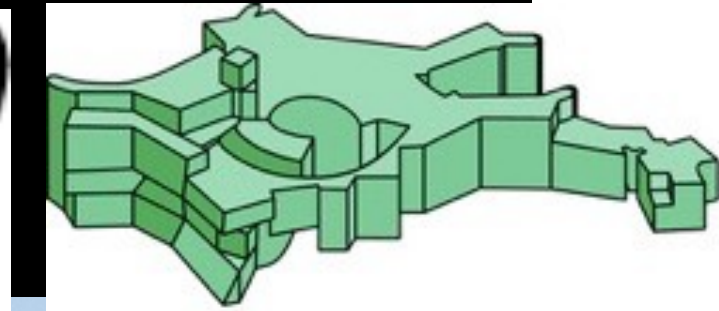


# EARLY RESULTS FROM HETDEX

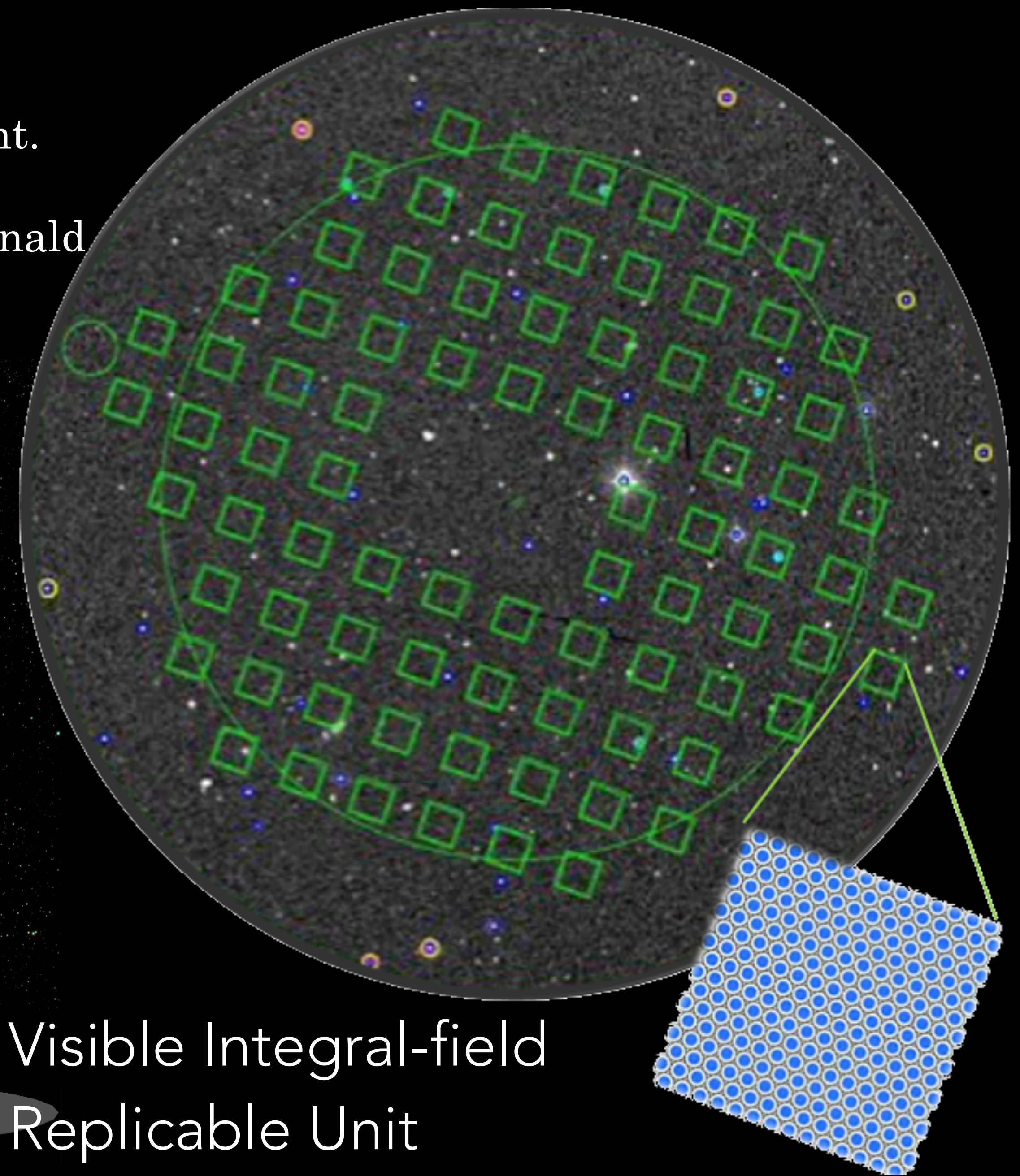
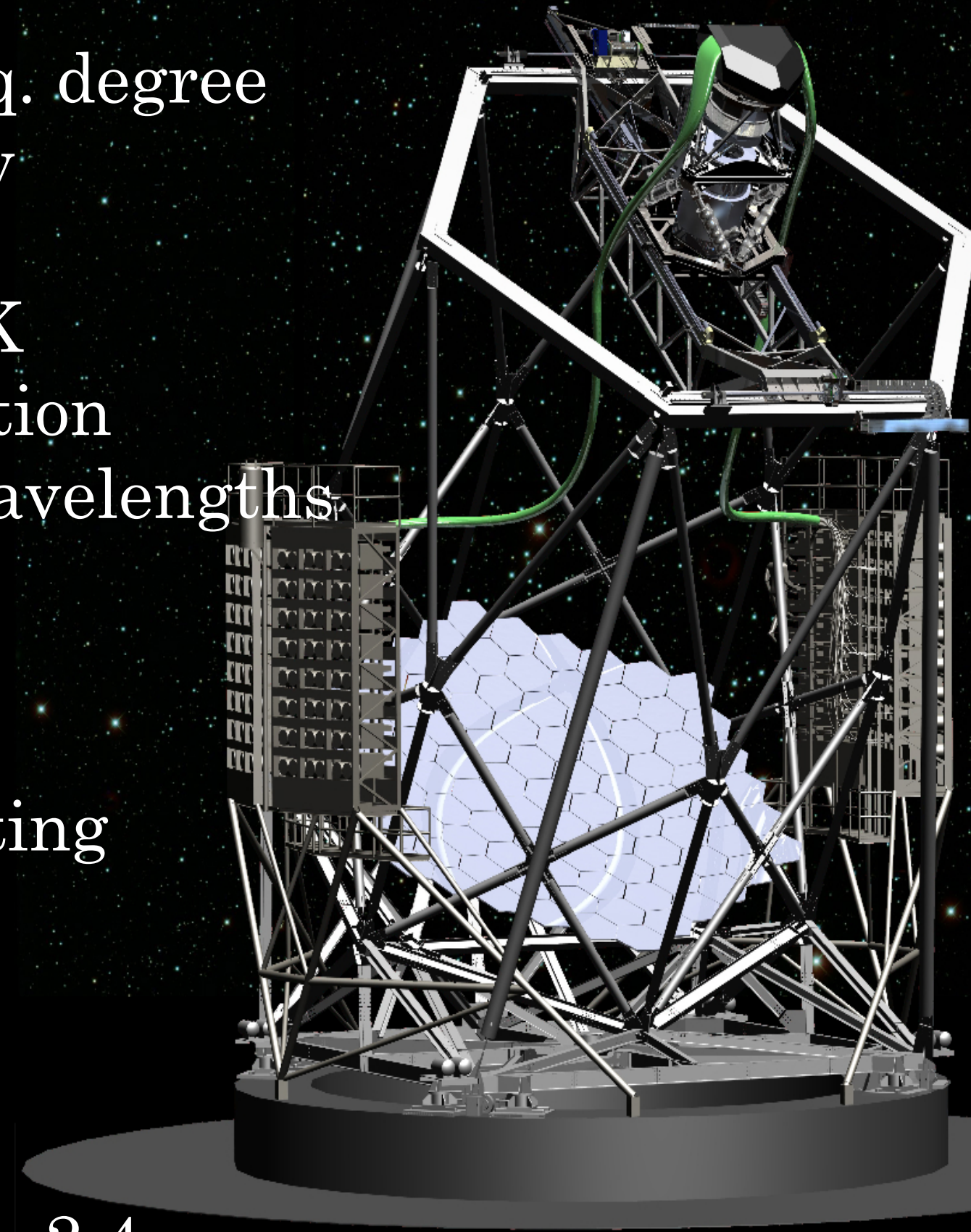
A Medium-Wide Spectroscopic  
Sky Survey of more than a Million  
Lyman Alpha Emitting Galaxies



ERIN MENTUCH COOPER, UNIVERSITY OF TEXAS AT AUSTIN  
HETDEX DATA MANAGER

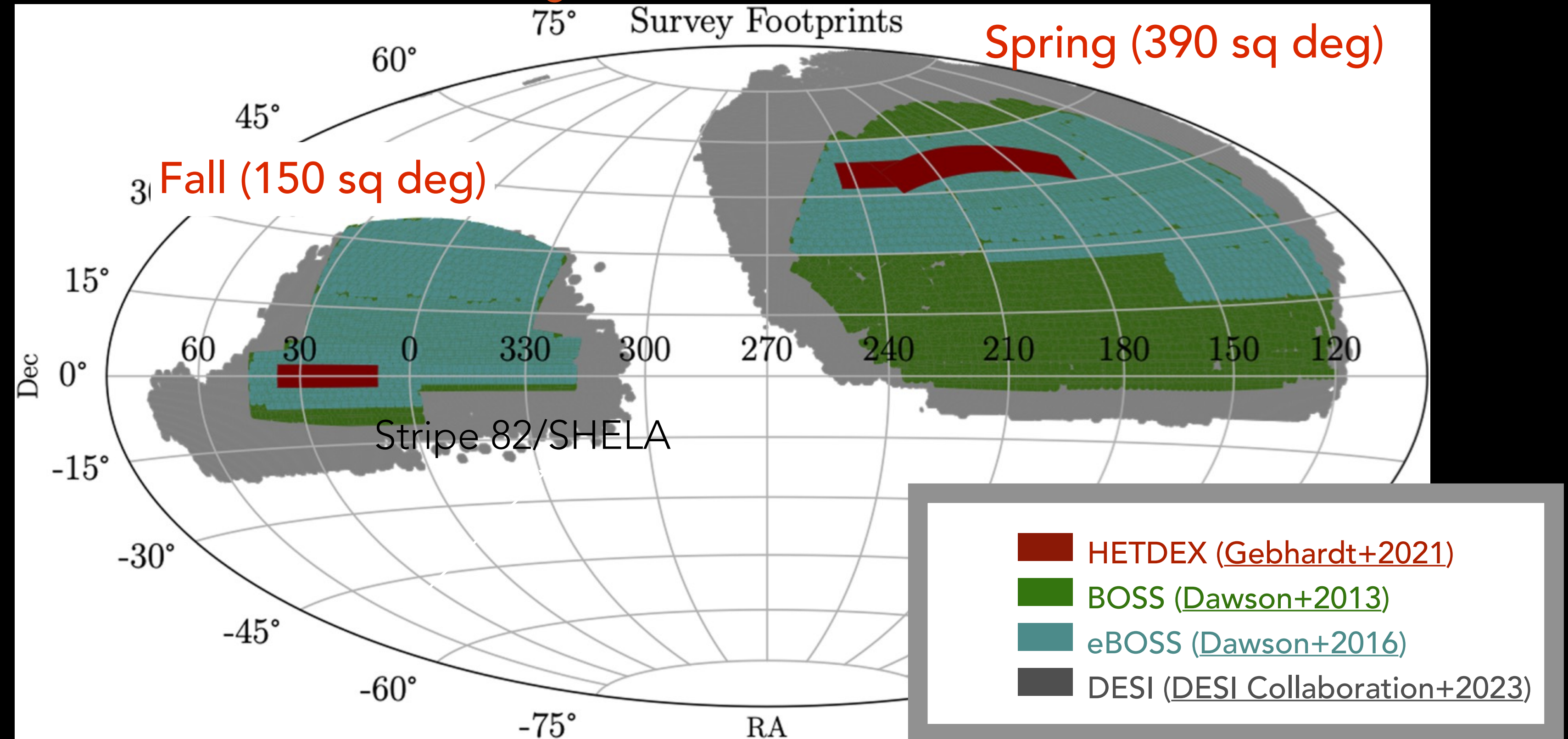
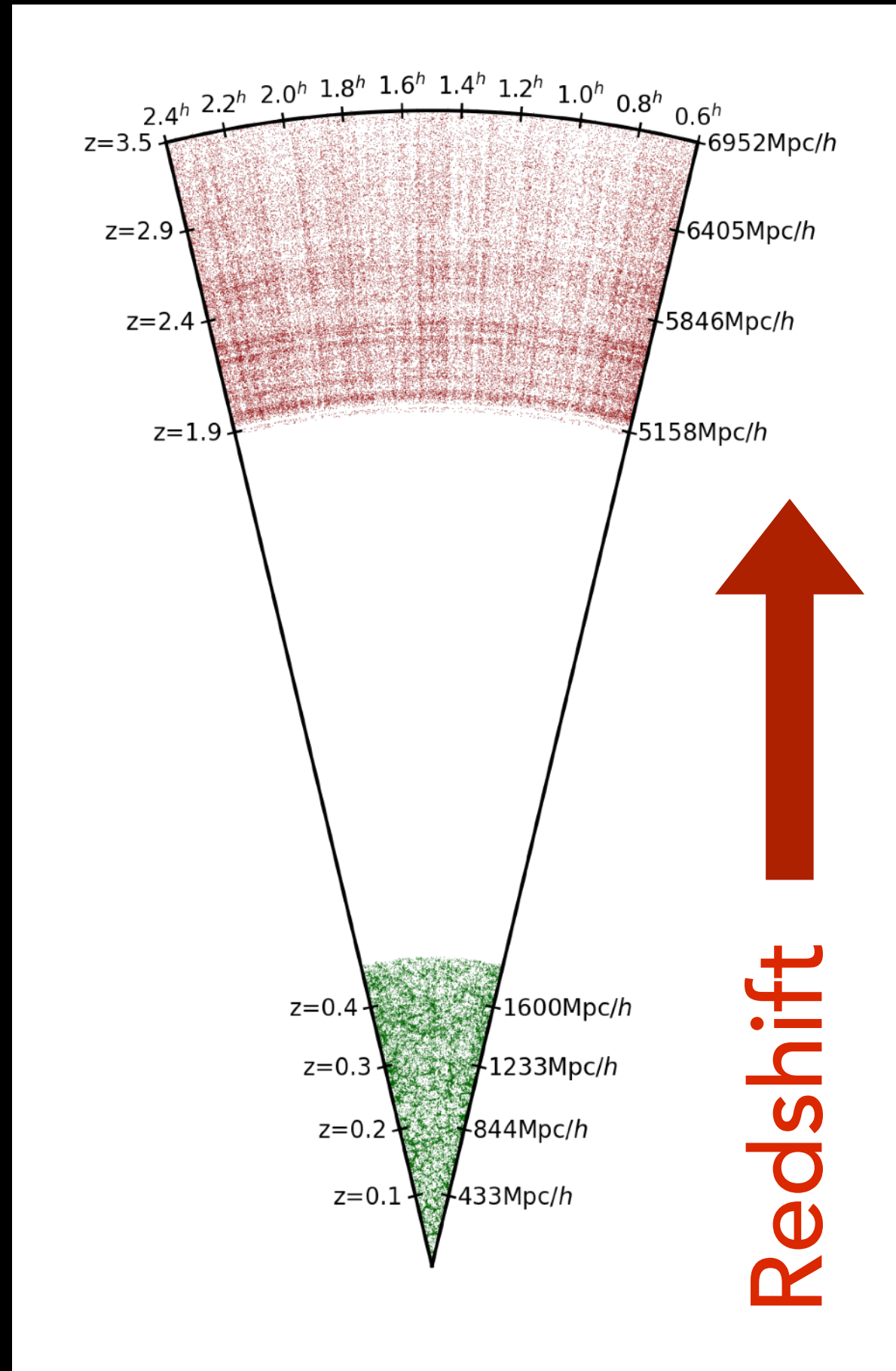
# HETDEX

- The Hobby-Eberly Telescope Dark Energy Experiment.
- HET is a  $\sim 10$  m telescope in West Texas at the McDonald Observatory equipped with the largest astronomical instrument built so far
- **Untargeted**, 540 sq. degree spectroscopic survey
- 35K fibers and 100K spectra per observation with  $R \sim 800$  and wavelengths 3500 – 5500 Å
- Map over 1 Million Lyman Alpha Emitting galaxies  $1.9 < z < 3.5$
- Constrain  $H(z)$  and  $D_A(z)$  to  $< 1\%$  for  $z \sim 2.4$

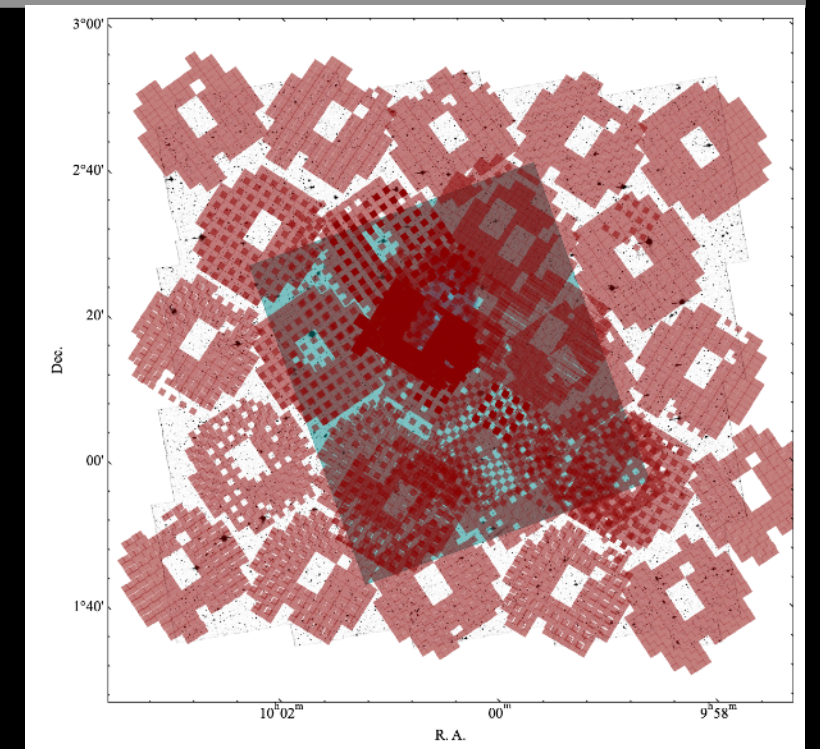


Visible Integral-field  
Replicable Unit  
Spectrograph (VIRUS)

# HETDEX - Two Main Survey Fields



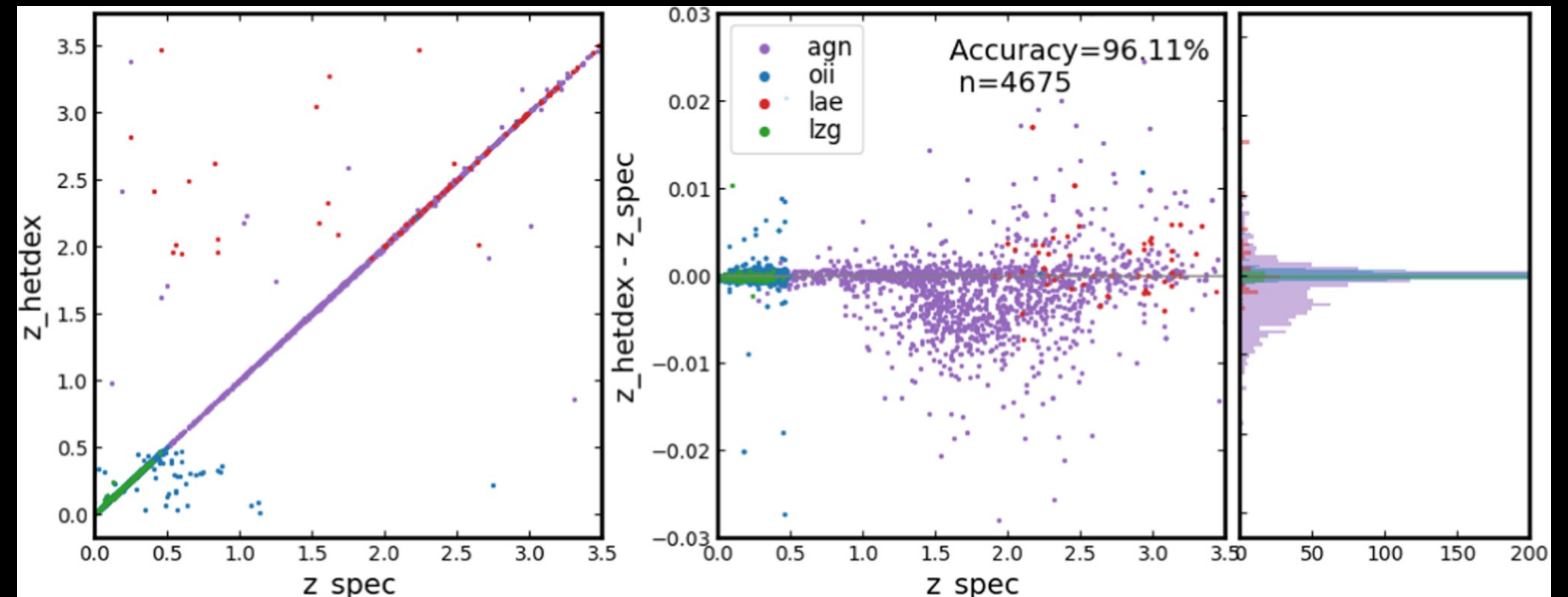
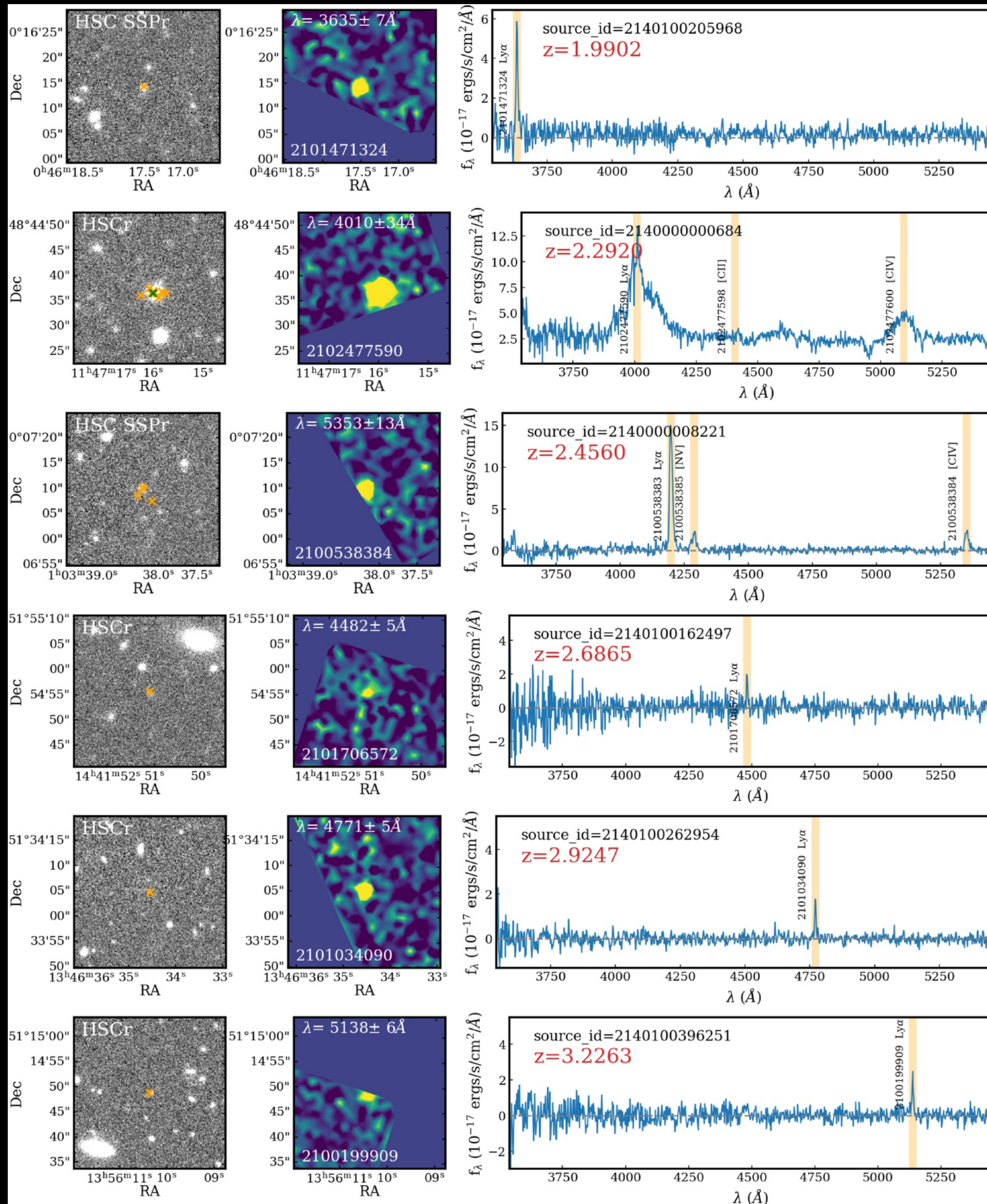
- Currently have 500K ELGs at  $z < 0.5$  and +800K LAEs at  $1.9 < z < 3.5$
- Non-contiguous tiling over main fields
- Full field coverage of COSMOS
- ~20% IFU fiber coverage in each 22 arcmin pointing
- Observing began in 2017 and is to be completed by end of 2024.
- Currently 90% complete.



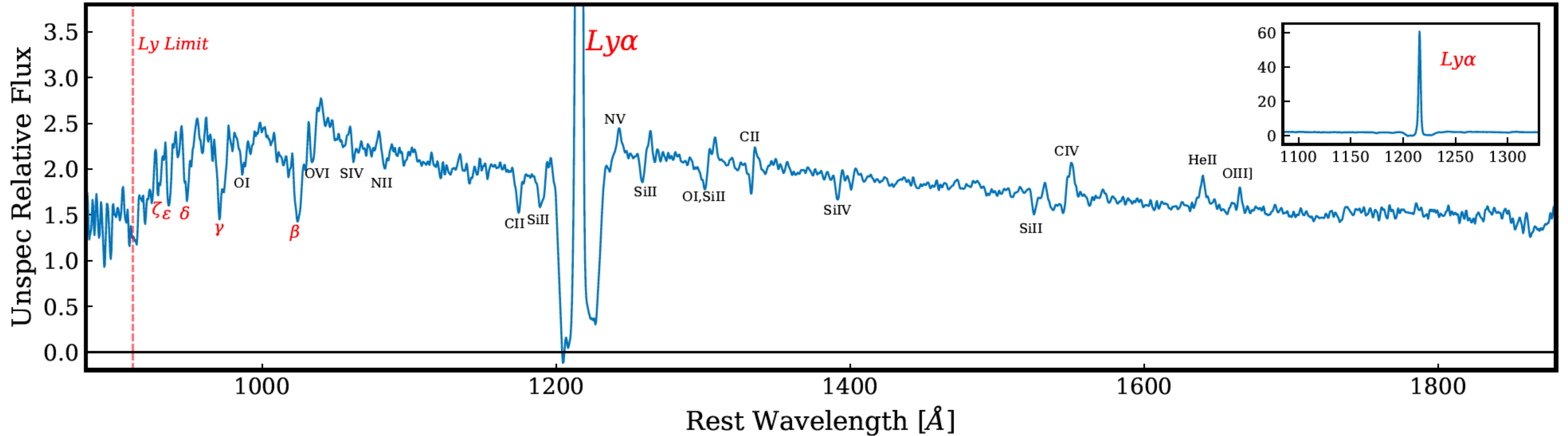
COSMOS

# HETDEX Public Catalog 1

- First source catalog published in [Mentuch Cooper+2023](#). Includes coordinates, redshifts and spectra of over 50K LAEs plus 200K other objects ( $z < 0.5$  ELGs, low- $z$  gals, AGN, stars)
- Redshifts are determined through multiple methods. Continuum sources ( $g < 22$ ) use spectral template fitting (**Diagnose** <https://github.com/grzeimann/Diagnose>), fainter sources rely on LAE/OII discrimination methods (**EliXeR**, [Leung+2017](#), [Davis+2023a](#)), AGN redshifts come from the HETDEX AGN Catalog 1 ([Liu+2022](#)). Accurate to 96% with LAE/OII discrimination better than 3%



# Stack of 50K HETDEX LAEs

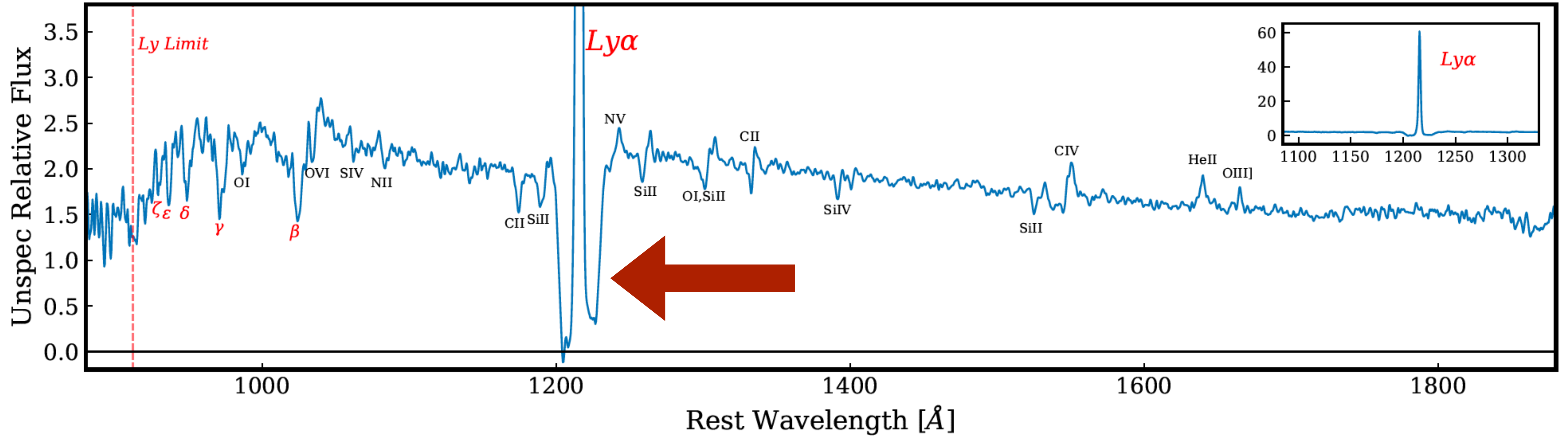


Credit: Dustin Davis/UT Austin Postdoc

Spectral stack of public sample in [Davis+2023b](#) produces remarkable spectrum of the average HETDEX LAE. Each bump and wiggle in this spectrum is a real spectral feature.



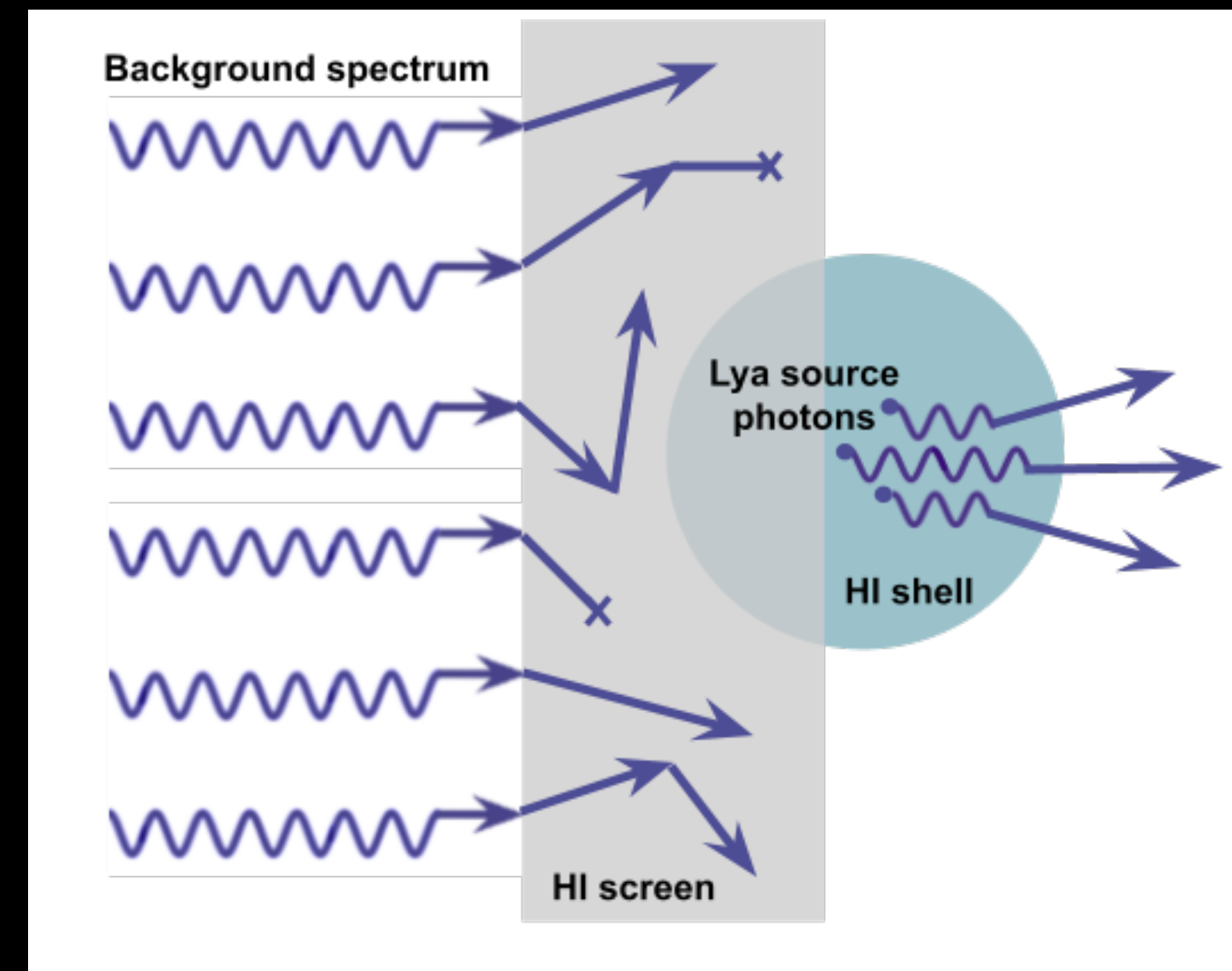
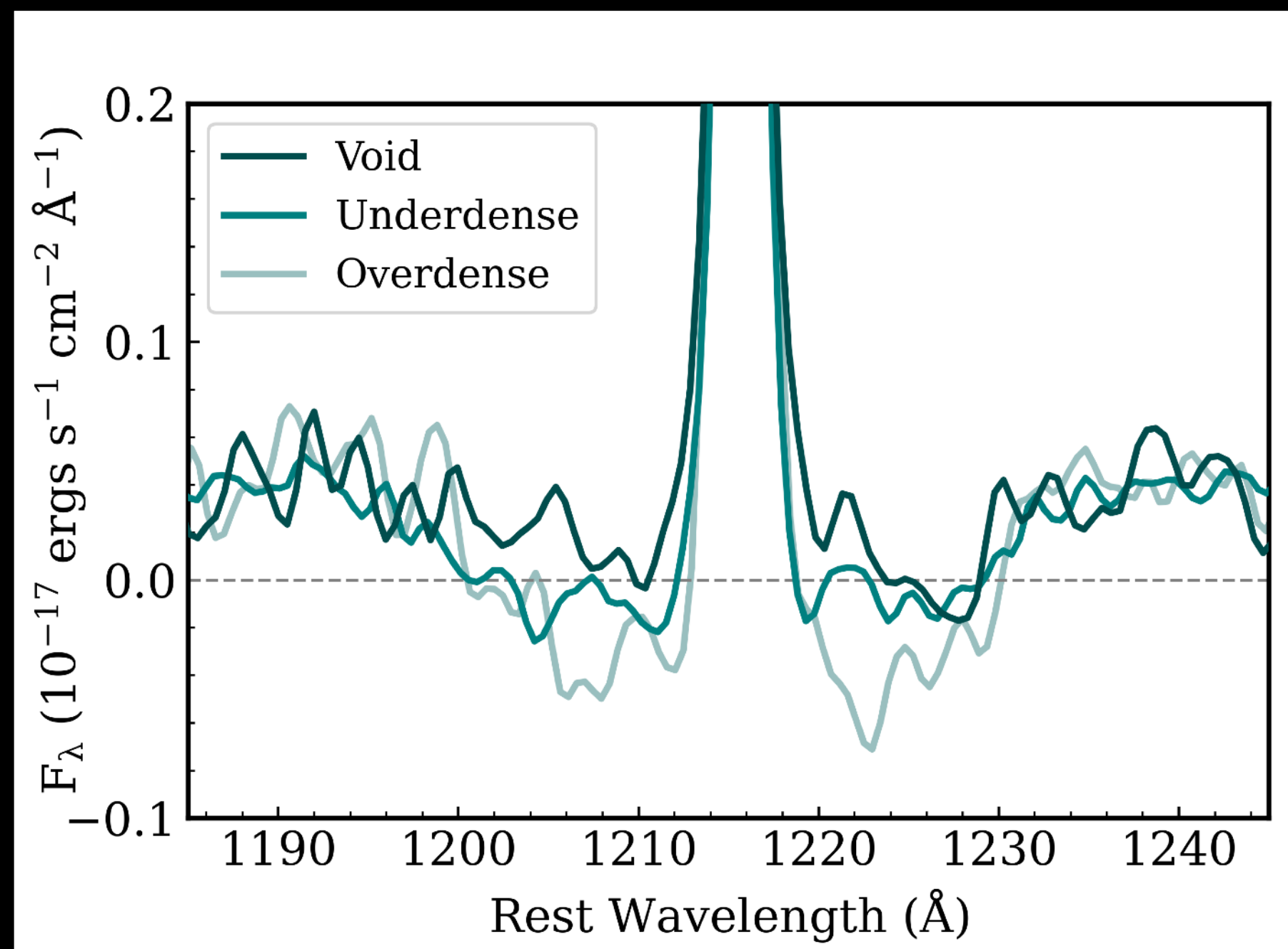
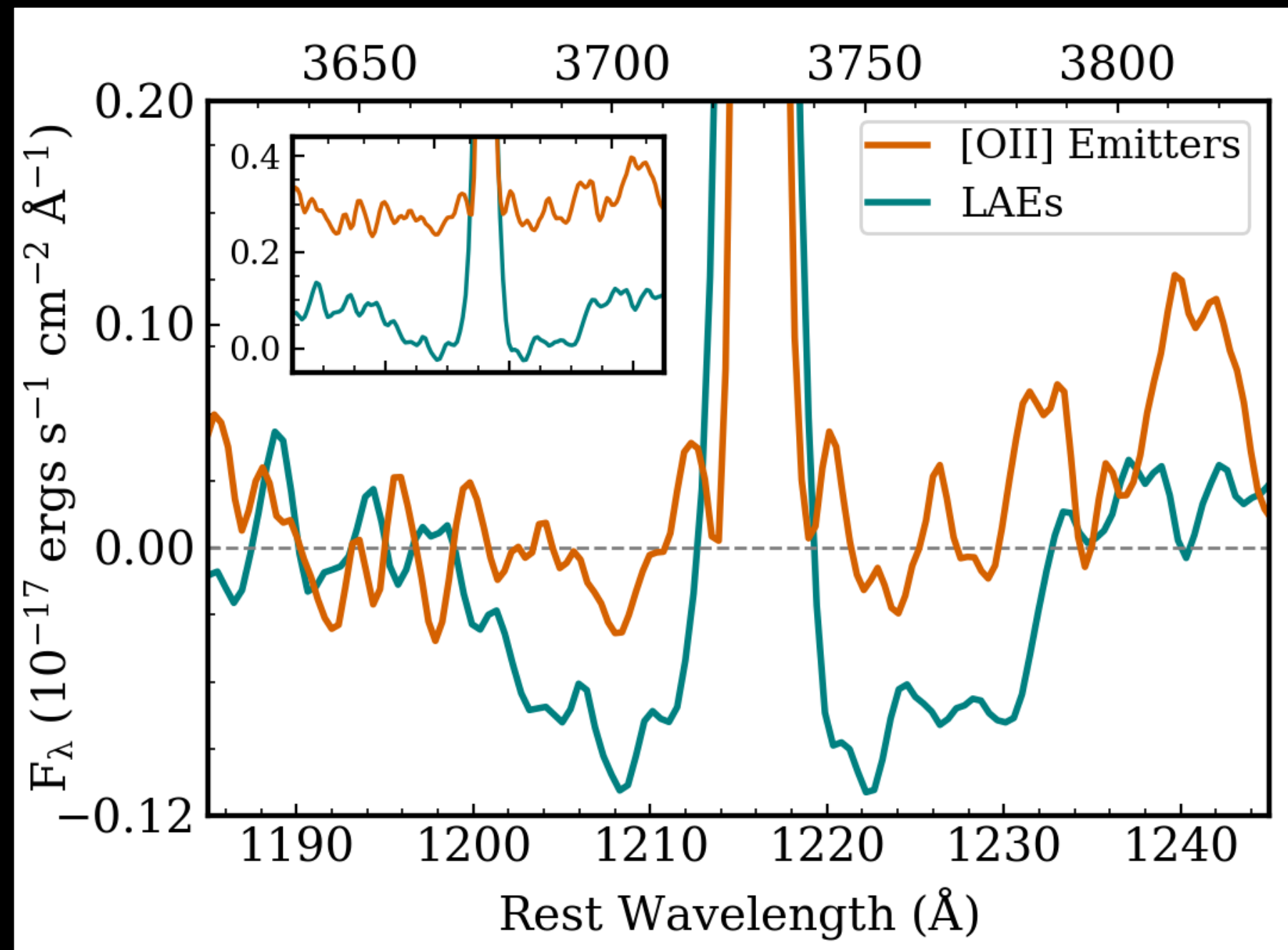
# Stack of 50K HETDEX LAEs



Nearly everywhere we detect Ly $\alpha$  emission, we see related Ly $\alpha$  absorption in stacked spectra.

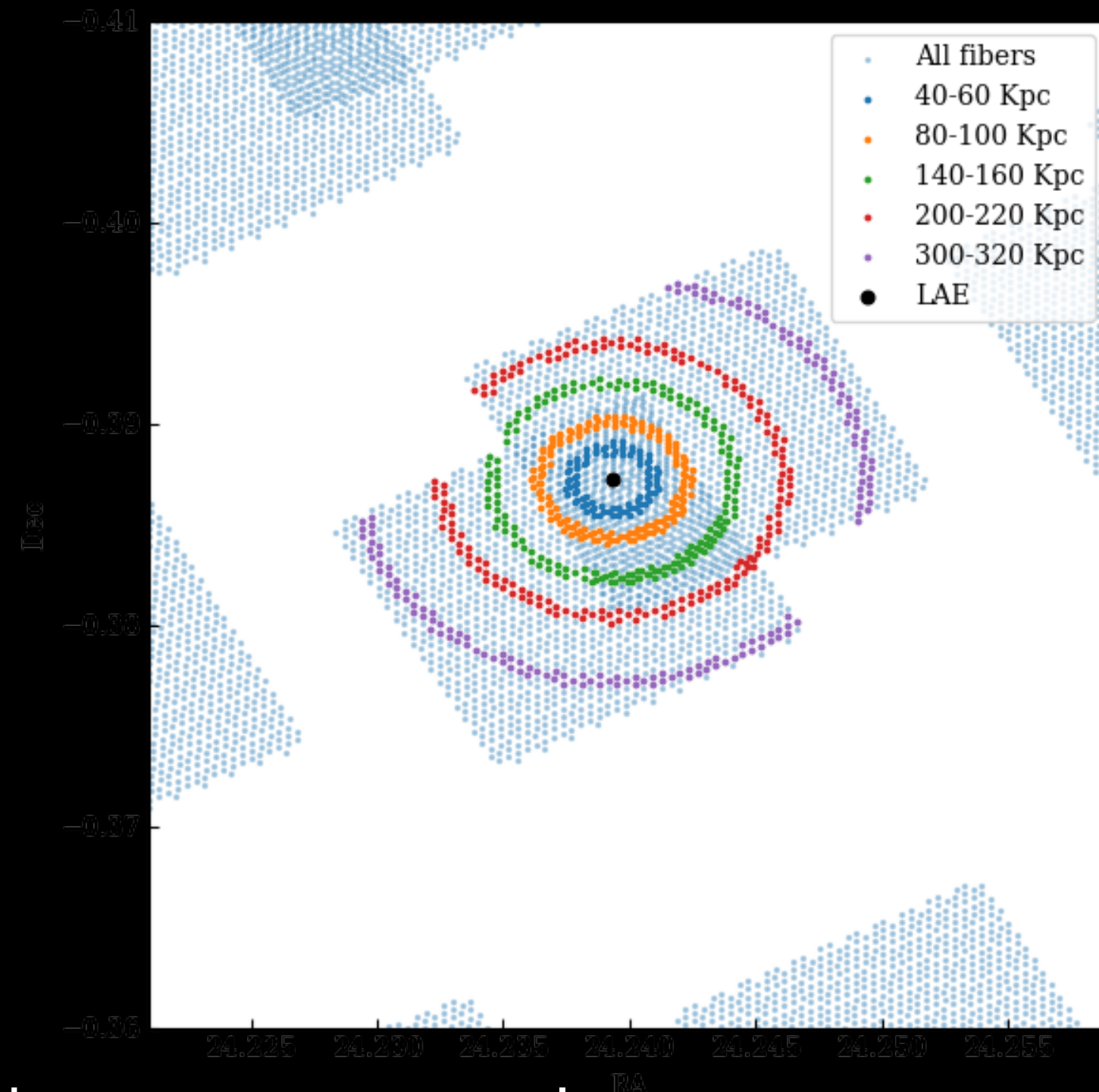
# Ly $\alpha$ Absorption

- Nearly everywhere we detect Ly $\alpha$  emission, we see related Ly $\alpha$  absorption in stacked spectra.
- In Weiss et al. 2024 ([arXiv: 2401.02490](https://arxiv.org/abs/2401.02490)), over 300K LAE spectra are stacked for various samples, in all of the stacks we find absorption wings which extend  $\sim 2000$  km/s both blueward and redward of the central Ly $\alpha$  emission
- Suggests neutral HI gas surrounding the central LAE is absorbing anisotropic background UV radiation.

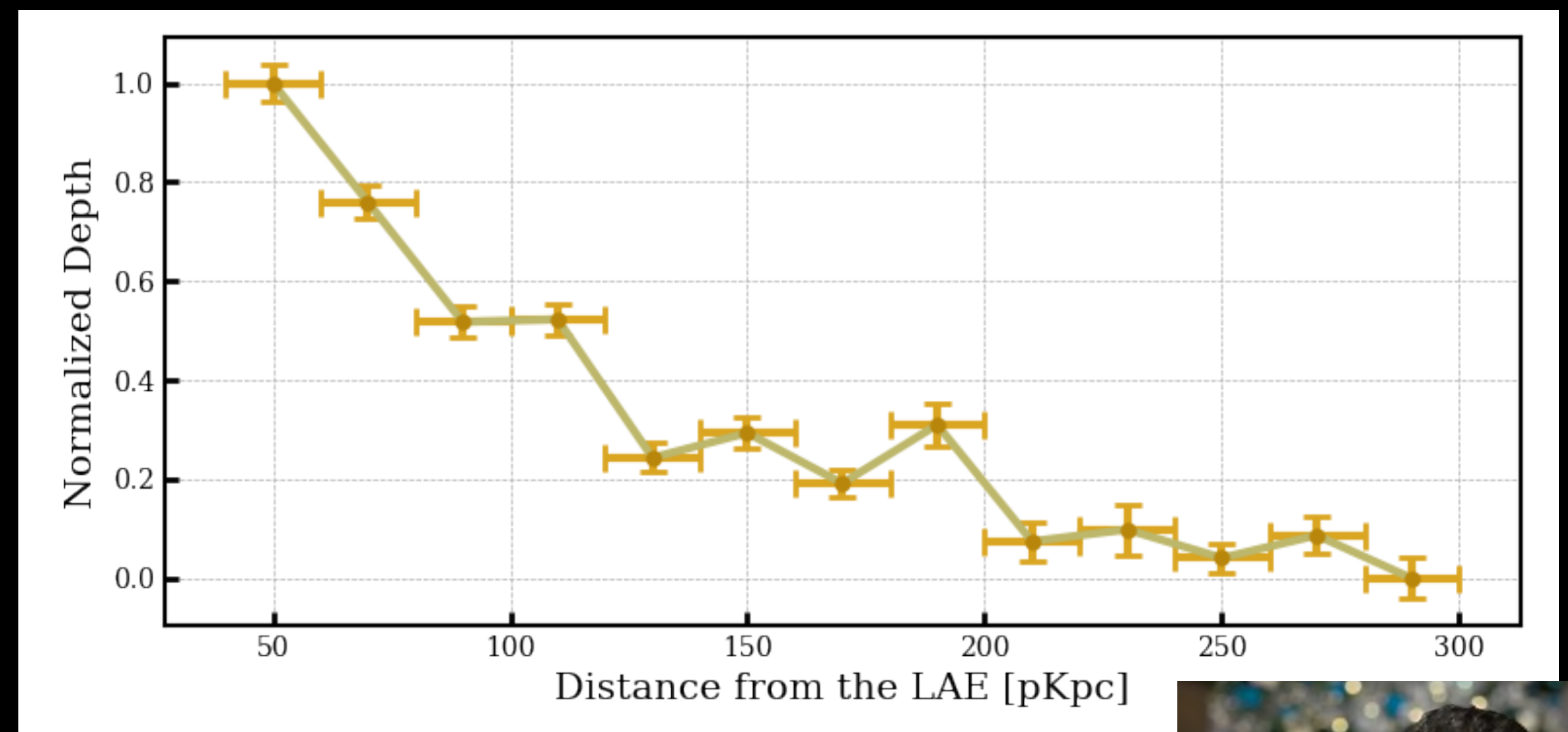
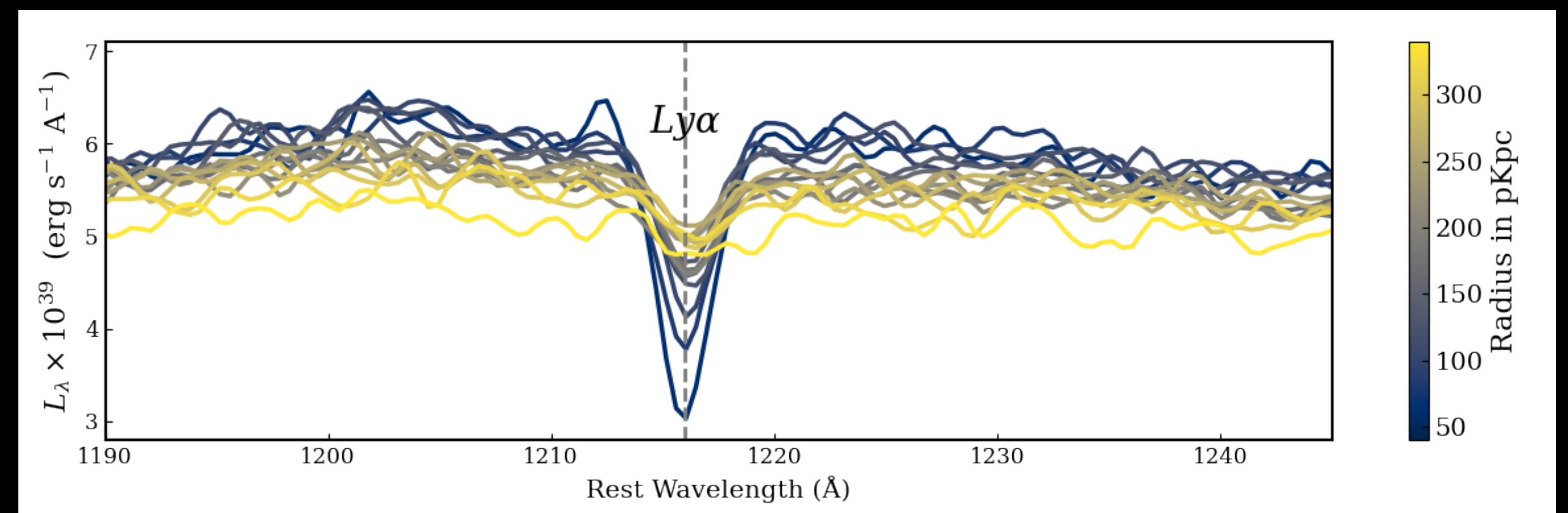


Laurel Weiss.  
PhD Candidate.  
UT Austin

# Ly $\alpha$ Absorption



Absorption is also seen spatially when fibers are stacked in annuli based on distance to central LAE.



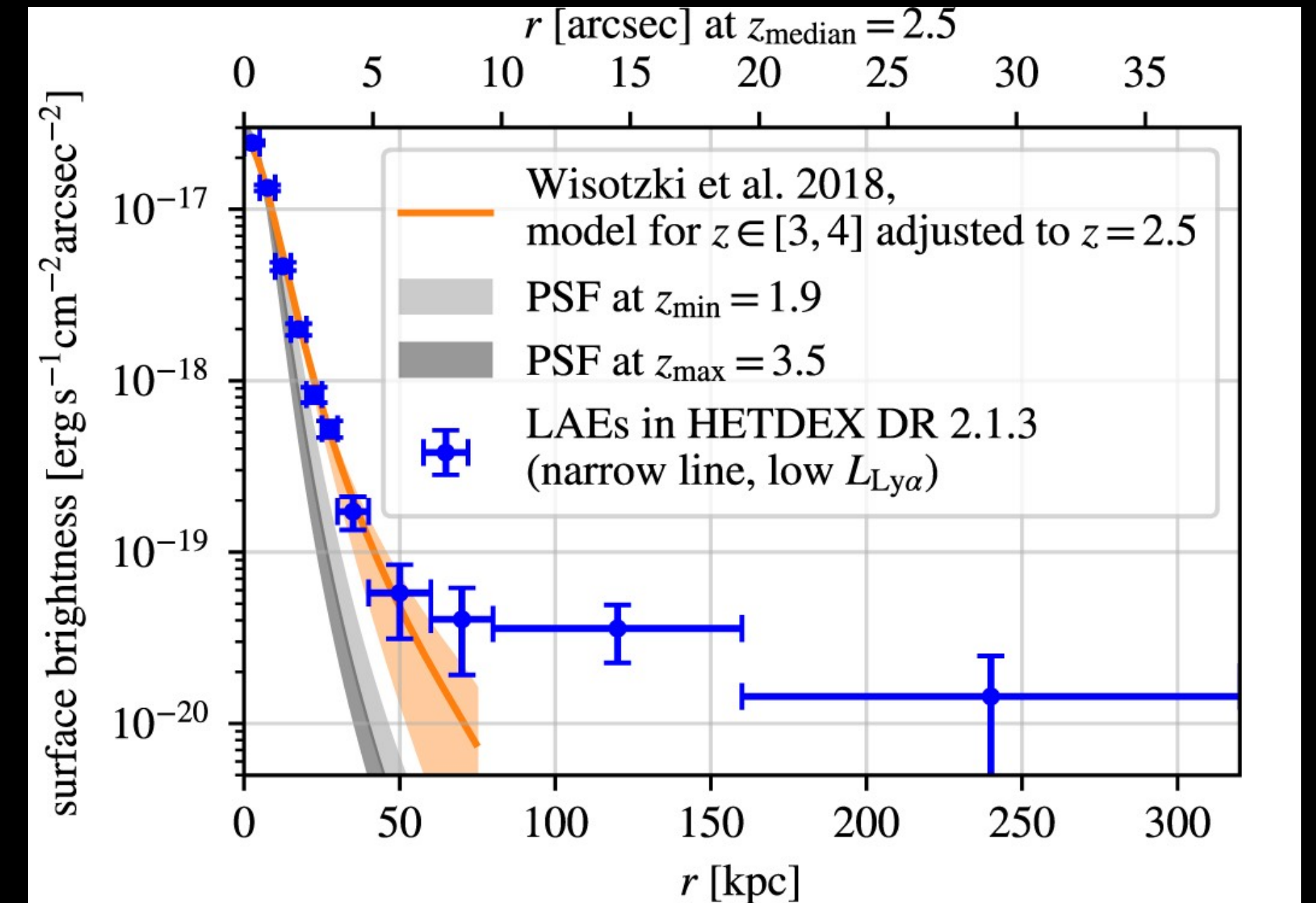
Check out this great work by **Mahan Mirza Khanlari** from UT-Austin Poster Session 407. Thursday @ 9-10 AM



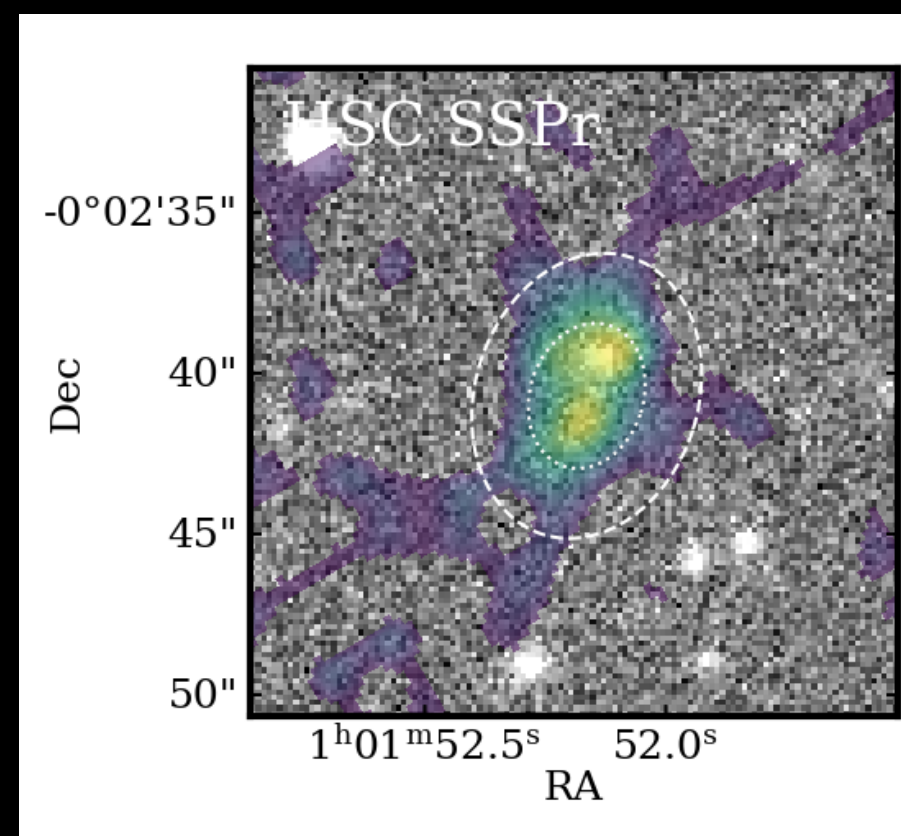
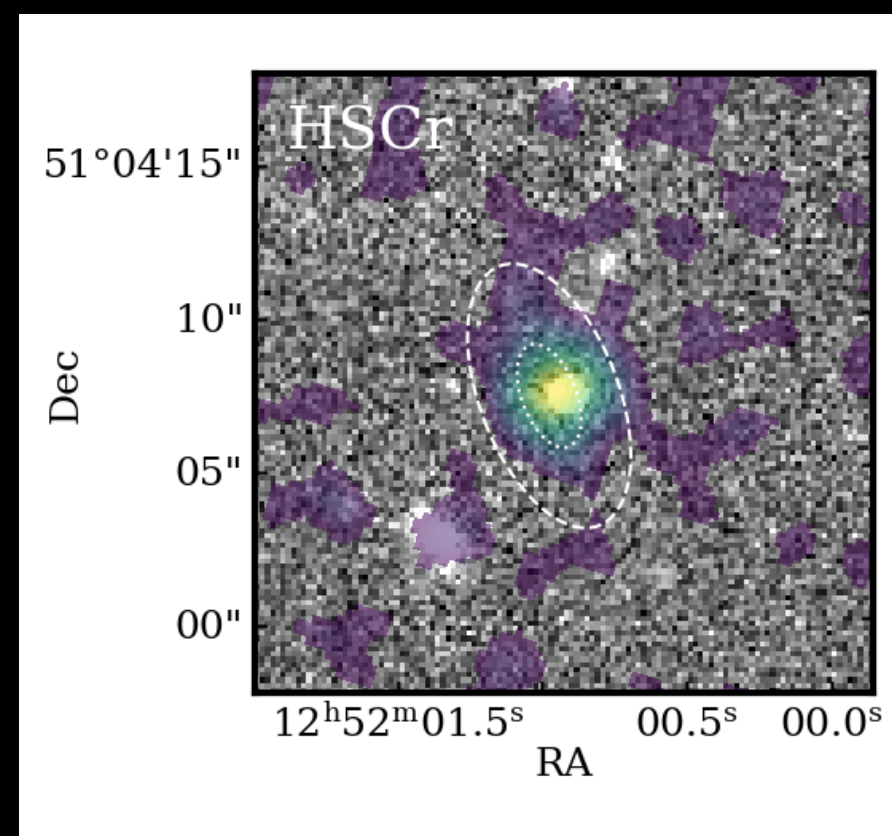
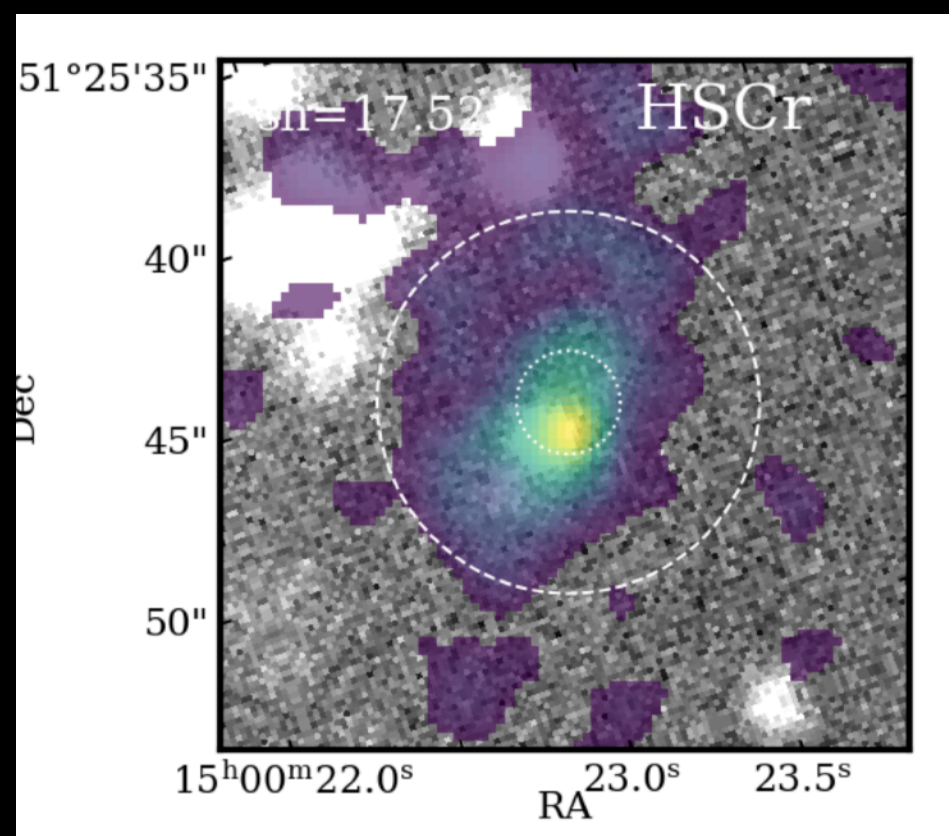


# Extended Ly $\alpha$ emission

- We find extended emission on scales of  $\sim 10''$  at distances up to 50 pkpc surrounding the most brightest LAEs in the sample.
- The latest internal HETDEX catalog contains +1K extended LAEs.
- 3/4 of these are not AGN dominated.



- In stacked samples of  $S/N > 6$  LAEs (with AGN removed), [Lujan Niemeyer+2022](#) find the emission extends out to 300 kpc.
- Inner  $\sim 100$  kpc, is dominated by resonant scattering from the central galaxy but at higher distances CGM heating appears to dominate.



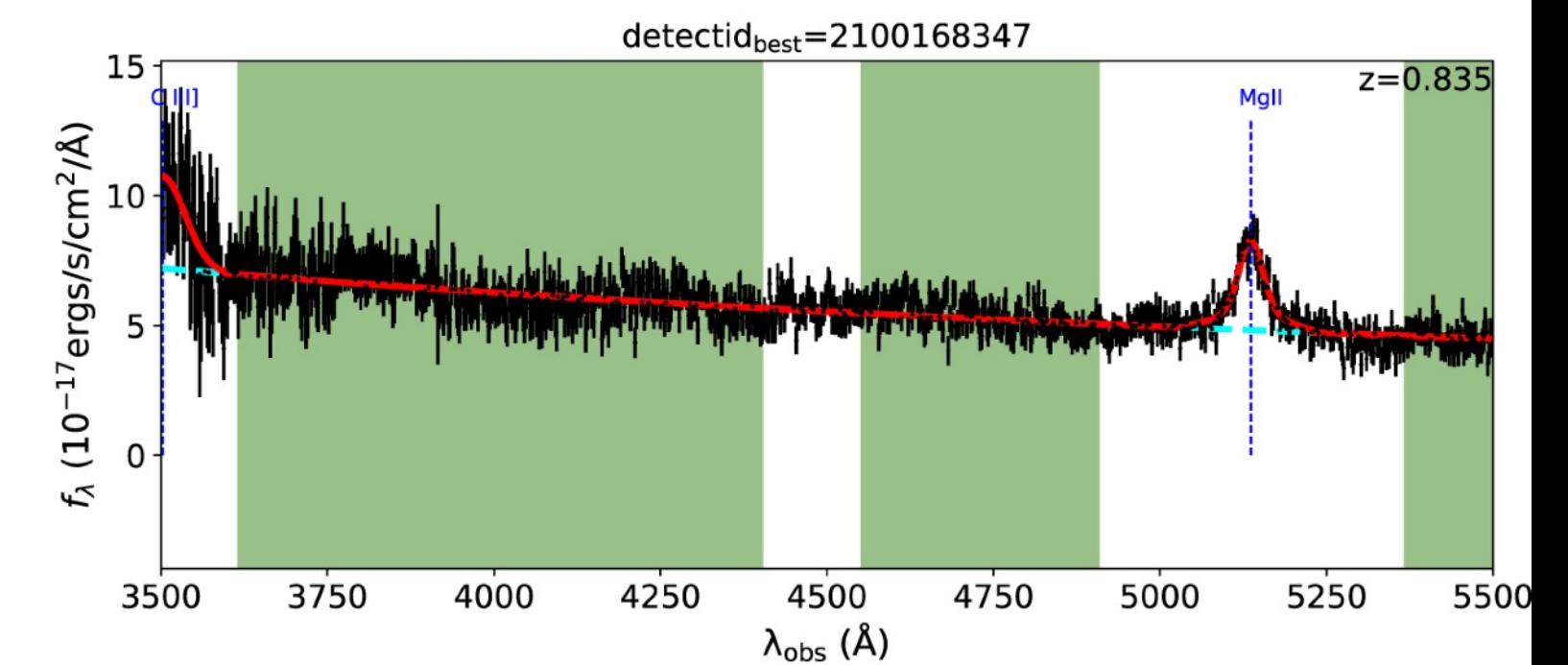
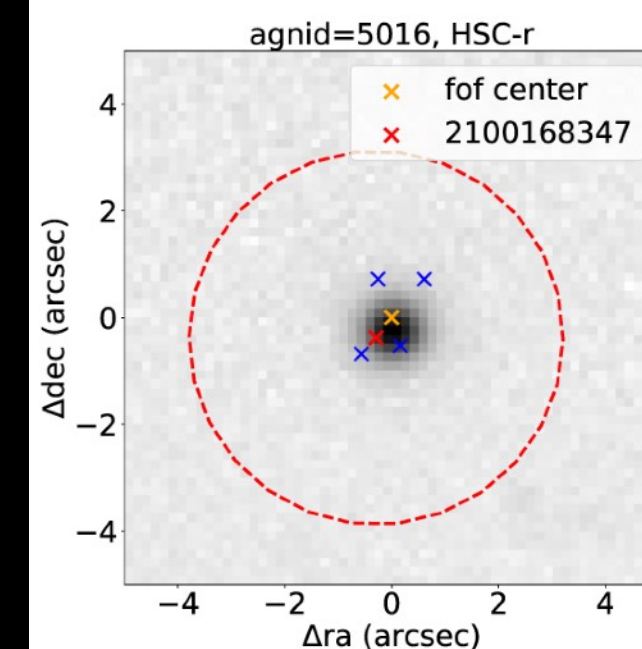
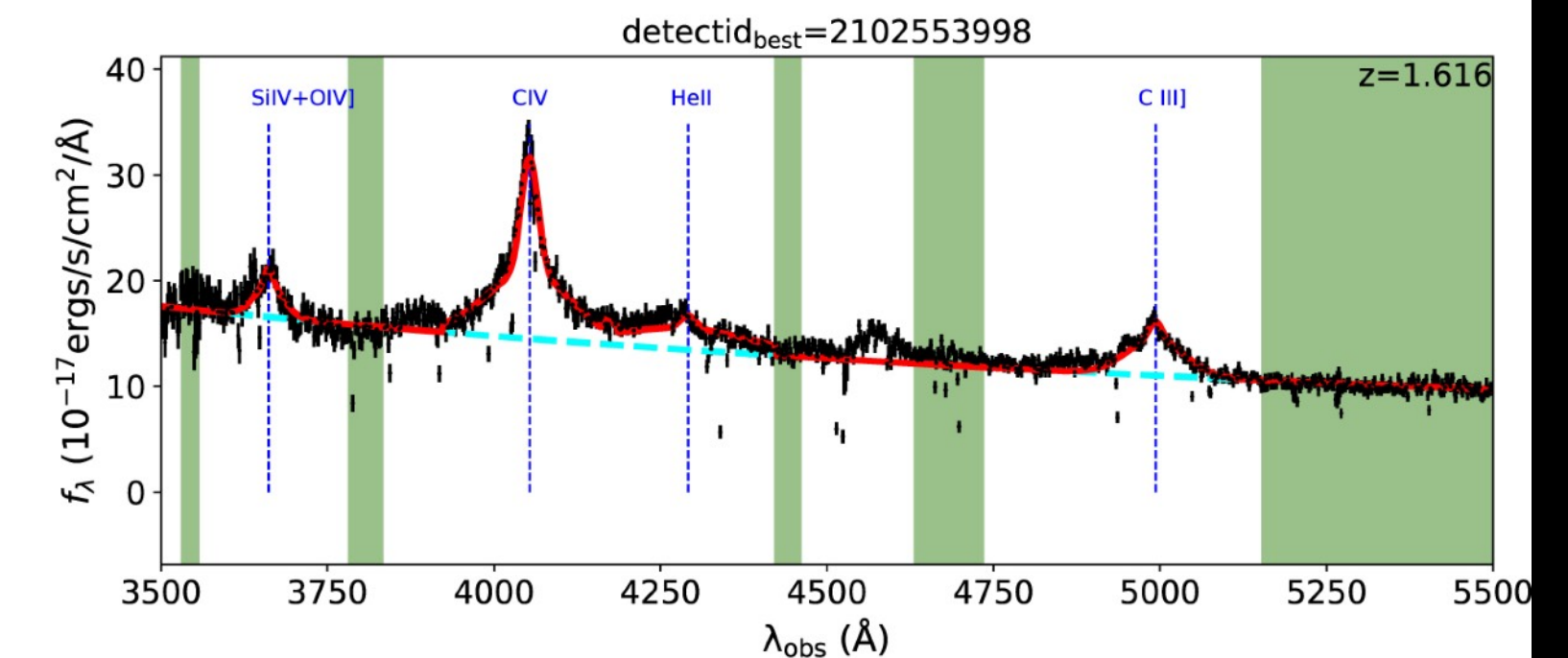
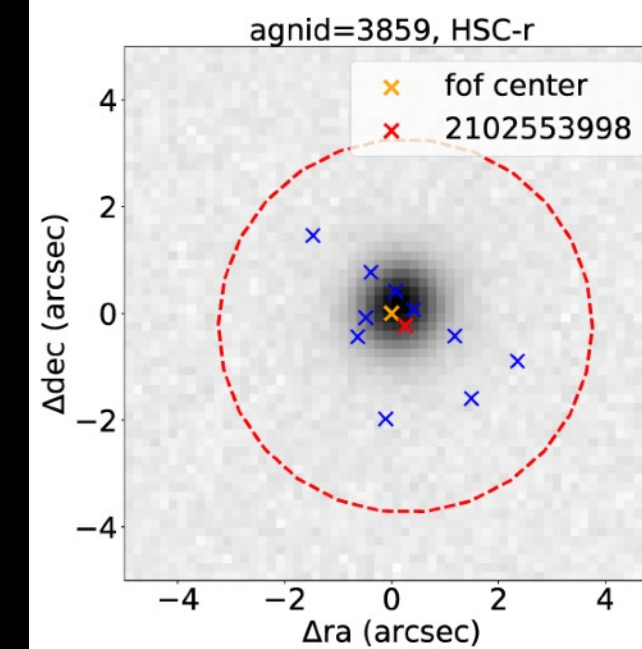
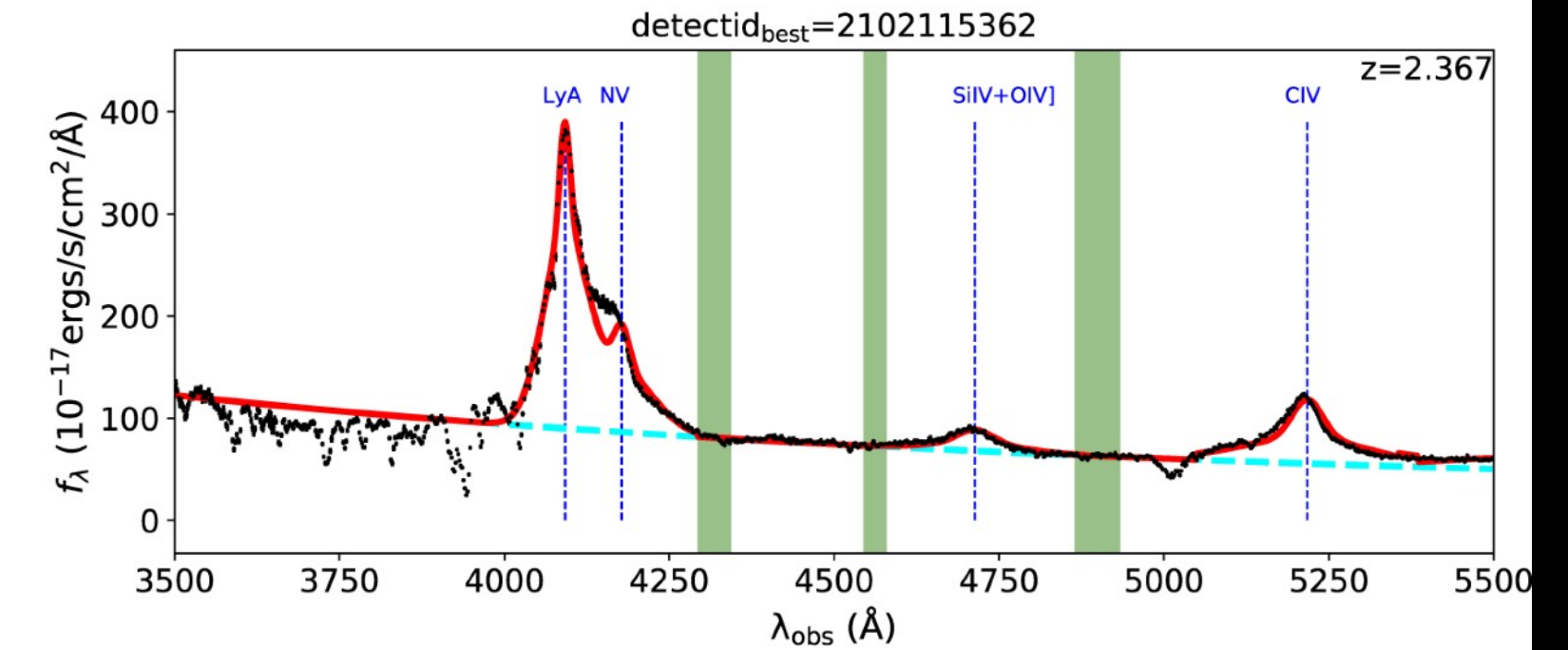
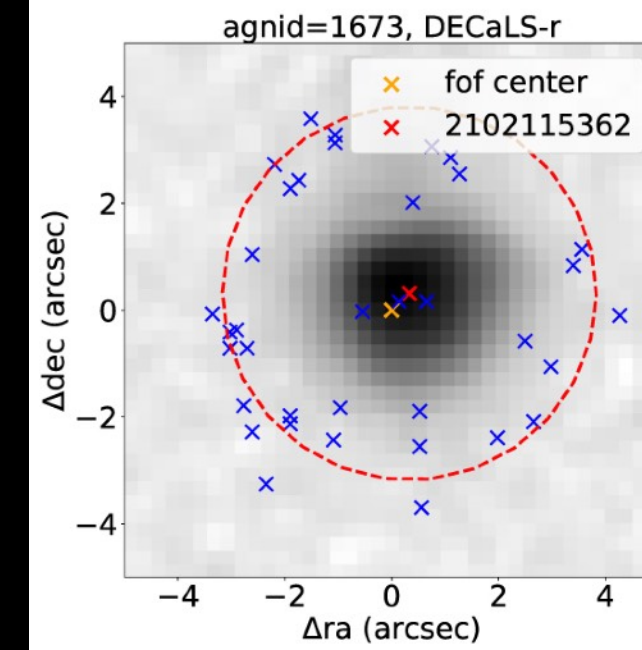
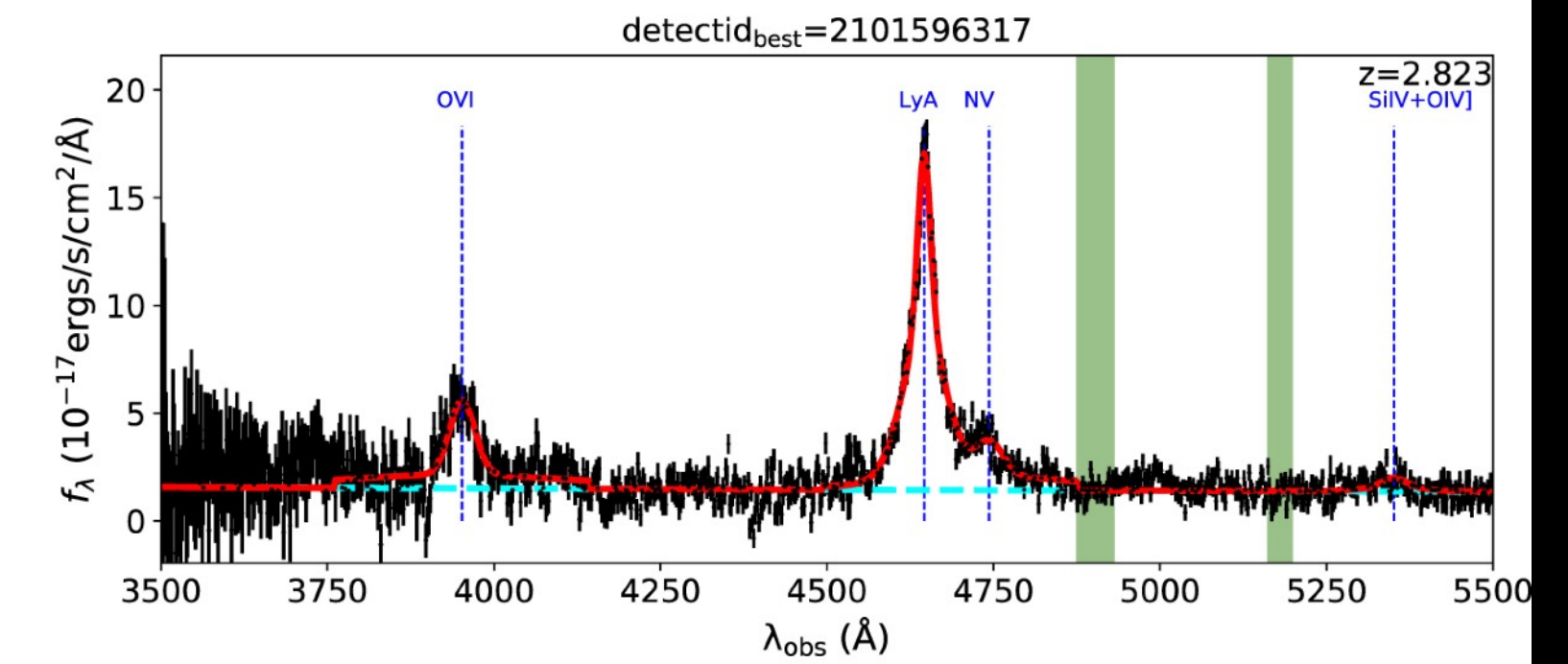
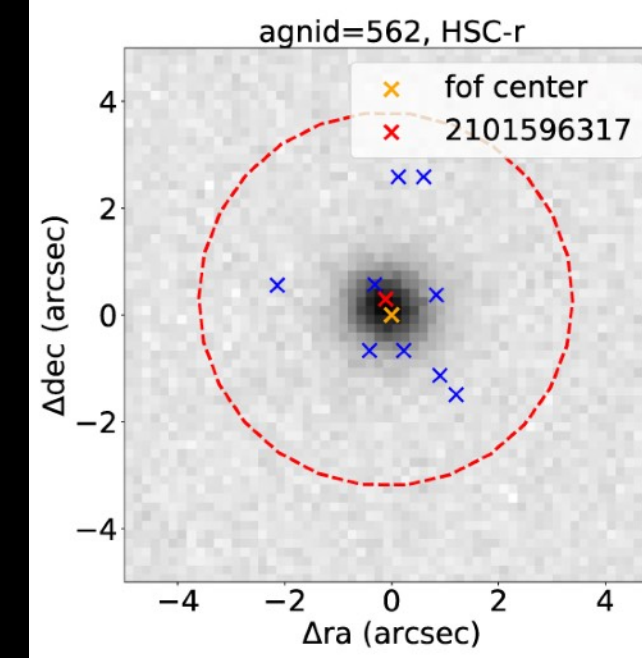
Mentuch Cooper et al, in prep

# HETDEX AGN

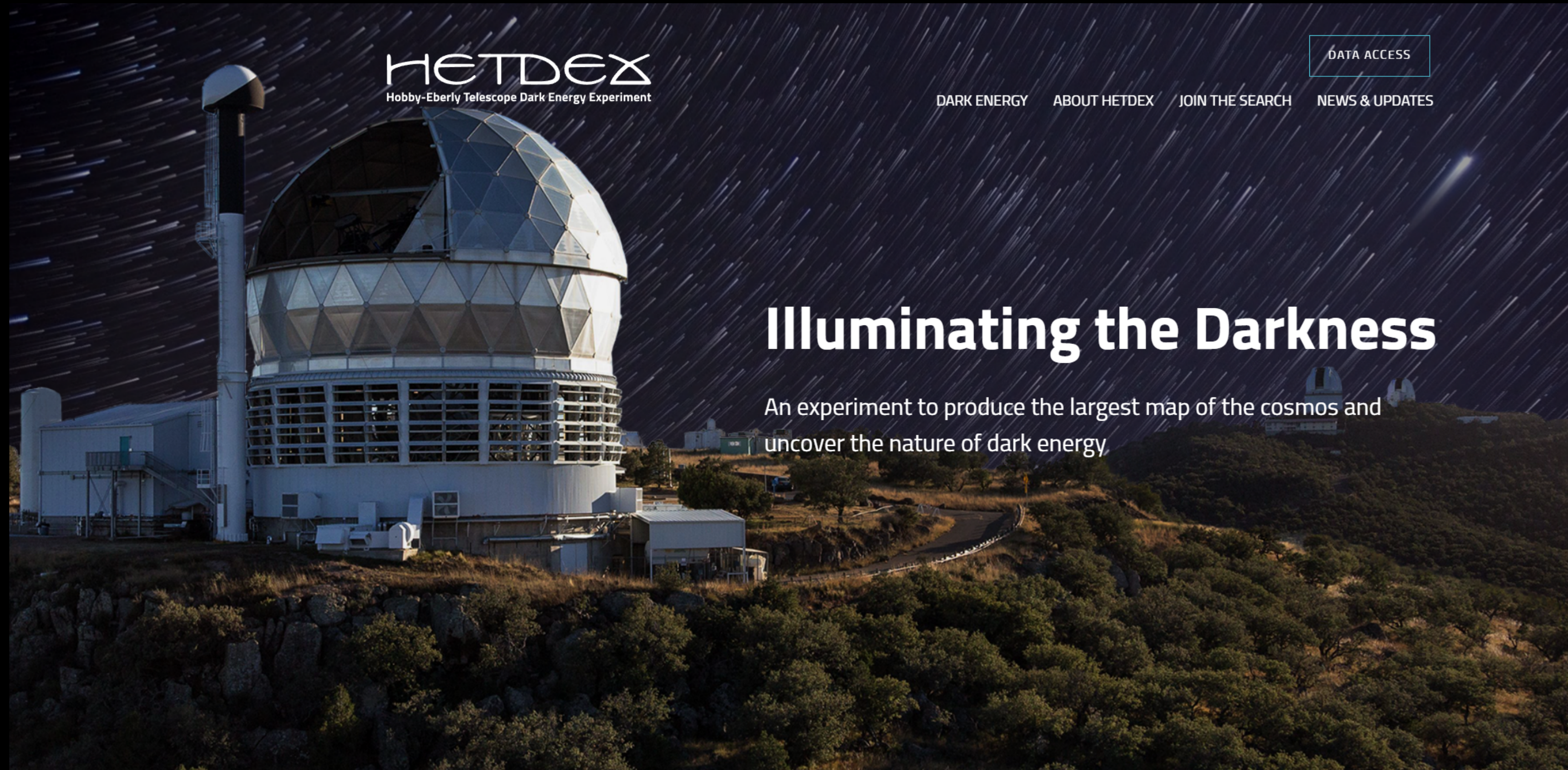
- First AGN catalog ([Liu+2022](#)) release contains 5322 AGN
- AGN are selected based on broad line emission and/or dual emission line selection (e.g. Ly $\alpha$ +CIV, OVI+Ly $\alpha$ , CIV+CIII, many more)
- HETDEX will ultimately find over 10K AGN without any photometric pre-selection



Check out undergraduate **Kristina Gatto's** (Sienna College) iPoster later today 5:30-6:30 PM (364) Finding the Most Extreme Galaxies and Black Holes in HETDEX



For more info visit: [hetdex.org](http://hetdex.org)



A cosmological survey of >1 million LAEs to measure Dark Energy at  $1.9 < z < 3.5$



Become a **Dark Energy Explorer** and help classify HETDEX data at [zooniverse.org](http://zooniverse.org)