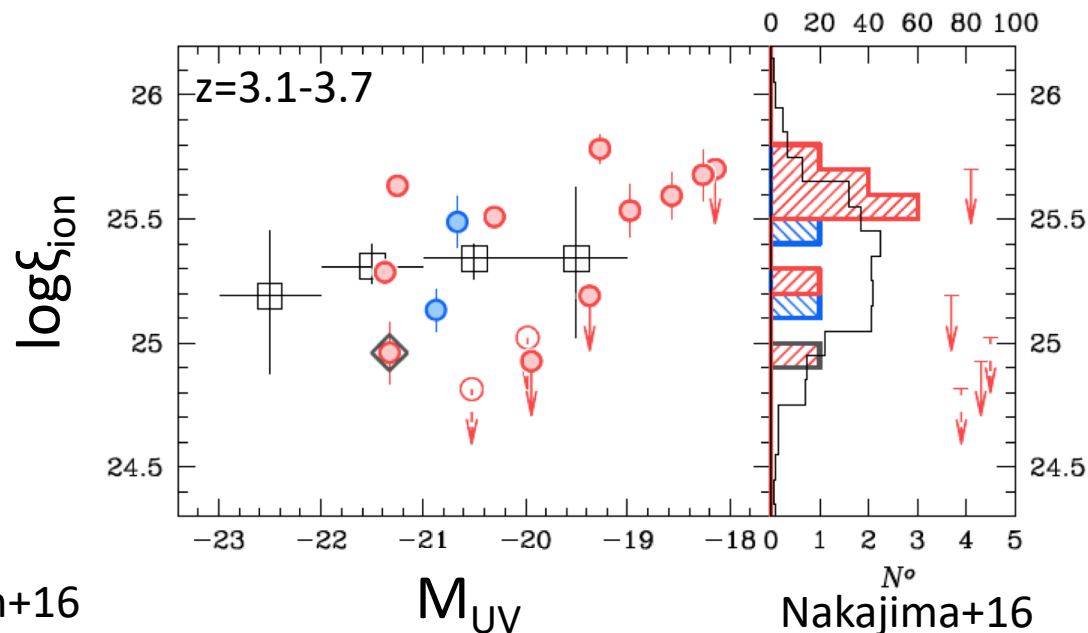
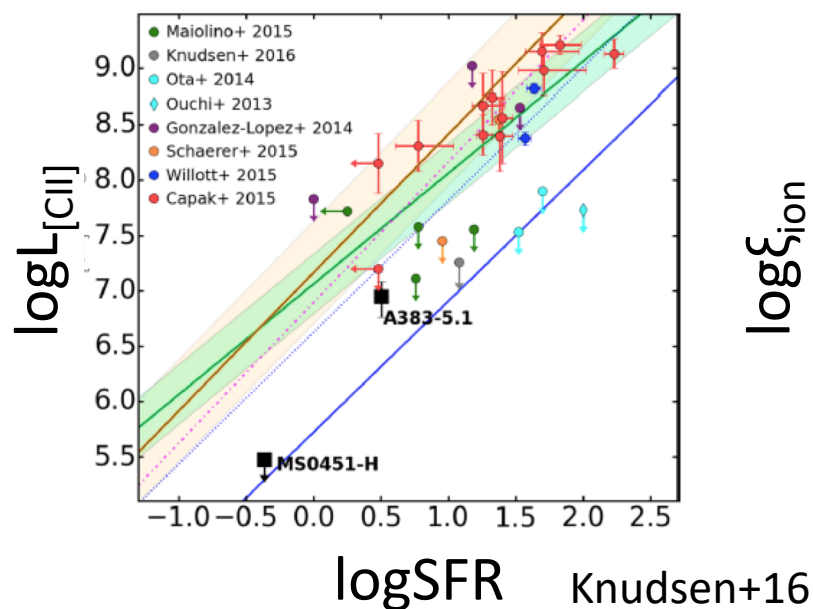
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Ryohei Itoh, Yoshiaki Ono, Ryo Higuchi, Akio K. Inoue, Jacopo Chevallard,
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Outline

- Introduction
- Method and Sample
- Results and Discussion
- Ongoing Work

ISM of $z > 4$ Galaxies

- Weaker [CII] emission in high- z galaxies
 - What is the origin? Metallicity? (e.g., [OIII], Ha needed)
- Reionization by star-forming galaxies (LAEs)?
 - ξ_{ion} : ionizing photon production efficiency (Ha needed)
- Rest-optical lines are important (but in IR at $z > 4$)

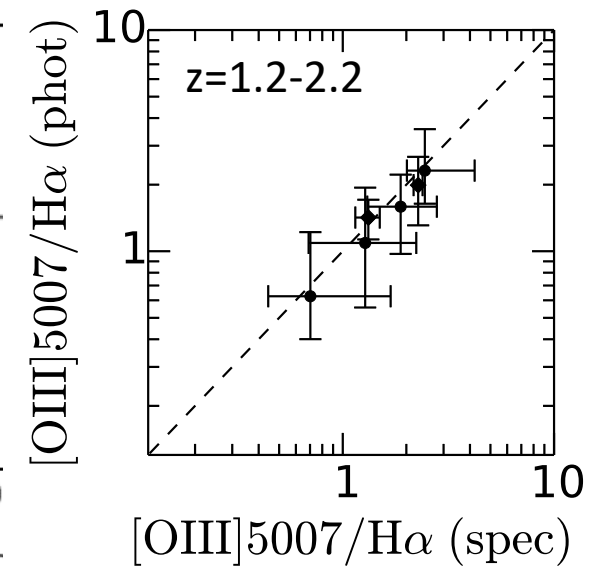
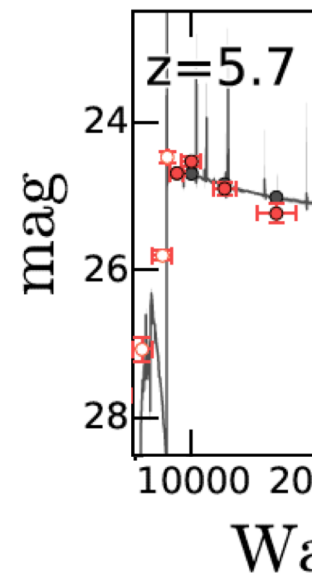
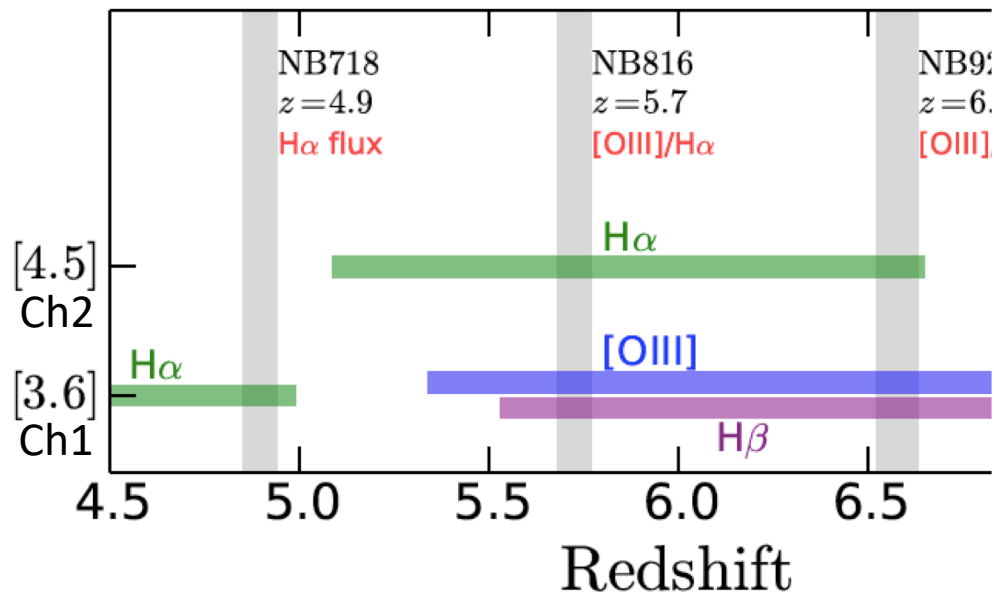


Spitzer/IRAC Excess Technique

- Spitzer (SPLASH) + NB obs (HSC)
- IRAC excess by strong emission
 - e.g., Roberts-Borsani+16, Faisst+16
 - Constraining $H\alpha$, $[OIII]$, $H\beta$ at $z=4.9-7.0$

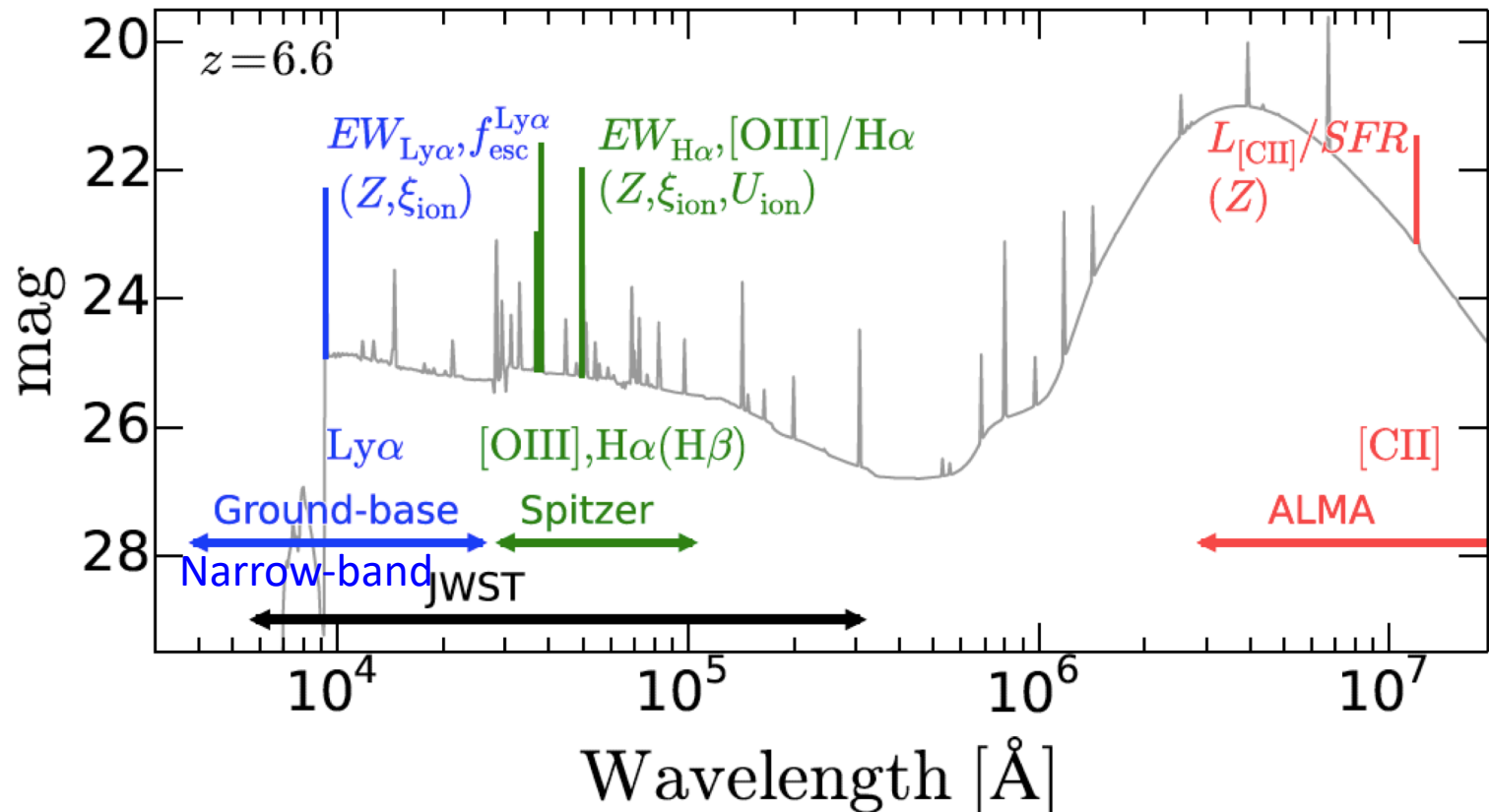


Caltech



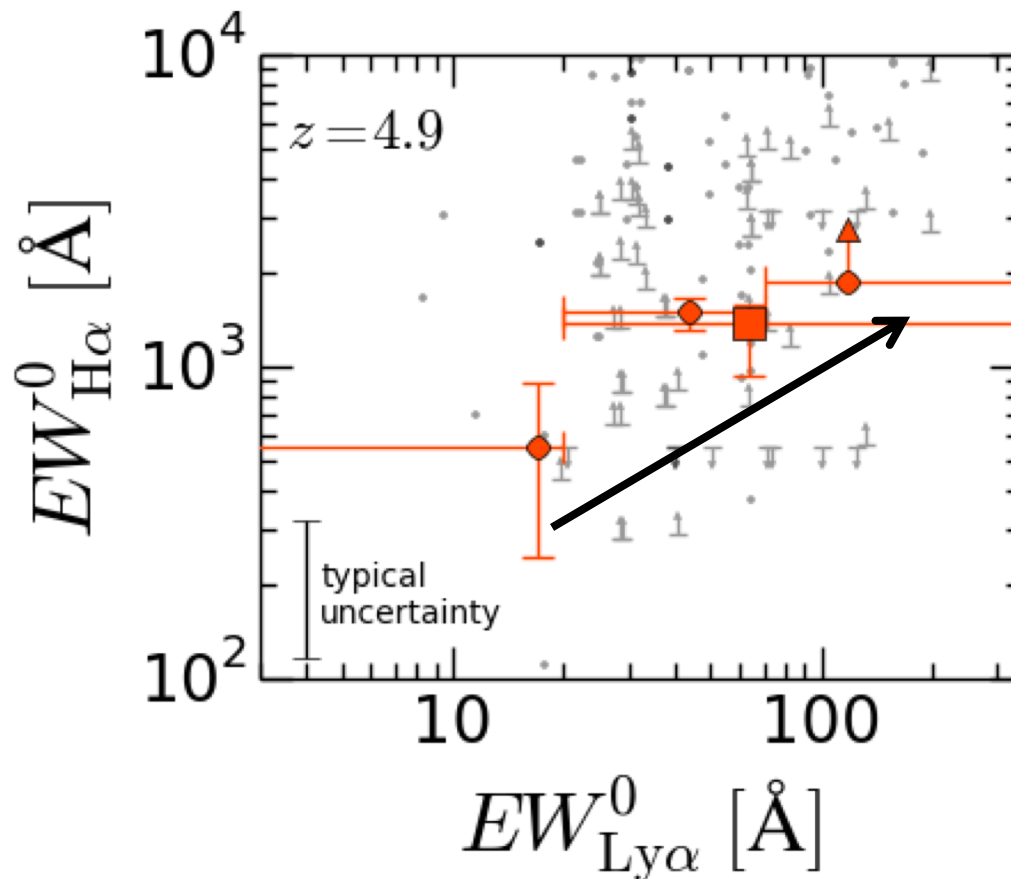
Our Sample: Subaru/HSC

- 1092 LAEs with Spitzer (Shibuya+18, Itoh+18, Zheng+in prep.)
 - $z=4.9, 5.7, 6.6, 7.0$ (NB718, NB816, NB921, NB973)
- 34 galaxies with ALMA/PdBI [CII] data (literature)



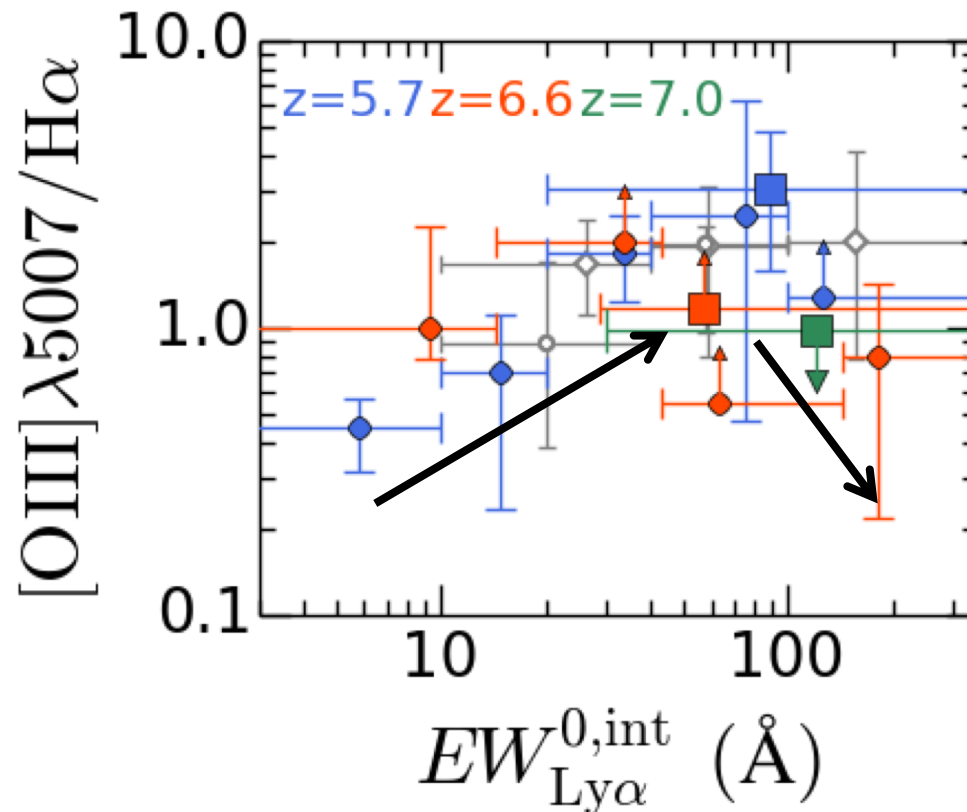
Result 1: H α EW

- H α EW positively correlates with Ly α EW
 - $EW_{H\alpha} \sim 2000 \text{ \AA}$ in high $EW_{Ly\alpha}$ galaxies



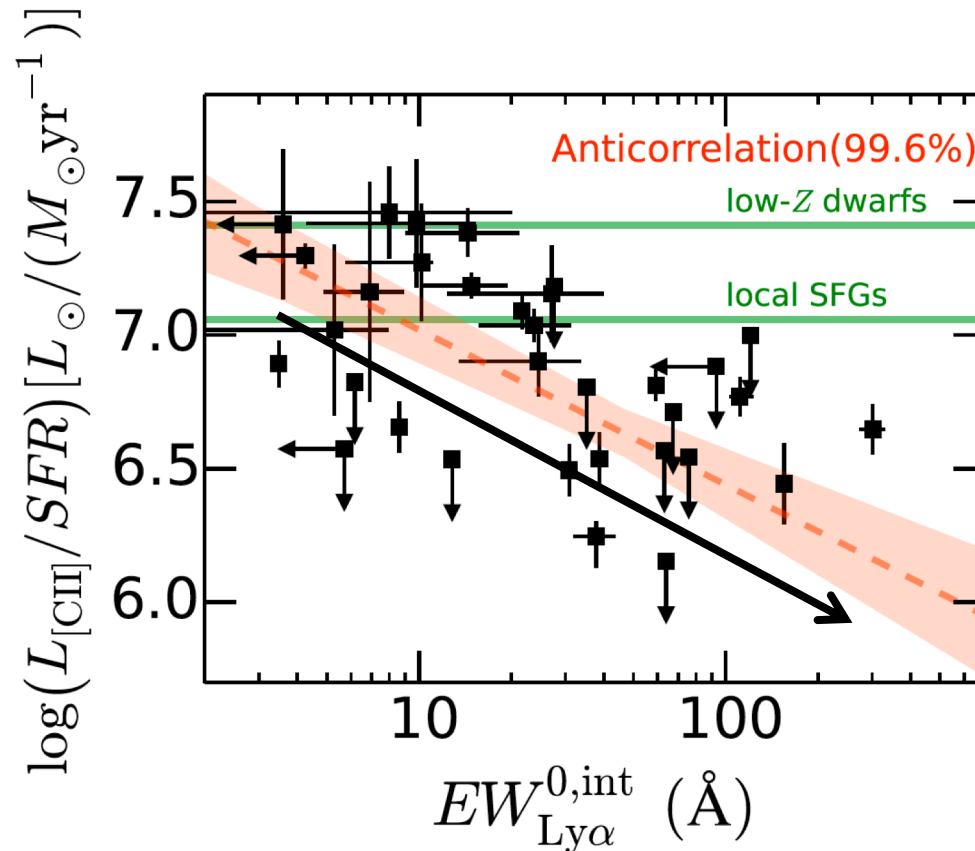
Result 2: [OIII]/Ha

- Turn-over trend in [OIII]/Ha- $EW_{Ly\alpha}$ plane
 - Indicating low-metallicity in high- $EW_{Ly\alpha}$ LAEs



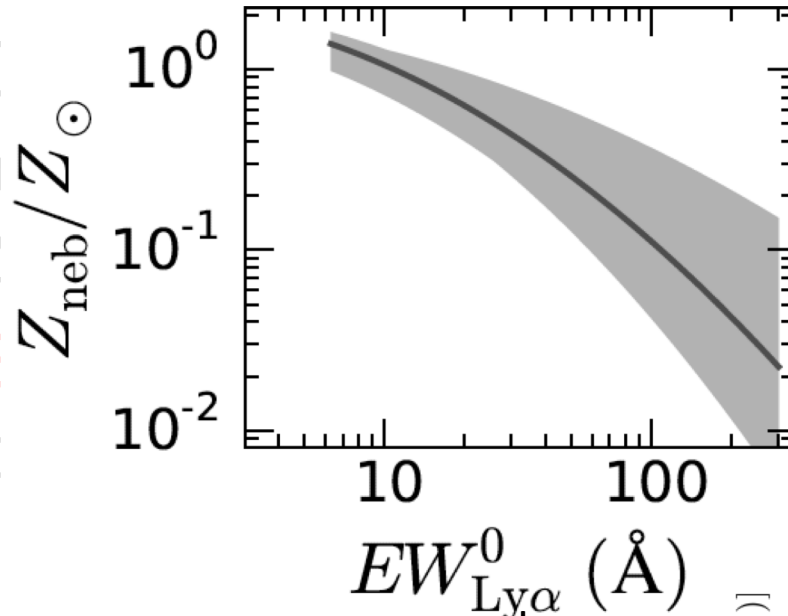
Result 3: [CII]-Ly α

- [CII]/SFR negatively correlates with Ly α EW
 - Confirming [CII] deficit in LAEs for the first time

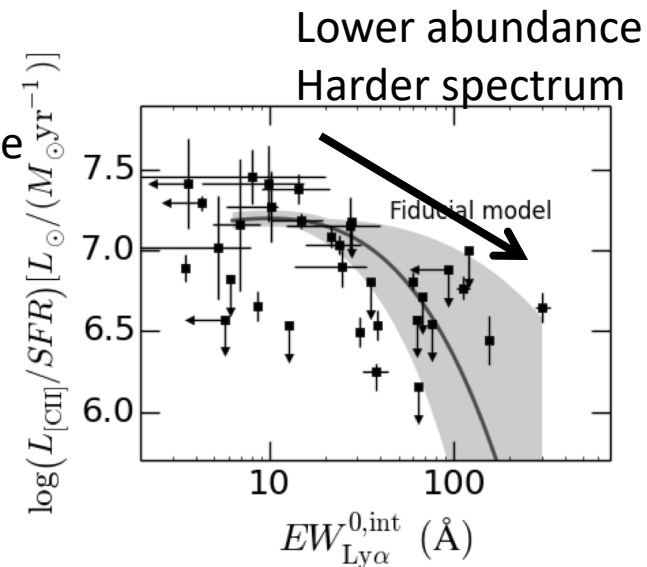
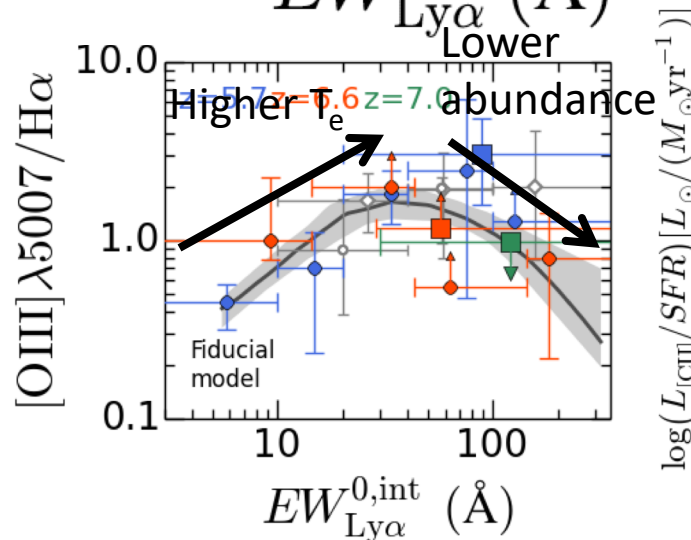
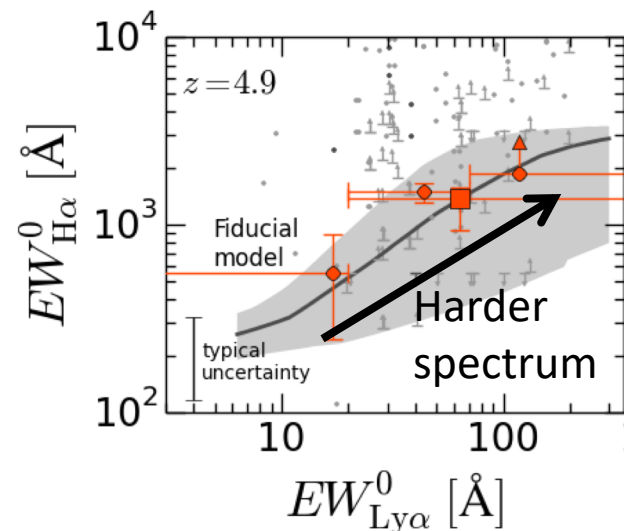


Metallicity-EW Ly α Anti-Correlation

- BEAGLE (Cenarro et al. 2016)
 - Stellar synthesis models
 - $-2 < \log(Z/Z_{\odot}) < 0$
- Metallicity-EW Ly α anti-correlation
- three relations

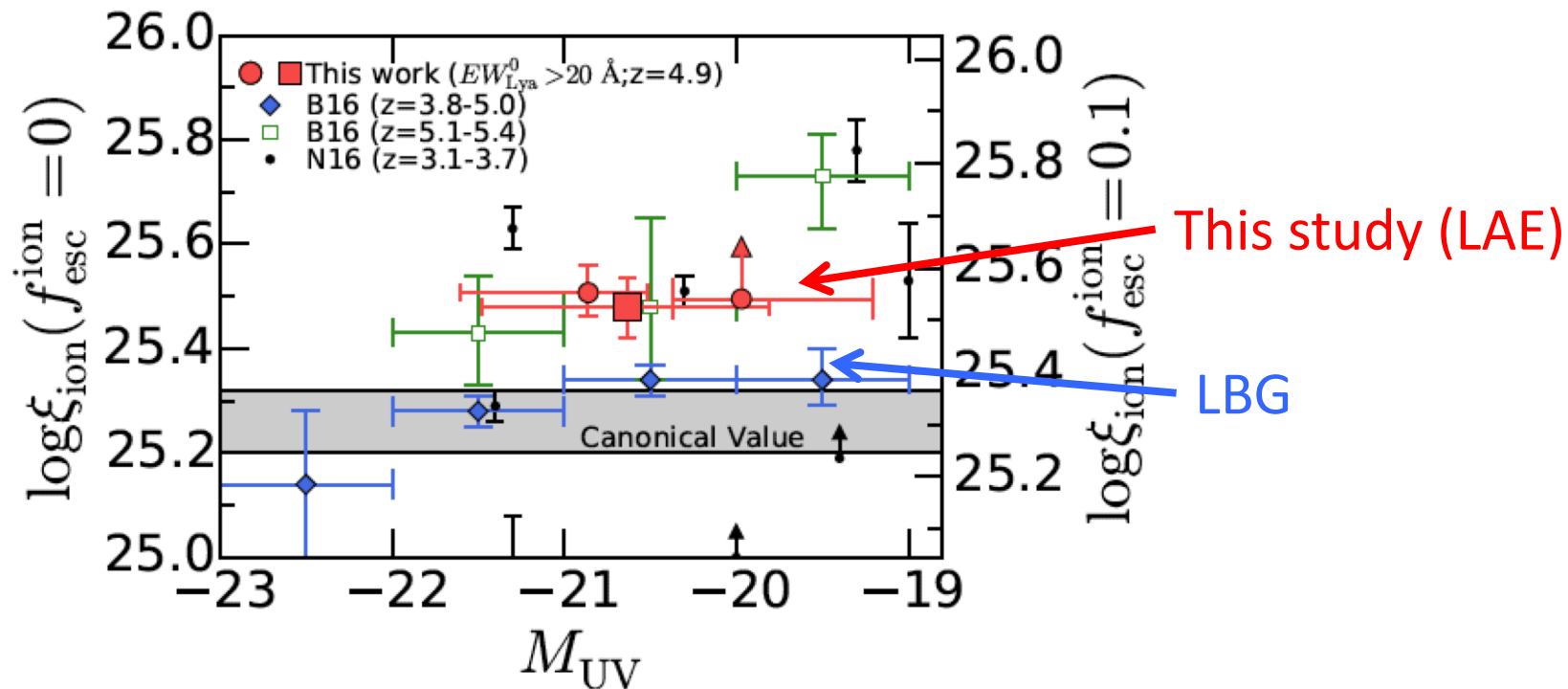


models
 $\log(\text{age/yr}) < 9.1$
 can explain the



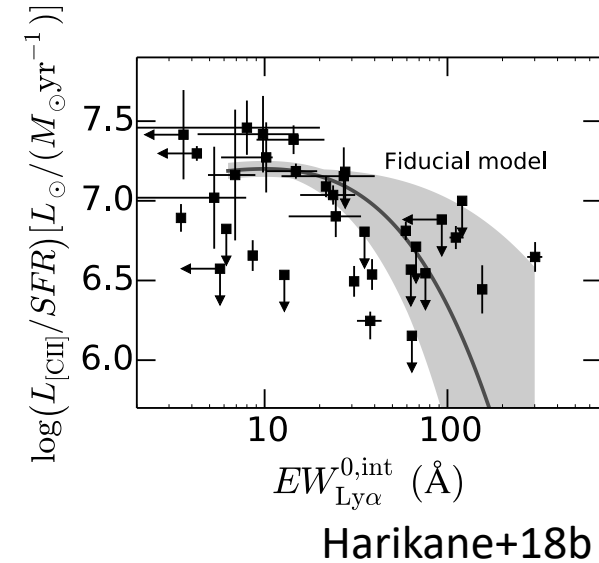
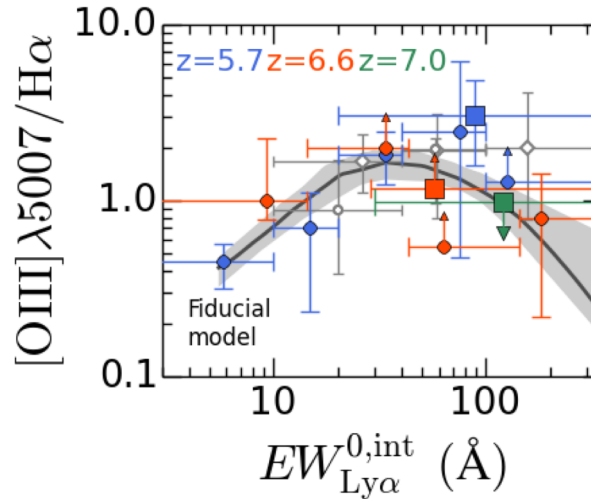
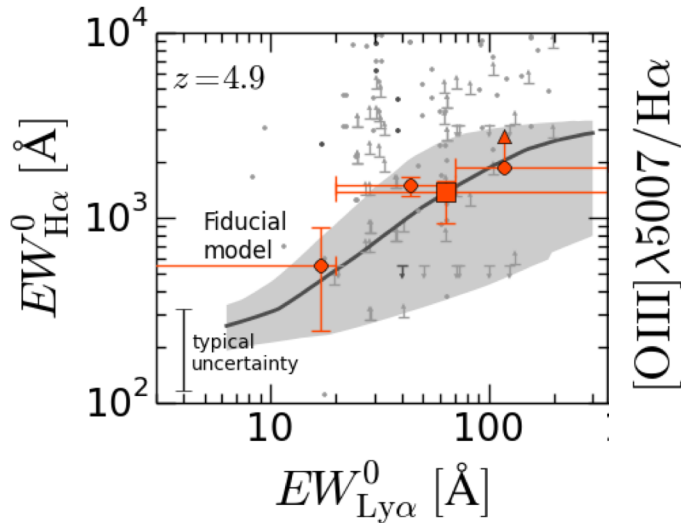
Implication for Cosmic Reionization

- Ionizing photon production efficiency ξ_{ion}
 - $\xi_{\text{ion}} = N(\text{H}^0)/L_{\text{UV}}$, $L_{\text{H}\alpha} = 1.36 \times 10^{-12} N(\text{H}^0) (1 - f_{\text{esc}})$
- $\log \xi_{\text{ion}} \sim 25.53$, higher than LBGs by 60-100%
 - Enough ionizing photons ($f_{\text{esc}} = 10\%$, UVLFs)



Summary

- ISM properties from ~ 1000 LAEs at $z=4.9-7.0$



- Metallicity- $EW_{Ly\alpha}$ anti-correlation can explain all results.
 - LAE: metal poor and high ξ_{ion}

