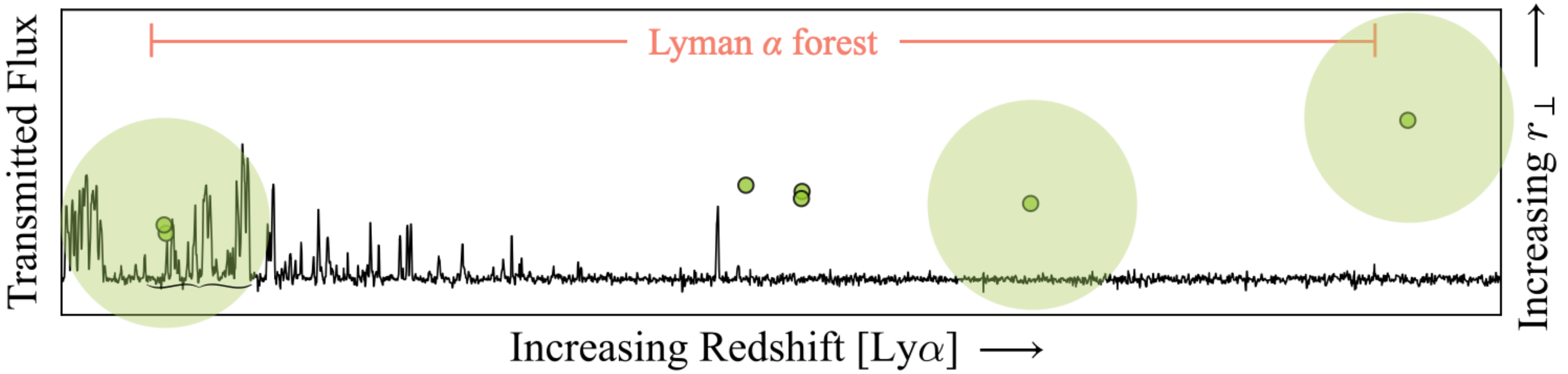
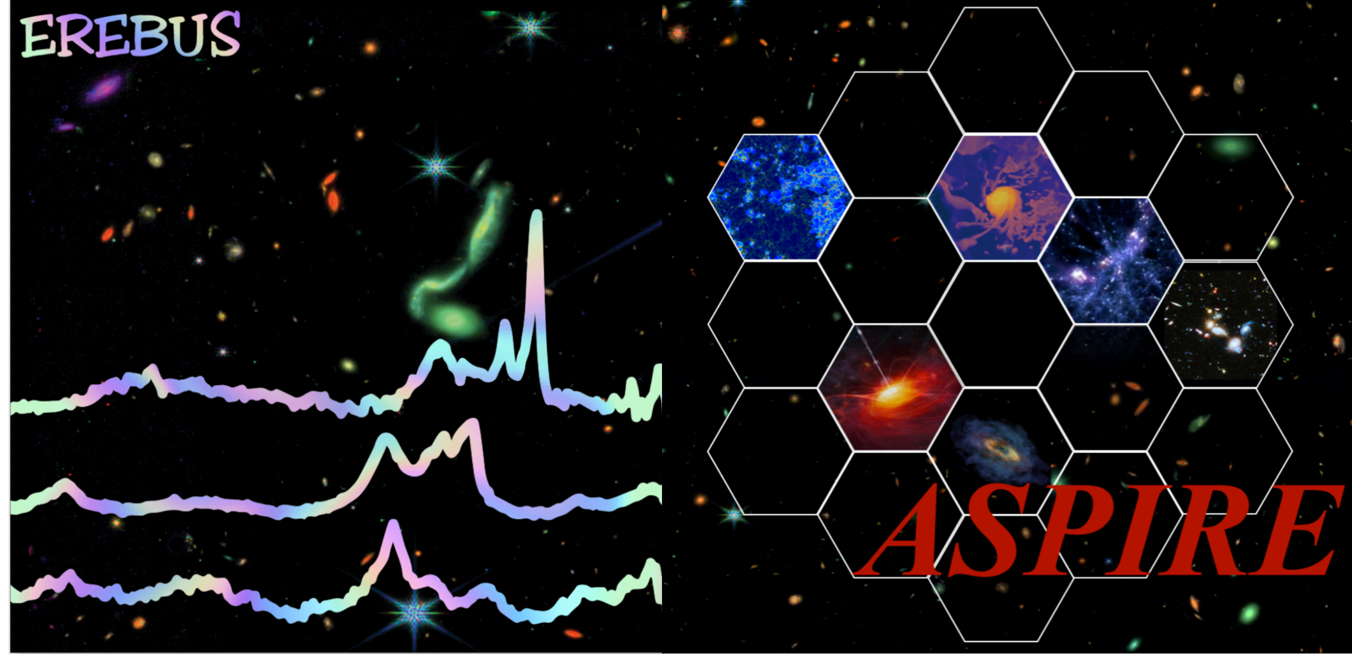
THE UNIVERSITY OF ARIZONA





Probing the connection between IGM transmission and galaxies during cosmic reionization using JWST ASPIRE quasar fields

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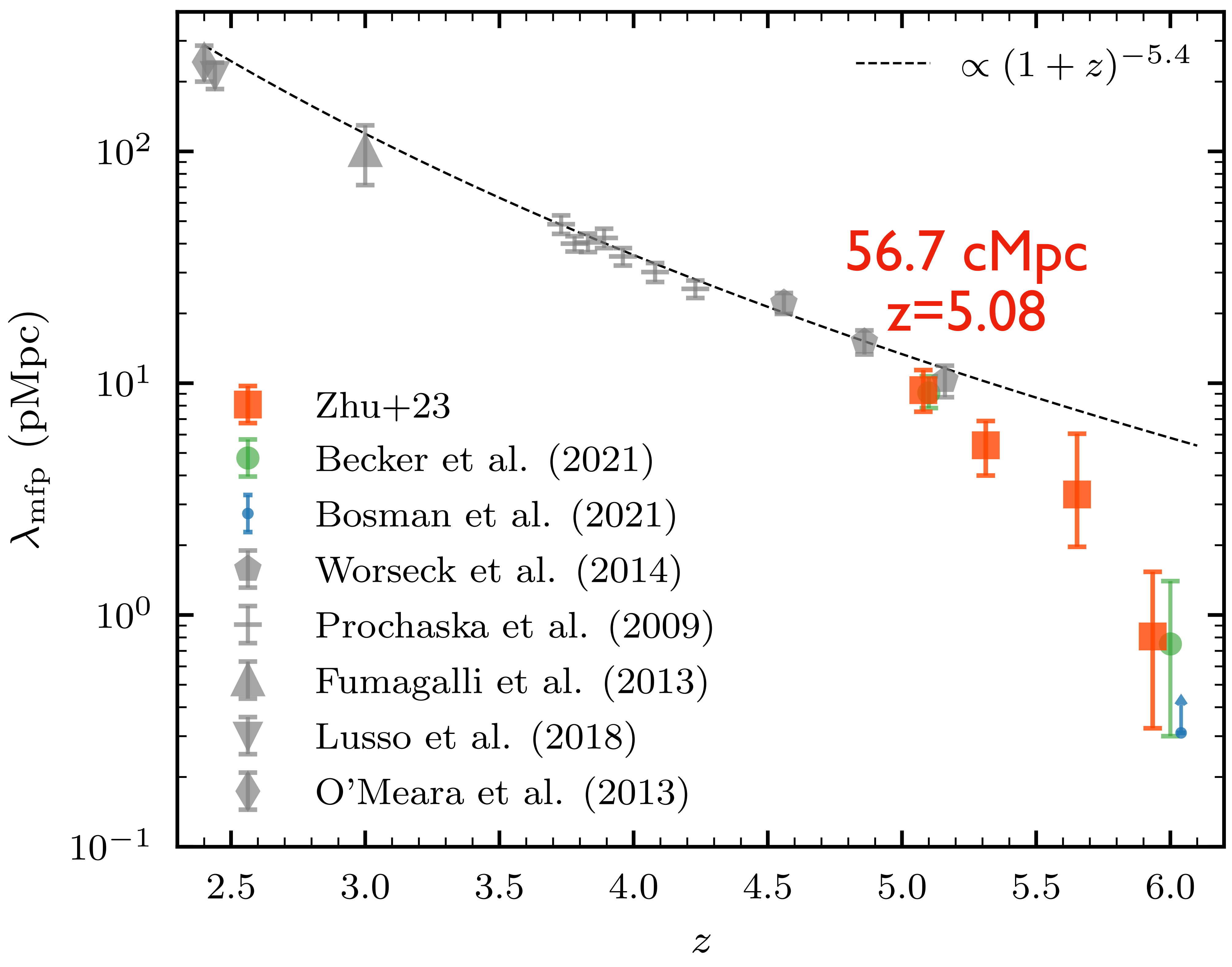
The University of Arizona
Advisors: Xiaohui Fan and Jinyi Yang

EREBUS Collaboration and ASPIRE Team

Jun 28, 2024, Cosmic Dawn at High Latitudes Conference

IGM during cosmic reionization

Rapid change in the ionizing photon mean free path at z>5

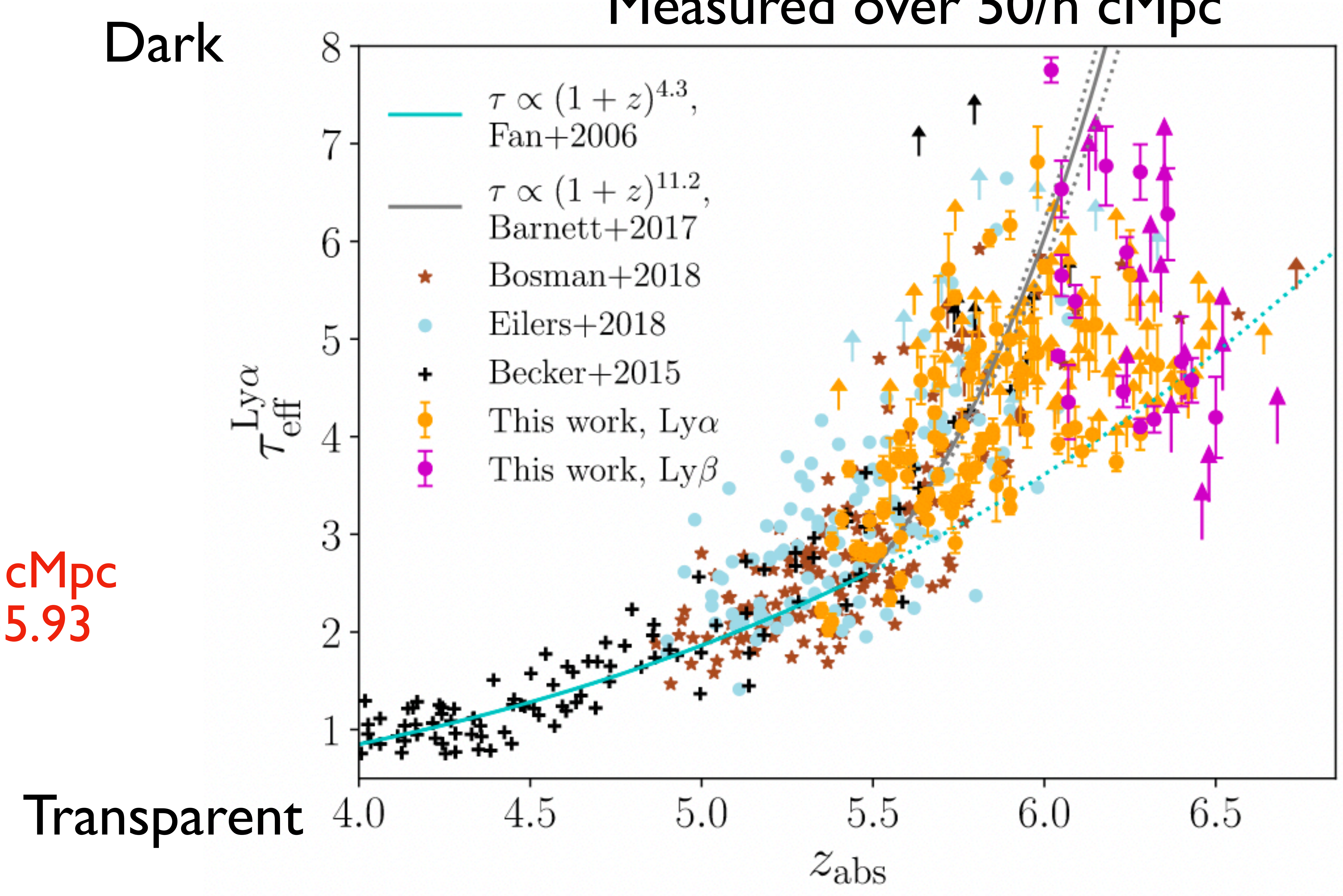


Zhu et al., 2023

Large scatter in IGM effective optical depth at z>5.5

Effective optical depth $\tau_{\rm eff} = -\ln < F/F_{\rm cont.} >$

Measured over 50/h cMpc

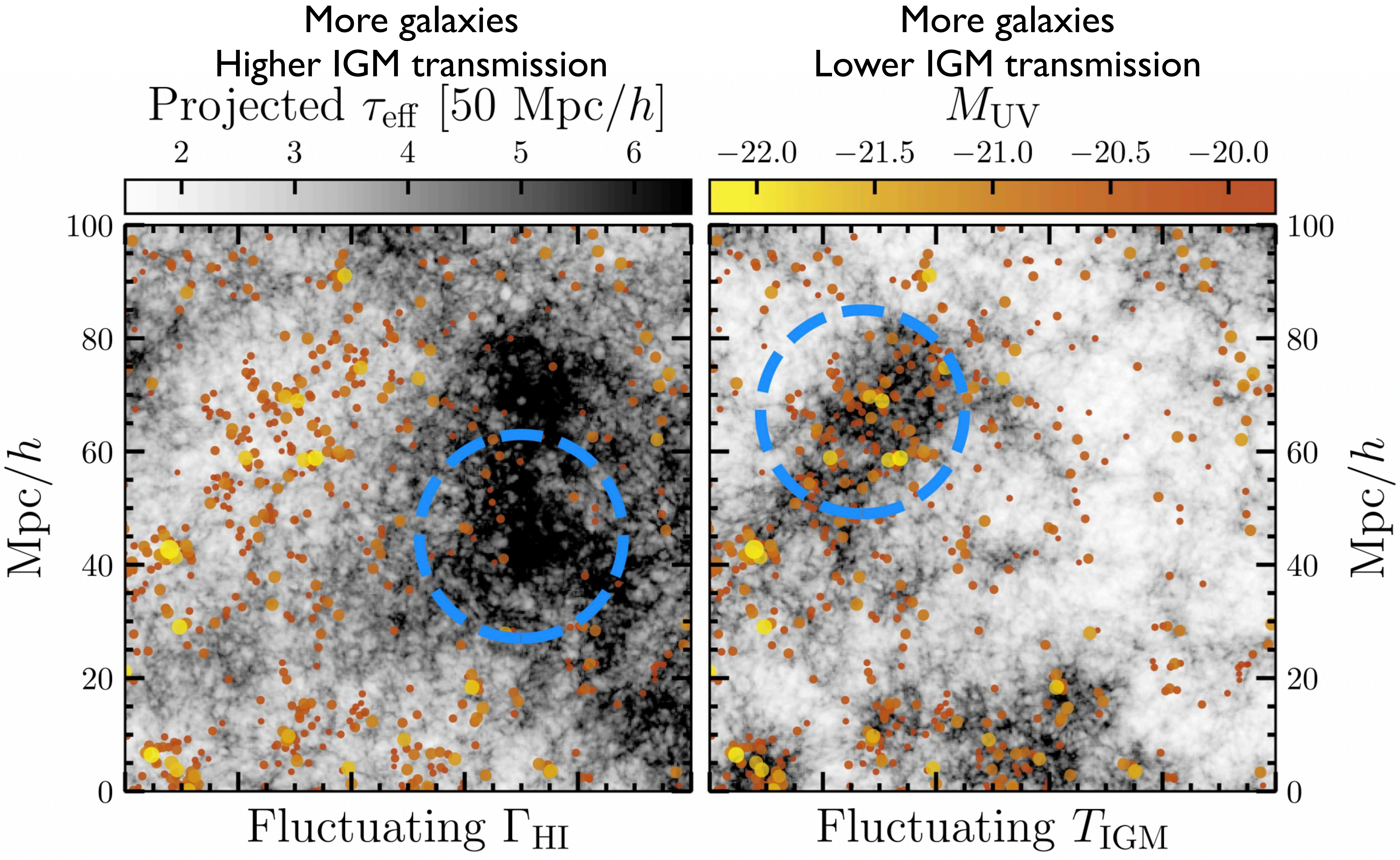


Yang et al., 2020
(See also Bosman et al., 2021, Laura's talk)

Large scale fluctuation in the IGM

The topology of reionization

Snapshots at z=5.7

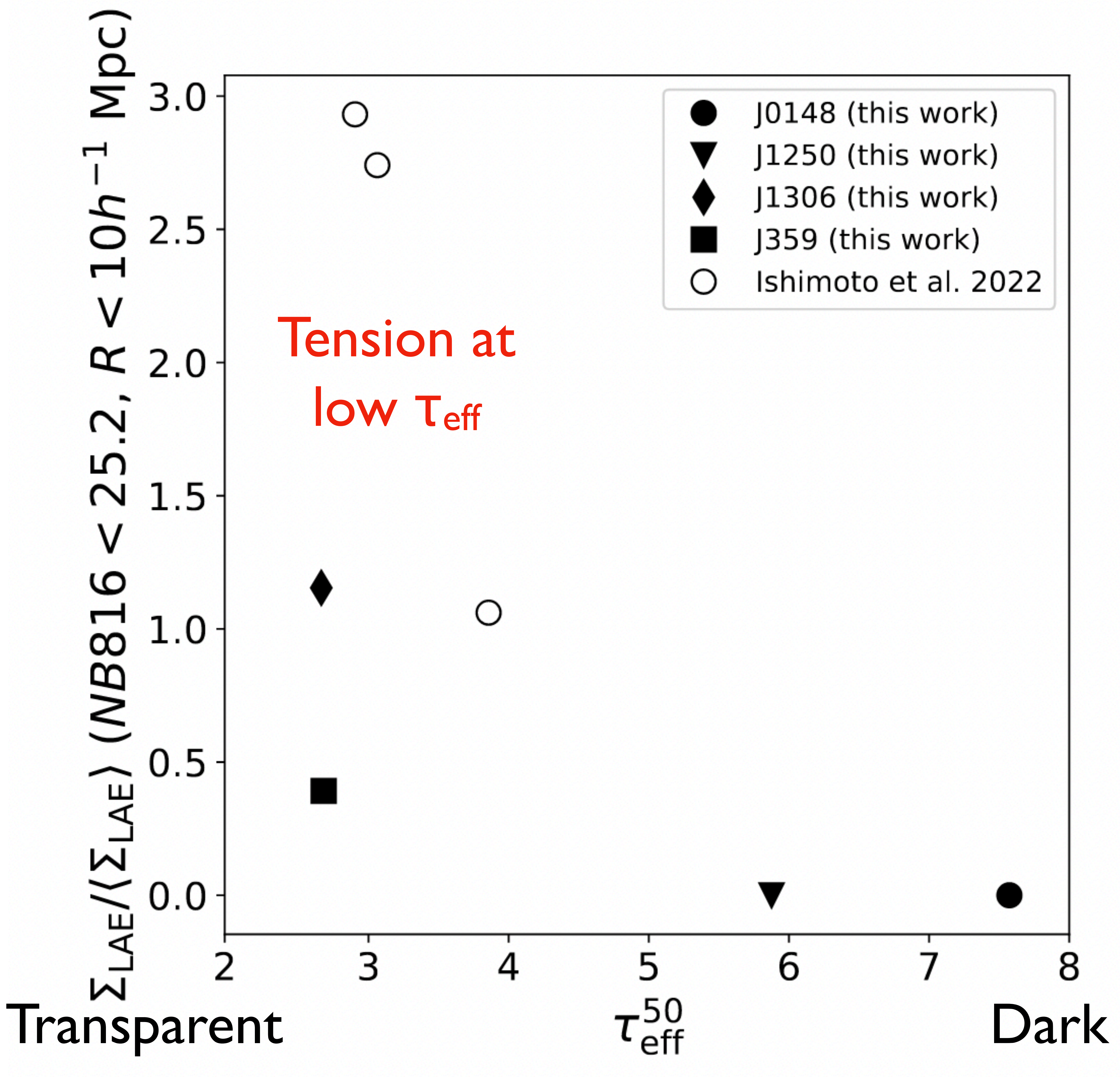


Davies et al., 2018

IGM transmission-LAE surface density

Tension at the low IGM effective optical depth

z~5.7 Ly-alpha emitters selected using HSC NB 816

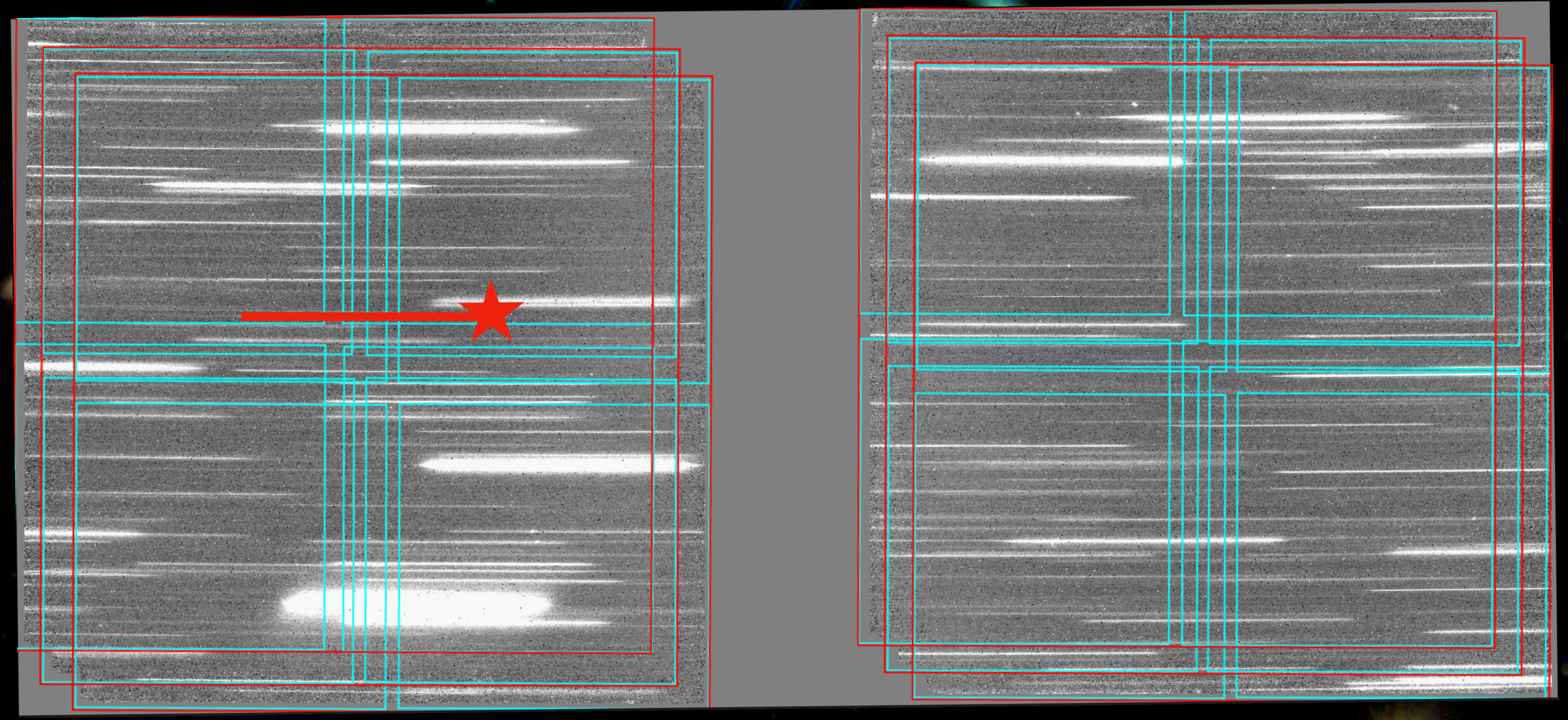


Christenson et al., 2023

ASPIRE

A SPectroscopic survey of Biased Halos In the Reionization Era: A Quasar Legacy Survey

- ✓65-hour JWST (GO 2078) PI: Feige Wang
- ✓100-hour ALMA (2022.1.01077.L)
- ✓Multi-wavelength extragalactic survey
- ✓A diverse team with ~80 investigators



- ✶ The large scale environment and dark matter halos of the first quasars
- ✶ Stellar emission from quasar host galaxies
- ✶ Early black hole growth and AGN feedback
- ✶ A spectroscopic survey of galaxies from cosmic dawn to the local universe
- ✶ Cosmic reionization
- ✶ Early metal enrichment

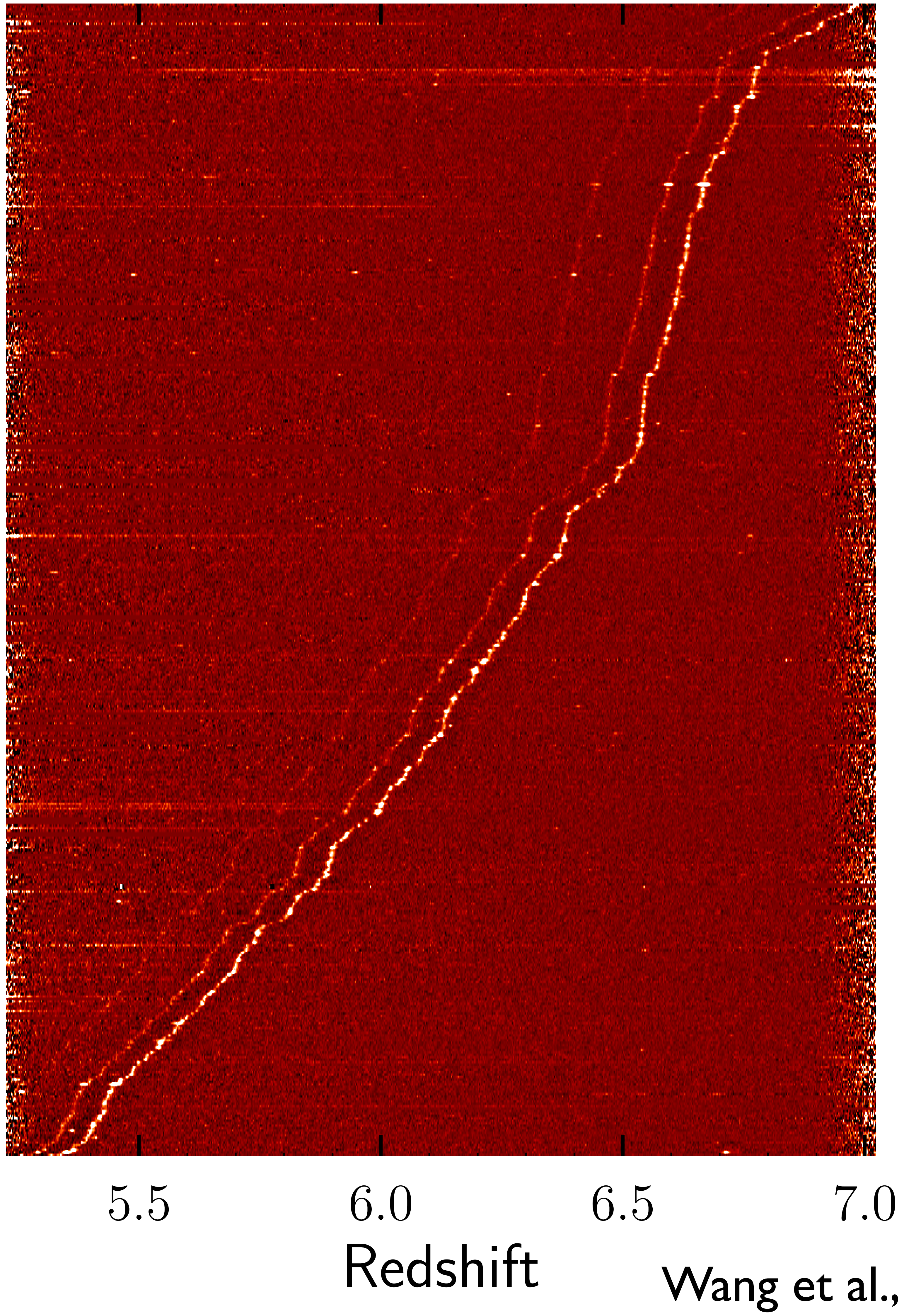
ALMA

https://aspire-quasar.github.io

ASPIRE program (GO 2078)

JWST NIRCam/WFSS observations in reionization-era quasar fields

473 [O III] emitters identified



[O III] emitters at the quasar redshift

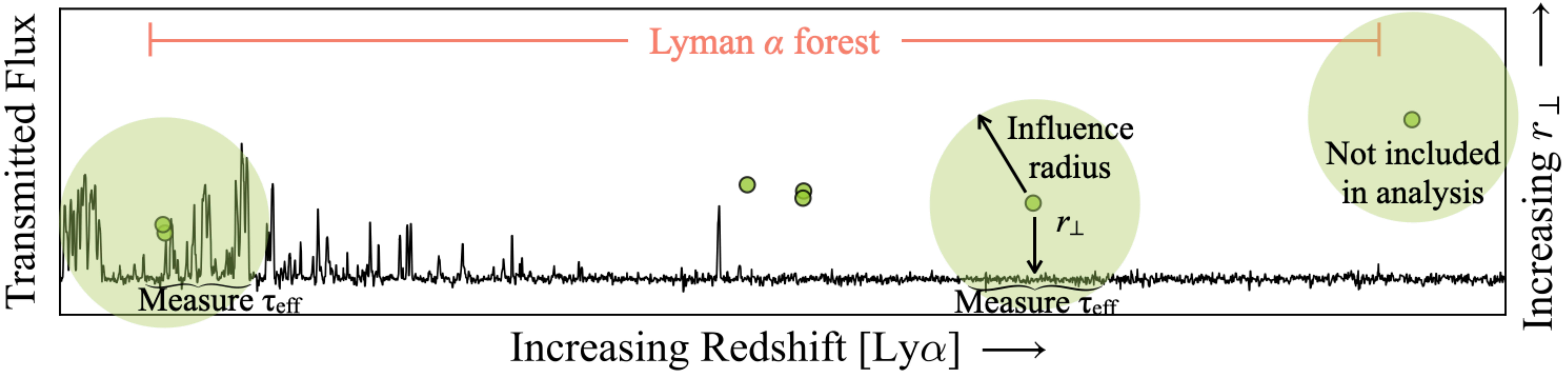
[O III] emitters in the quasar Lyman-alpha forest

see also Koki's talk

Wang et al., in preparation

IGM transmission around [O III] emitters

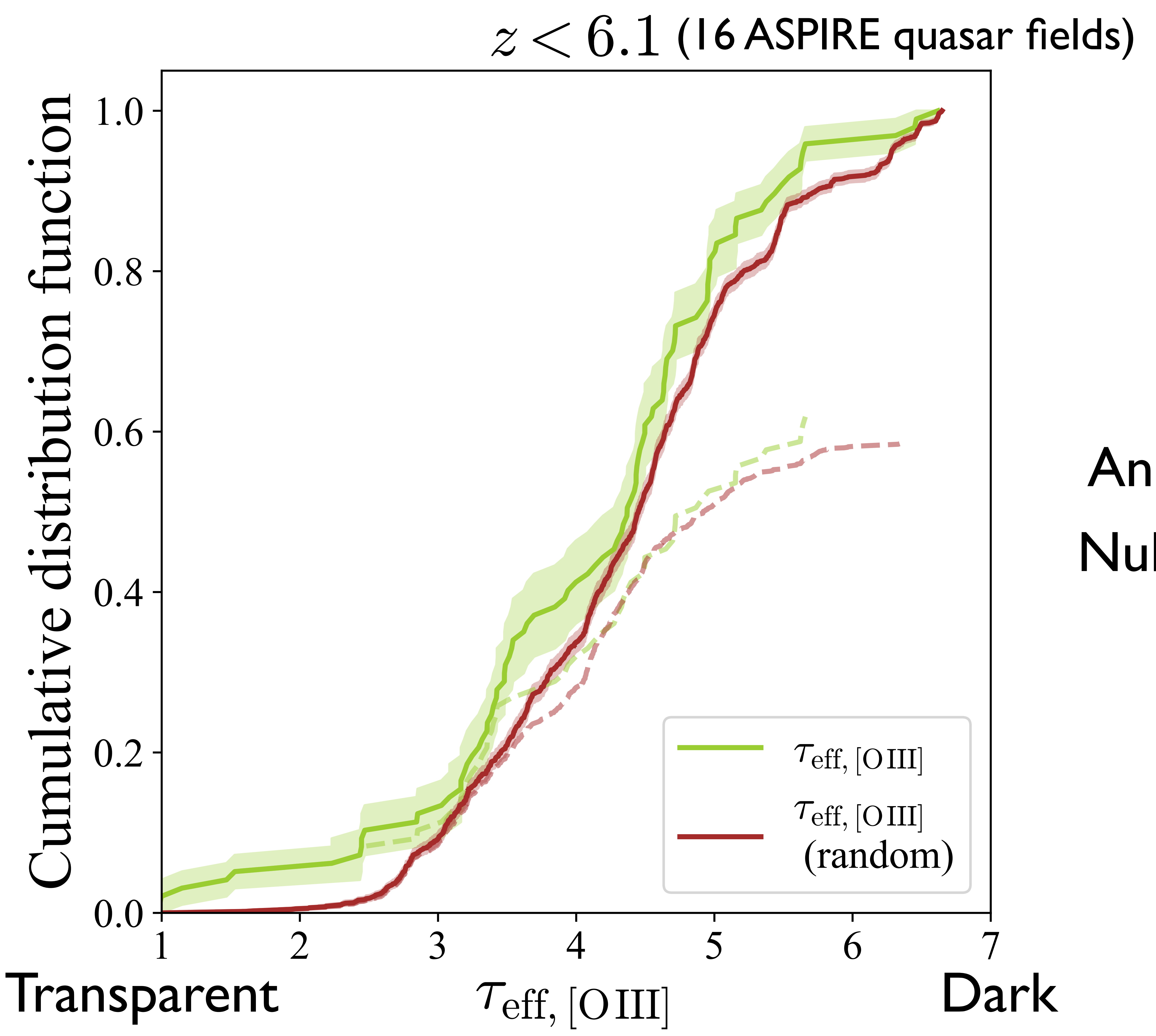
Measured within an “influence radius”



Jin et al., submitted

Excess IGM transmission around z<6.1 [O III] emitters

Adopting an influence radius of 25/h cMpc



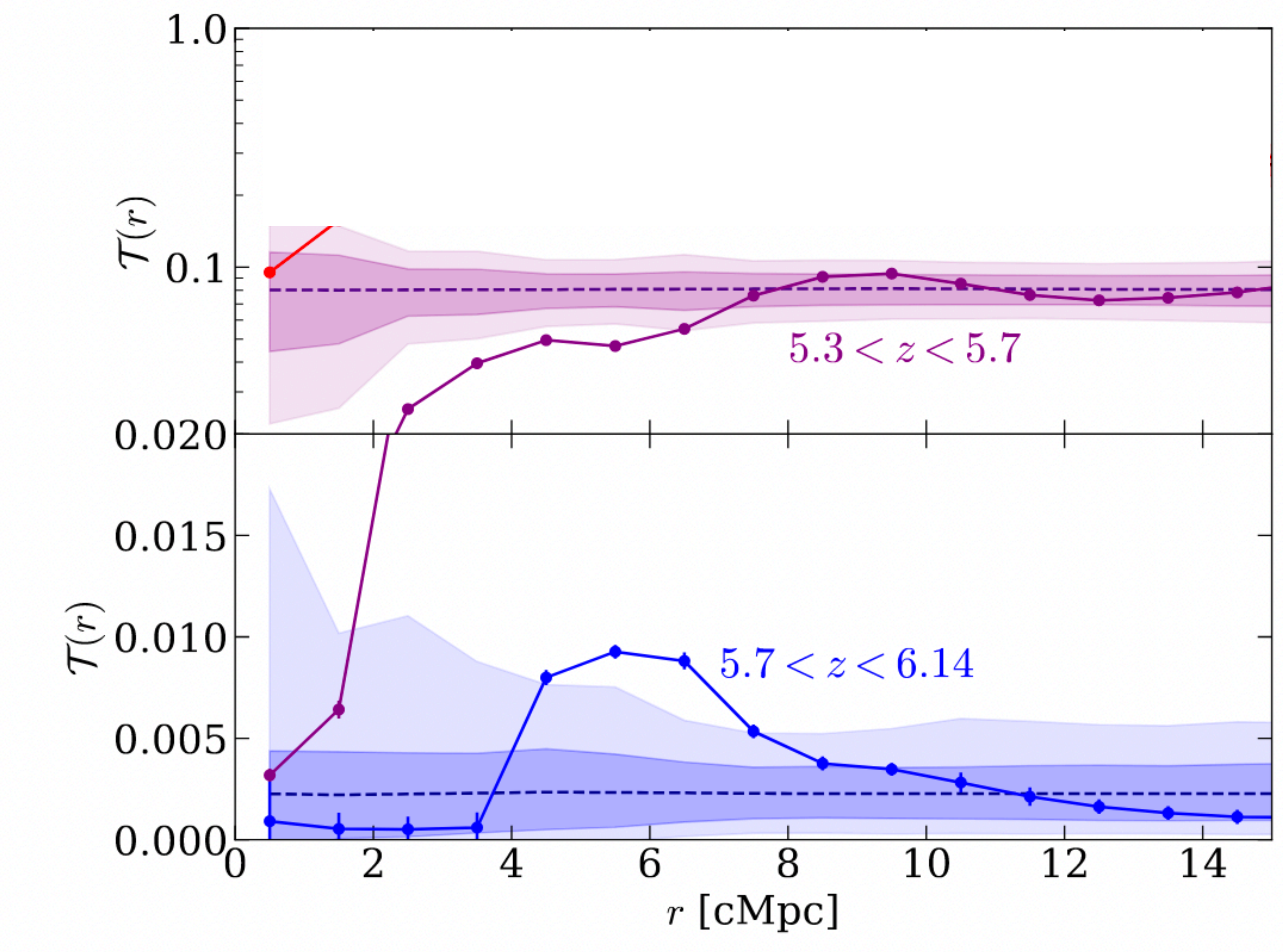
Anderson-Darling test

Null hypothesis p-value
0.02

Jin et al., submitted, see also Koki's talk

Excess IGM transmission at different redshifts?

The IGM-galaxy cross-correlation function result from the EIGER program



Kashino et al., 2023

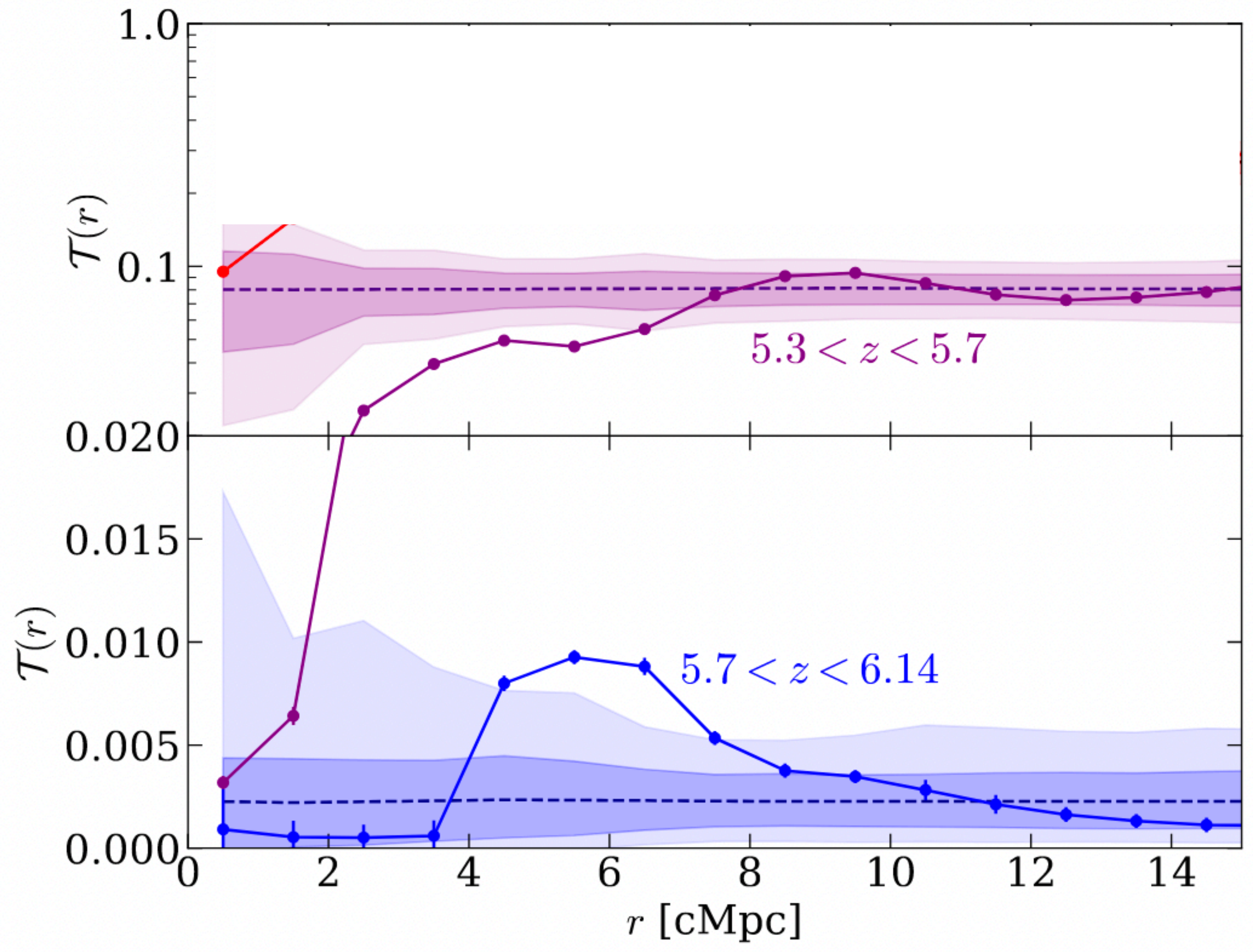
z<5.7

→ Monotonically increasing IGM transmission up to 15 cMpc

See also Daichi's talk

Excess IGM transmission at different redshifts?

The IGM-galaxy cross-correlation function result from the EIGER program



z<5.7

→ Monotonically increasing IGM transmission up to 15 cMpc

z>5.7

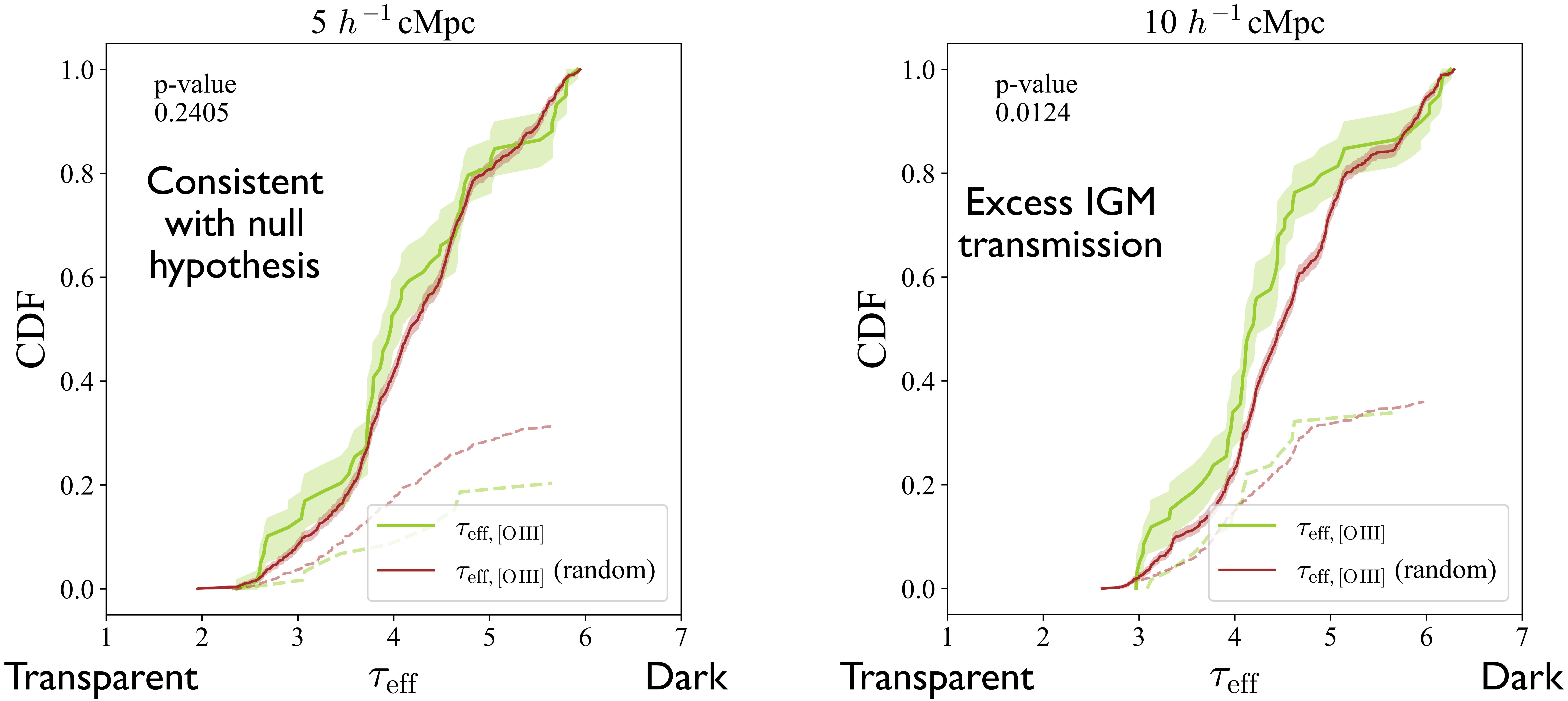
→ Peak in IGM transmission at 5 cMpc

Kashino et al., 2023

See also Daichi's talk

z>5.7: Excess IGM transmission @ ≥ 10/h cMpc

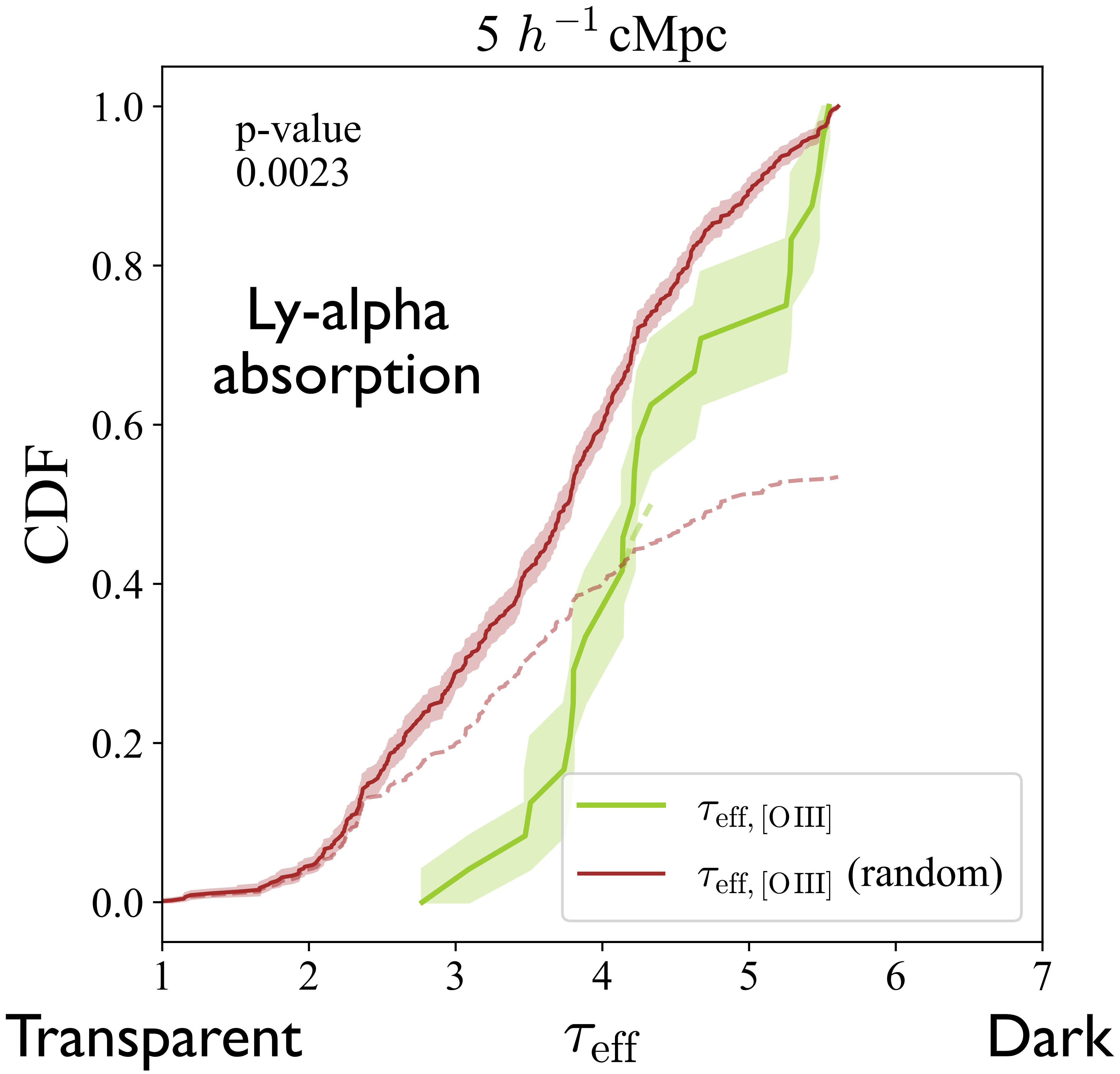
Consistent with the fluctuating UVB models



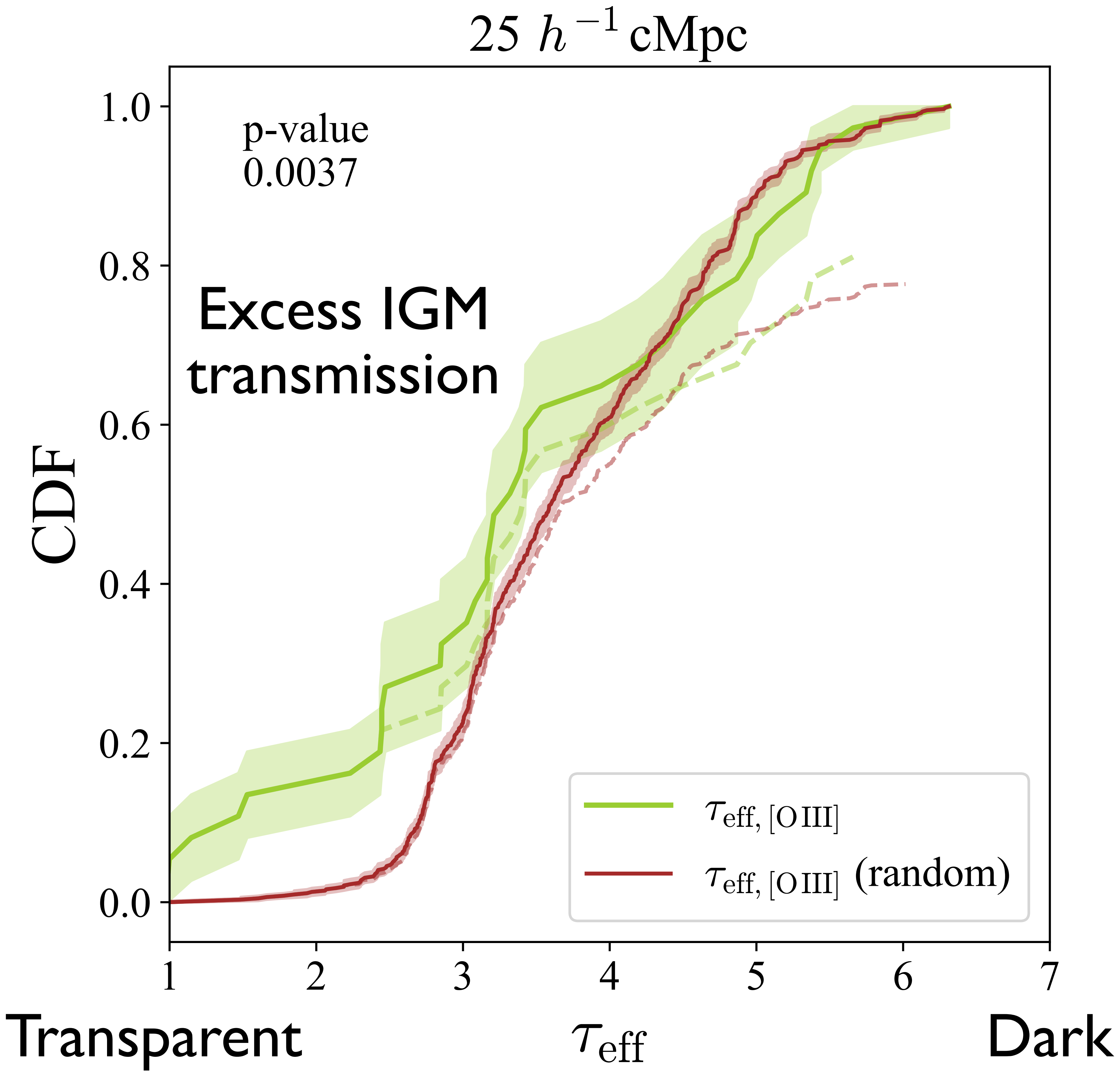
Jin et al., submitted

z<5.7: Excess IGM transmission @ ≥ 25/h cMpc

Ly-alpha absorption within 5/h cMpc



See also Enrico's talk



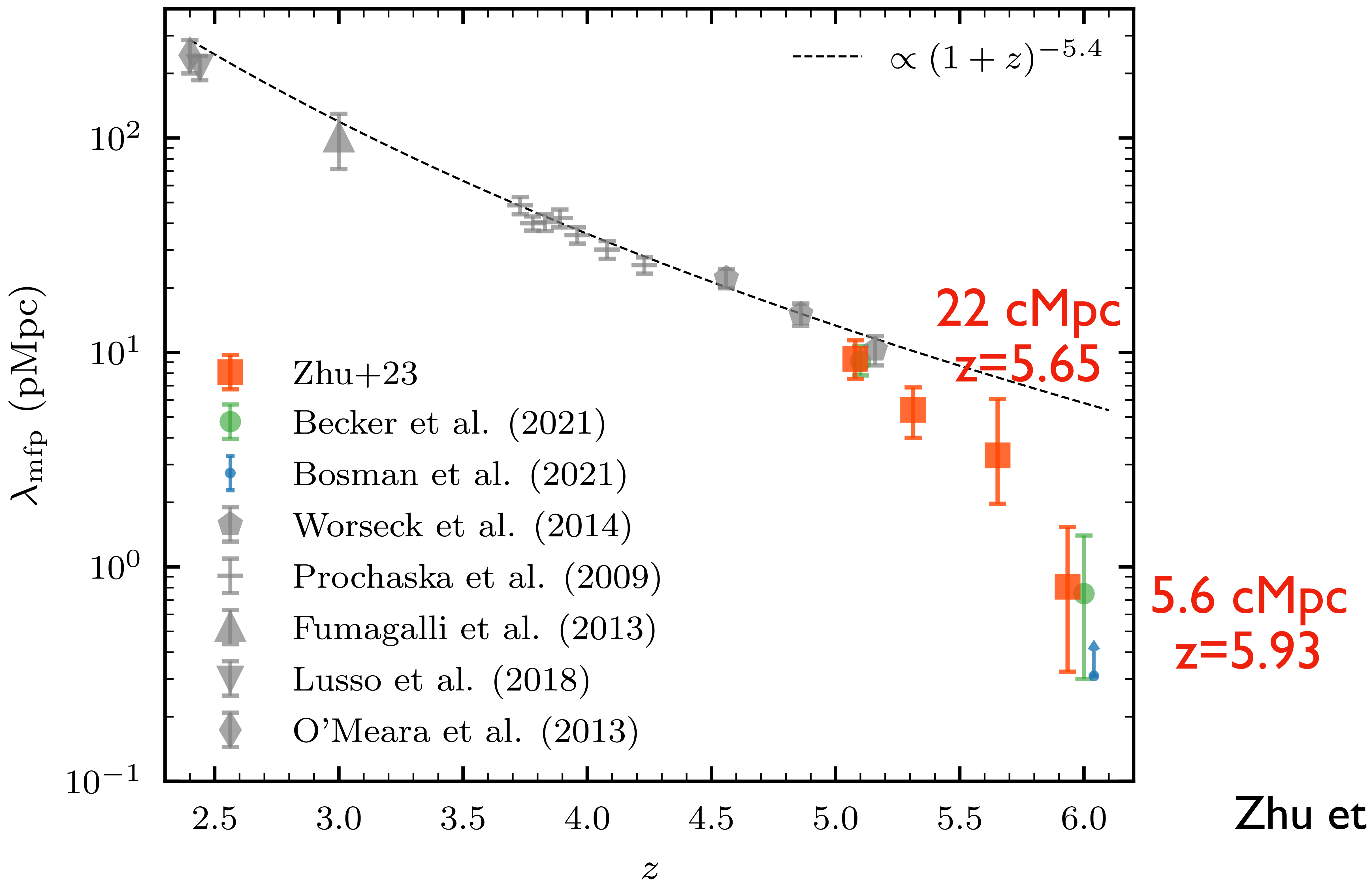
Jin et al., submitted

Redshift evolution of scales of excess transmission

Coincident with the fast redshift evolution of ionizing photon mean free paths

[O III] Redshift	5.4<z<5.7	→	5.7<z<6.1
Scales showing excess IGM transmission around [O III] emitters	>=25/h cMpc		>=10/h cMpc

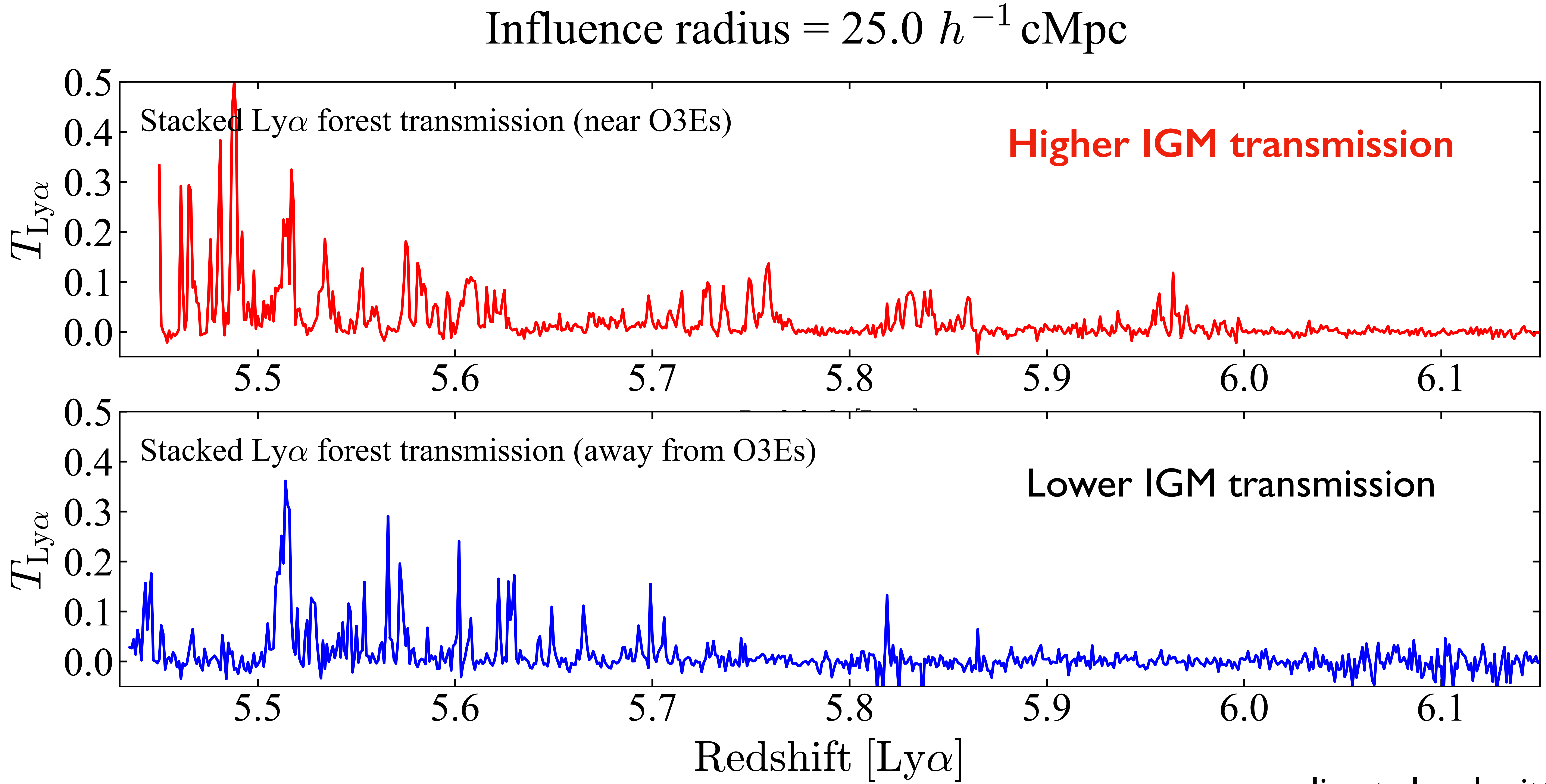
Redshift evolution of ionizing photon mean free path



Zhu et al., 2023

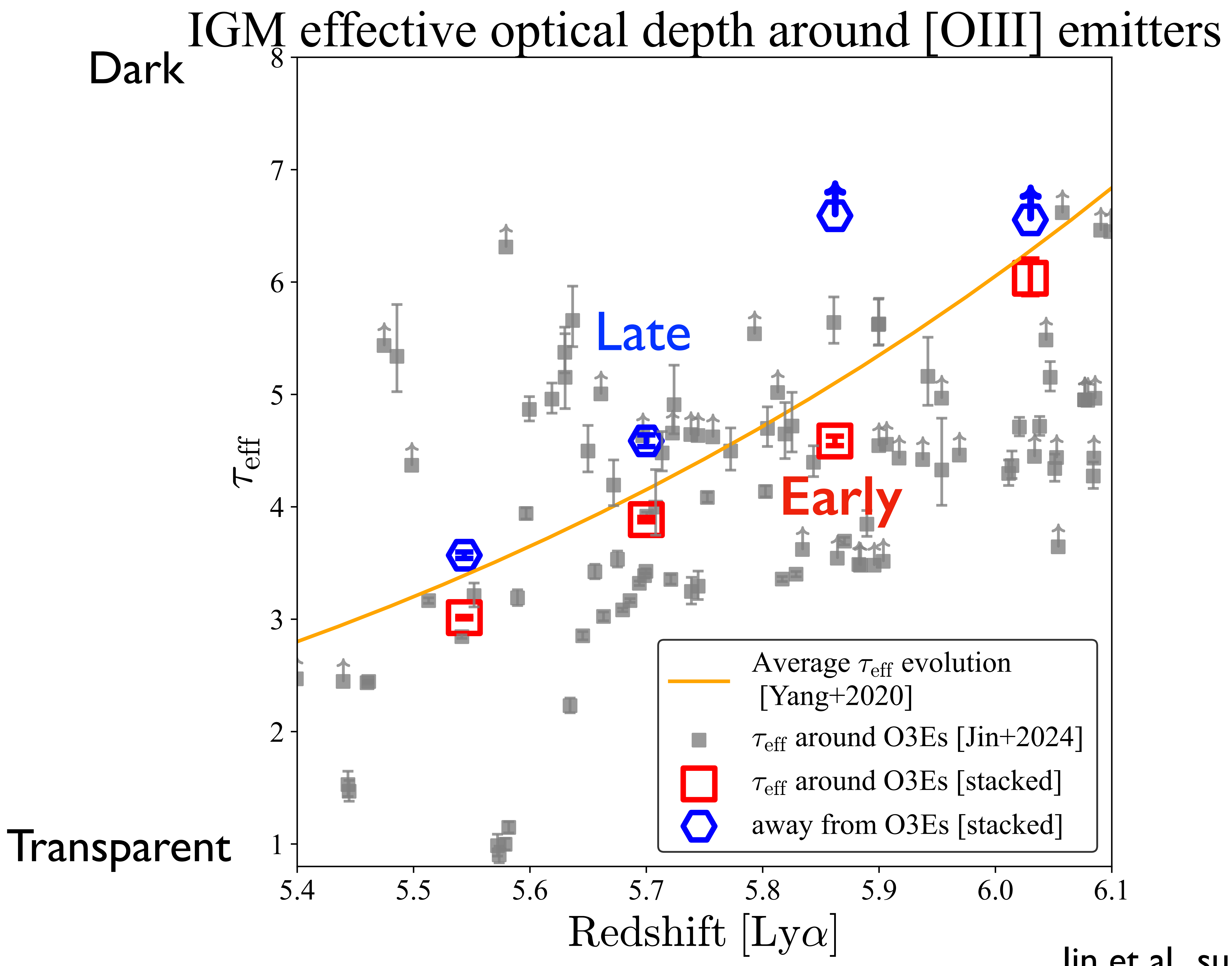
Stacked IGM Ly-alpha transmission

Higher IGM transmission around [O III] emitters



Jin et al., submitted

Earlier reionization around [O III] emitters



Jin et al., submitted

Summary

- We find excess IGM Ly-alpha transmission around z>5.7 and z<5.7 [O III] emitters at scales beyond the ionizing photon mean free path at corresponding redshifts. There is an Ly-alpha absorption within 5/h cMpc from z<5.7 [O III] emitters.
- We find the scatter in the IGM effective optical depth is likely associated with the large-scale fluctuations in the ionizing background.
- We find the IGM patches around [O III] emitters reach the same optical depth at least dz~0.1 ahead of those IGM patches where no [O III] emitters are detected, supporting earlier reionization around [O III] emitters.
- We have new/incoming data from 6-10m ground-based telescopes covering the quasar Lyman-alpha forest to increase our sample size to 25 ASPIRE quasar fields.

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