Reionization History and Sources Probed by LAEs

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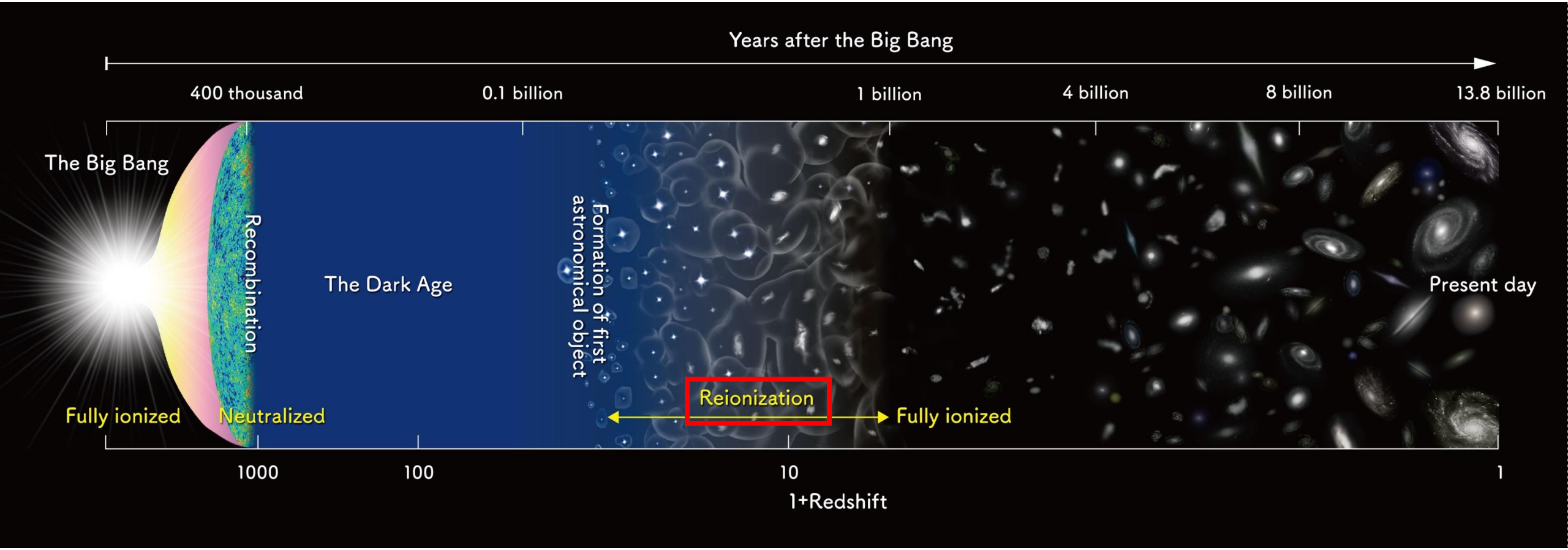
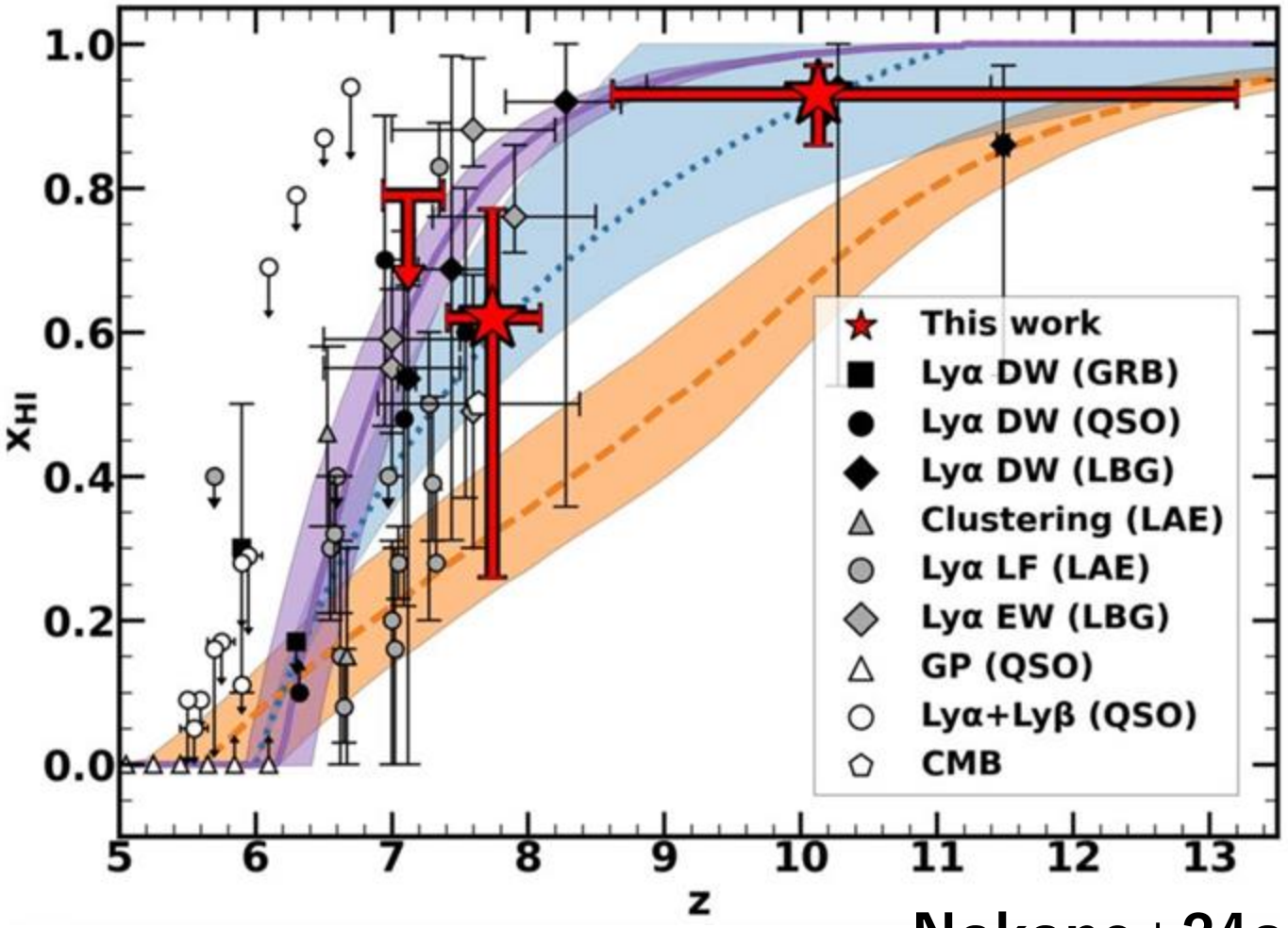
Introduction



NAOJ

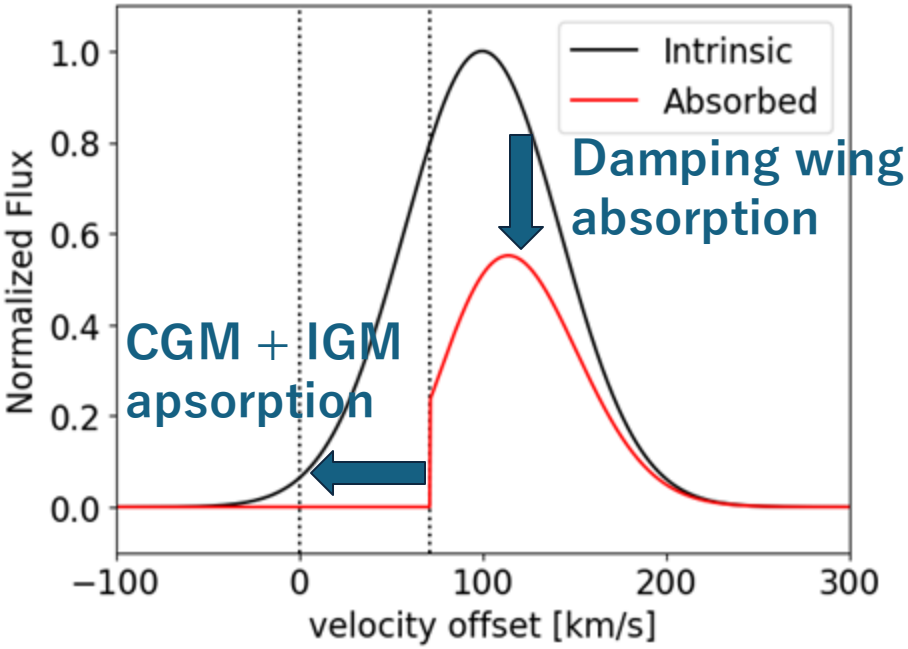
Reionization history: not fully understood

Introduction



Nakane+24a

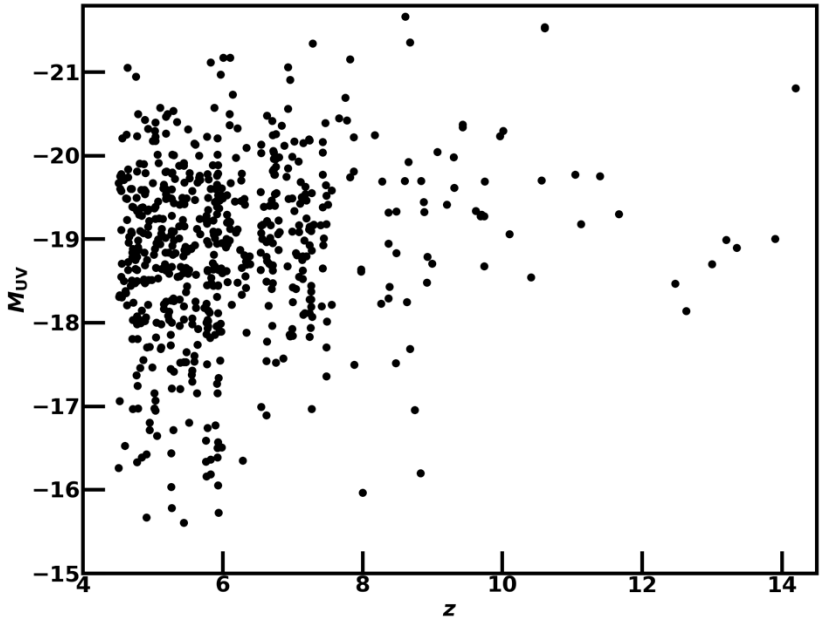
Lyα line profile



1. statistical error
→large sample

2. systematic error
→realistic simulation

Data



- JWST NIRSpec spectra

- JADES + CEERS + GLASS + GO 1433 + DDT 2750 (4289 galaxies)

→Redshift determined (2565 galaxies)

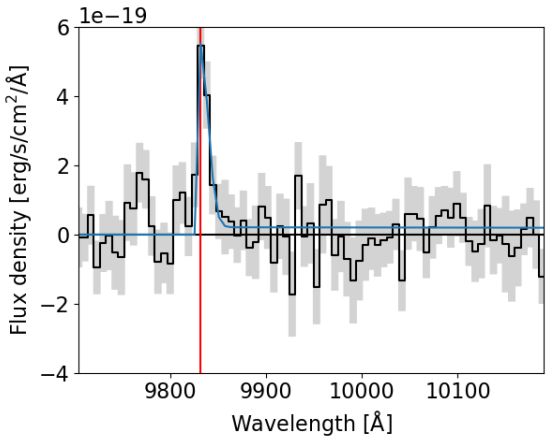
→$z > 4.5$, rest-frame 1216 Å included in spectrum (**629 galaxies**)

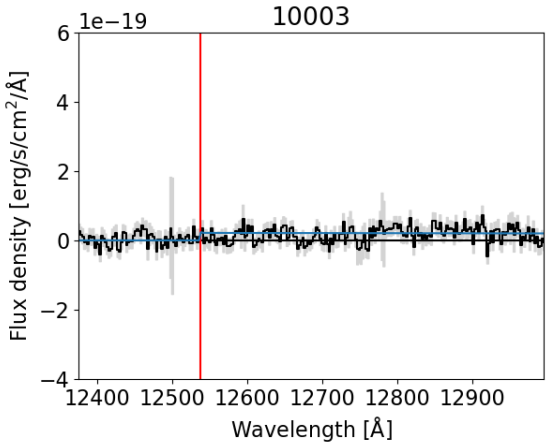
- Our sample: 629 galaxies (mostly from JADES: 494 galaxies)

Redshift range: $z \sim 4.5 - 14.2$ (mostly from nebular lines)

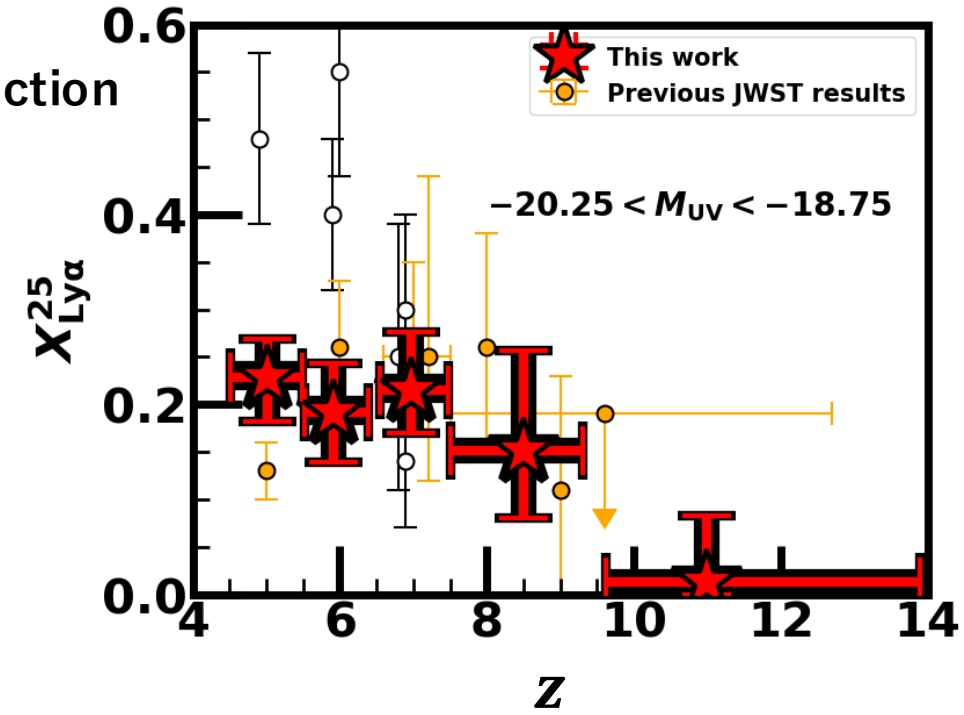
Analysis

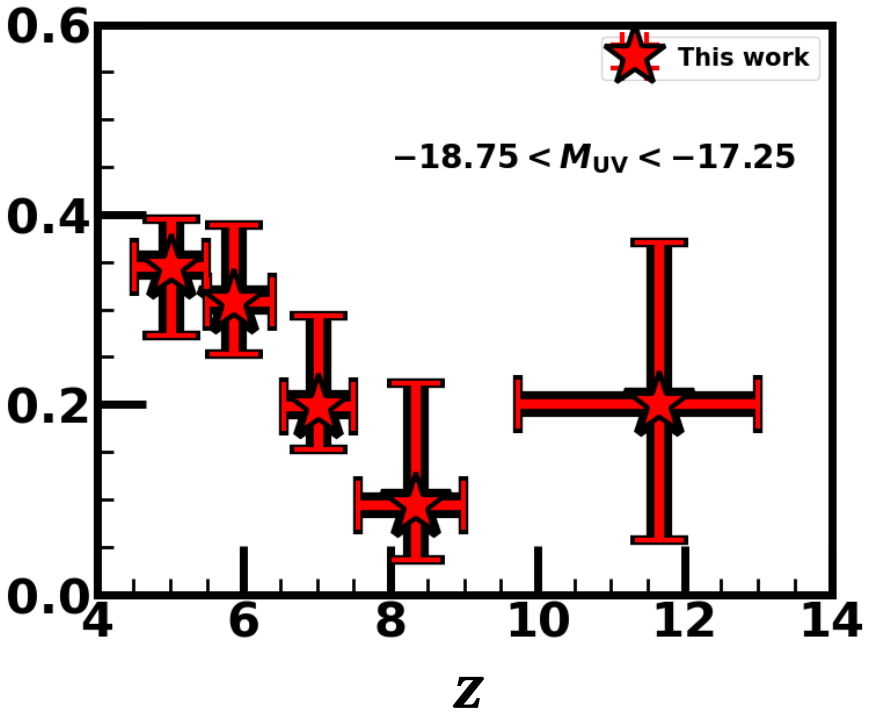
$$EW = \frac{F_{\mathrm{Ly}\alpha}}{f_{\mathrm{con}}(1+z_{\mathrm{spec}})}$$





LAE fraction

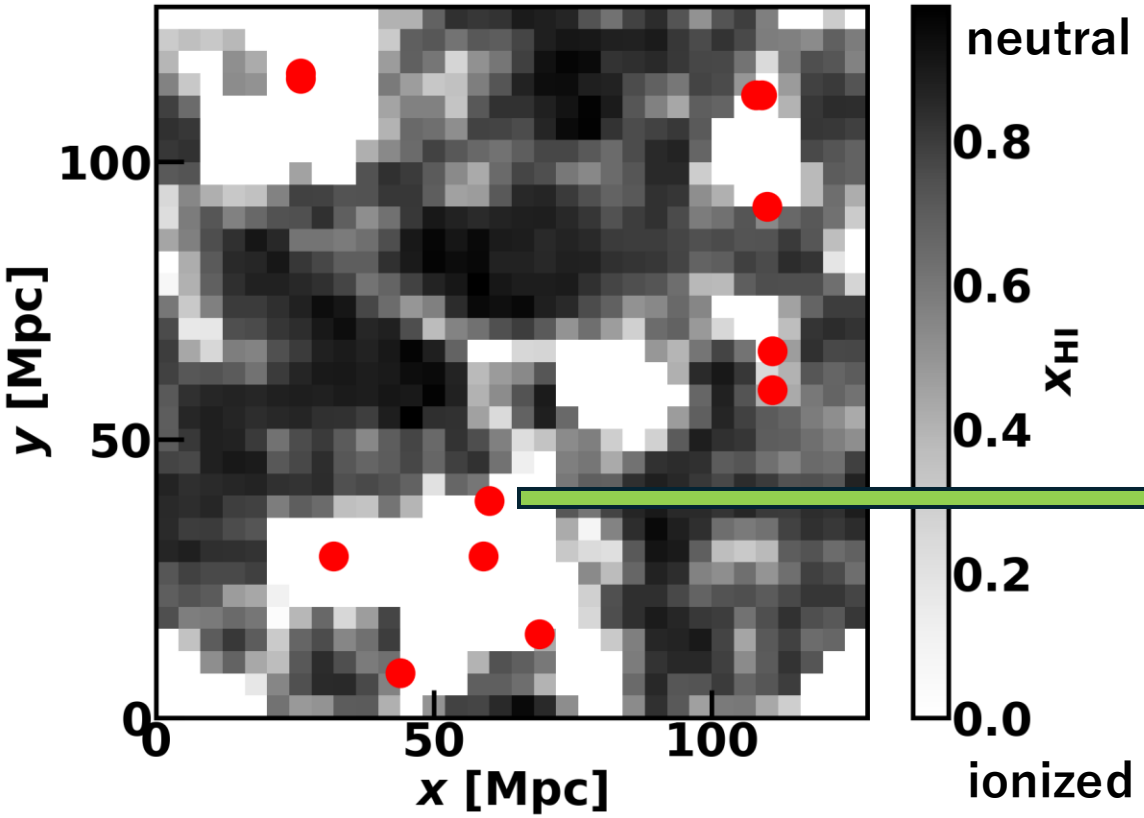




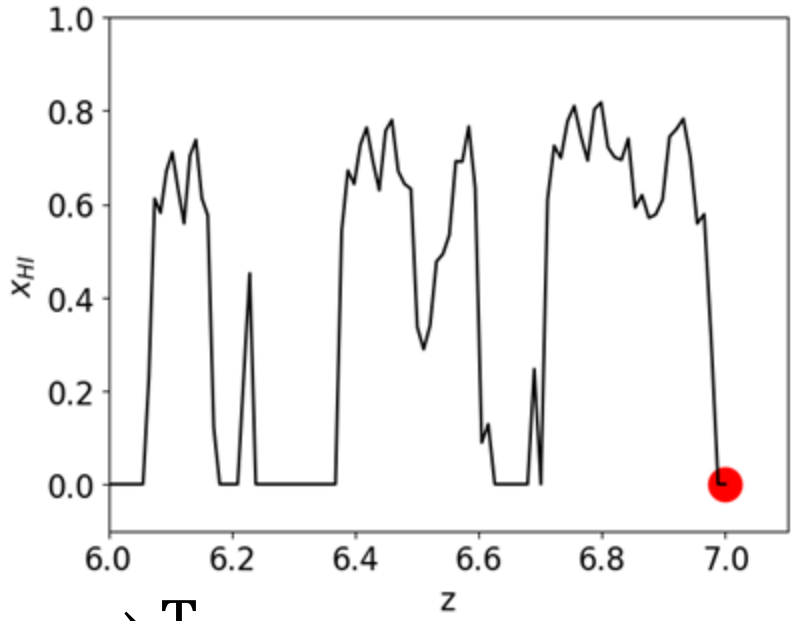
21cmFAST Simulation

EW measurements → **x_{HI} estimate**

simulation



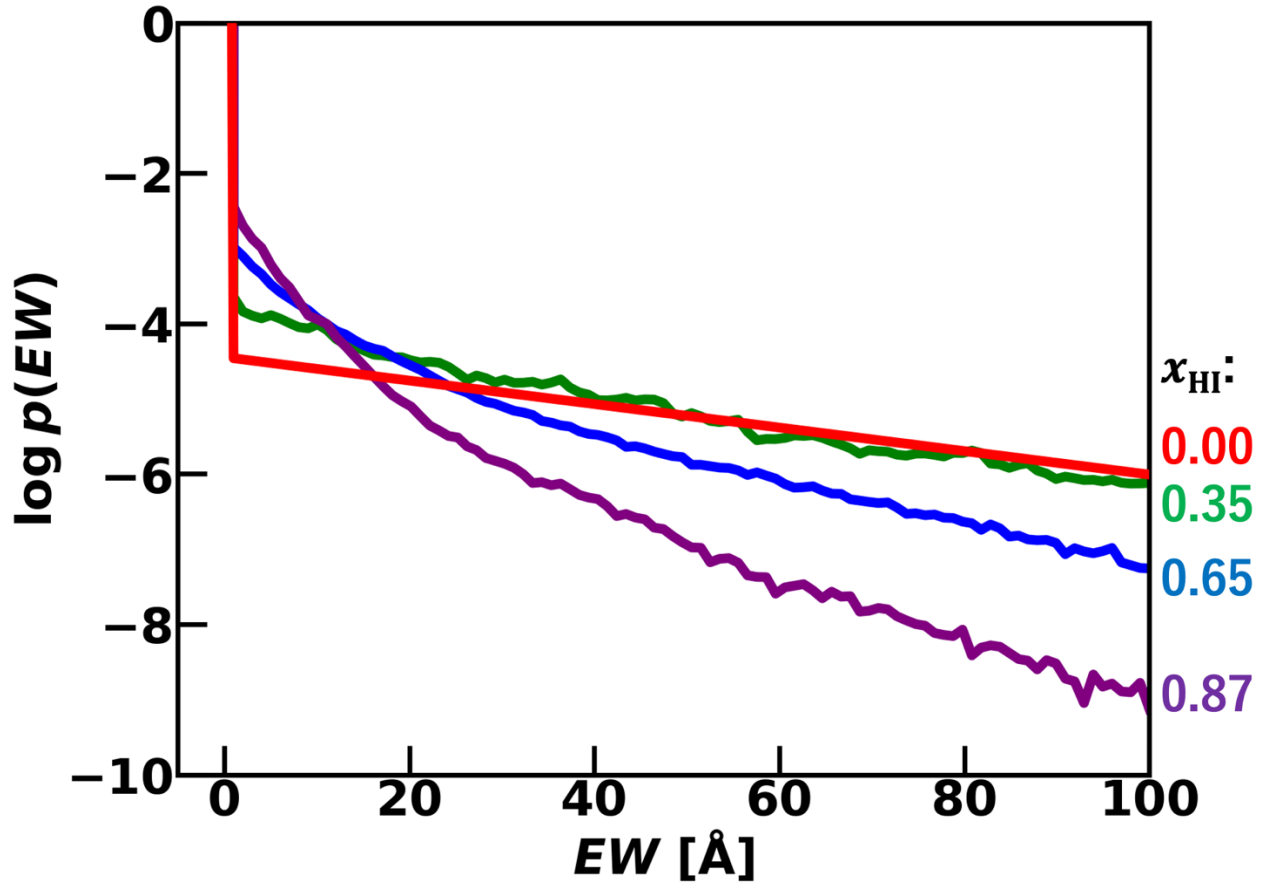
line-of-sight x_{HI} distribution



→ $\mathrm{T_{IGM}}$

EW Distribution from the Simulation

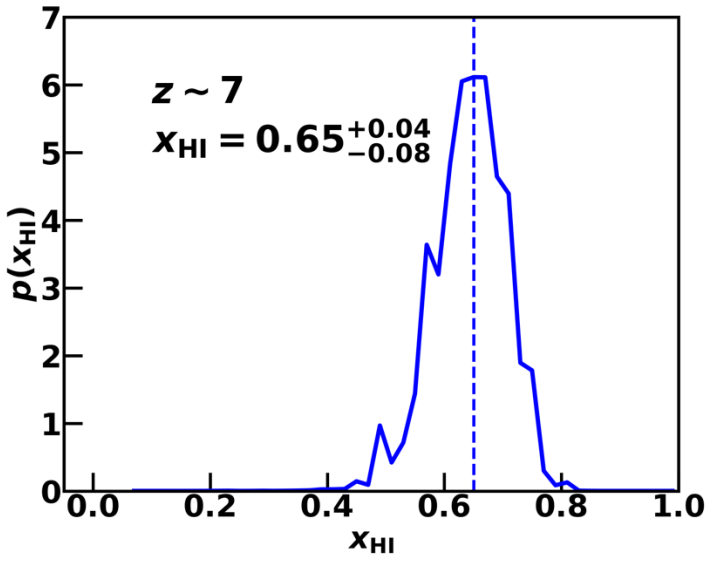
$$p(EW \mid x_{\mathrm{HI}}) = p_{z=5}(EW) \times \mathrm{T}_{\mathrm{IGM}}(x_{\mathrm{HI}})$$



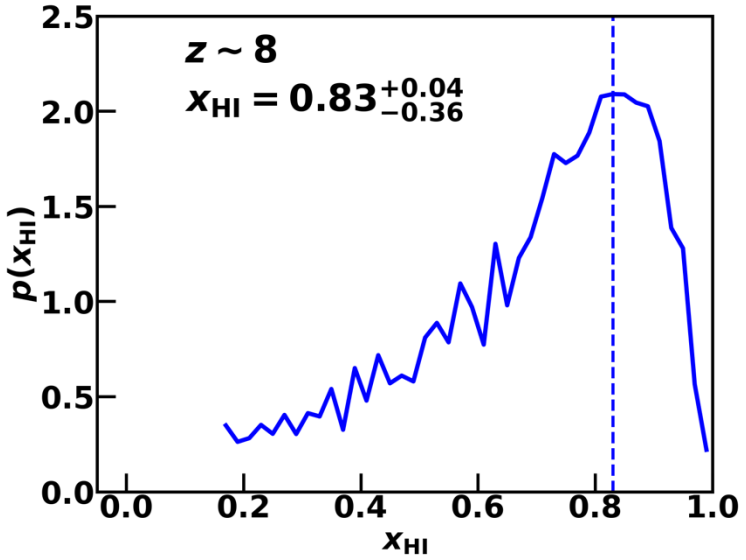
x_{HI} Estimation

$$p(x_{\mathrm{HI}} \mid \{EW\}) \propto \prod p(EW_i \mid x_{\mathrm{HI}})$$

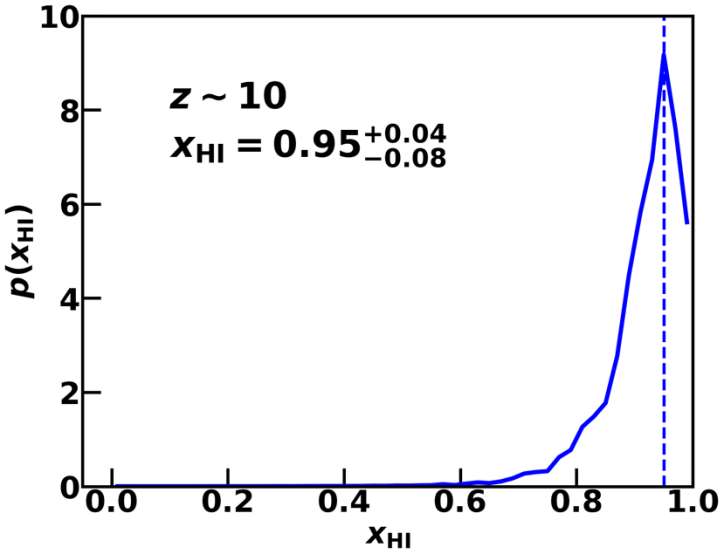
$z \sim 7$



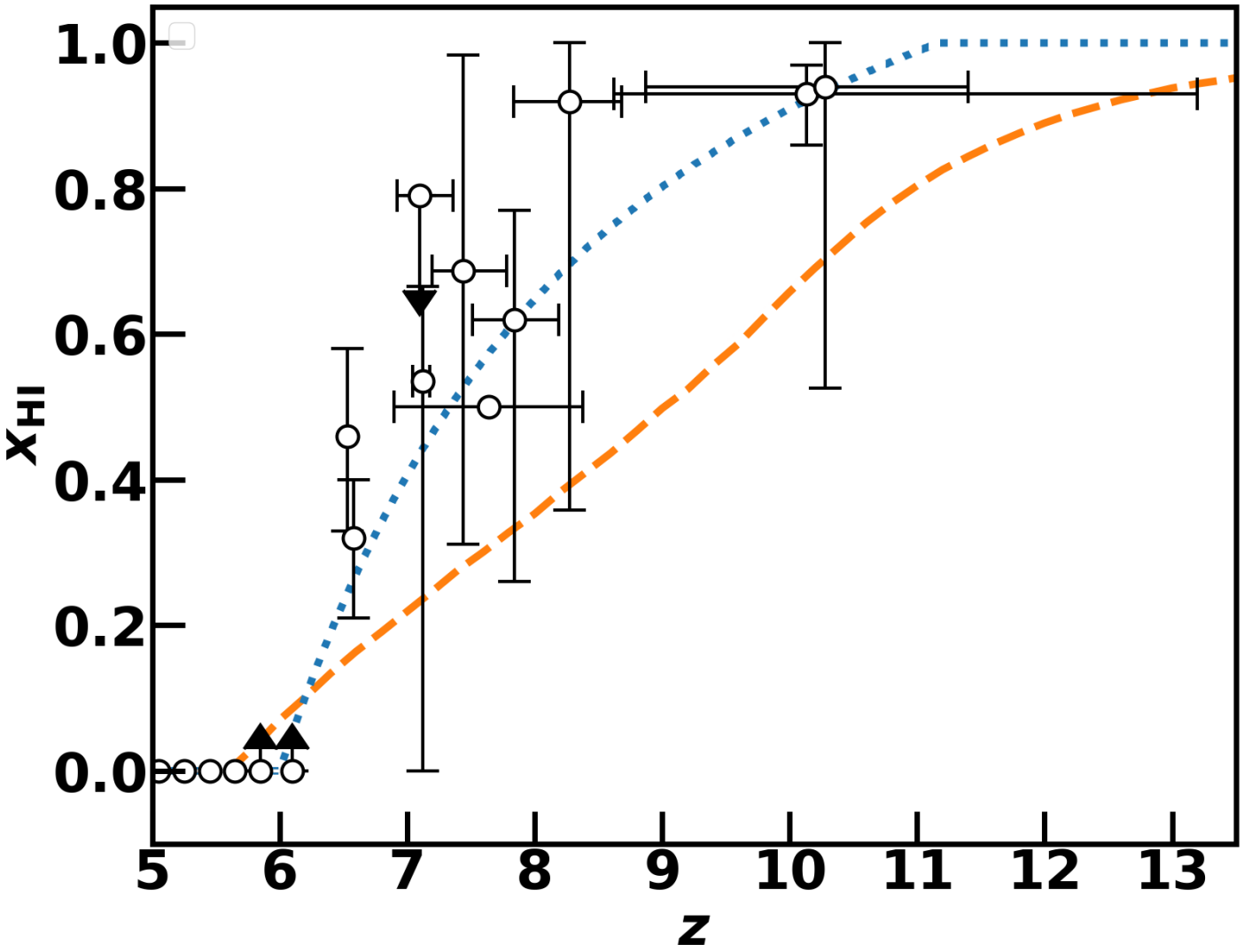
$z \sim 8$



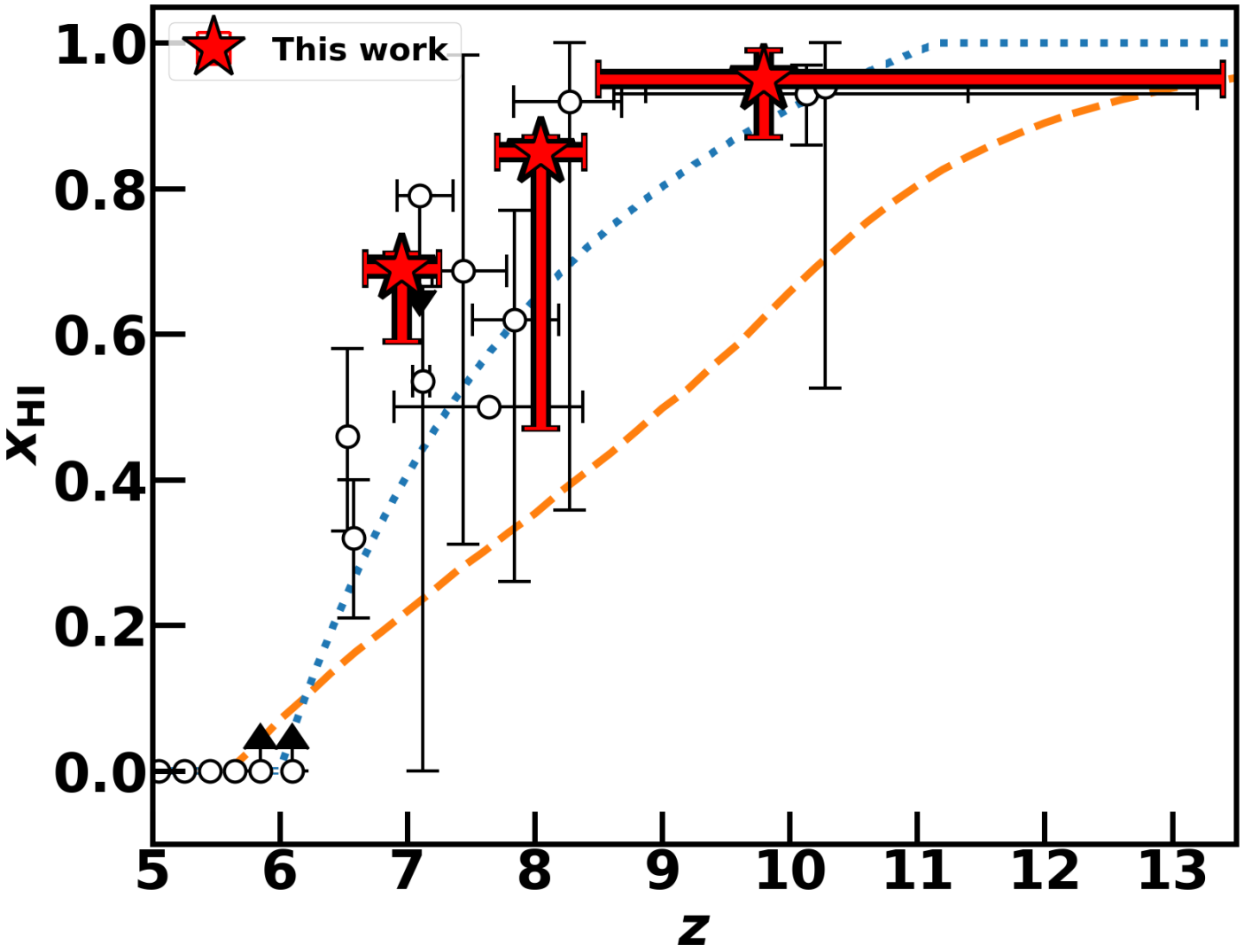
$z \sim 10$



Cosmic Reionization History



Cosmic Reionization History



Rapid x_{HI} decline
at $z \sim 6-8$
→Major ionizing sources:
massive haloes?

EoR Parameter Estimation

Basic EoR parameters:

・Ionizing efficiency ζ

→ # of ionizing photons

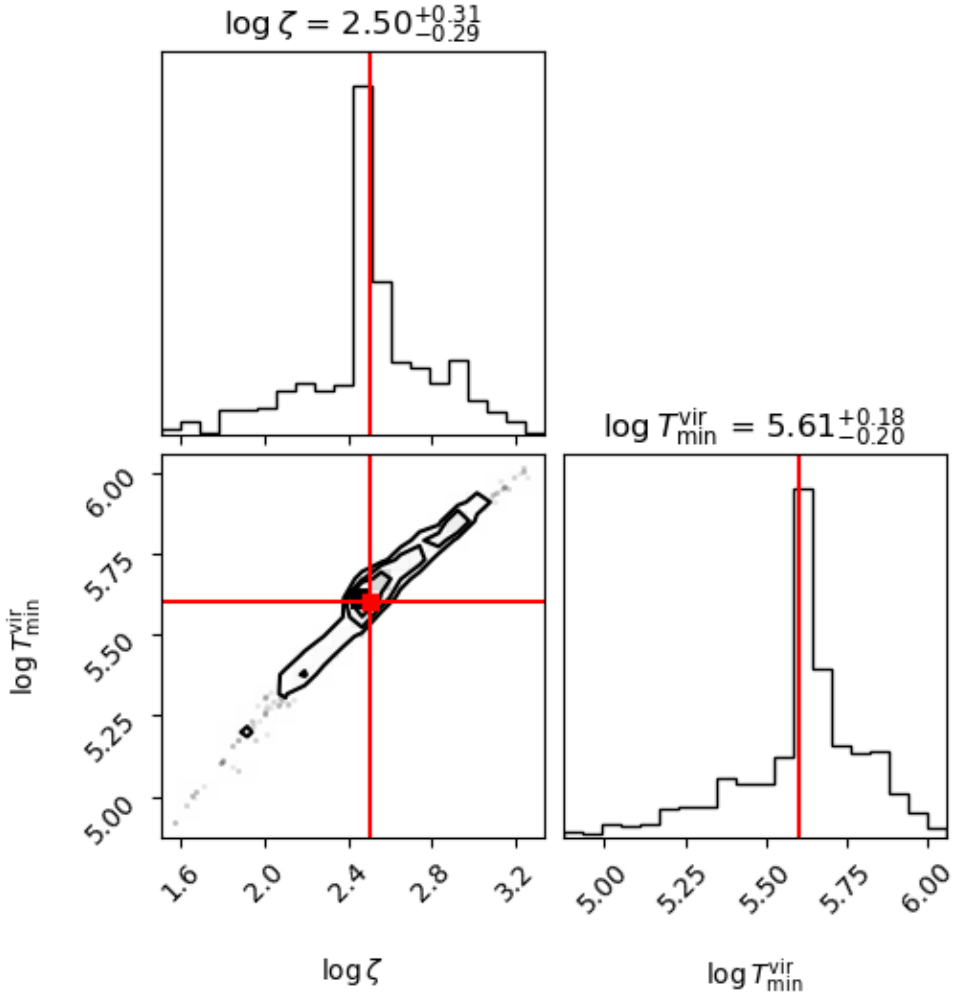
・Minimum virial temperature of ionizing photon-emitting haloes $T_{\mathrm{vir}}^{\mathrm{min}}$

→ Minimum halo mass

EoR Parameter Estimation

- LAEs (This work)
- Ly α LF + ACF (Umeda+ in prep.)
- QSO Ly α, Ly β forest (McGreer+15)
- CMB $\tau = 0.056$ (Planck Collaboration+20)

$T_{\rm vir}^{\rm min} \sim 10^{5.6}$ K
Minimum halo mass at $z \sim 6$: $\sim 10^{10.3}\ M_\odot$
faintest ionizing sources at $z \sim 6$: -17 mag



Summary

- Ly α EW measurements of 629 galaxies
  + simulation by 21cmFAST

- x_{HI} estimates: rapid decline at $z \sim 6-8$

- Reionization sources: massive haloes?