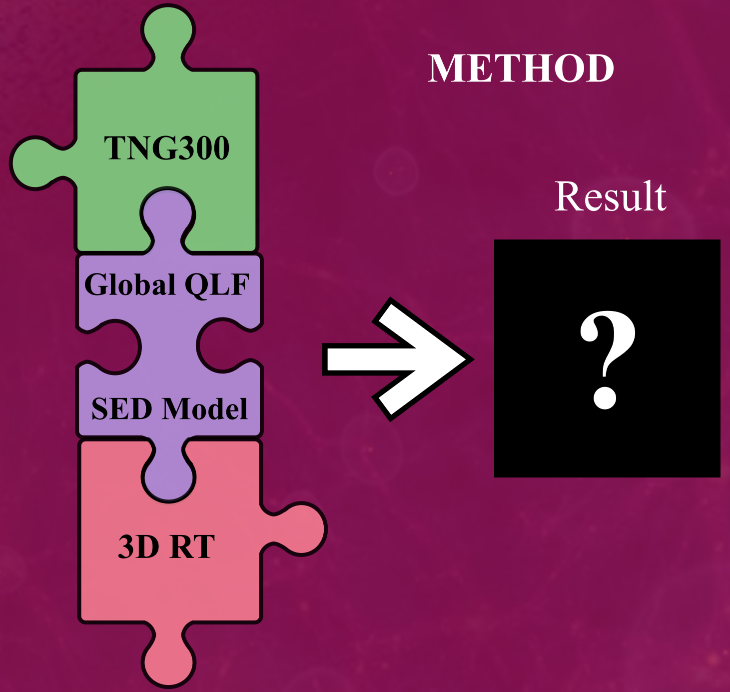
Implications of Global Quasar LF Constraints on Helium Reionization

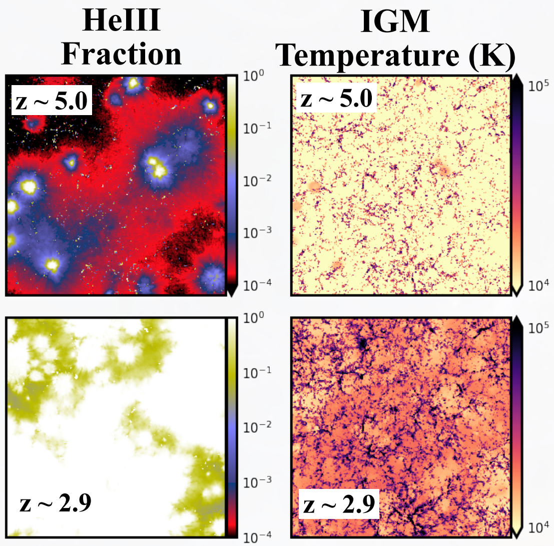
Arghyadeep Basu
Max Planck Institute for Astrophysics (MPA), Garching
Collaborators: Benedetta Ciardi, Enrico Garaldi et. al

SCIENTIFIC GOAL

Predict HeII Lyman-α forest features using global constraints on the QLF and compare with observed forest properties via running radiative transfer simulations.

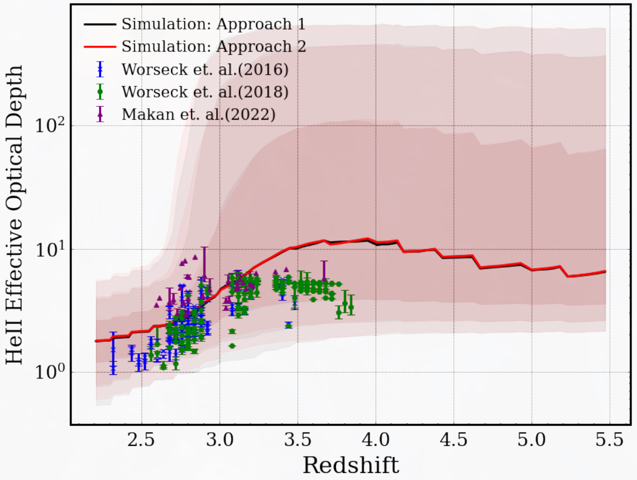
METHOD





Slice maps show effect of QSOs onto the IGM

Simulations reproduce the scatter in the low-z HeII optical depth observations.



Want to know more?

Please contact me !

I am waiting for you !

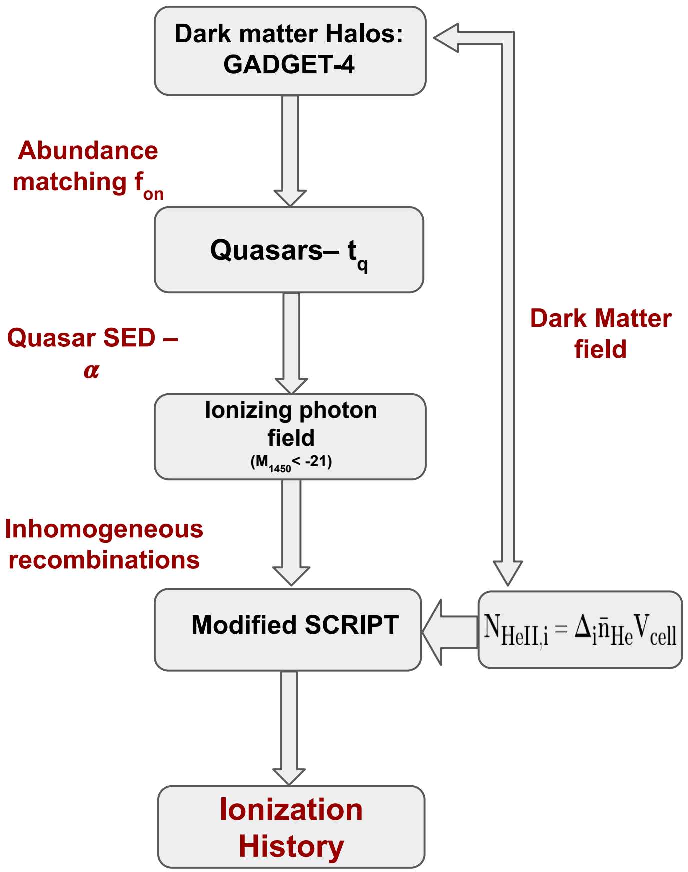
Marseille , 3-7 July '23

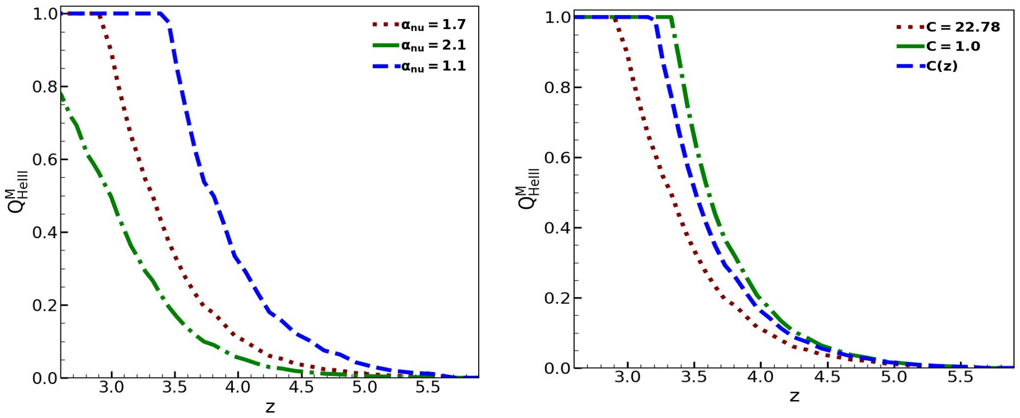
Semi-numerical Simulations of the Epoch of Helium Reionization

Akanksha Kapahtia
(Post Doctoral Fellow)
&
Tirthankar Roy Choudhury

NCRA • TIFR

Ionization history





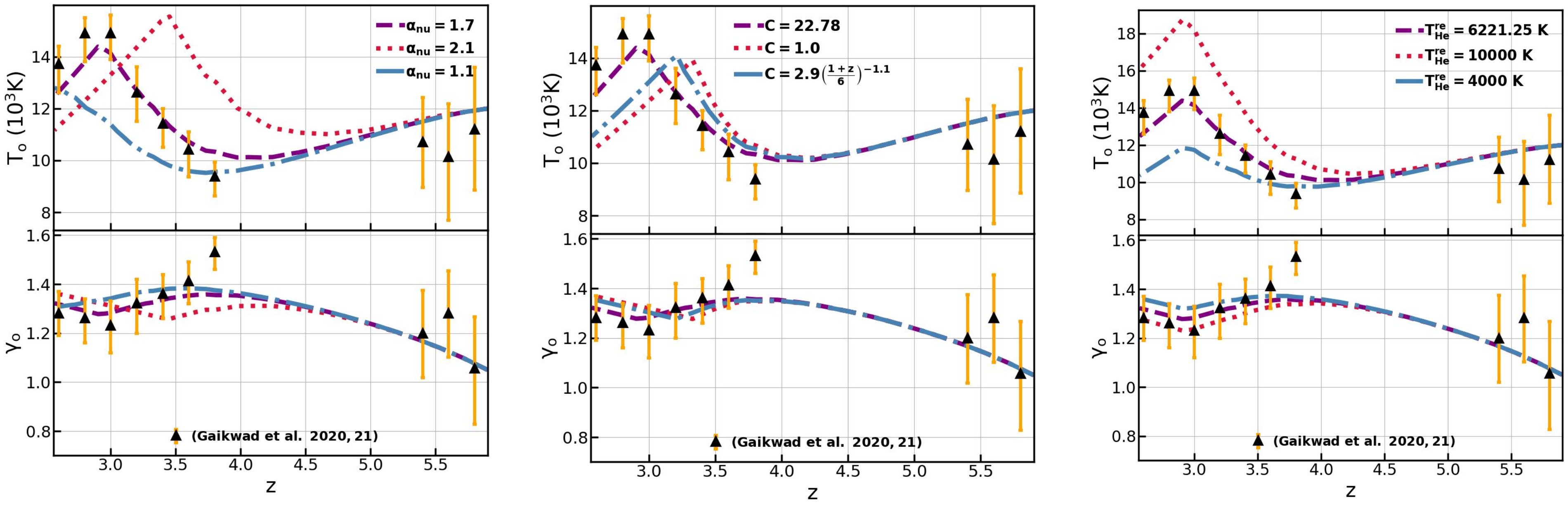
Photoionization heating: Subgrid Formalism

Adiabatic expansion of the universe

Adiabatic expansion and contraction due to structure formation

The dominant heating due to photoionization heating by hydrogen and helium ionization is by solving:

$$\frac{dT_i}{dz} = \frac{2T_i}{1+z} + \frac{2T_i}{3\Delta_i}\frac{d\Delta_i}{dz} + T_{re}^{He}\left[C_{He,i}\alpha_B^{HeIII}\chi_{HeIII,i}n_{He,i}(1+z)^3 + \frac{d\chi_{HeIII}}{dt}\right]\frac{dt}{dz} + T_{re}^{H}C_{H,i}\alpha_B^{HII}n_{H,i}(1+z)^3\frac{dt}{dz}$$



Lilian Lee and the CRISTAL + MPE Galaxy Evolution teams
lilian@mpe.mpg.de

MAX PLANCK INSTITUTE
FOR EXTRATERRESTRIAL PHYSICS

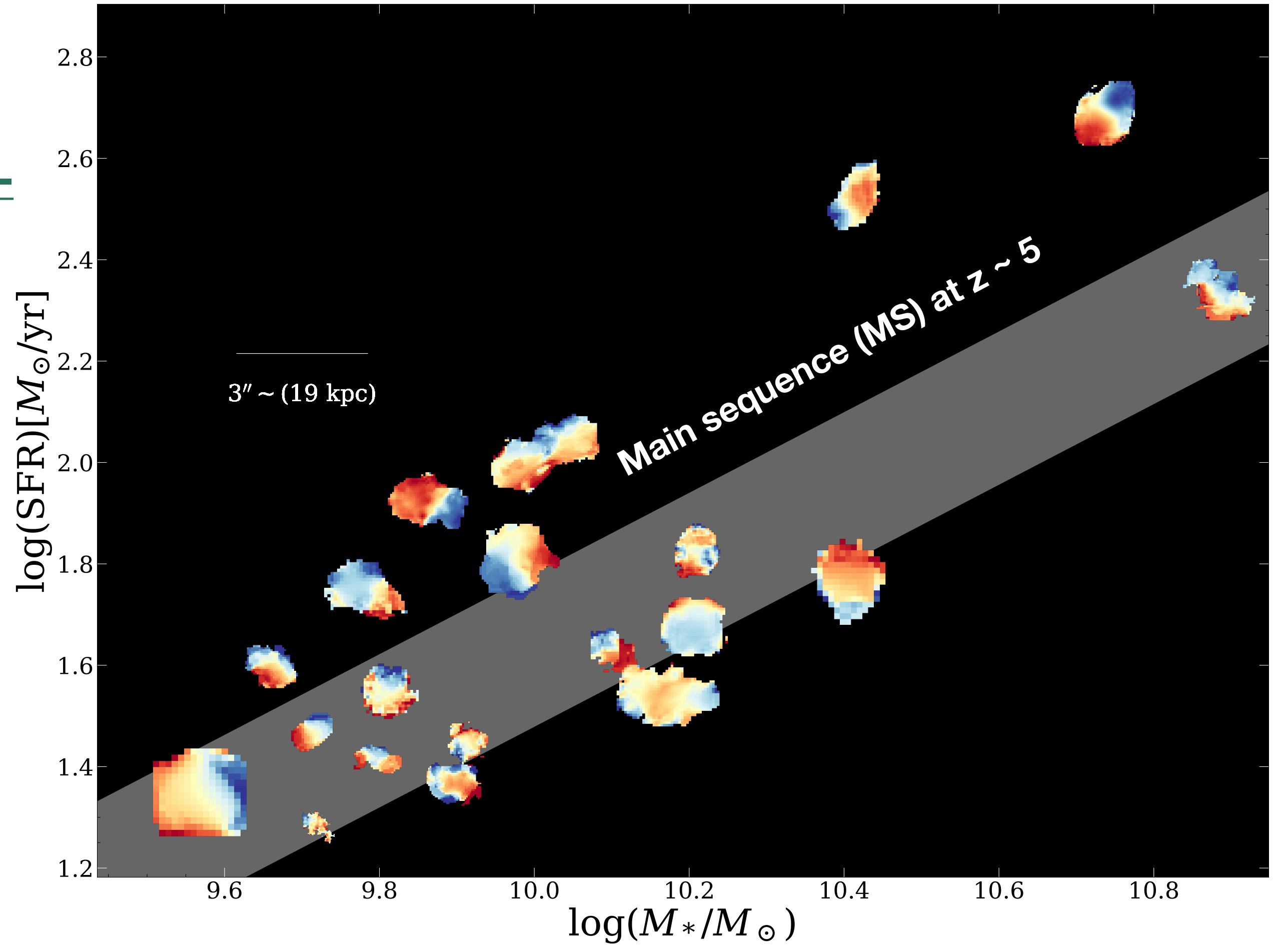
CII Surveys e.g. **ALPINE** ($z \sim 4-6$) (Le Fèvre+20) and **REBELS** ($z \sim 7-8$) (Bowens+22) along with other studies at $z > 4$ have pioneered kinematic studies at these epochs

Need homogenous sample of typical star-forming galaxies (SFGs)

CRISTAL
[CII] resolved ISM in star-forming galaxies with ALMA

See Rodrigo's talk on Friday!

- 19+ MS SFGs at $4 < z < 6$
- High resolution (0.1" - 0.4", ~ kpc scale)
- Sensitive data up to ~ 8h integration time



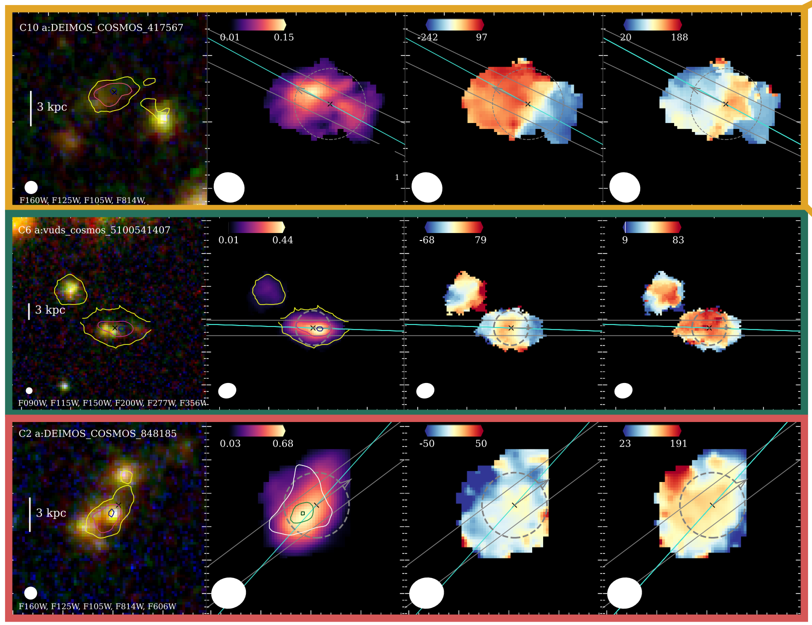
CRISTAL
[CII] resolved ISM in star-forming galaxies with ALMA

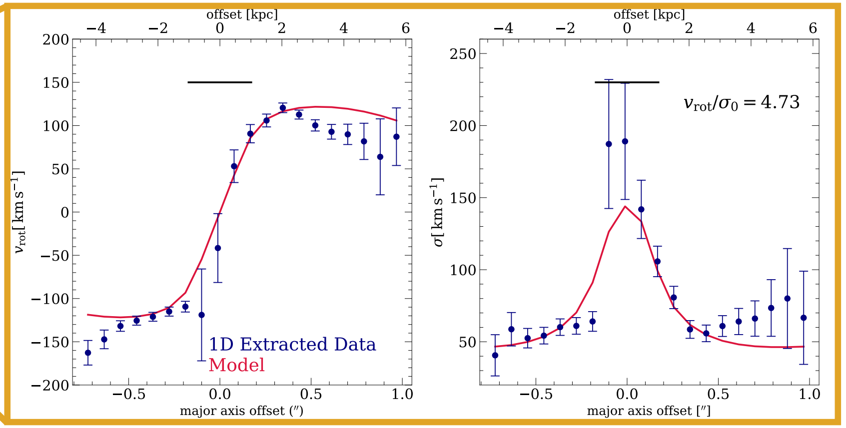
HST | Line intensity | Velocity map | Dispersion map

Disk

Interacting disk

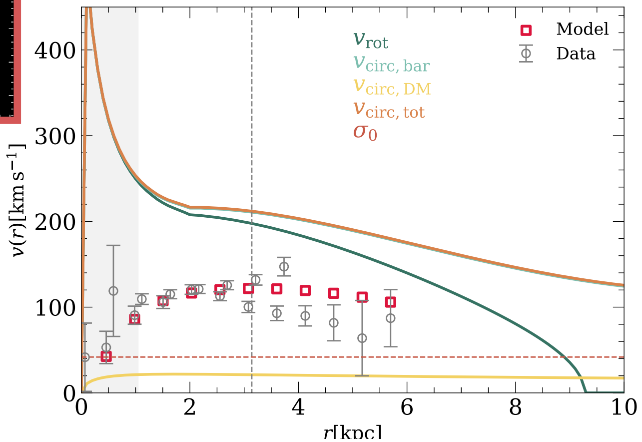
Non-disk





~ 30% kinematically classified disks (consistent with JWST Ferreira+23)

Mass budget from rotation profile



DysmalPy

e.g. Davies+11, Price+21, Liu+22, Lee+23 (in prep.)

3D modelling: Corrected for beam-smearing and projection effects

Lilian Lee lilian@mpe.mpg.de

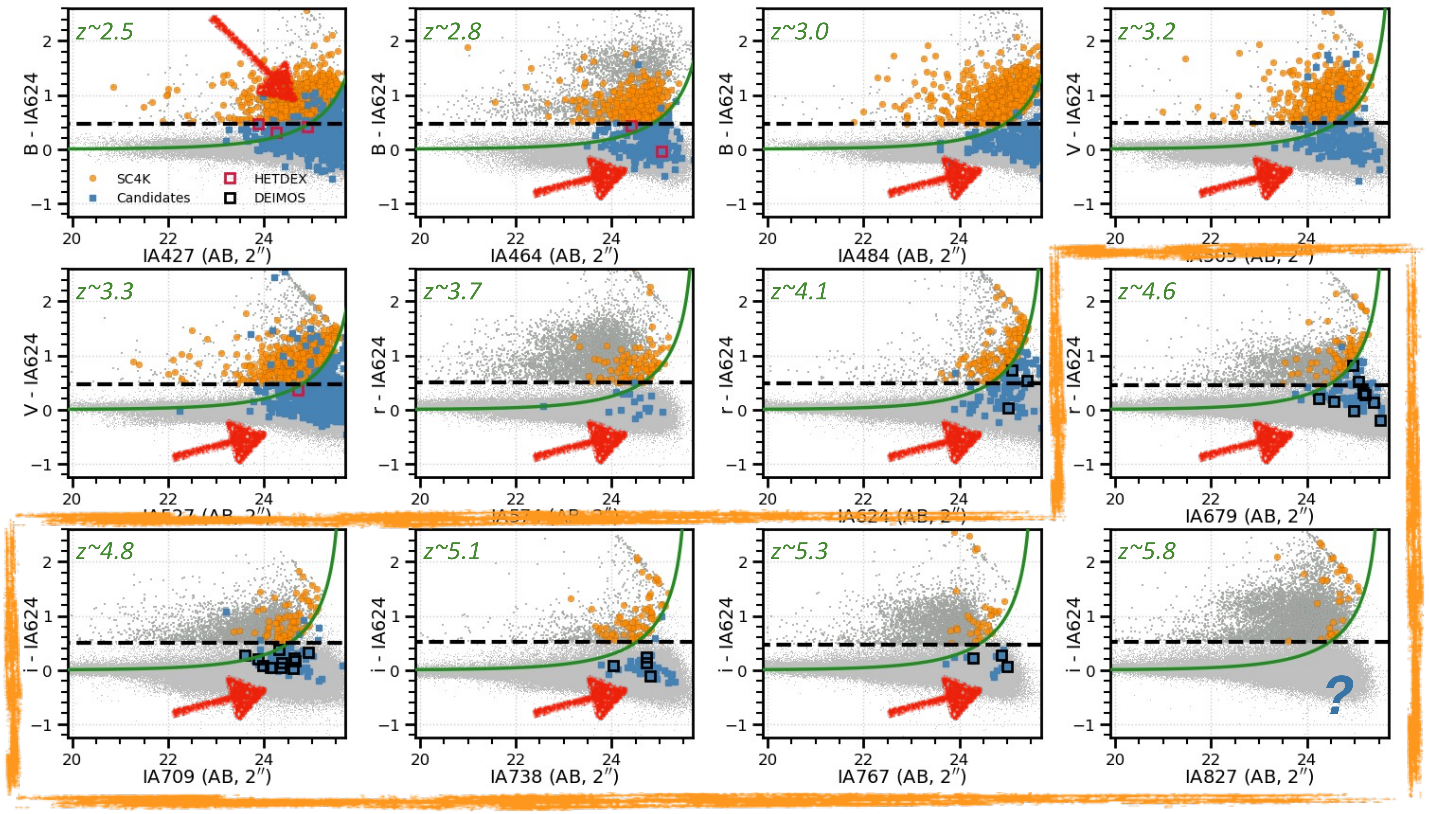
Identifying more than 7k new LAEs in the COSMOS field

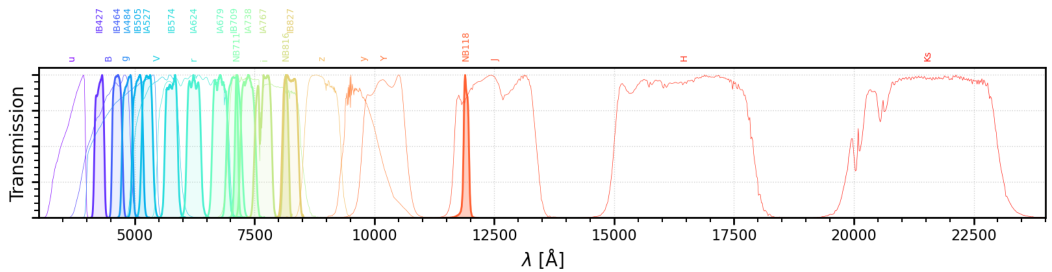
Implications for the Lyα luminosity function

FLAEMING

https://asofiafonso.github.io/flaeming-page/index.html

Have we been missing LAEs?

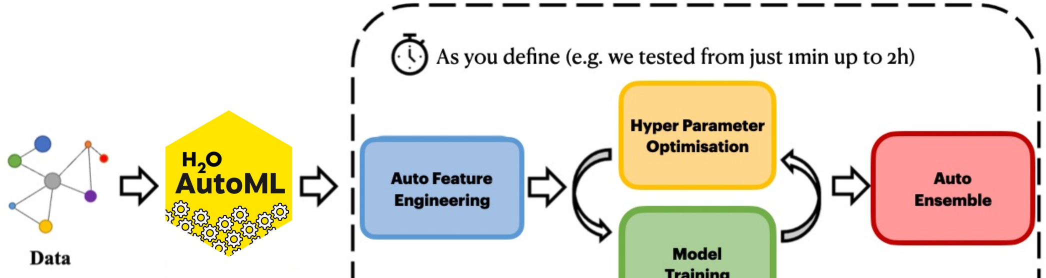




Optical to Near-Infrared

Fluxes + Uncertainties & Normalisation (unit-norm)

Can Machine Learning help us?

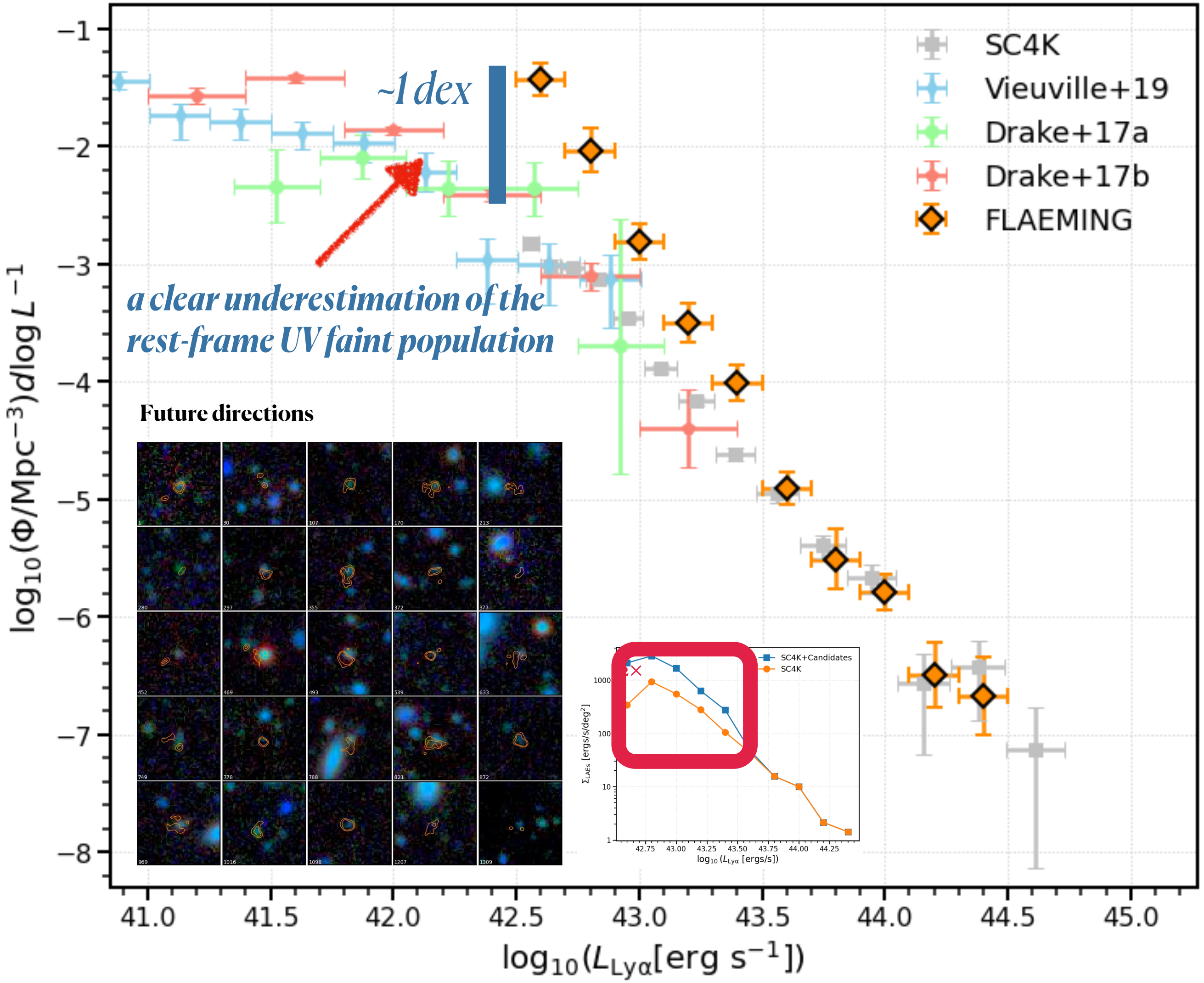


LeDell & Poirier 2020

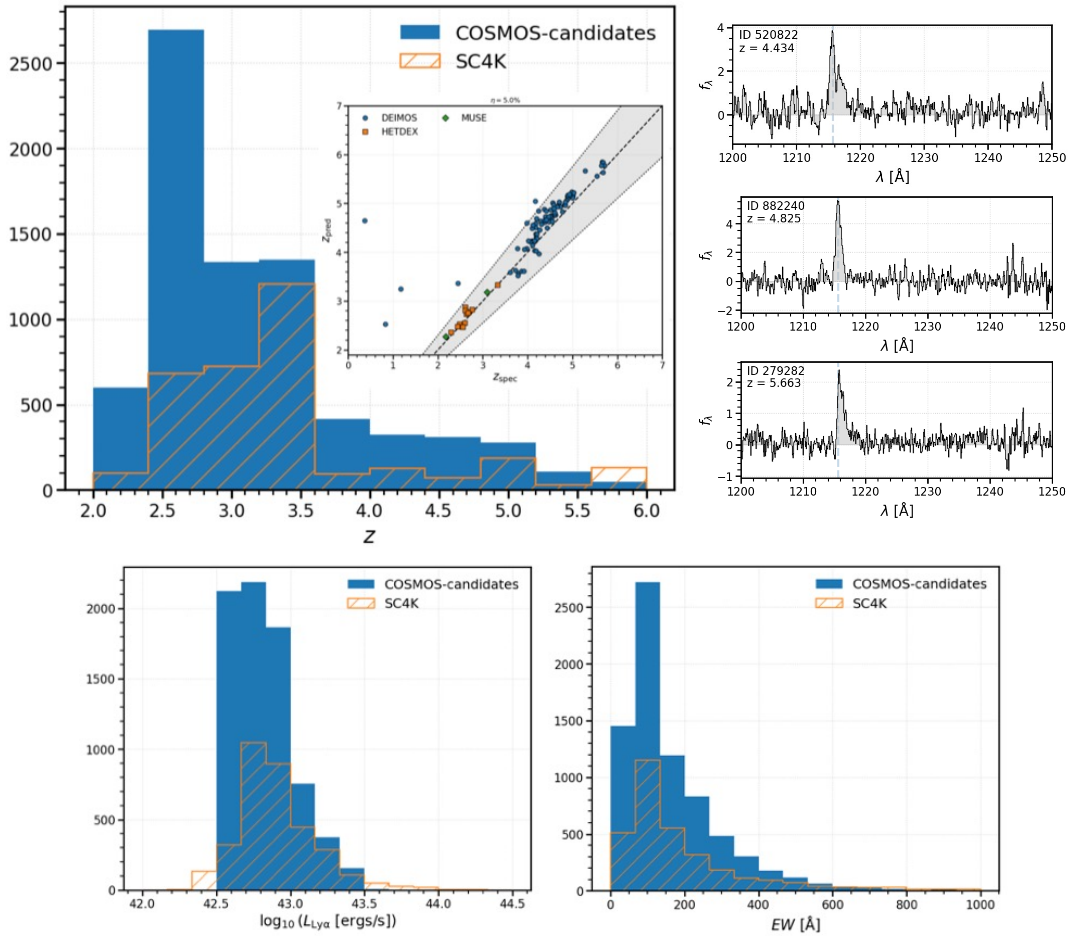
Ana Paulino-Afonso
paulinoafonso@astro.up

Identifying more than 7k new LAEs in the COSMOS field

Implications for the Lyα luminosity function



On the new sample overall properties: hints for spectroscopic follow-up



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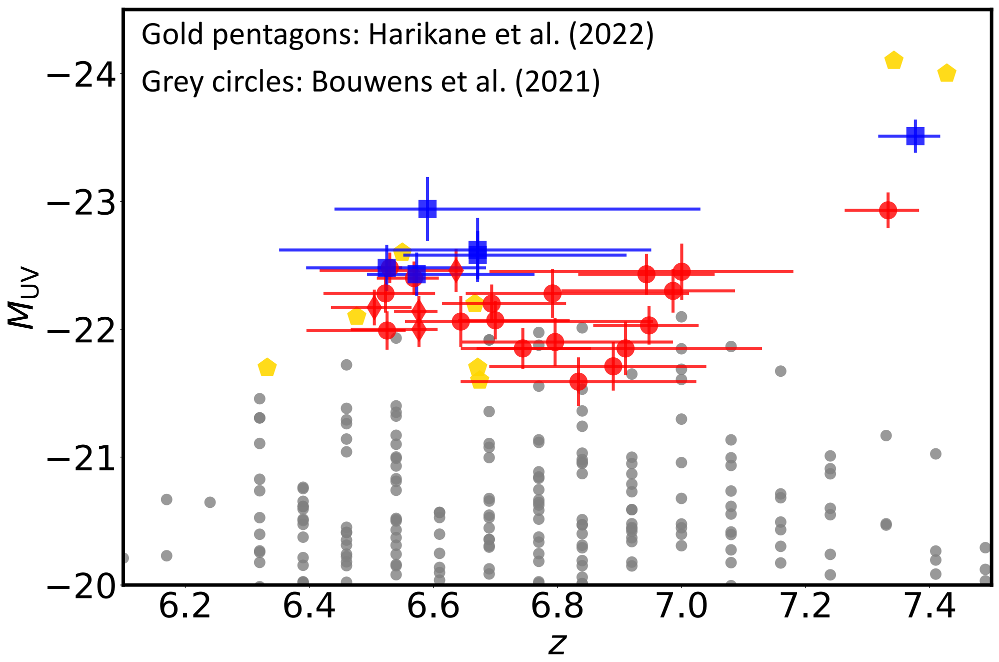
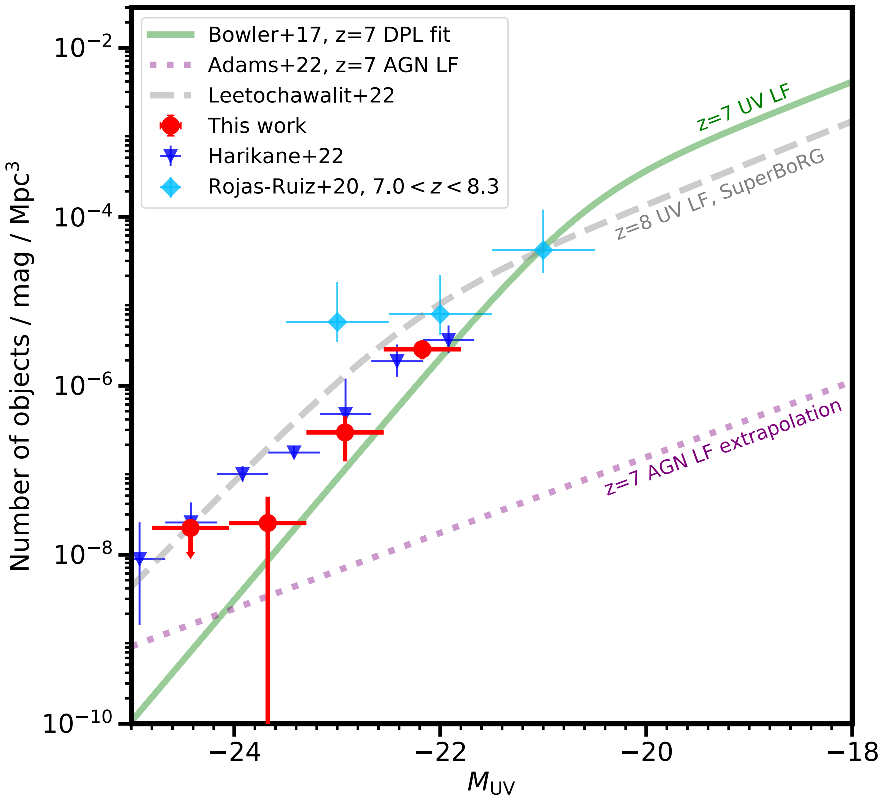
The bright end of the galaxy luminosity function at z=7 from the VISTA VIDEO survey

Rohan Varadaraj (University of Oxford)



- NIR data vital for brown dwarf removal



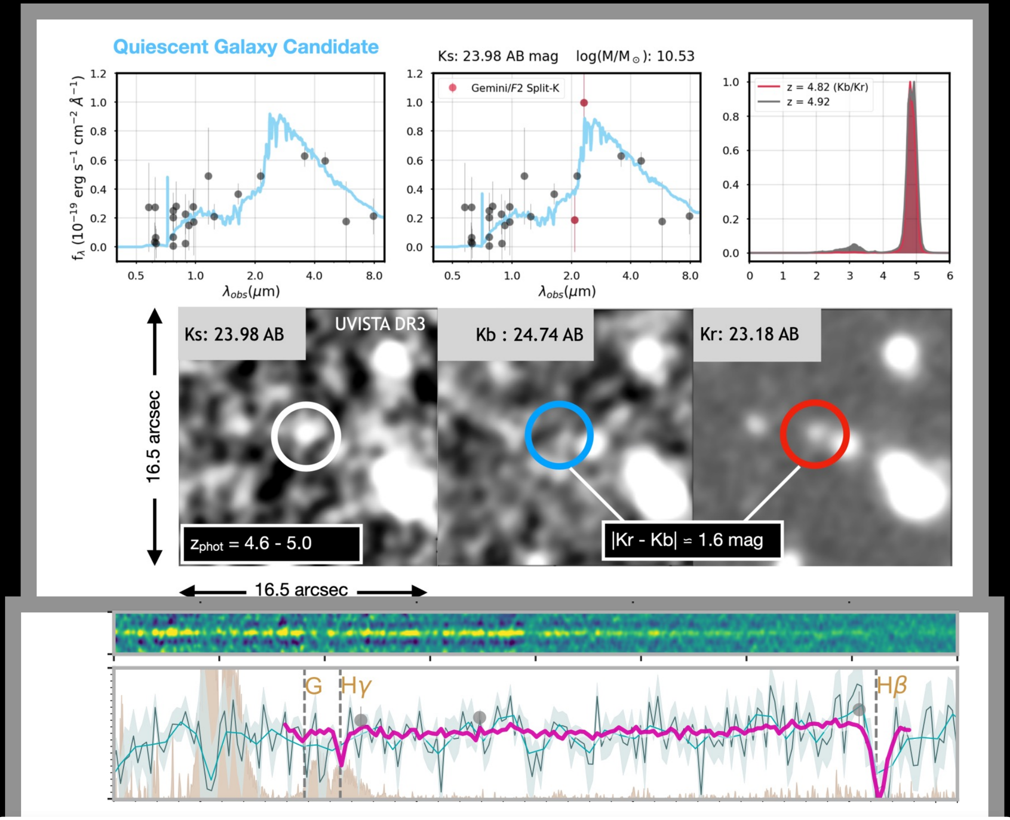
- Lack of mass quenching and/or dust obscuration in first Gyr.
- AGN do not contribute until $M_{\rm UV} < -24$ to the UV LF at z=7.

arXiv:2304.02494

The FENIKS Survey: Spectroscopy of Massive Quiescent Galaxies at z ~ 3 - 5

Jacqueline Antwi-Danso

In collaboration with: Casey Papovich, Themiya Nanayakkara, James Esdaile, Karl Glazebrook, Taylor Hutchison, Katherine Whitaker, Z. Cemile Marsan, Ruben Diaz, Danilo Marchesini, Adam Muzzin, Kim-Vy Tran, David Setton, Yasha Kaushal, Joshua S. Speagle, Justin Cole



11 hours of Keck/MOSFIRE spectroscopy

New split-K imaging from FENIKS yields < 3% accurate photometric redshifts and < 5% outlier fraction at z > 4

- Older quiescent population at z > 3
- Large stellar mass implies ~98% baryons converted to stars
- AGN at z = 3.6 with outflow velocity > 1000 km/s
- Approved NIRSpec Cycle 2 program to confirm these

The FENIKS Survey: Spectroscopy of Massive Quiescent Galaxies at z ~ 3 - 5

TEXAS A&M UNIVERSITY

UNIVERSITY OF TORONTO

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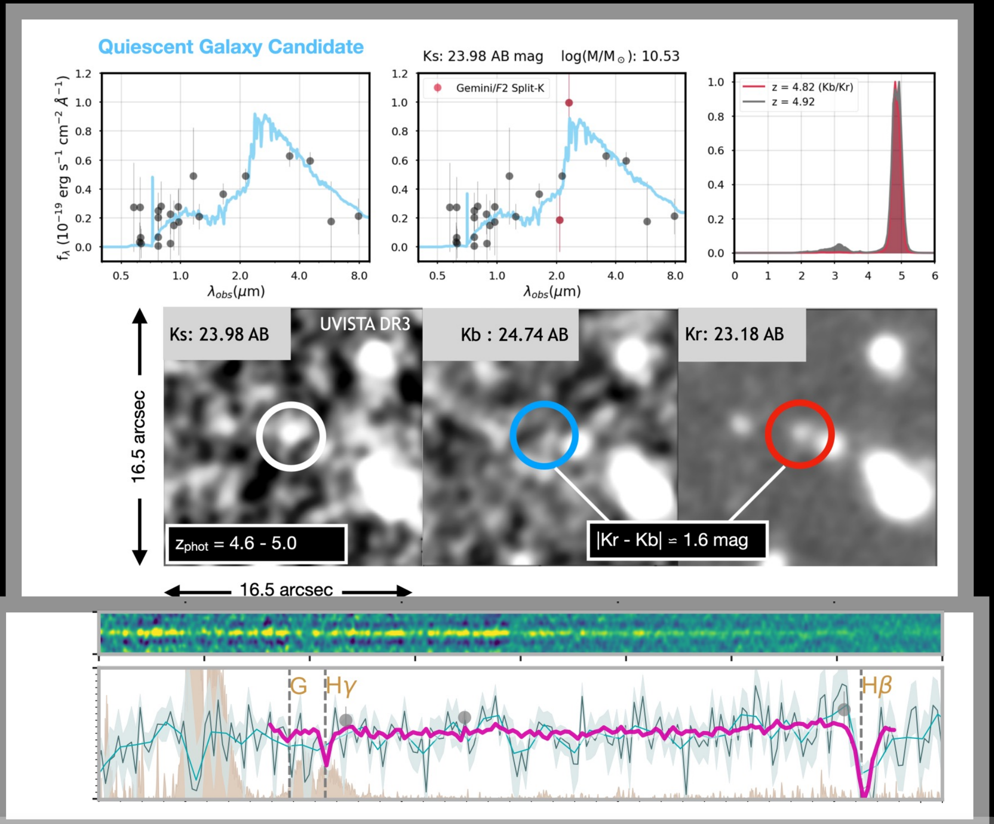

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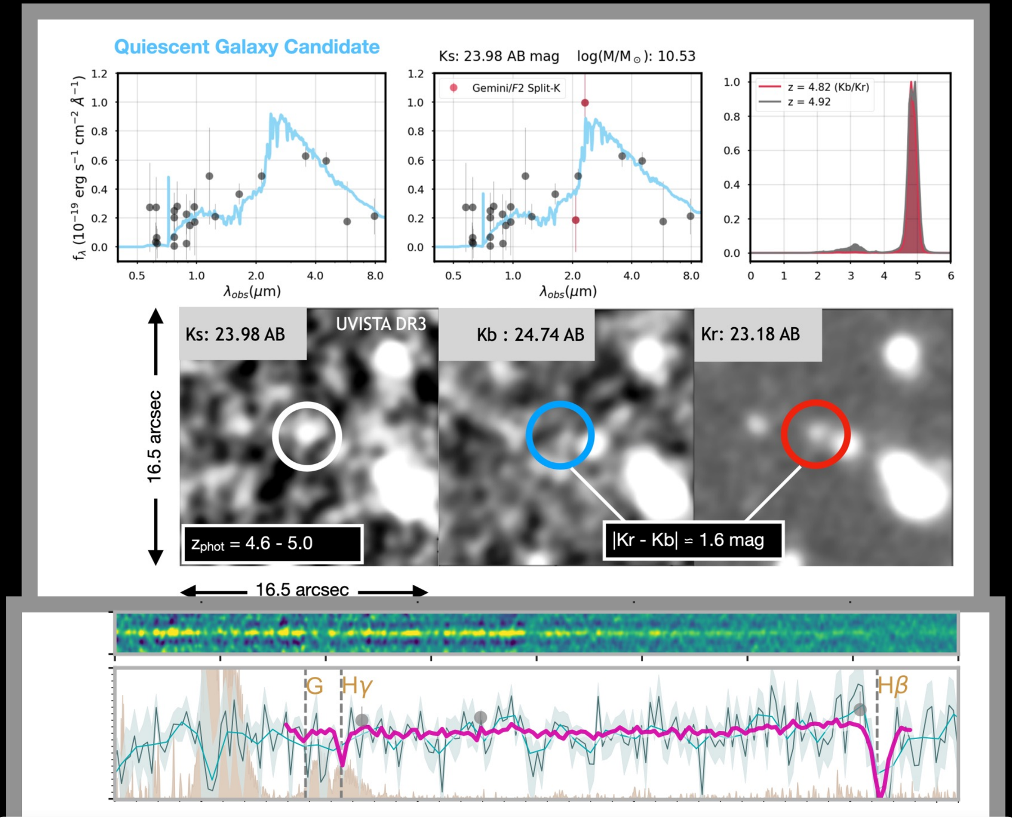

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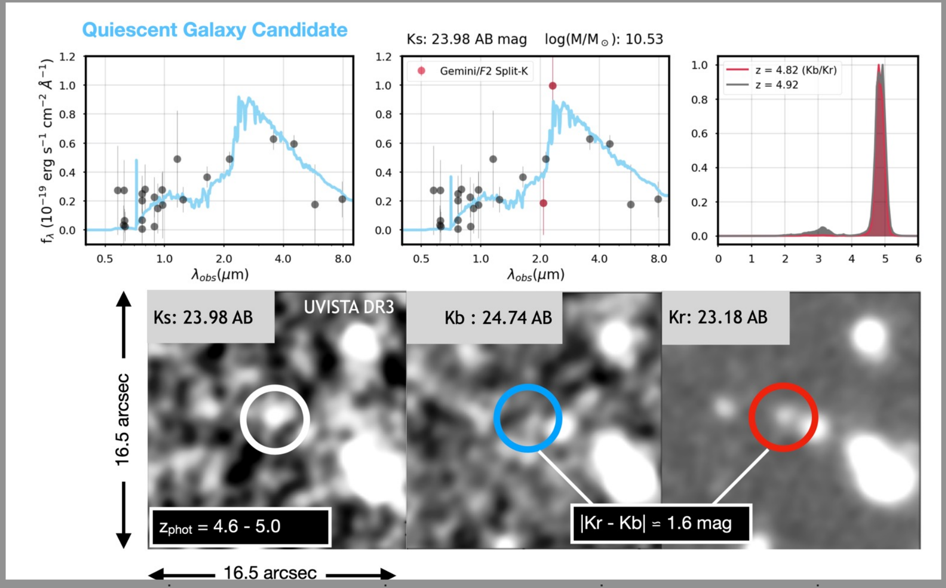

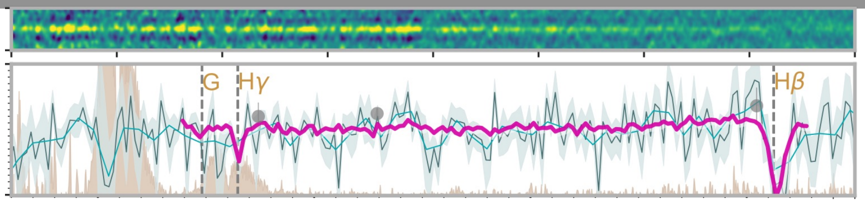

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The FENIKS Survey: Spectroscopy Of Massive Quiescent Galaxies at $z \sim 3$ - 5

JACQUELINE ANTWI-DANSO

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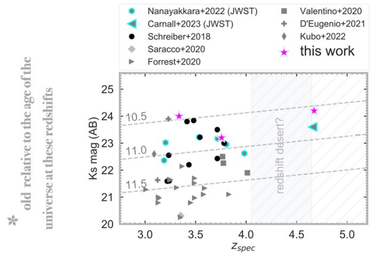
UNIVERSITY OF TORONTO

TEXAS A&M UNIVERSITY

link to paper

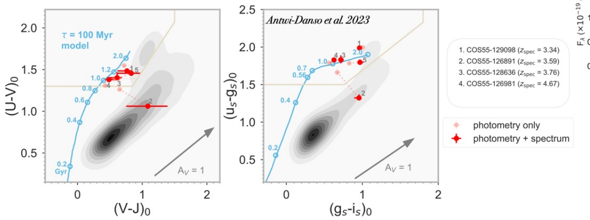
2 "Old* " Quiescent Galaxies

Only a handful of quiescent galaxies have been detected at z > 3.5. Our FENIKS galaxies are some of the faintest ever discovered from the ground at these redshifts. These observations reveal a glaring lack of spectroscopically-confirmed galaxies at z > 4, likely due to a bandpass issue (explored in detail in our paper).



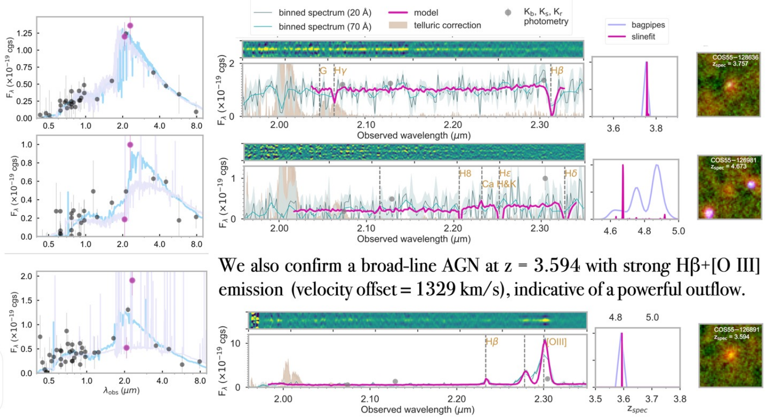
* old relative to the age of the universe at these redshifts

The rest-frame UVJ and $(ugi)_s$ colors of 3 out of our 4 quiescent candidates are consistent with 1-2 Gyr old stellar populations, which is consistent with the existence of *older* quiescent galaxies at these redshifts (e.g., Nanayakkara et al. 2022).



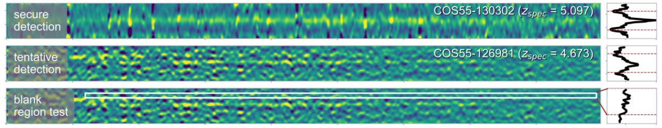
1 *Keck*/MOSFIRE Observations

We report one secure (z=3.757) and two tentative z = 3.336 and z=4.673 spectroscopic confirmations of massive $\log(M_\star/M_\odot) > 10.3$) quiescent galaxies (two displayed below) with 11 hours of *Keck*/MOSFIRE *K*-band observations. Our candidates were selected from the FENIKS survey, which uses deep *Gemini*/Flamingos-2 *KbKr* imaging which is sensitive to the characteristic red colors of galaxies at z > 3 with strong Balmer/4000 Å breaks and also sensitive to galaxies with strong emission lines.



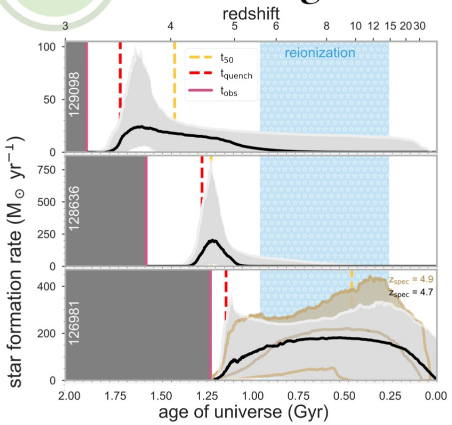
We also confirm a broad-line AGN at z = 3.594 with strong Hβ+[O III] emission (velocity offset = 1329 km/s), indicative of a powerful outflow.

Tentative vs Secure Detections



*the results for 130302 will be presented in a forthcoming paper (Marsan et al. *in prep*)

3 Possible Progenitors

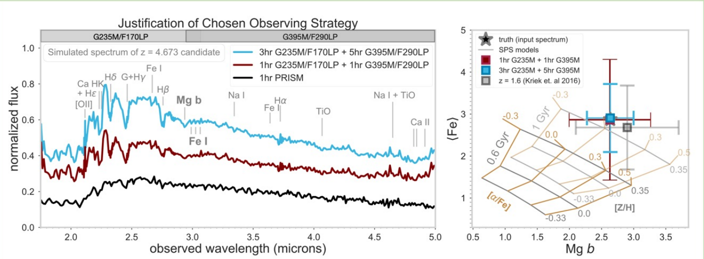


The SFH of our highest redshift candidate ($\log(M_\star/M_\odot)=11.35$) suggests that its progenitor was already in place by z ~ 7-11, having reached ~ 10^{11} M by z ~ 10, making it uncomfortably massive based on model predictions (e.g., Labbé et al. 2023). At these redshifts, a stellar mass this high requires a baryon to stellar conversion efficiency of 98% (assuming a number density of 1.8×10^{-5} Mpc^{-3}), near the maximum rate given predictions from ΛCDM. We will investigate this using higher S/N data from our upcoming *JWST* program.

Future Work

Upcoming *JWST* Observations

Our galaxies are ideal candidates for *JWST* spectroscopy, which will allow us to place much firmer constraints on their **ages** and **star formation histories**. Our observations and other recent ones targeting massive quiescent and UV-bright galaxies suggest that galaxy formation began earlier than previously thought (e.g,. Carnall et al. 2023, Harikane et al. 2023). Our observations have shed light on this issue, yet it is far from being completely resolved. In our approved Cycle 2 program (**GO 4318**), we will use the continuous wavelength coverage from NIRSpec to *directly* constrain the ages and formation timescales of our massive quiescent candidates via the detection of age, metallicity, and abundance indicators. This requires 30+ hours on the most sensitive ground-based spectrographs, but with *JWST*, we can make these measurements to better accuracy in only 8 hours.

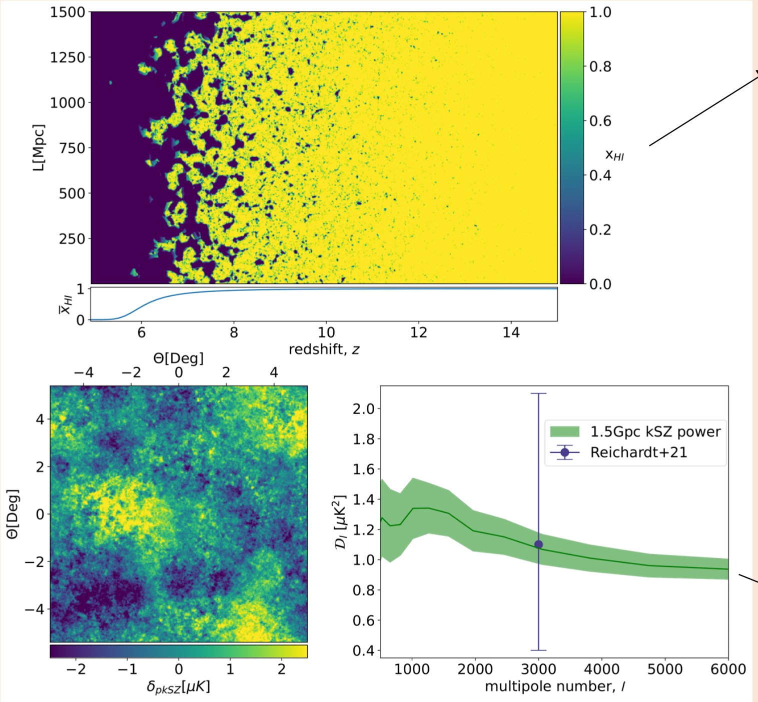


Inferring the bulk properties of reionizing galaxies from the kSZ and other observations

SCUOLA NORMALE SUPERIORE

Ivan Nikolić
SNS Pisa
with Andrei Mesinger, Yuxiang Qin, Adélie Gorce

Using patchy kSZ signal measured recently (Reichardt+21) and other observations (Lyman-α forest, CMB optical depth, UV luminosity function) we can infer the EoR history and properties of the sources responsible for it.

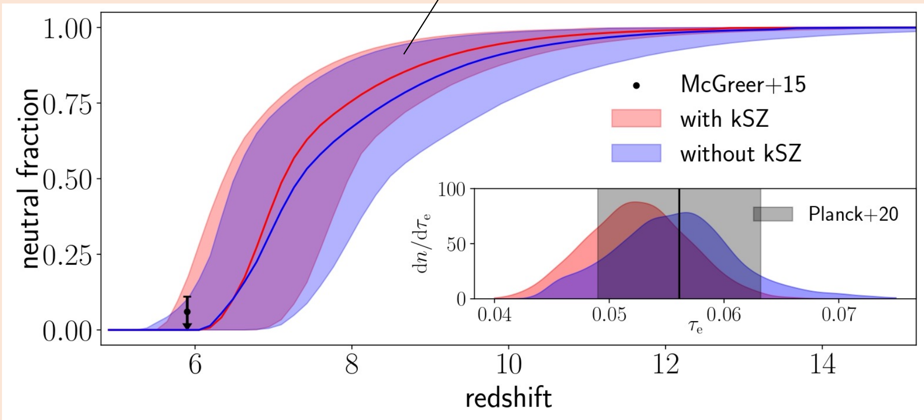


21cmFAST lightcones

Forward-modelled observations

+ (Lyα forest, UVLFs, CMB tau)

Current kSZ measurement points to a **late and rapid reionization**!



EoR summaries

$$z_r = 7.12^{+0.44}_{-0.41}$$

$$\Delta_z \equiv z(\overline{x_{\rm H}} = 0.75) - z(\overline{x_{\rm H}} = 0.25) = 1.16^{+0.24}_{-0.19}$$