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Probing reionisation with cross-correlations of galaxies and the IGM transmission

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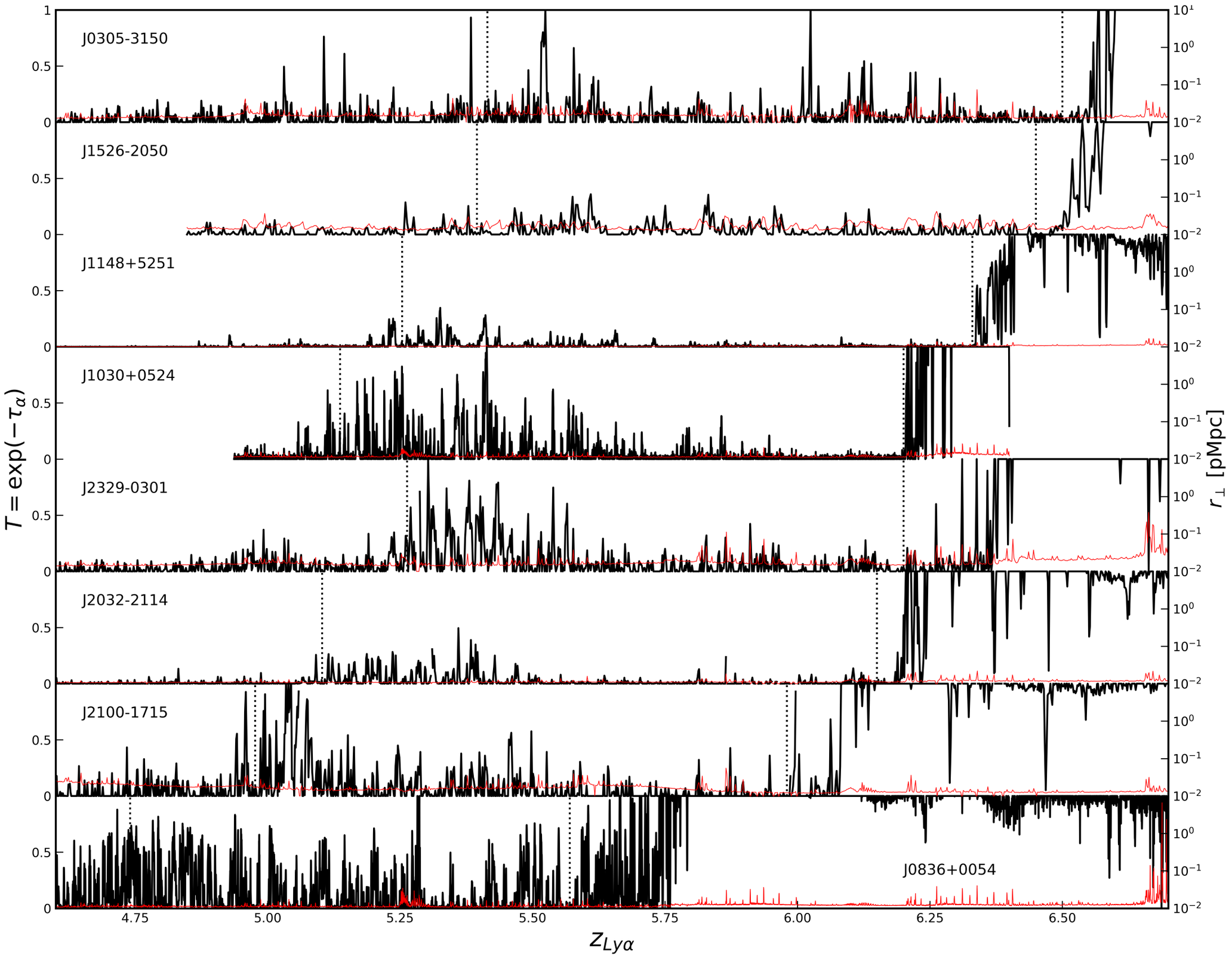
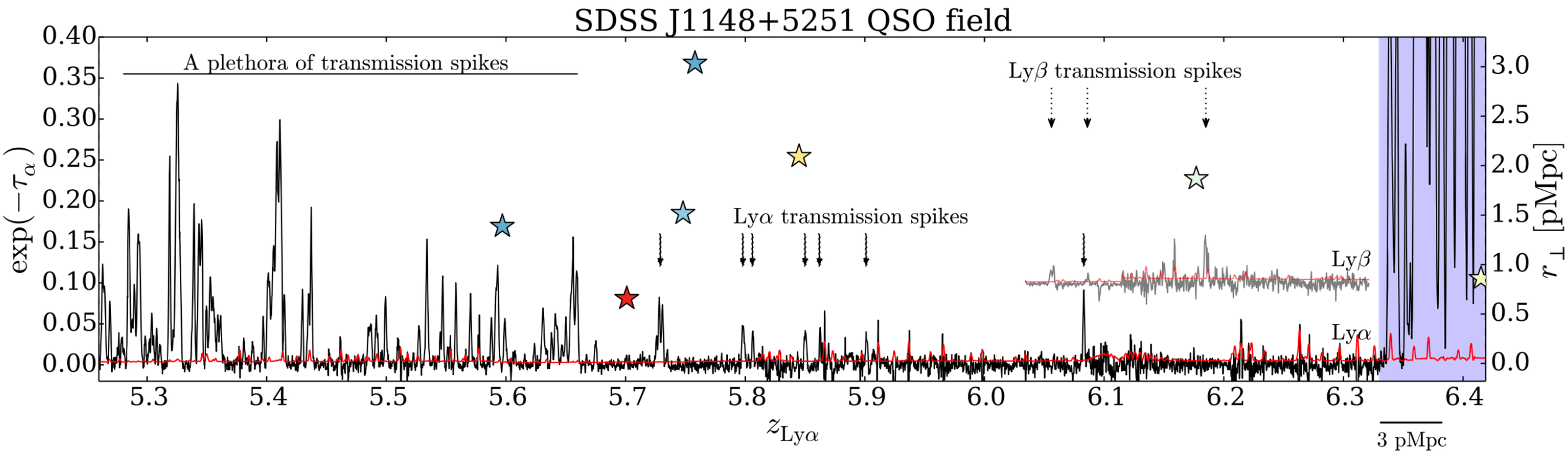
We know when reionisation was completed
- but we are ignorant about which sources did it



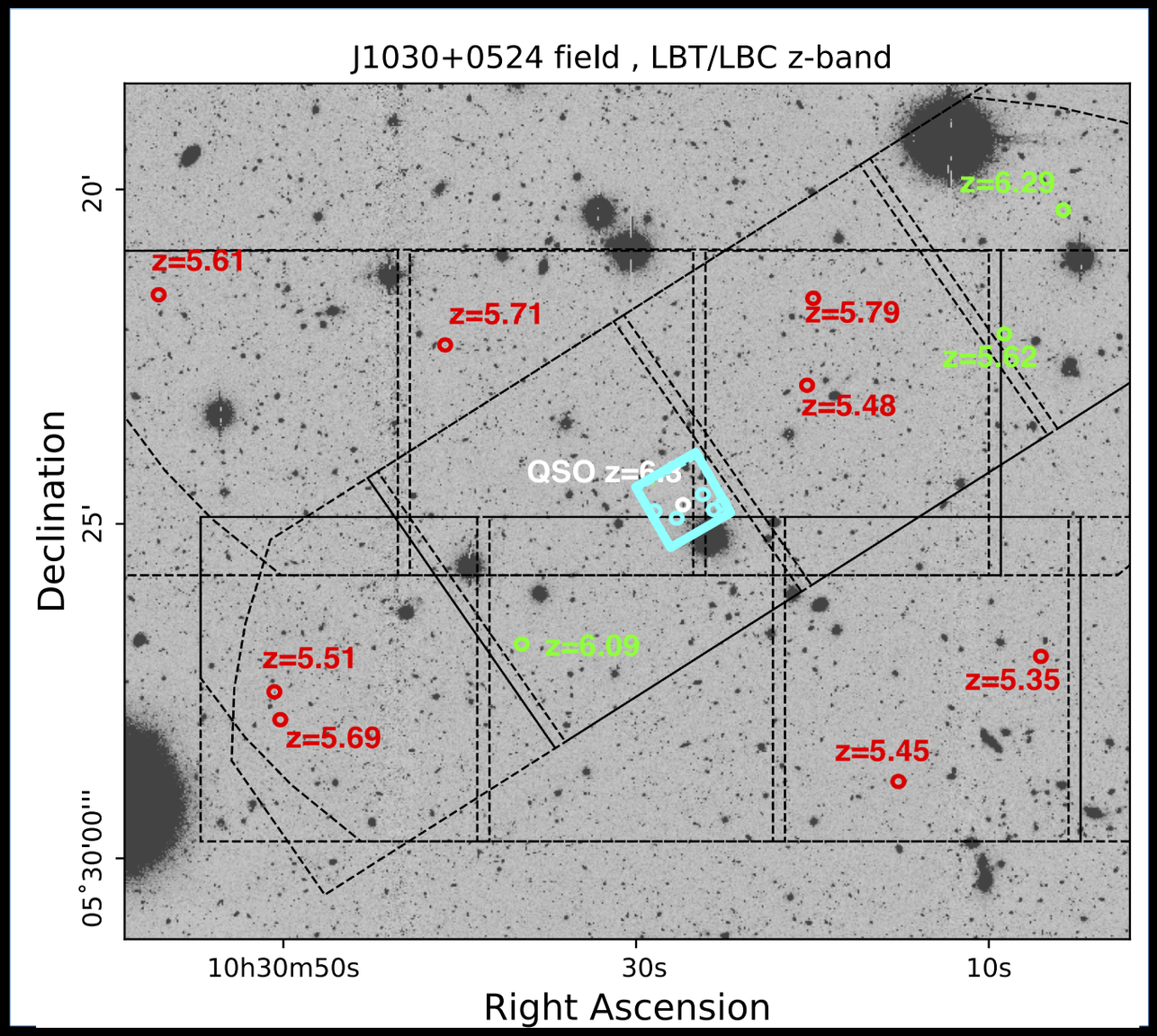
An idealised view of reionisation: galaxies trace “ionised bubbles”

Kakiichi+18, MNRAS, 479

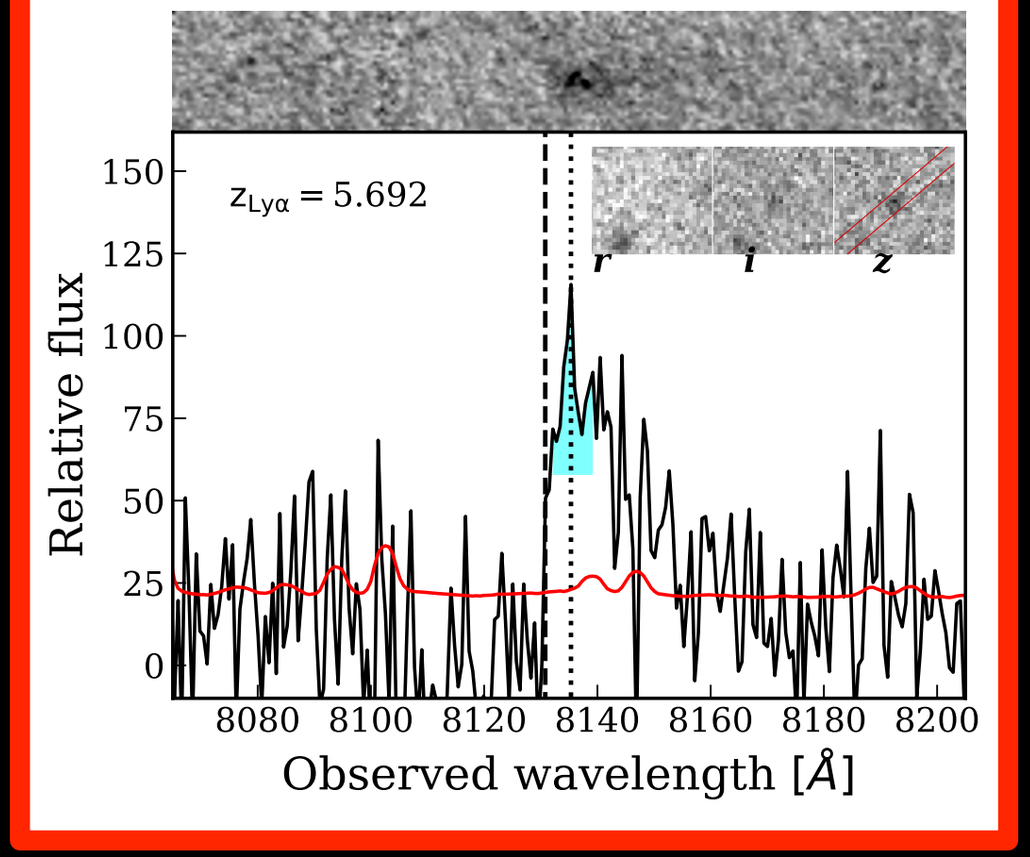


→ Spectroscopic surveys of field galaxies with background QSO to probe cross-correlations with the IGM transmission

A survey of LBGs and LAEs in 8 z>6 quasar fields

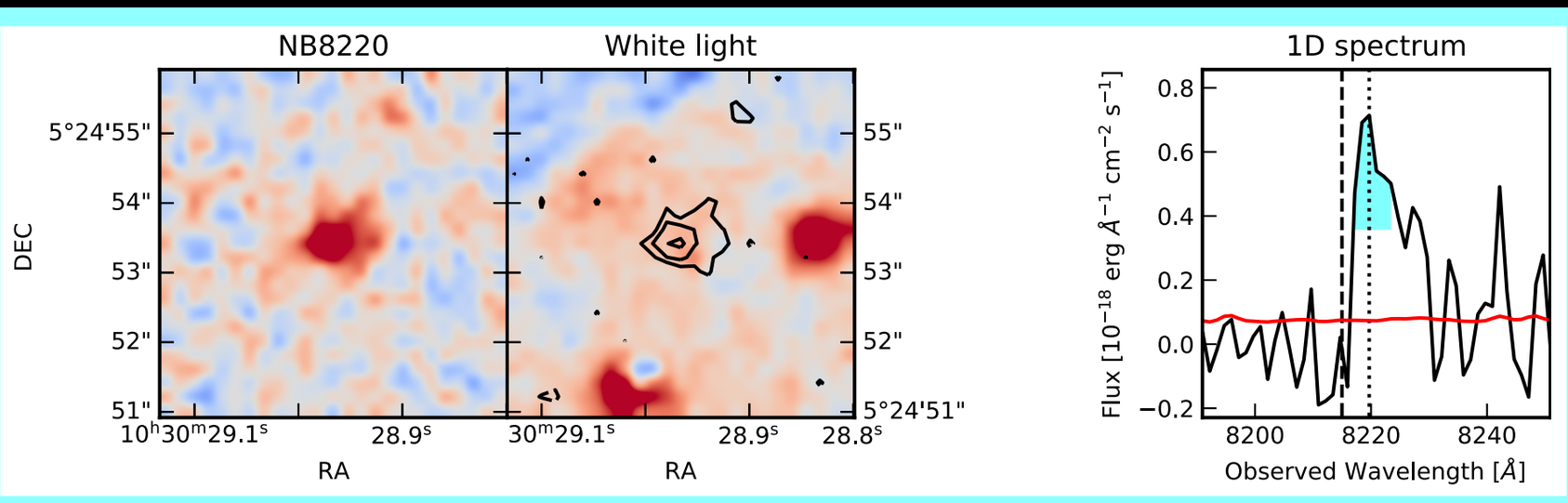


DEIMOS/Keck



Meyer et al., in prep

MUSE/VLT



LAE (MUSE)
LBG (DEIMOS)
LBG (DEIMOS, Paper I)
LAE (DEIMOS)

J0305-3150
J1526-2050
J1148+5251
J1030+0524
J2329-0301
J2032-2114
J2100-1715
J0836+0054

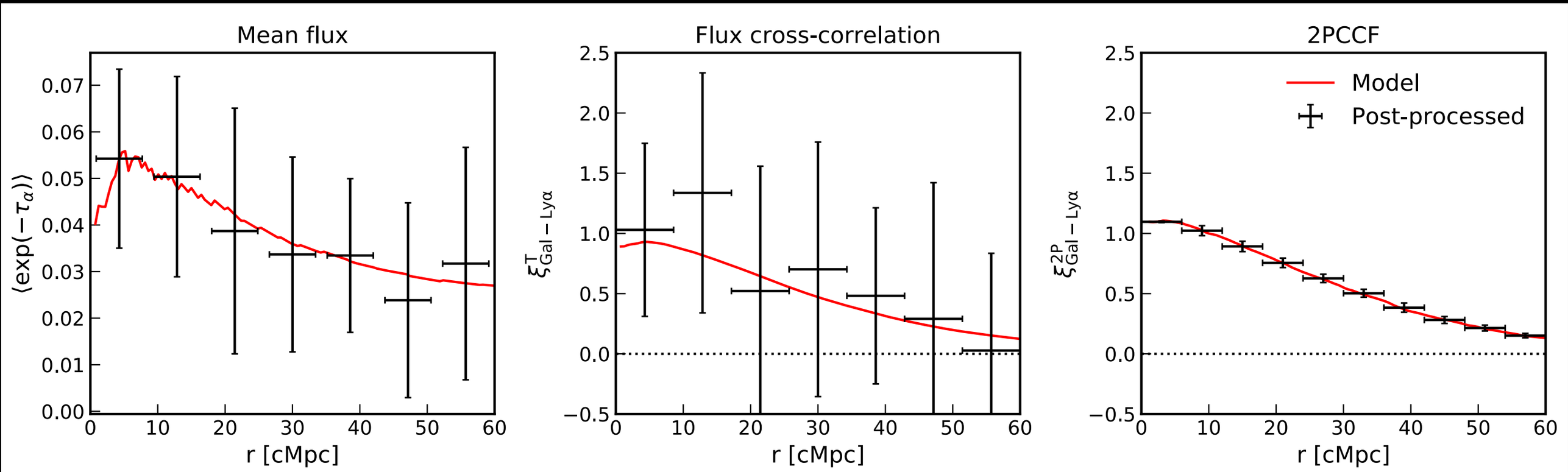
$T = \exp(-\tau_\alpha)$

$r_\perp$ [pMpc]

$z_{Ly\alpha}$

Meyer et al., in prep

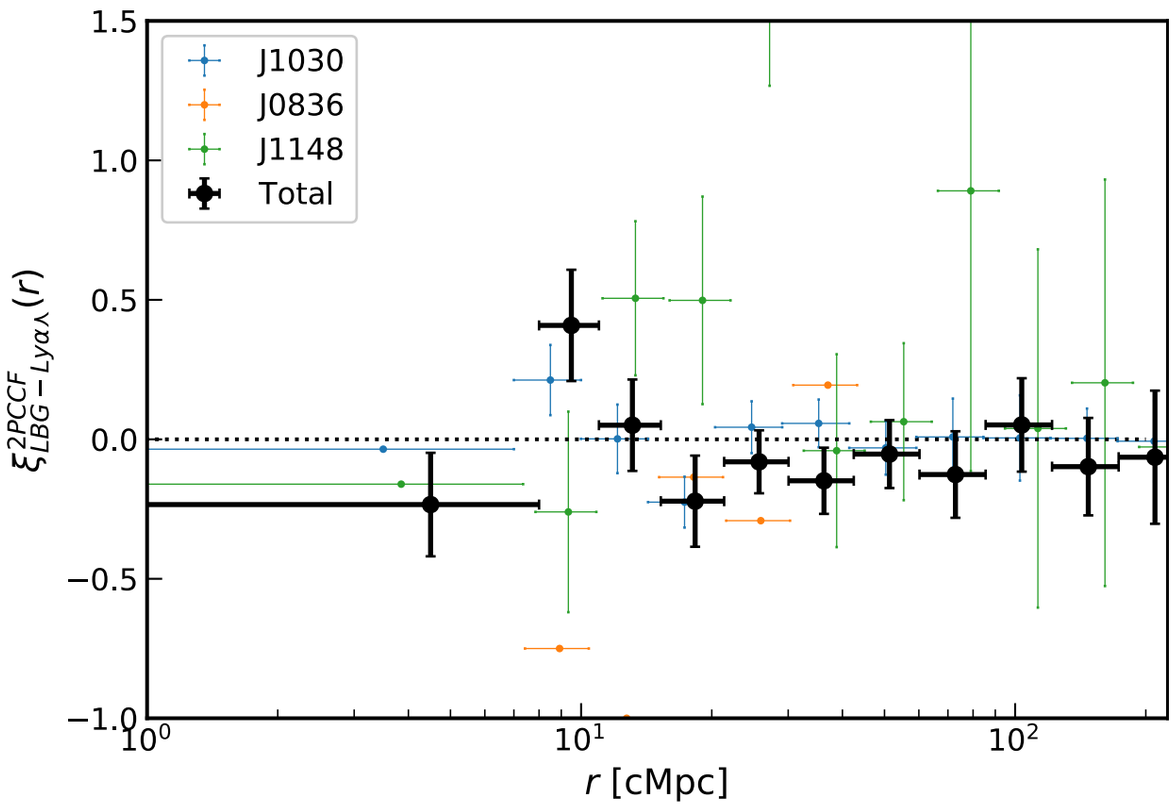
Which statistic to probe the galaxy - IGM opacity connection?



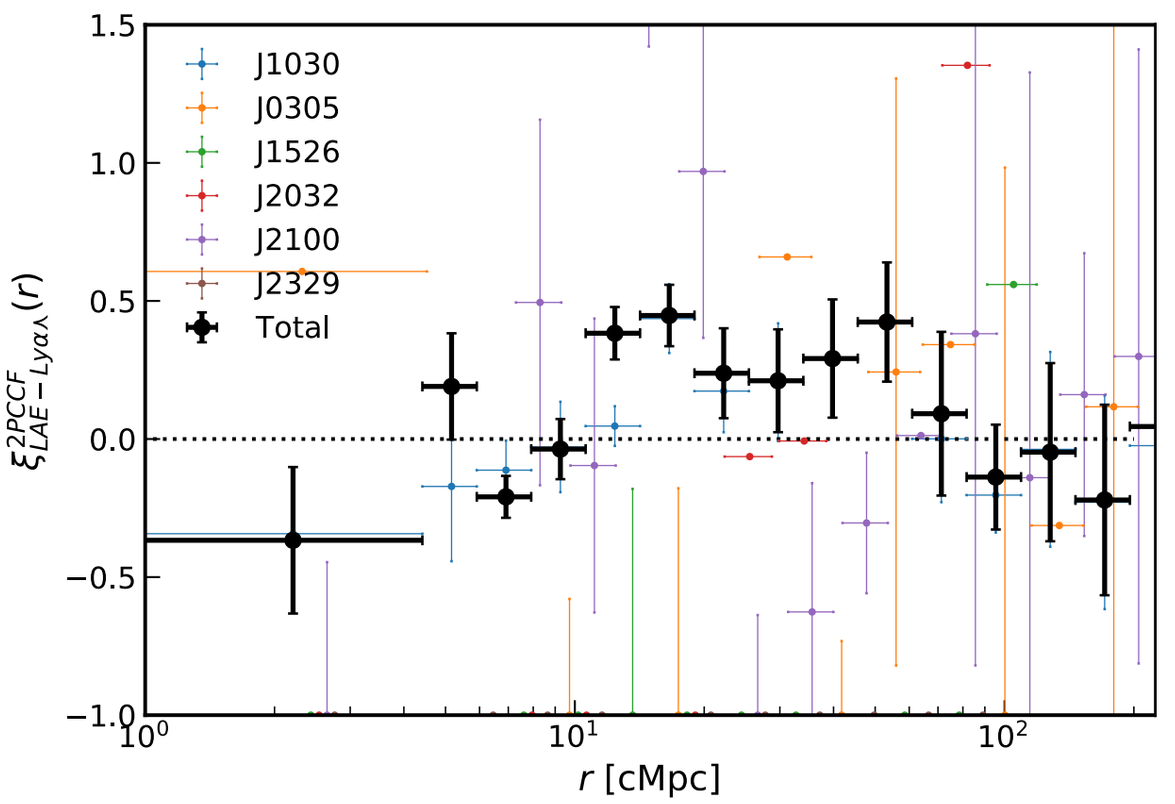
The two-point correlation of transmission spikes is better defined than the mean flux around galaxies (at z>5.5 with few QSOs)

The 2-point cross-correlation function of LAEs and transmission spikes reveals association on ~10s cMpc scales!

LBG - Lyα



LAE - Lyα



No signal -> cosmic variance?
(13 LBGs, 3 QSOs)

Clear signal
(22 LAEs, 6 QSOs)

Meyer et al., in prep

Modelling the two-point cross-correlation of transmission spikes and galaxies: all galaxies matter!

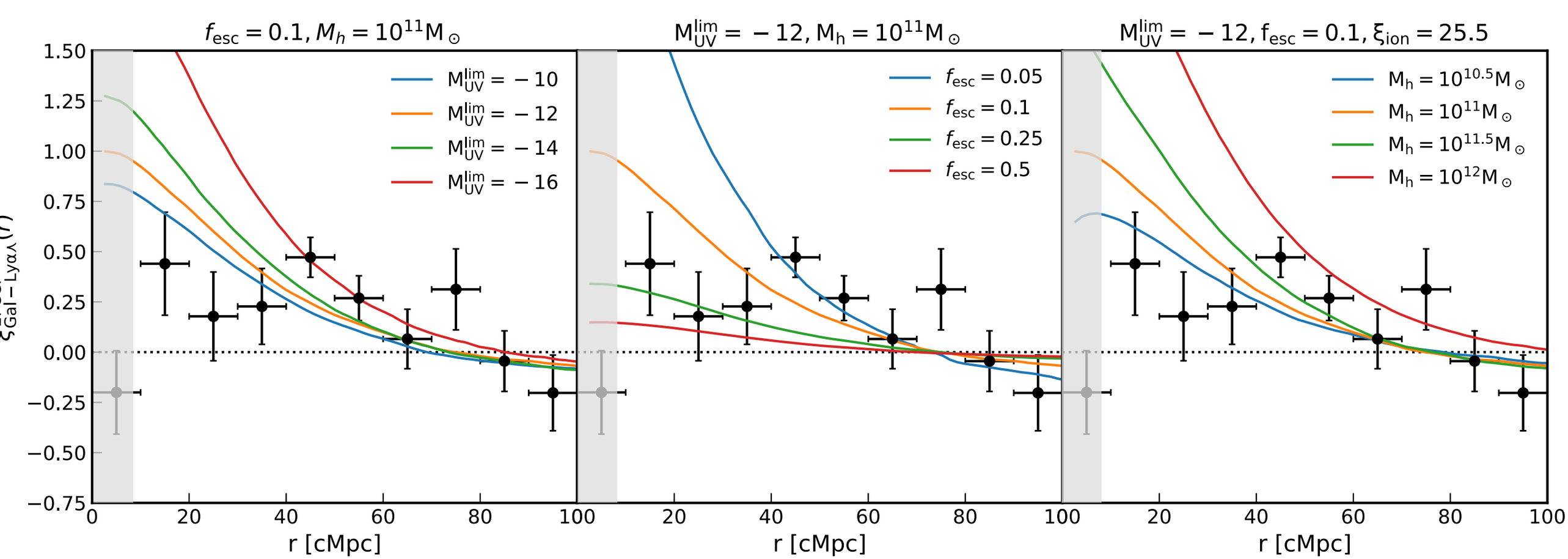
$$\langle \Gamma_{HI}(r) \rangle \propto \langle f_{\rm esc} \xi_{\rm ion} \rangle \times (\text{Galaxy abundance: Tracer+Clustering})$$

$$\tau_\alpha \simeq 11 \Delta_b^{2-0.72(\gamma-1)} \left(\frac{\Gamma_{\rm HI}}{10^{-12}\ {\rm s}^{-1}} \right)^{-1} \left(\frac{T_0}{10^4\ {\rm K}} \right)^{-0.72} \left(\frac{1+z}{7} \right)^{9/2}$$

$$P(< \Delta_b^{\rm max}(r)) = \int_0^{\Delta_b^{\rm max}(r)} P_V(\Delta_b) {\rm d}\Delta_b$$

We constrain the luminosity-averaged escape fraction and ionising efficiency of all galaxies contributing to reionisation

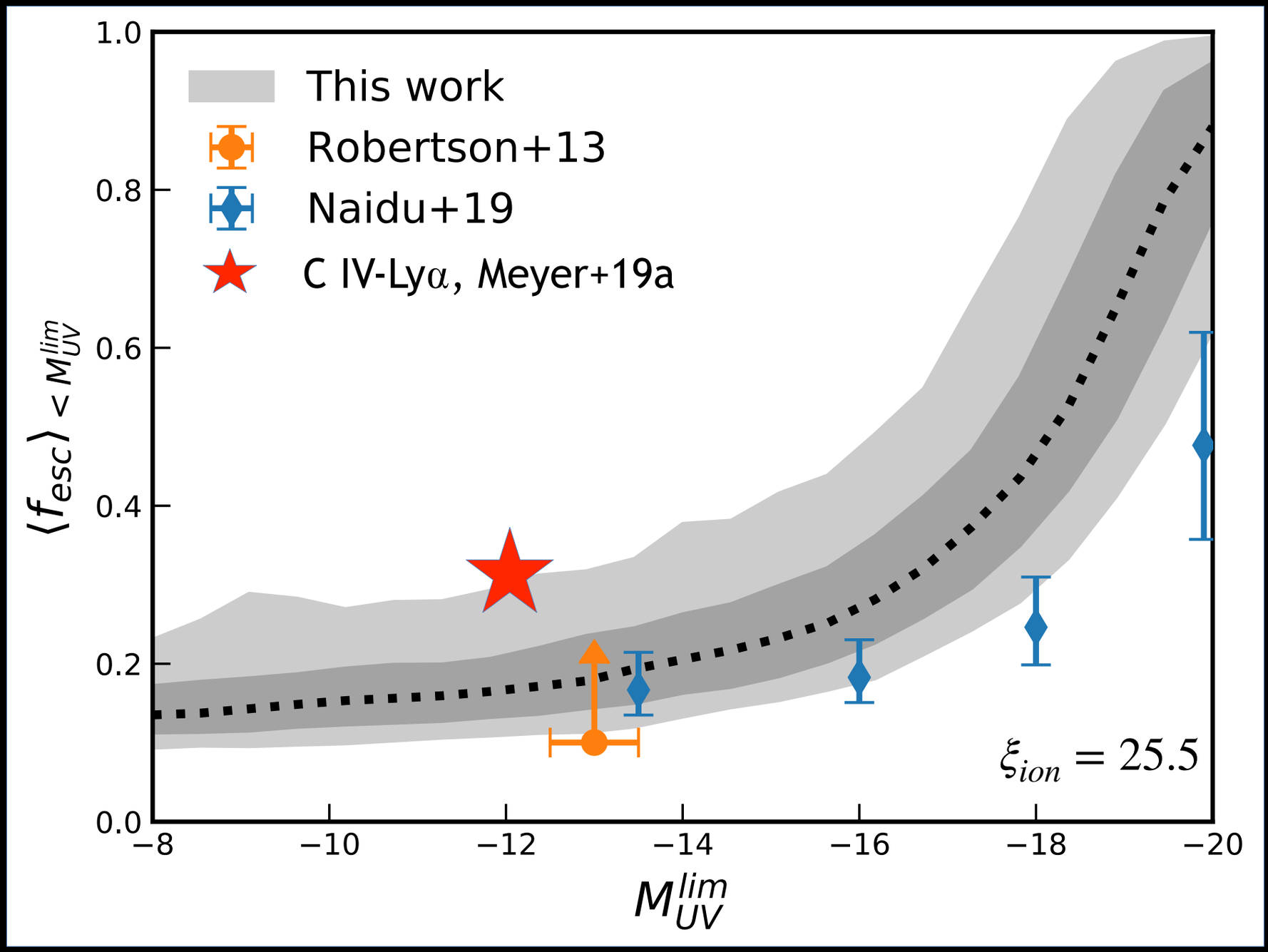
Our model captures well the two-point cross-correlation
(except on the small scales)



Meyer et al., in prep

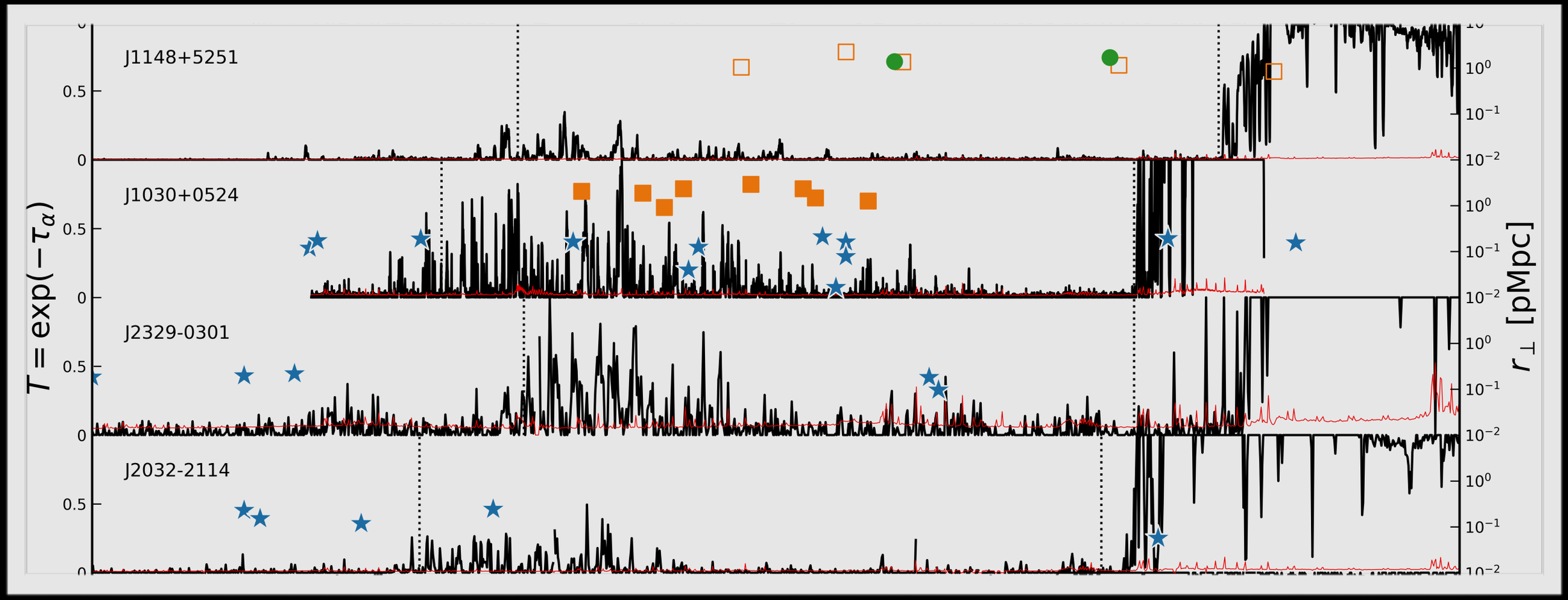
High-z galaxies need large escape fractions to drive reionisation!

Preliminary



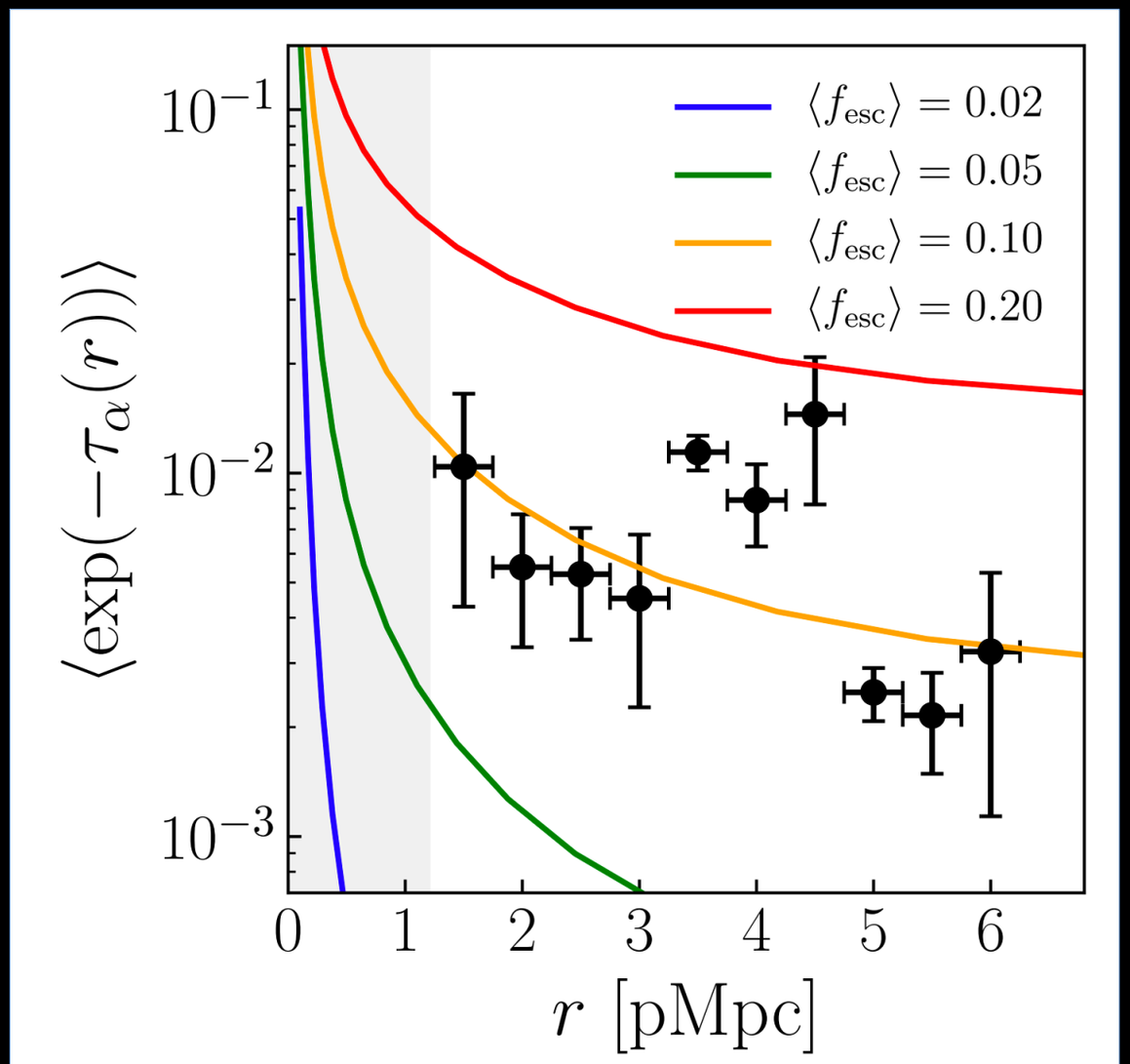
Conclusions

- First detection of LAE-IGM transmission 2 point correlation signal
- Constraint on luminosity-average escape fraction
- “The end of the beginning”: IGM-galaxy/metal absorber correlations will probe different populations of sources

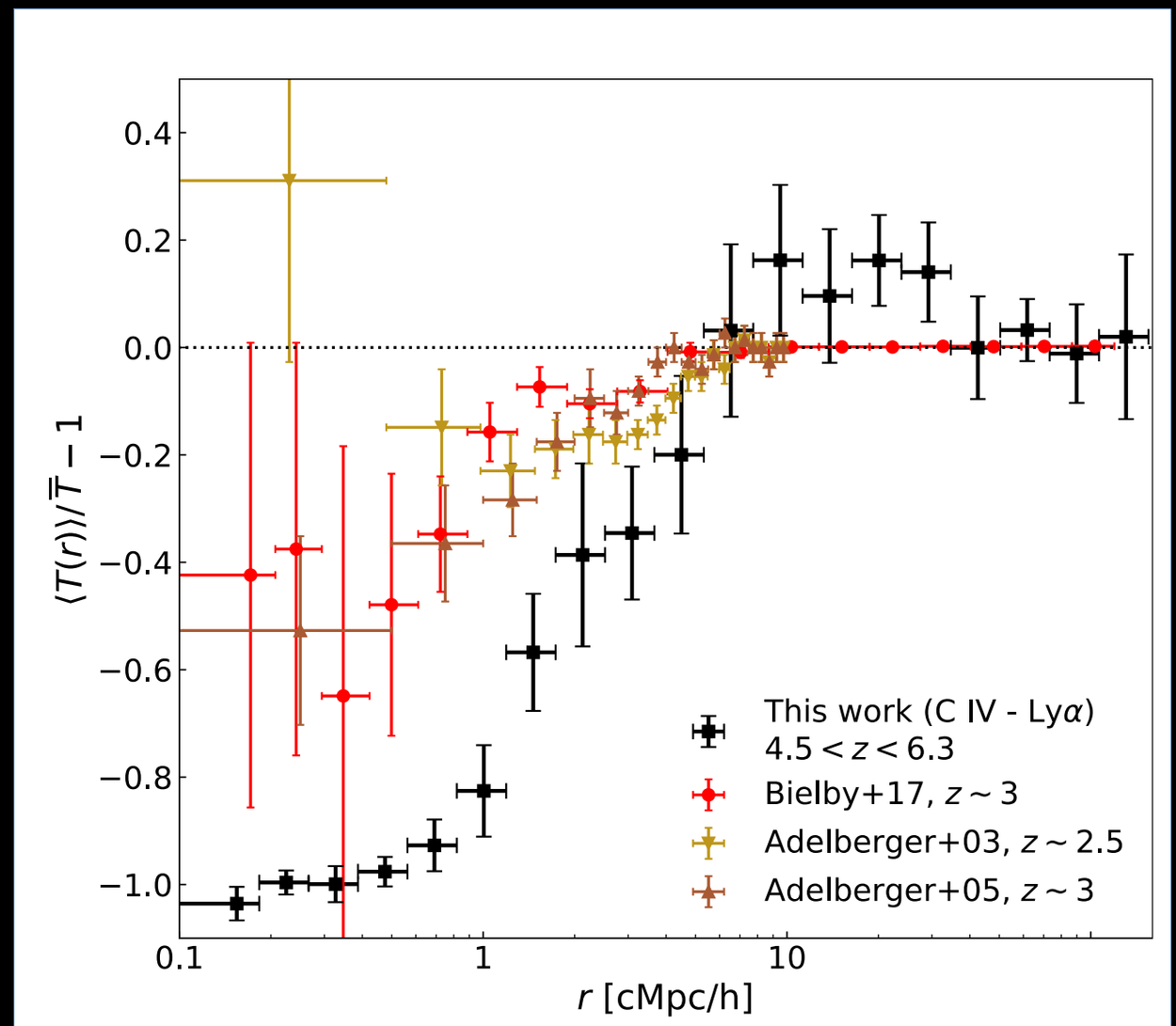


Extra slides

Previous attempts at galaxy-IGM correlations

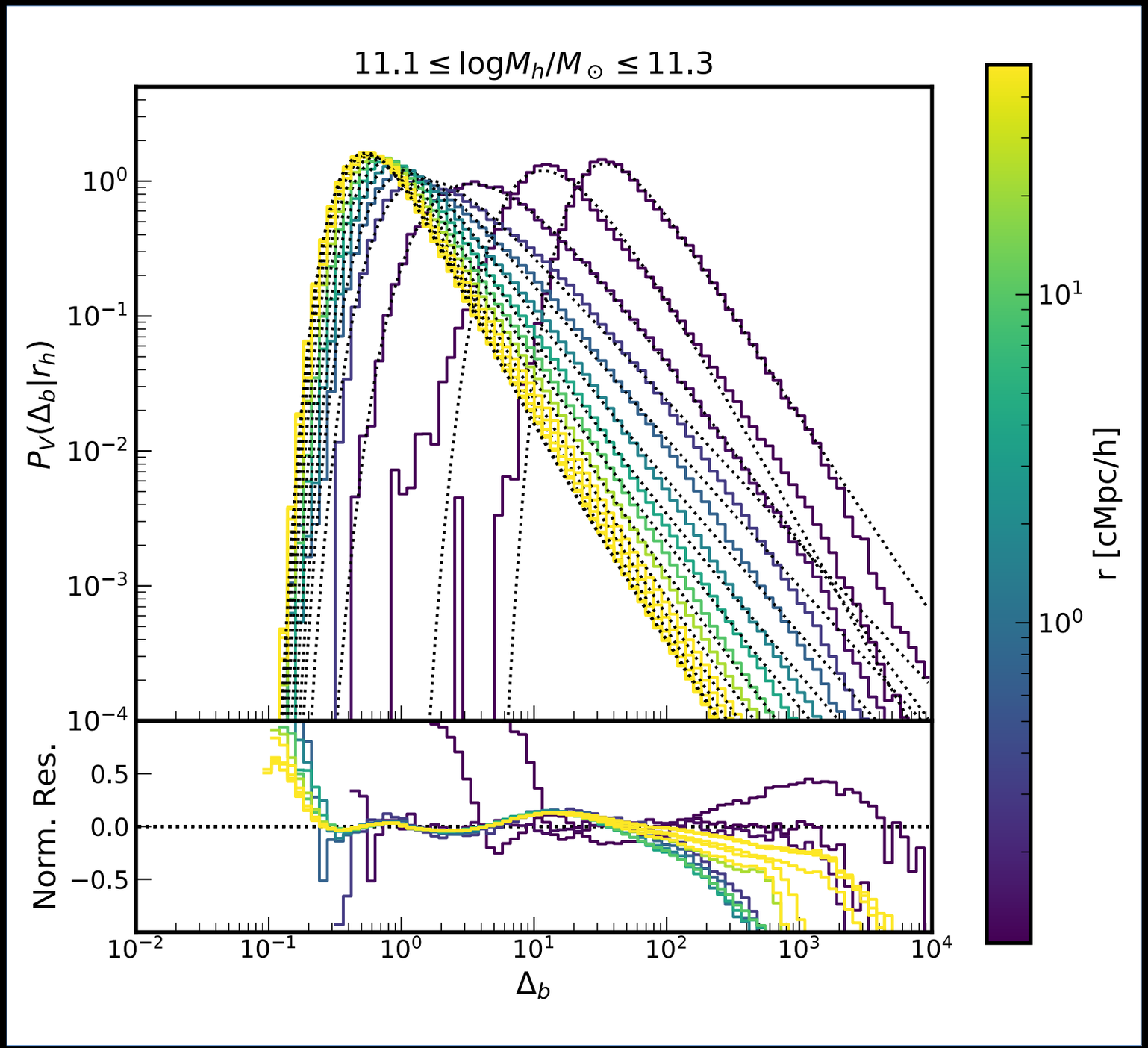


1 QSO / 5 LBGs / z~5.8
Kakiichi+18, MNRAS, 479



15 QSOs / 37 C IV / z~5.2
Meyer+19, MNRAS, 483

Taking into account the enhanced gas overdensities closer to the LAE/LBG host halo center



- Gas overdensity PDF extracted from IllustrisTNG100-2 at z=5.85
- Parametrised following MHR+2000, Pawlik+2009

Meyer et al., in prep