THE WHO, WHAT, AND WHEN OF REIONIZATION

CONSTRAINTS ON THE TIMELINE AND SOURCES

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THE RELICS, CLASH, GLASS, SURFSUP TEAMS

SHEDDING NEW LIGHT ON THE FIRST BILLION YEARS OF THE UNIVERSE
3 JULY 2023

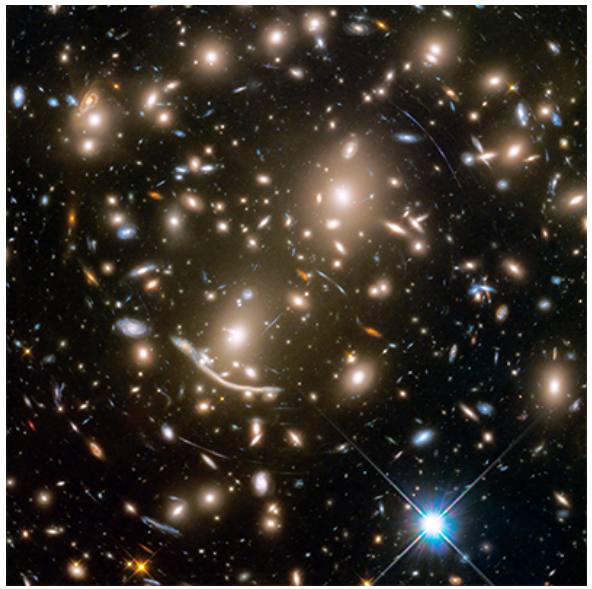
THE BIG QUESTIONS

1. How did reionization progress?

2. What are the physical properties of first galaxies?

LENSED GALAXY SAMPLES

DETECTING FAINT GALAXIES WITH NATURE'S MAGNIFYING GLASS



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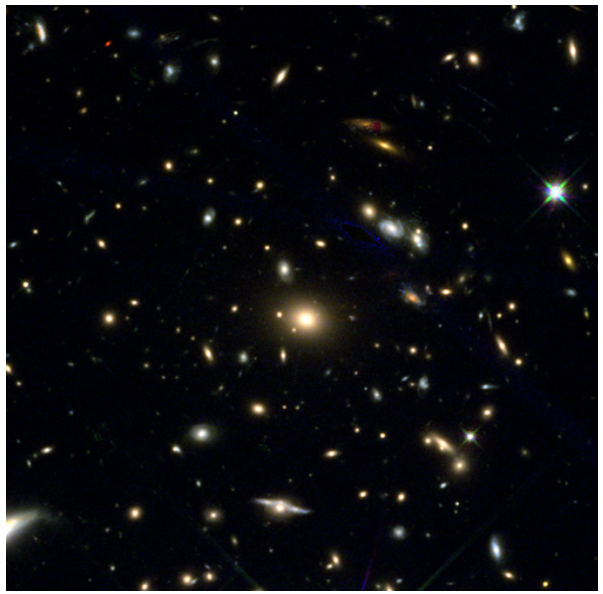

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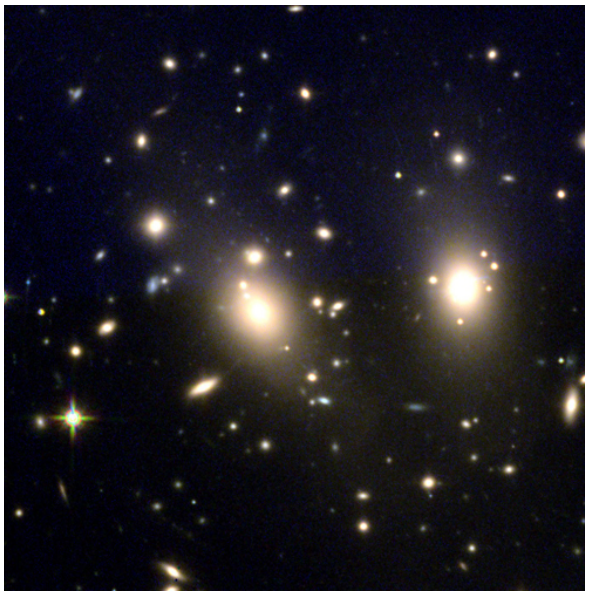


RXJ1347

FRONTIER FIELDS

CLASH

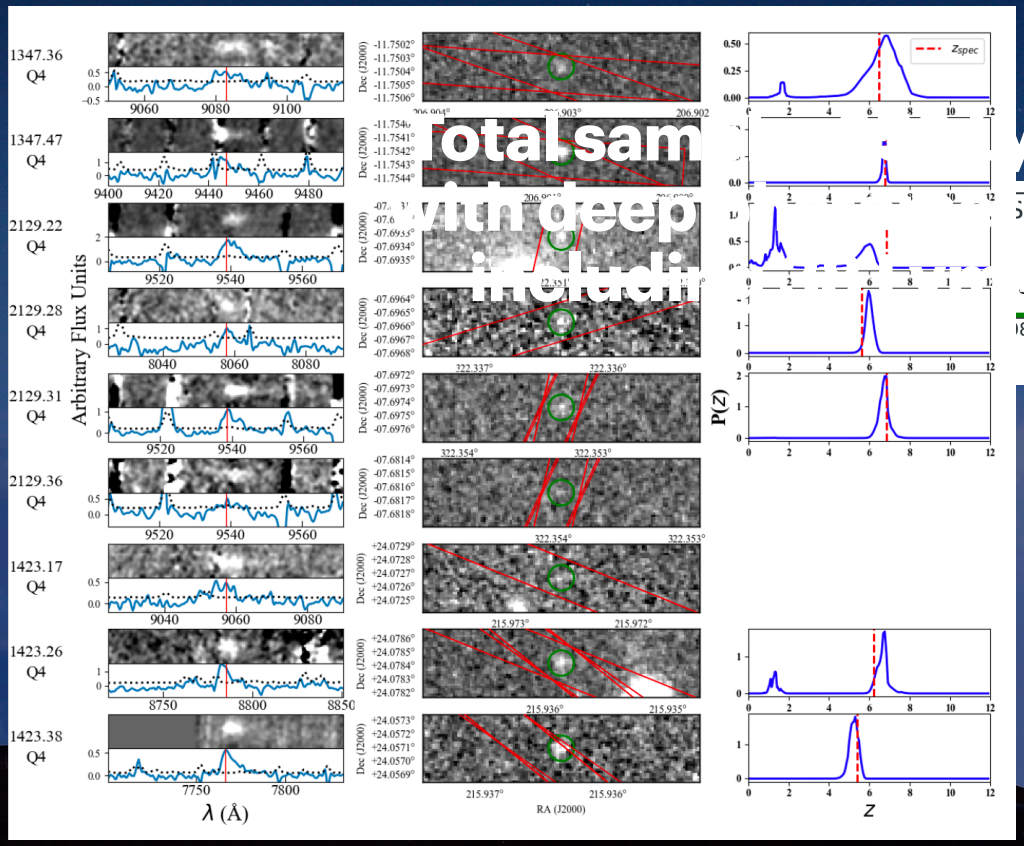
GLASS
The Grism Lens-Amplified Survey from Space

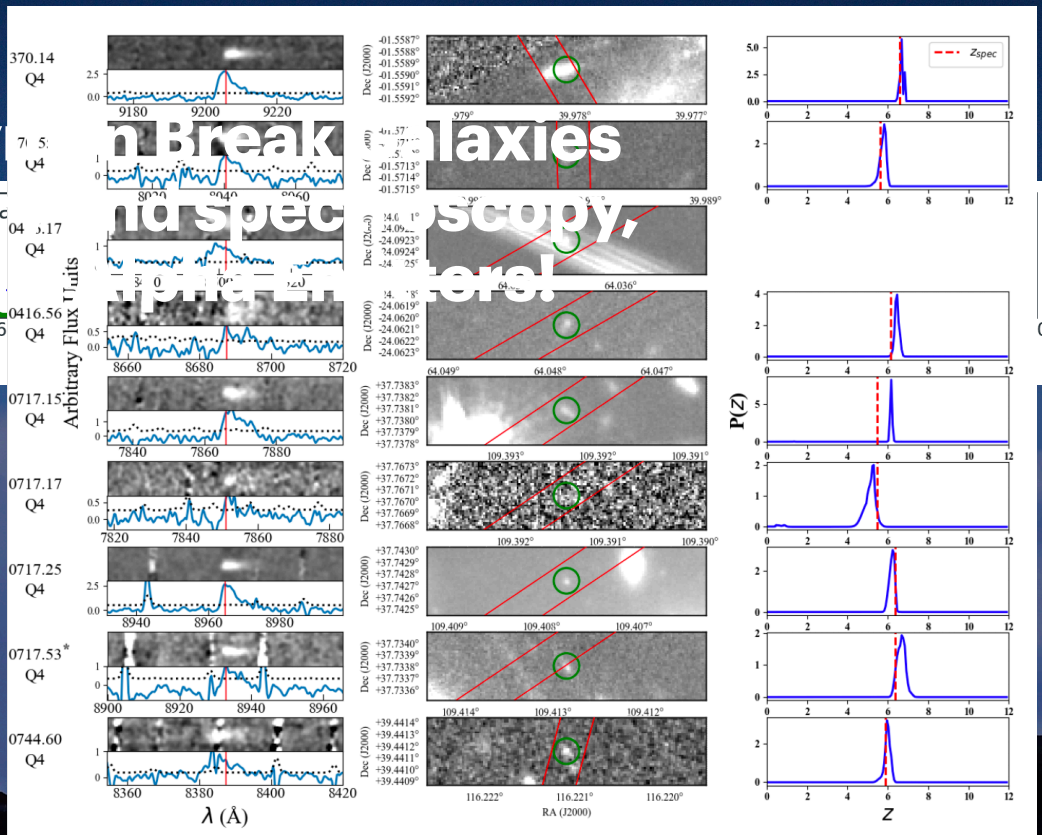
SURFS UP

RELICS
Reionization Lensing Cluster Survey

SPECTROSCOPIC SEARCH FOR LYA

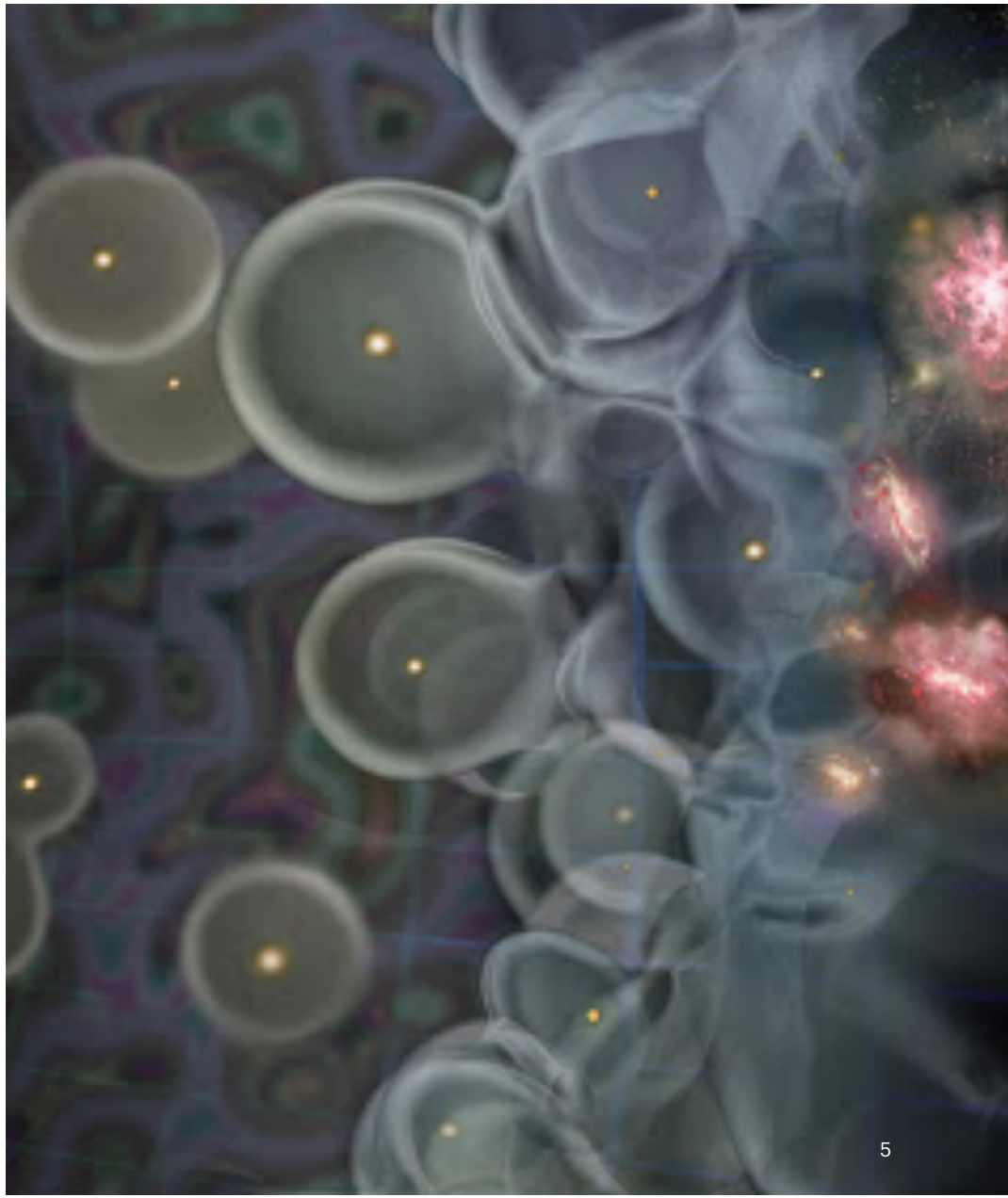
KECK OBSERVATORY



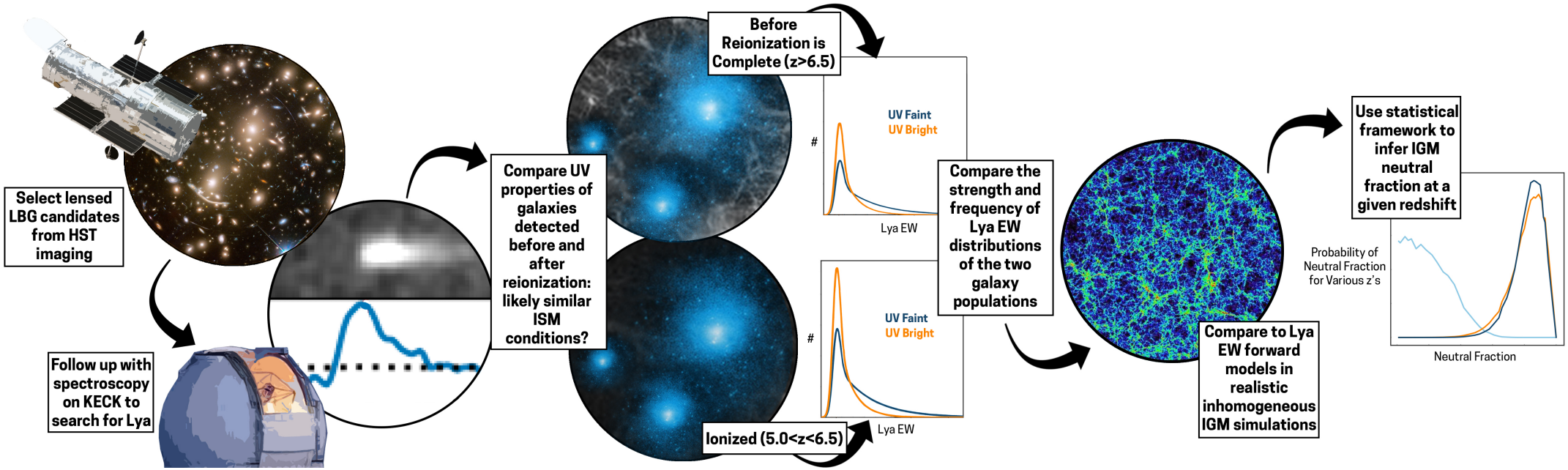


CONSTRAINING THE NEUTRAL HYDROGEN FRACTION WITH FAINT GALAXIES

USING BAYESIAN ANALYSIS TO DETERMINE HOW IONIZED THE UNIVERSE IS AT Z ~ 6.7 AND Z~7.6



HOW DO WE USE LYMAN ALPHA EMISSION TO INFER THE IGM NEUTRAL FRACTION?

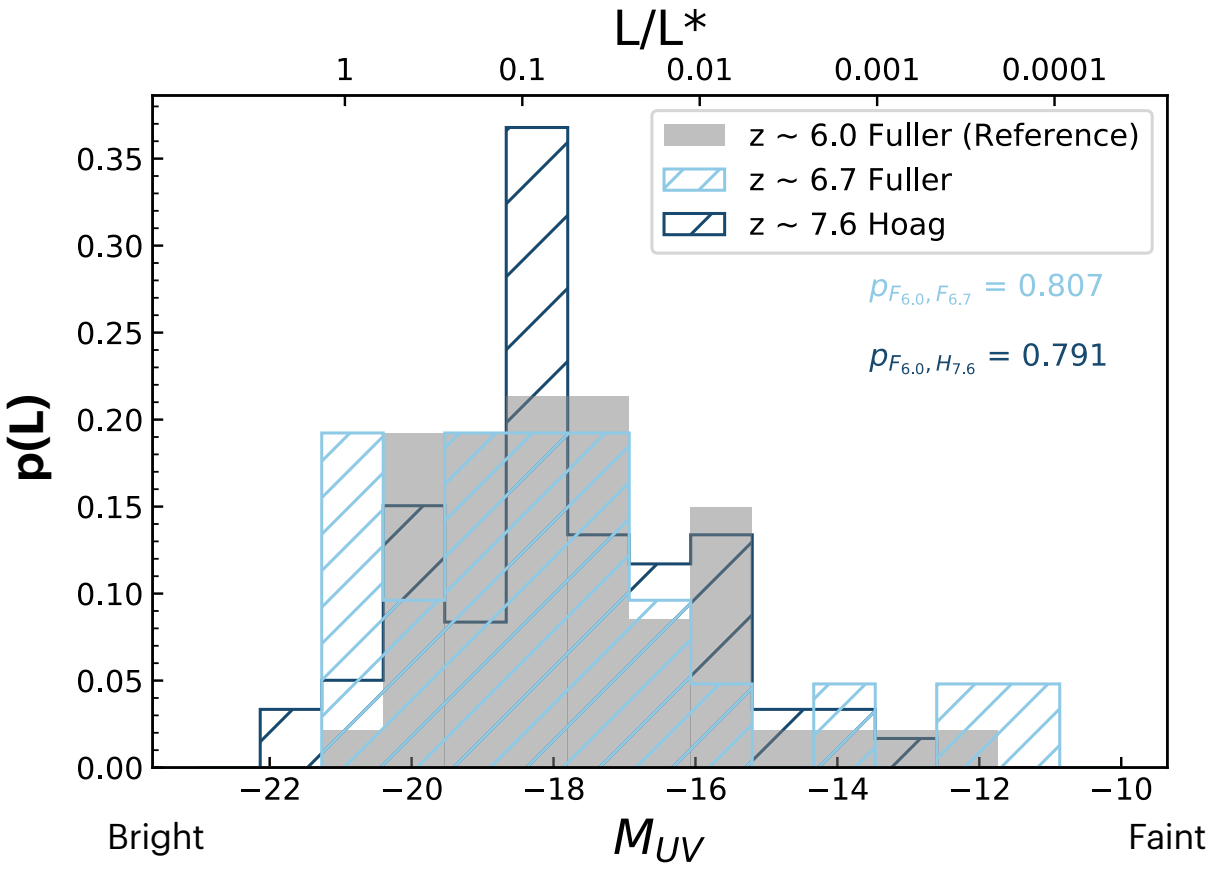


INCLUSION OF A FAINT REFERENCE SAMPLE

MATCHING GALAXIES BY LUMINOSITIES

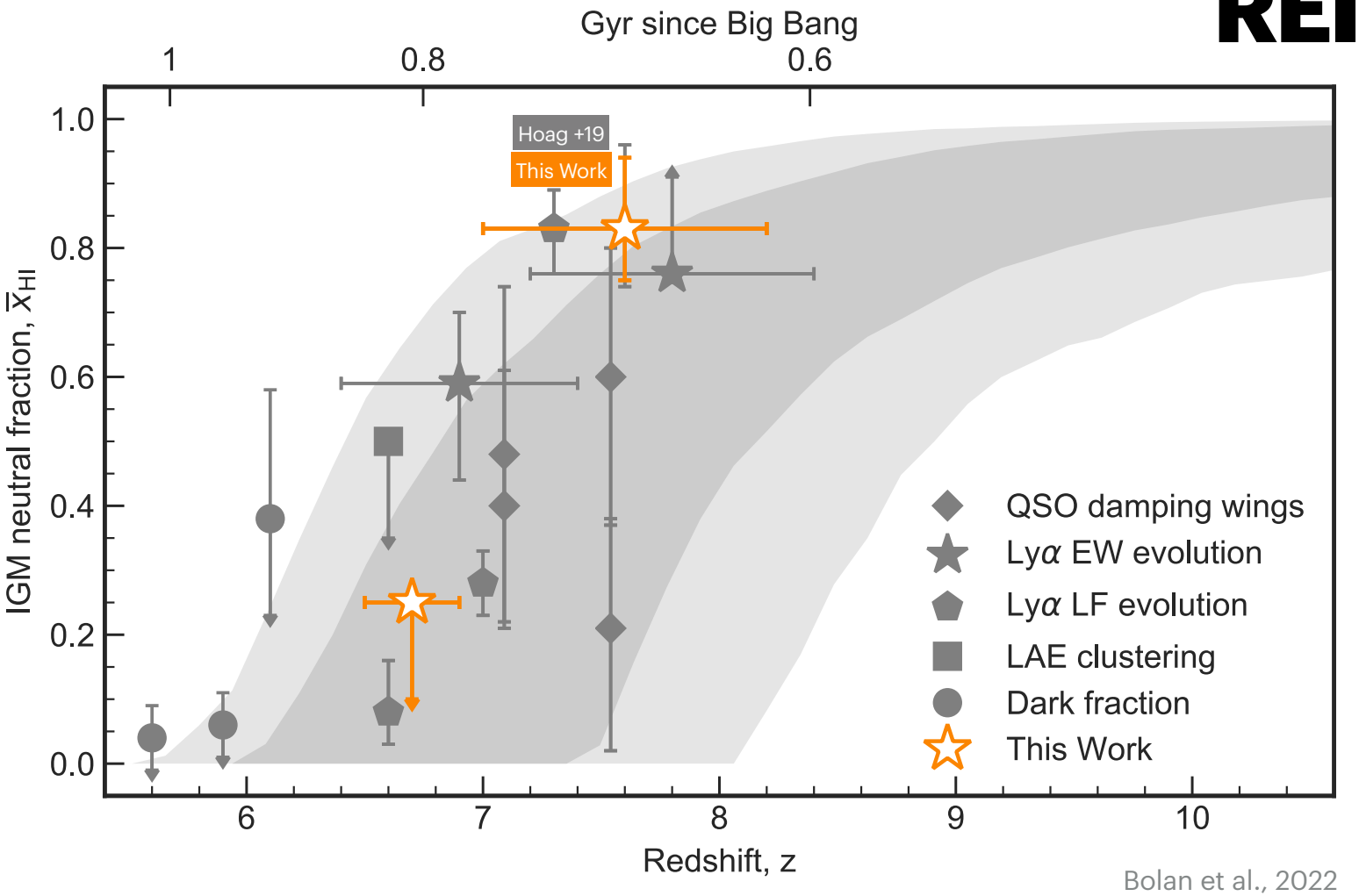
The galaxies used in the reference sample at z ~ 6.0 have a similar luminosity distribution to those at high redshift

This allows for better isolation of ISM effects on Lya emission



Bolan et al., 2022

ADDING TO REIONIZATION HISTORY



Bolan et al., 2022

Our results are consistent with a late and rapid reionization, and agree with results from CMB and dark pixel fraction determinations

PHYSICAL PROPERTIES OF LYMAN ALPHA EMITTERS

HOW DO LYA PROPERTIES AND PHYSICAL PROPERTIES CORRELATE?

COMPARING LAES AND NONEMITTERS

ARE THERE DIFFERENCES IN PHYSICAL PROPERTIES?

Physical (stellar and UV) properties

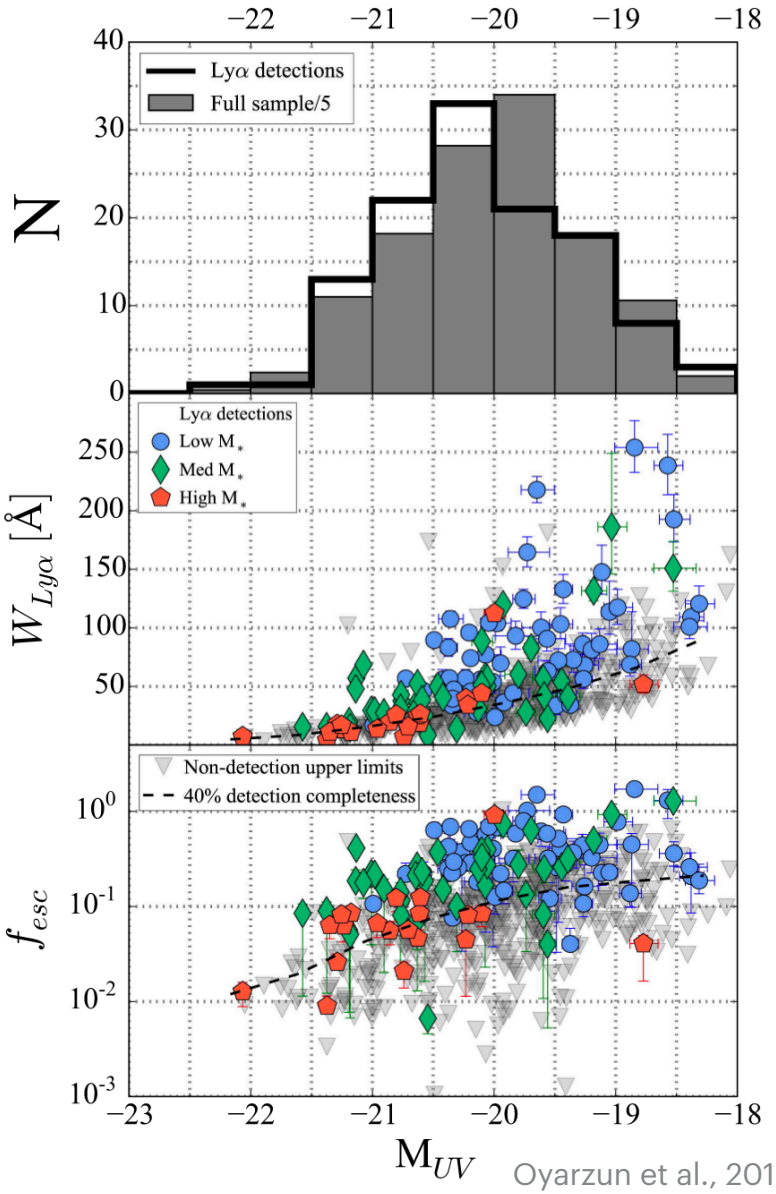
- Stellar mass
- Age
- SFR and sSFR
- UV Beta slope
- UV luminosity
- CIII] upper limits

OTHER STUDIES

WHAT MIGHT WE EXPECT TO SEE?

Lower redshift studies (i.e. Hathi+16, Oyarzu+17, Chavez Ortiz+23) have found

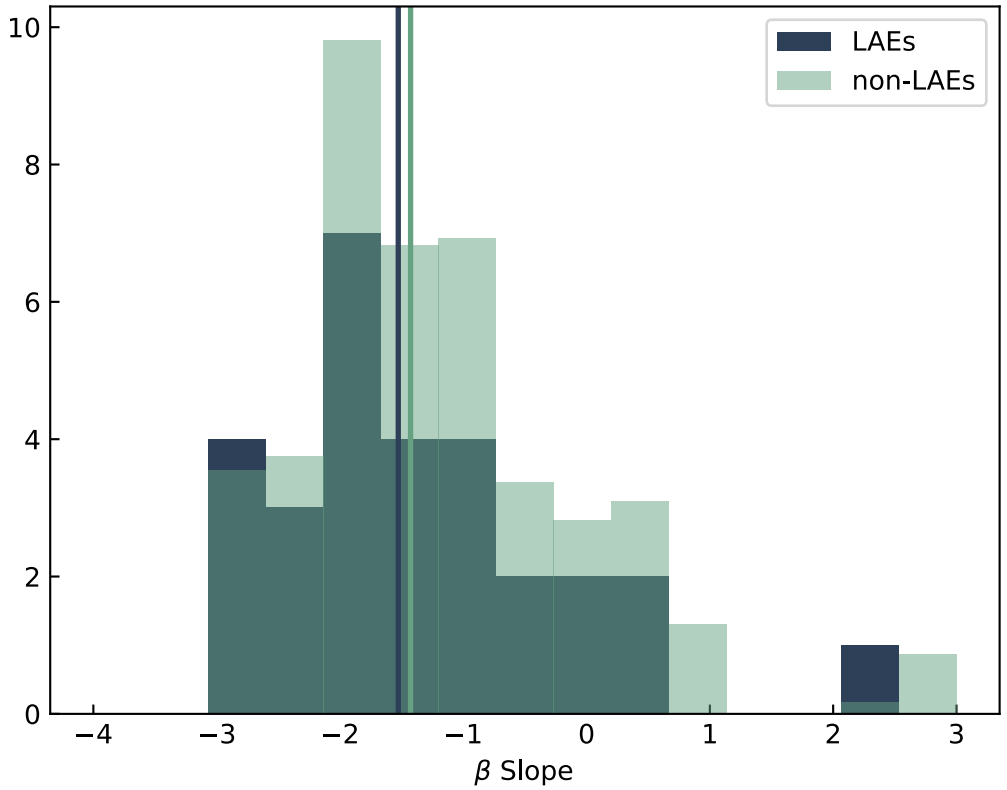
- **Anticorrelation between Lya EW and UV brightness, beta slope, SFR, and M***
- **LAEs tend to be brighter, have bluer beta slopes, and lower SFRs and M*s than nonemitters**



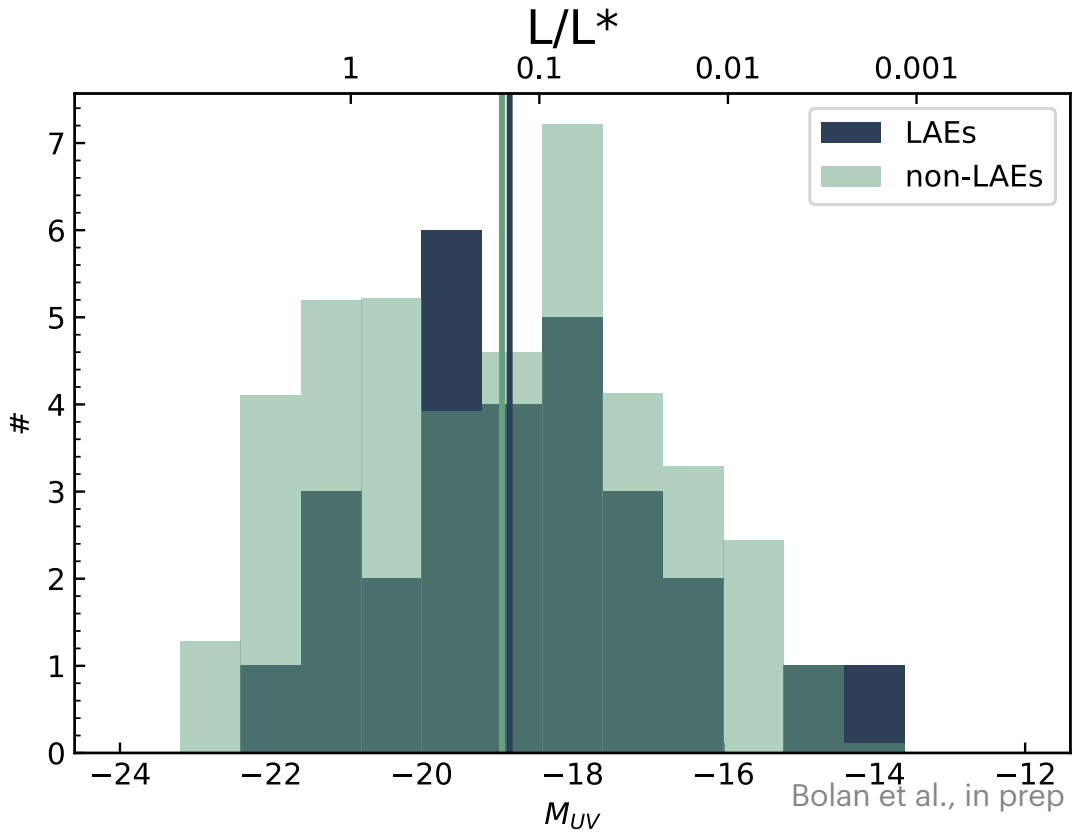
Oyarzun et al., 2017

PRELIMINARY RESULTS

UV Beta Slope



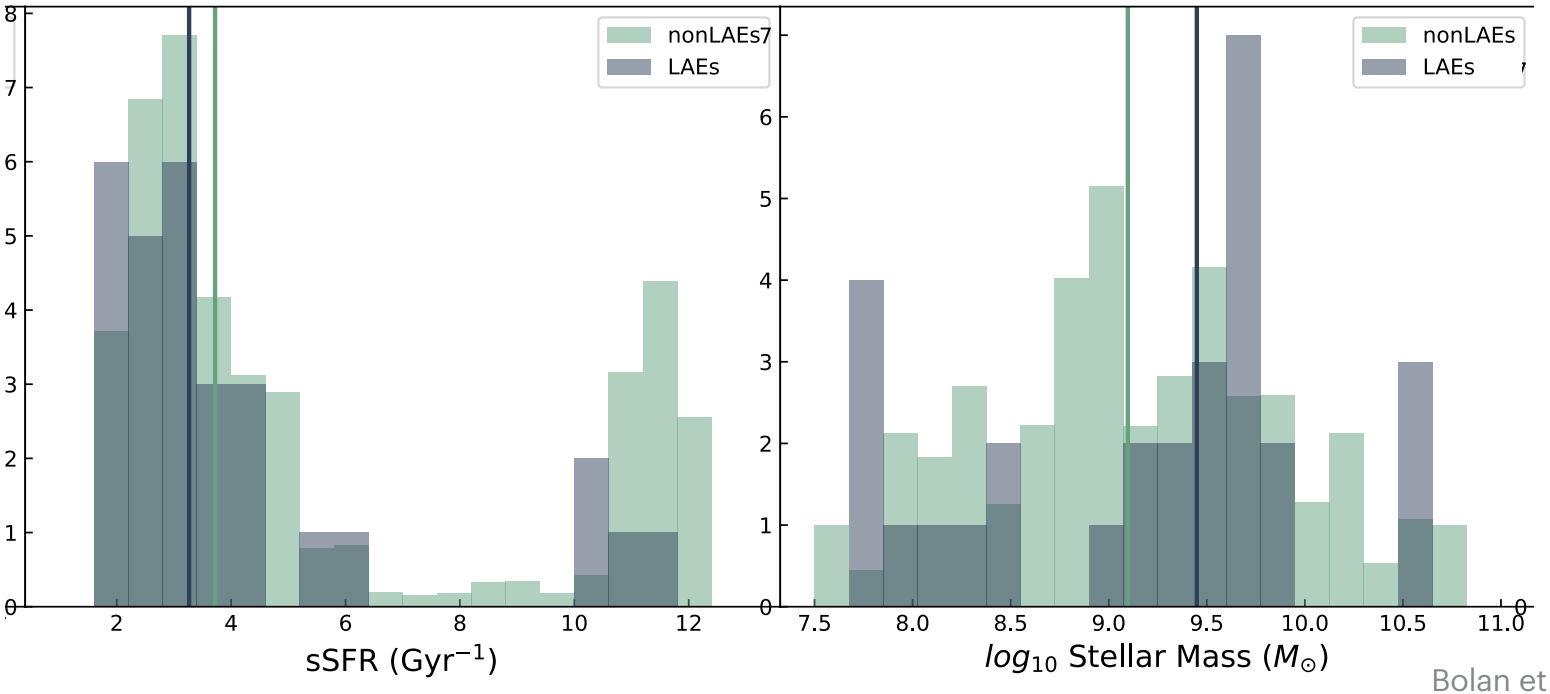
UV luminosity



Bolan et al., in prep

PRELIMINARY RESULTS

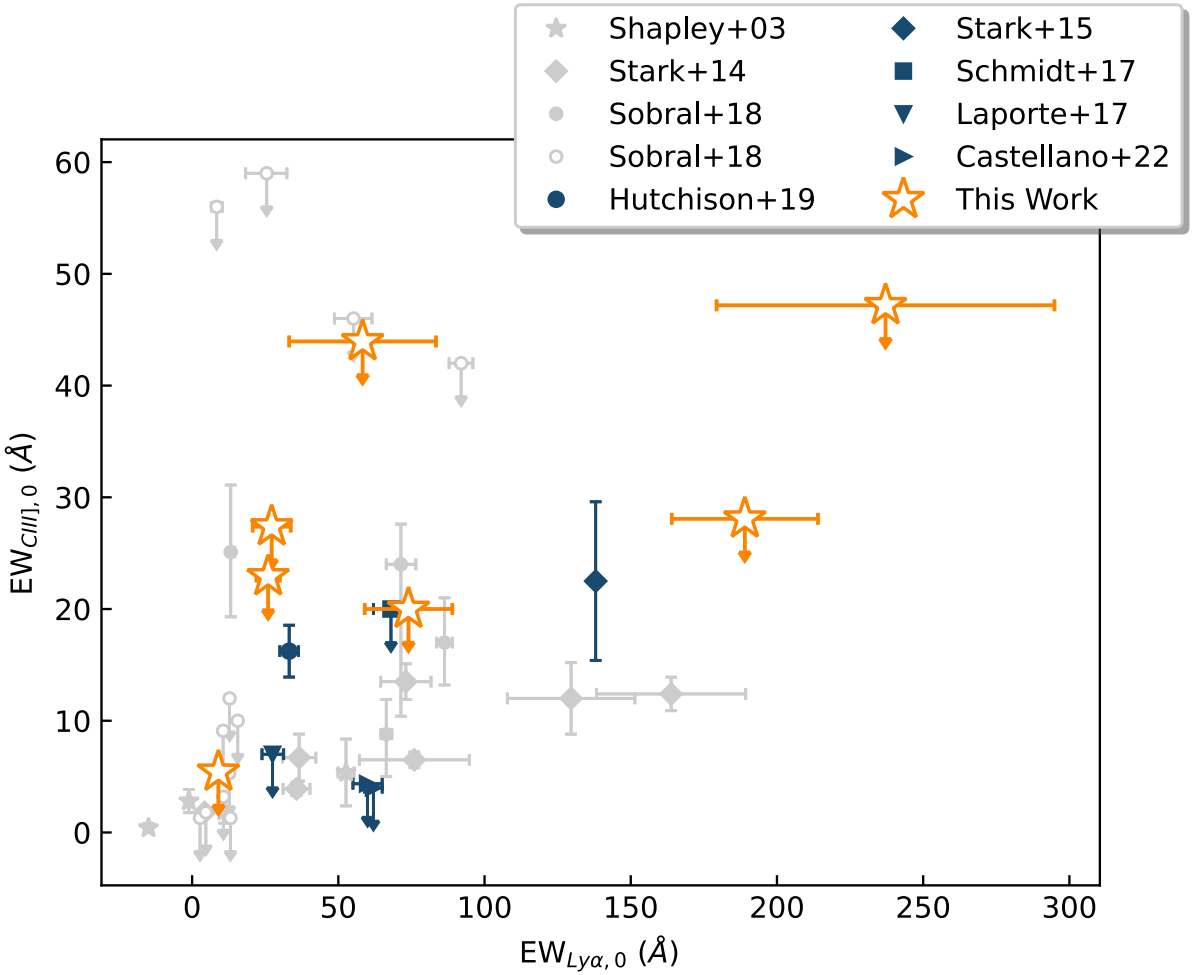
SED Property Distributions (weighted by P(z) and Lya EW fractions)



Bolan et al., in prep

Estimated stellar properties from SED fitting

LIMITS ON CIII] STRENGTH AT Z ~ 7



CONCLUSIONS

1. We infer a **fairly fast and late reionization** scenario where the neutral fraction of hydrogen drops from 0.83 to <0.25 within ~150 Myrs

2. We find **no significant difference** between the distribution of physical properties for LAEs and non emitters

3. We find CIII] emission in a typical sample of z~7 galaxies to be constrained to <20Å, implying that they do **not have very extreme nebular emission properties**

THANK YOU!