Modelling LAEs in the Epoch of Reionization with OBELISK:

Exploring the Connection Between Lyman-α Spectra and Lyman-Continuum Escape

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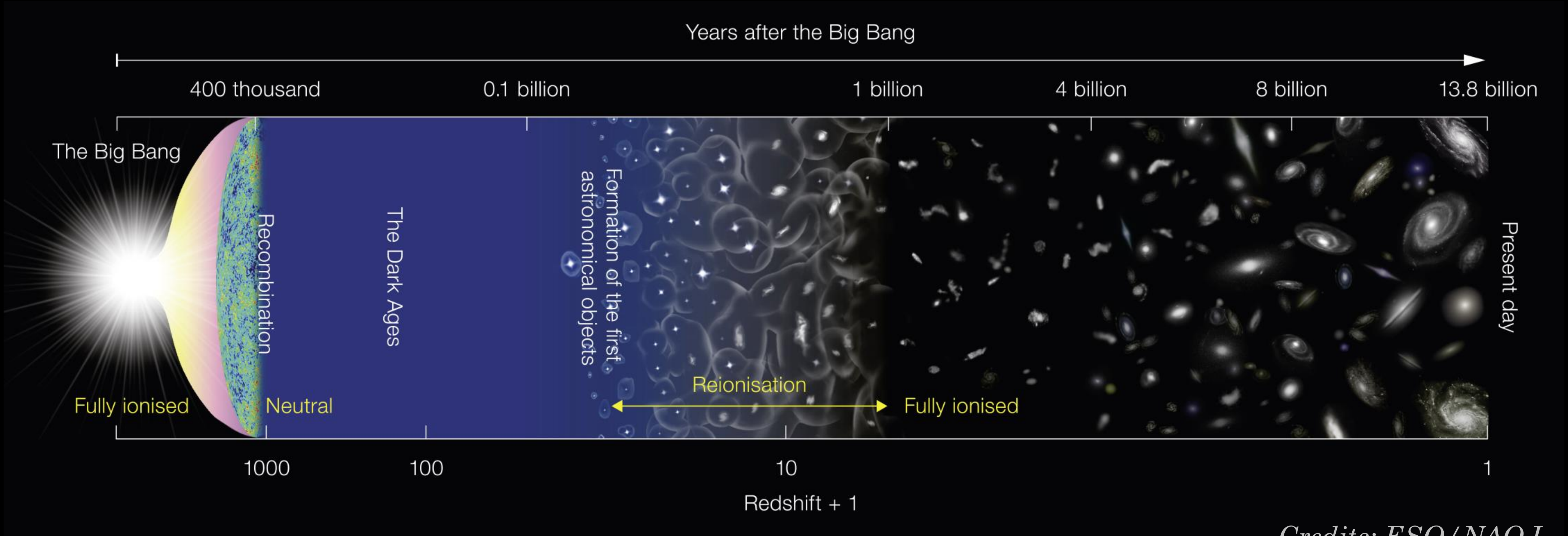
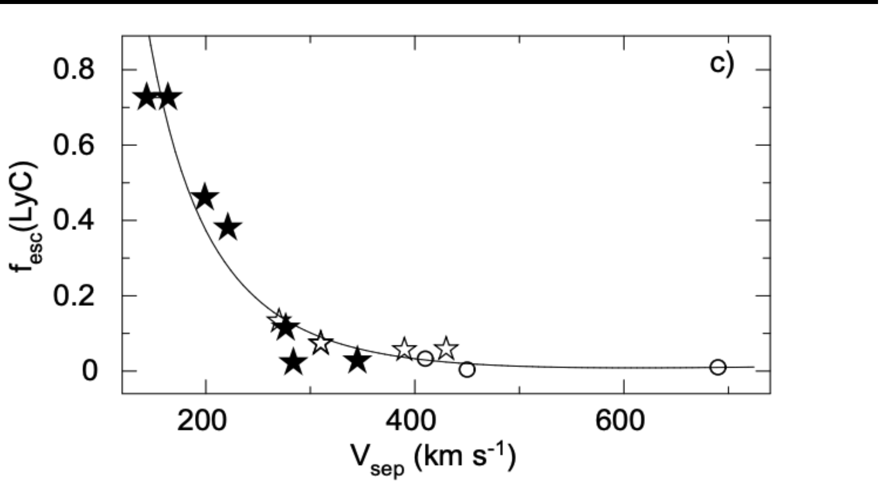
Introduction

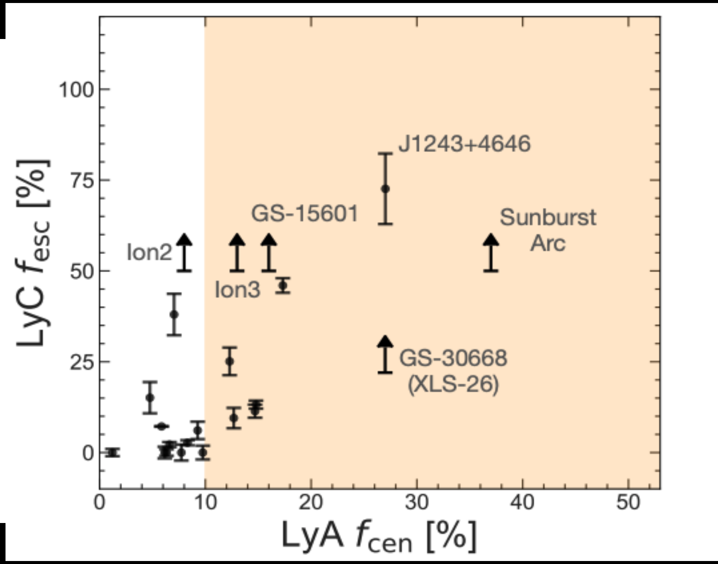
Epoch of Reionization

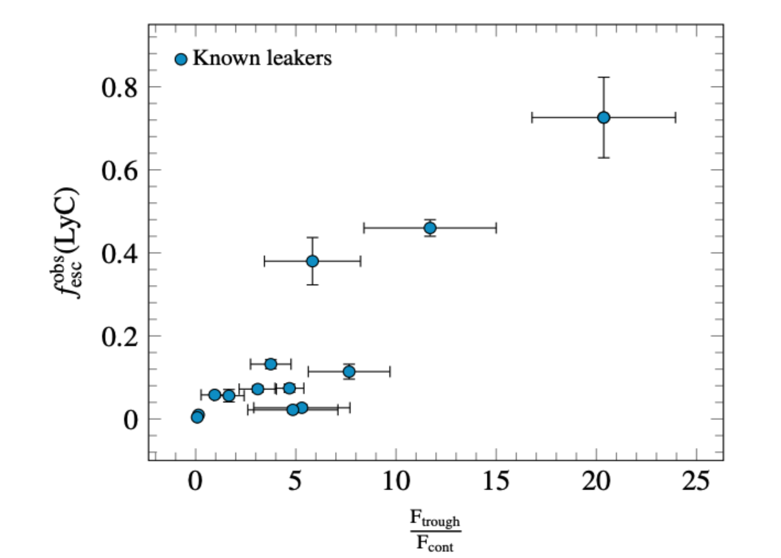


Credits: ESO/NAOJ

How to find $f_{esc}(LyC)$ from observations?







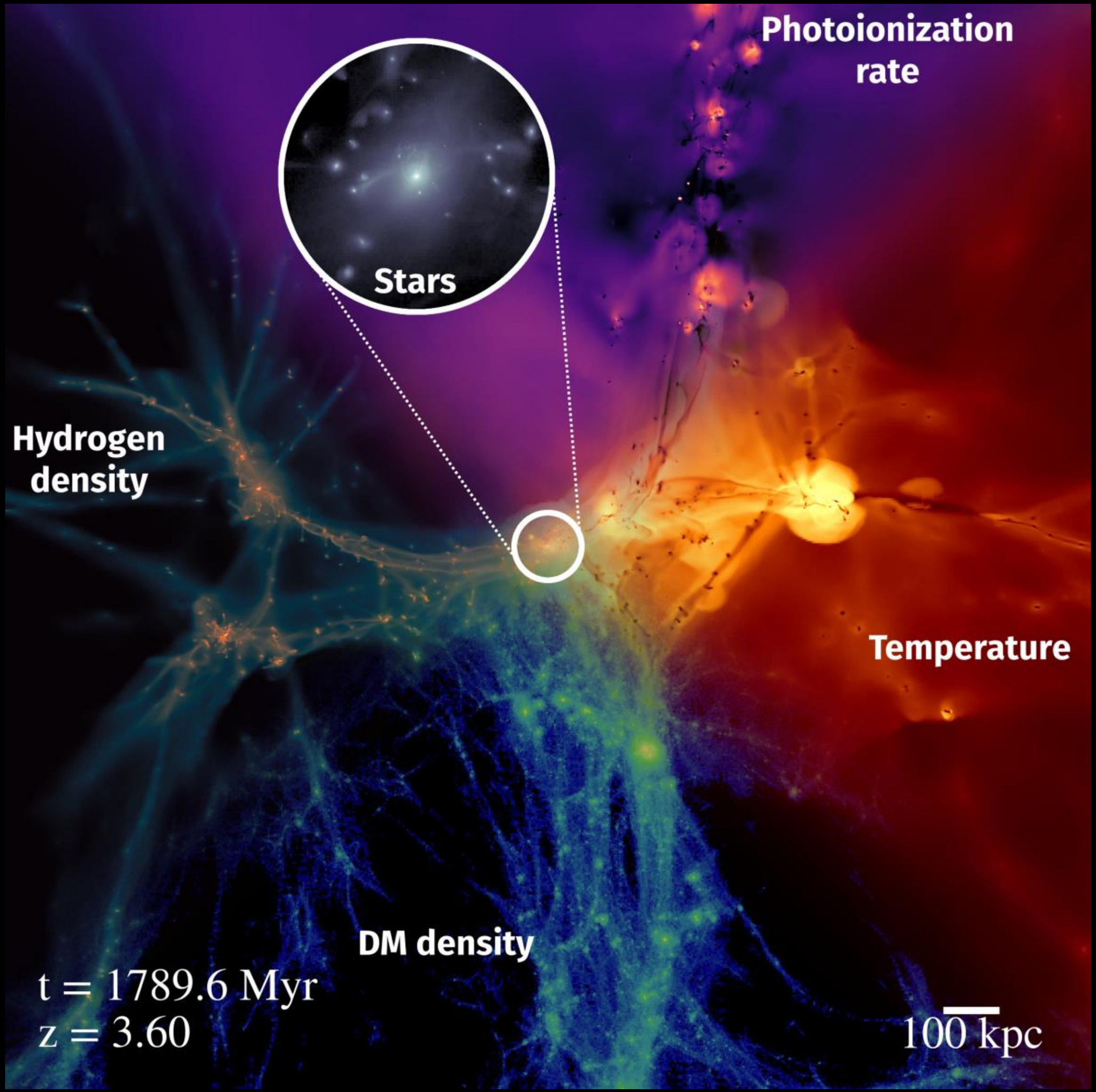
Credits: Izotov et al., 2018

Credits: Naidu & Matthee et al., 2021

Credits: Gazagnes et al., 2020

OBELISK

High-resolution, radiation-hydrodymanical simulation of a subvolume of Horizon-AGN which follows the evolution of DM, gas, stars and BHs via gravity, hydrodynamics, radiative transfer and non-equilibrium thermochemistry.



Credits: Trebitsch et al. 2021

Galaxy sample

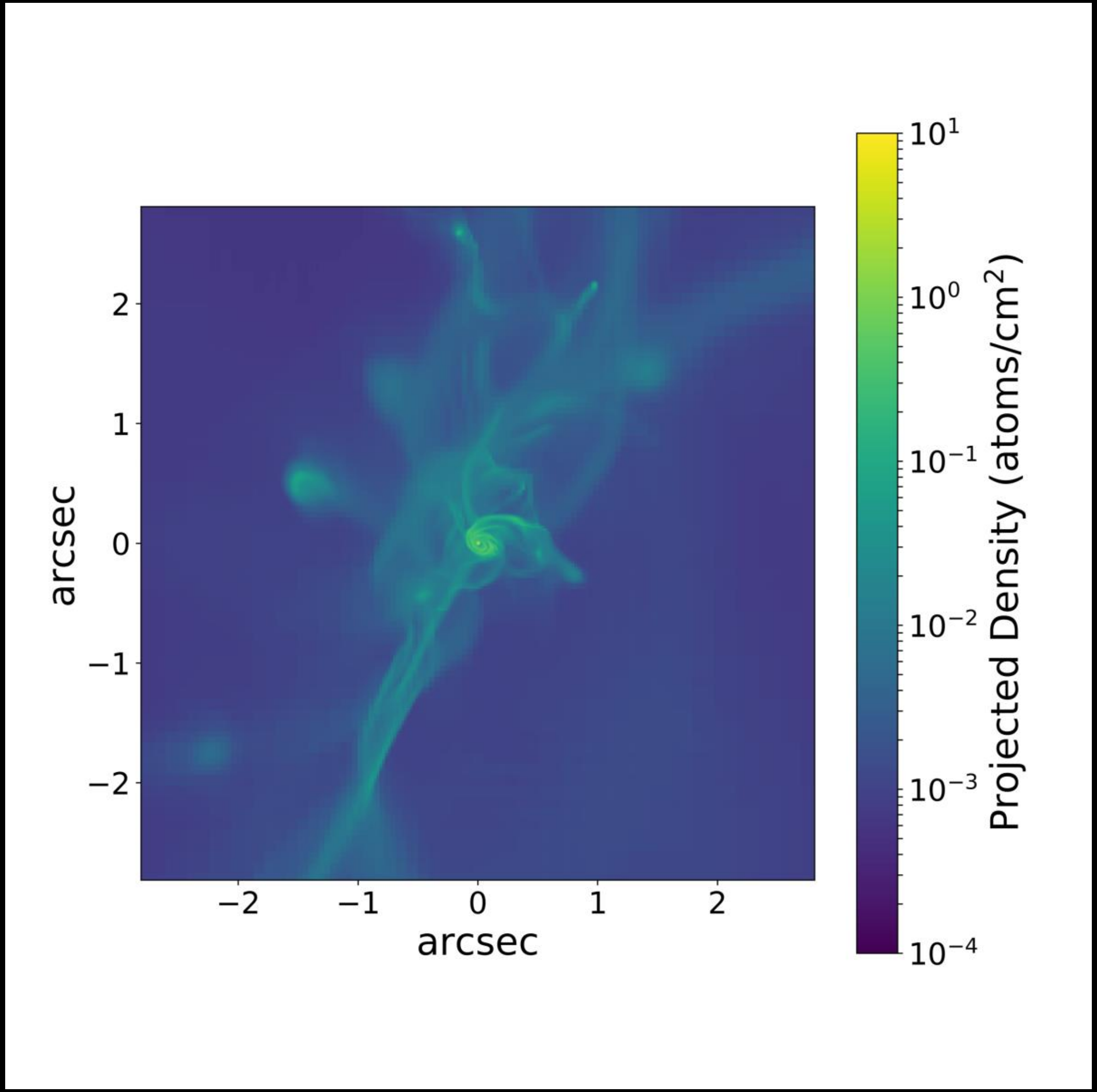
Sample of 13 UV selected galaxies with $3D\ M_{UV}$ from -19 to -19.5

Redshift 6

Mass range: $10^7 - 10^{10}\ M_\odot$

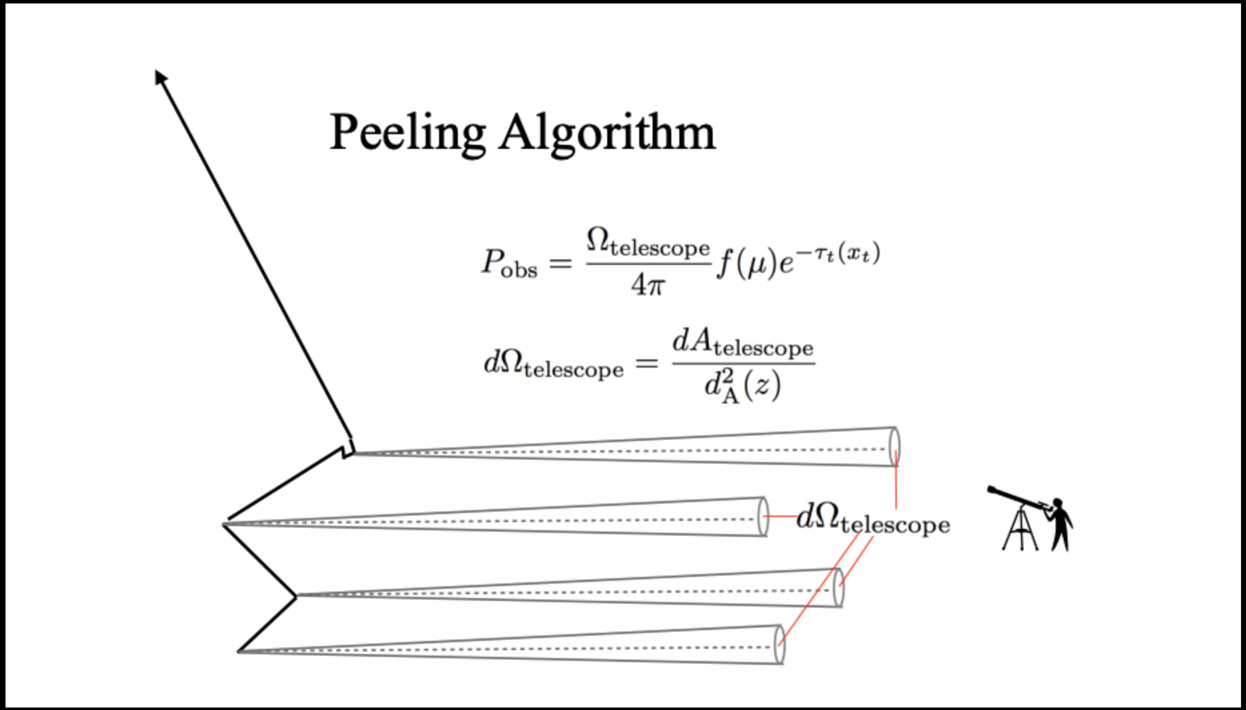
SFR: 0.7-31 $M_\odot$/yr

$f_{esc}(LyC)$: 0.001 - 0.2



RASCAS

The radiative transfer of Lyman-α was performed with RASCAS and the mock observations were made with the peeling off algorithm.



Credits: Dijkstra 2017

Dust Models

Dust following Metals

- Following the formulation of Laursen et al., 2009
- Constant dust-to-metal ratio
- Values based on Large Magellanic Cloud

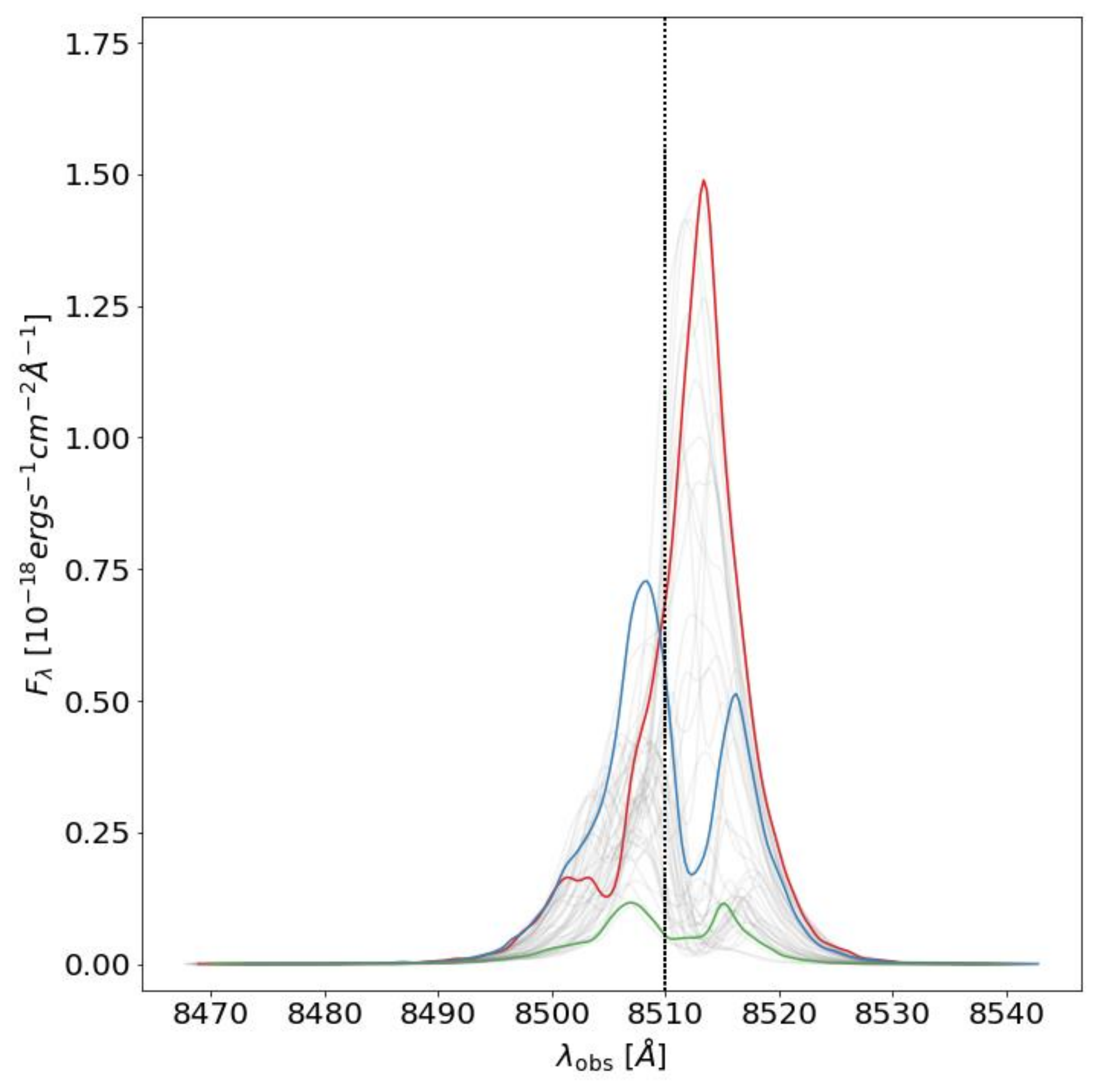
Dust from OBELISK

- Subgrid dust model treated separately from metals (Trebitsch et al., 2021)

Lyman-α line properties

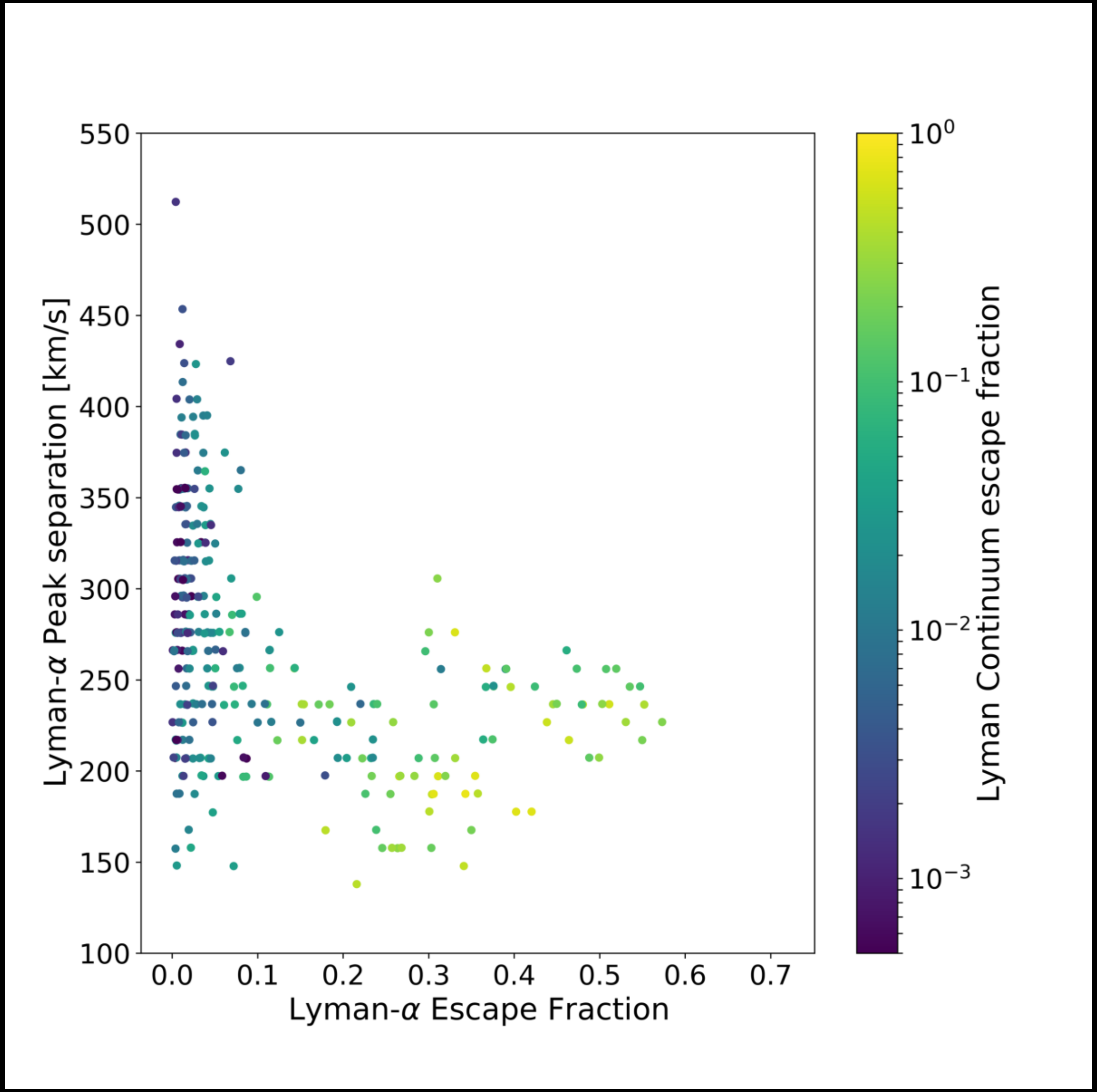
Lyman-α spectra

Large variety of profile emerging from the same galaxy when viewed in from different angles.



$V_{sep}(Ly\alpha)$ vs $f_{esc}(Ly\alpha)$

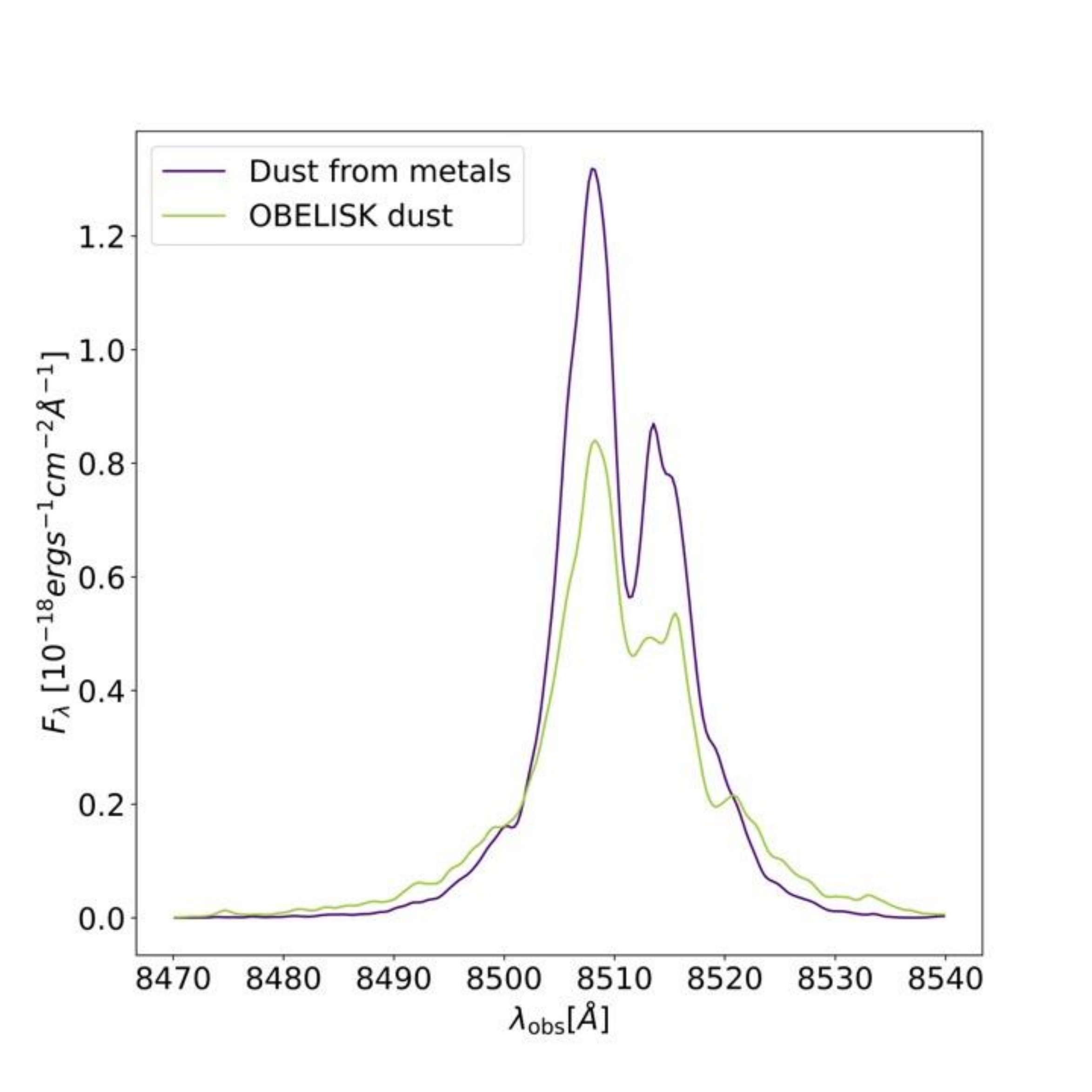
Higher Lyman continuum escape fraction at higher Lyman-α escape fractions for a given peak separation.



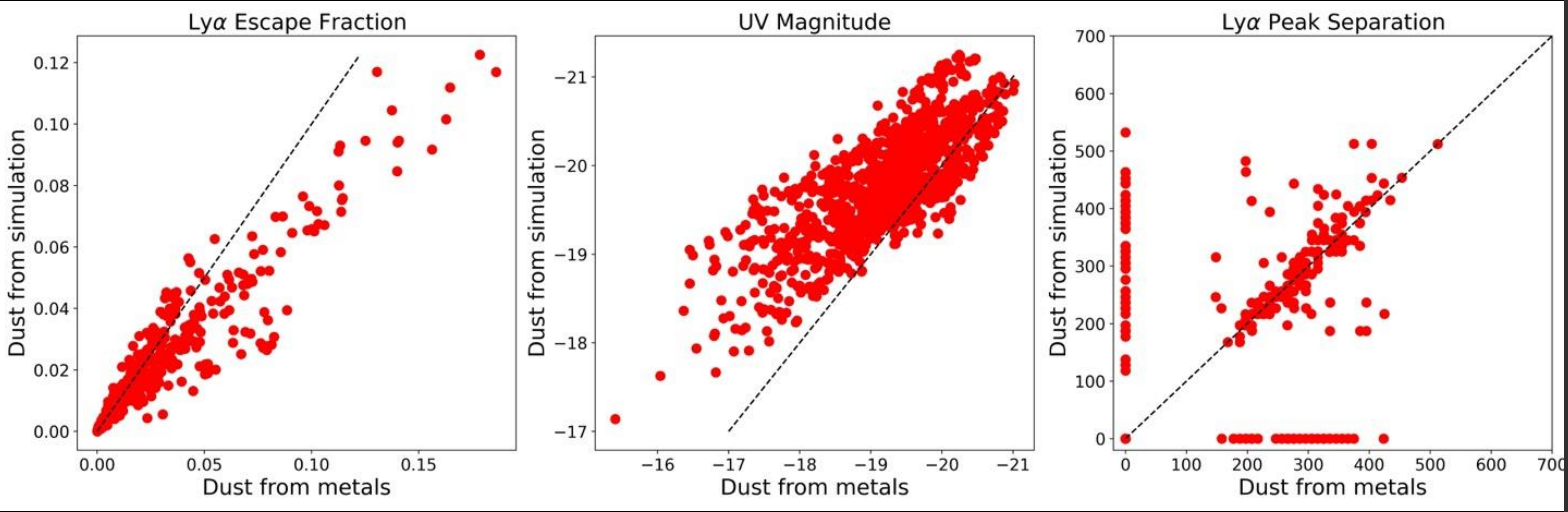
Dust comparison

Comparison of the same line of sight

Difference in emerging profiles when looking at the same line of sight with the two dust models.



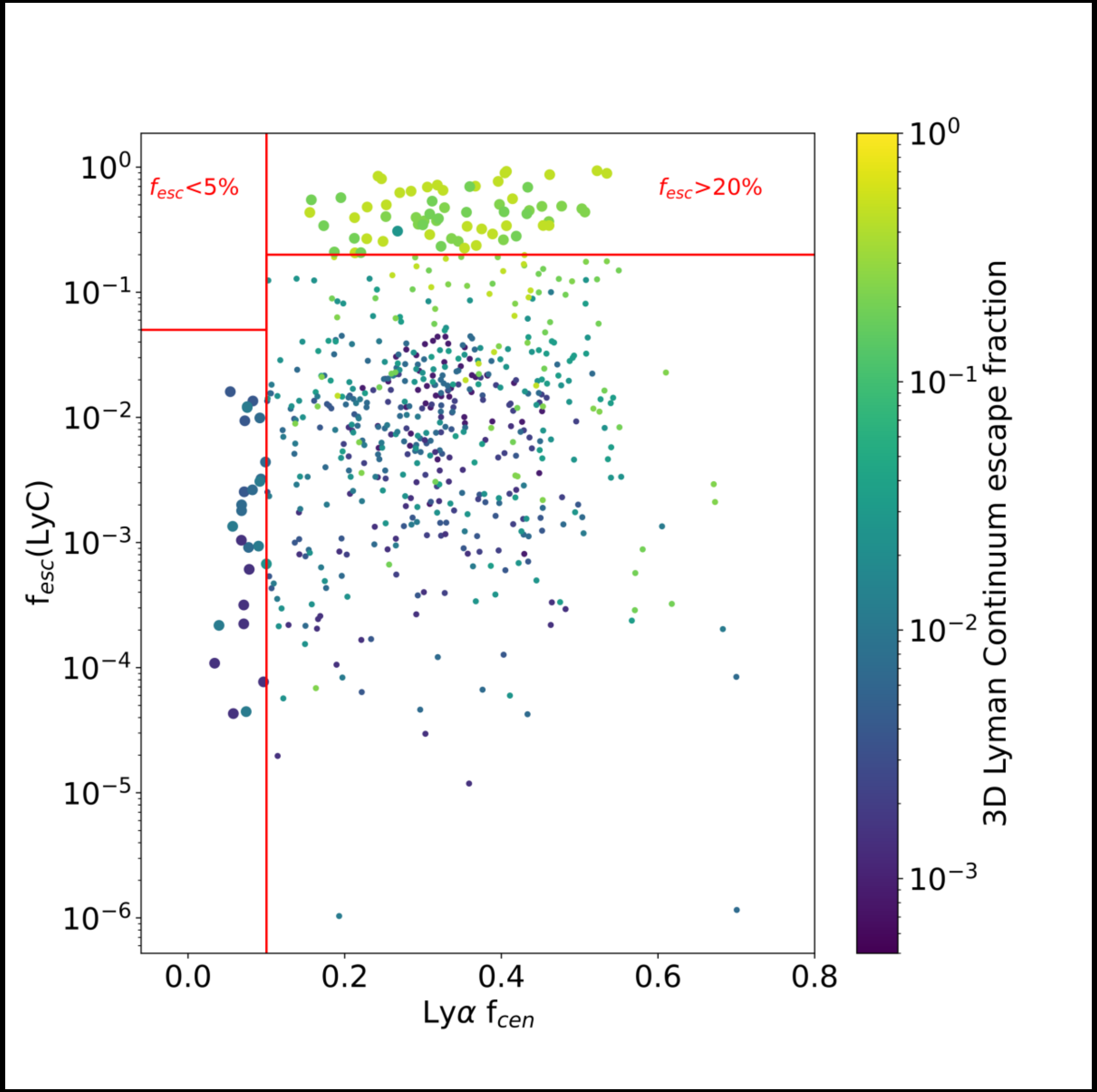
Dust comparison



Estimate of $f_{esc}(LyC)$

Central Flux Fraction

Most points do not follow the criterion found by Naidu & Matthee+21, especially in the case of galaxies with low 3D $f_{esc}(LyC)$



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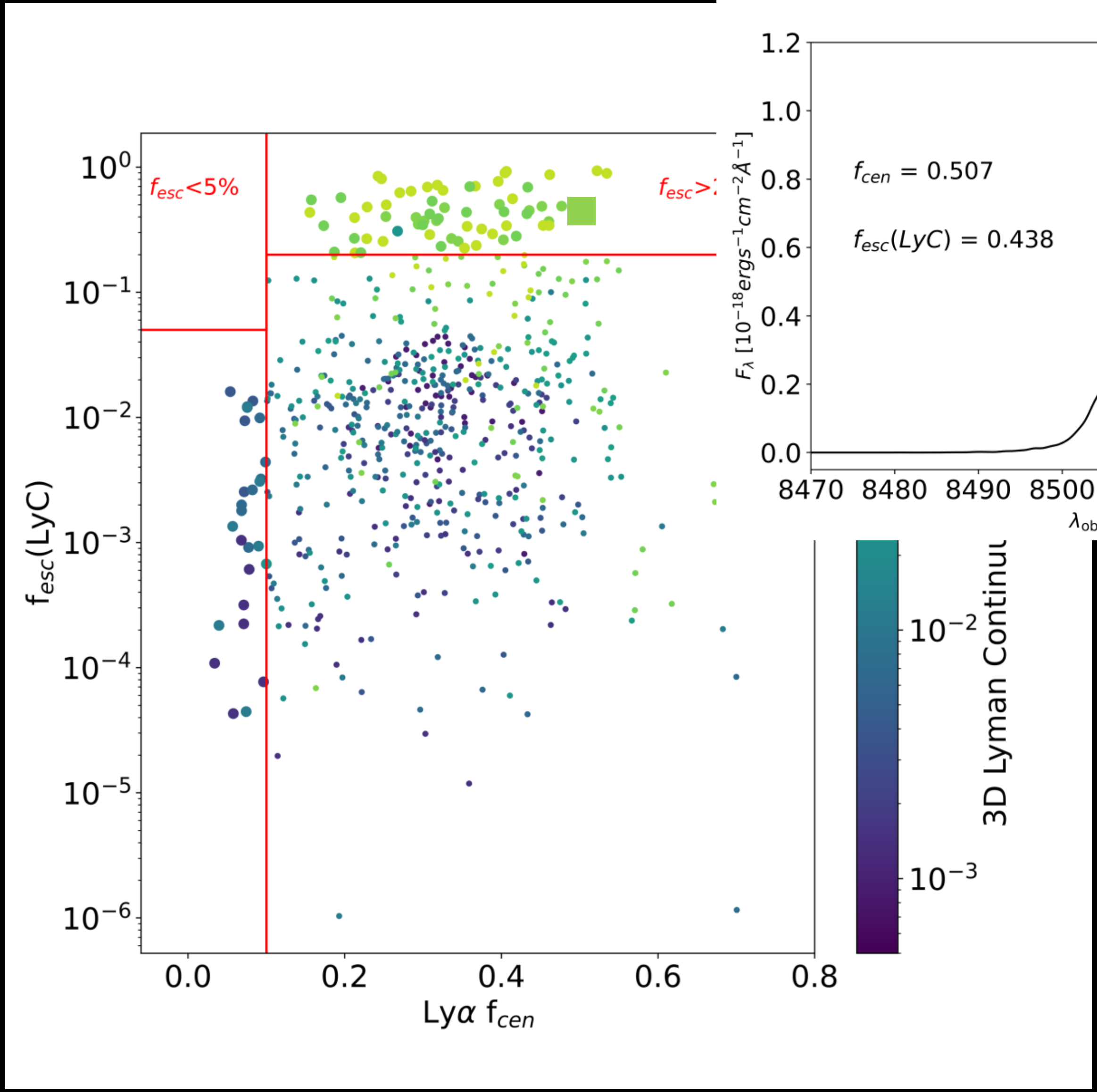

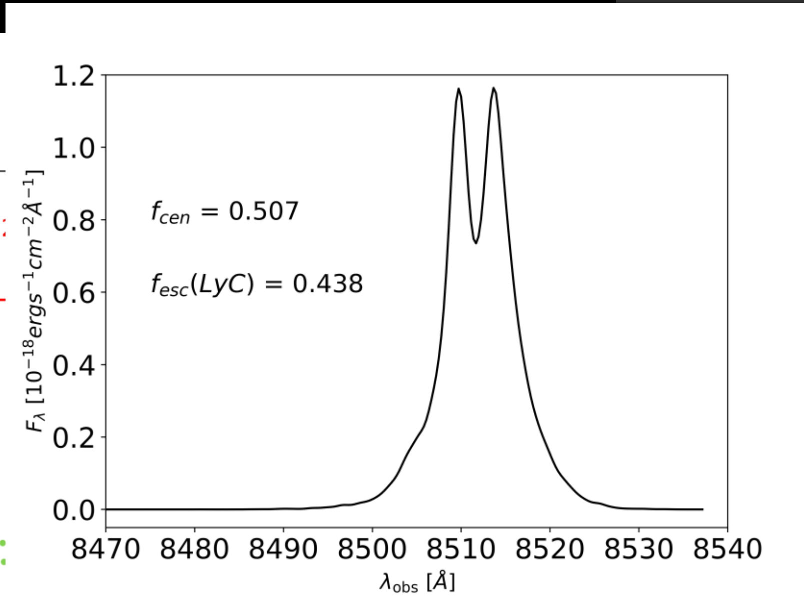

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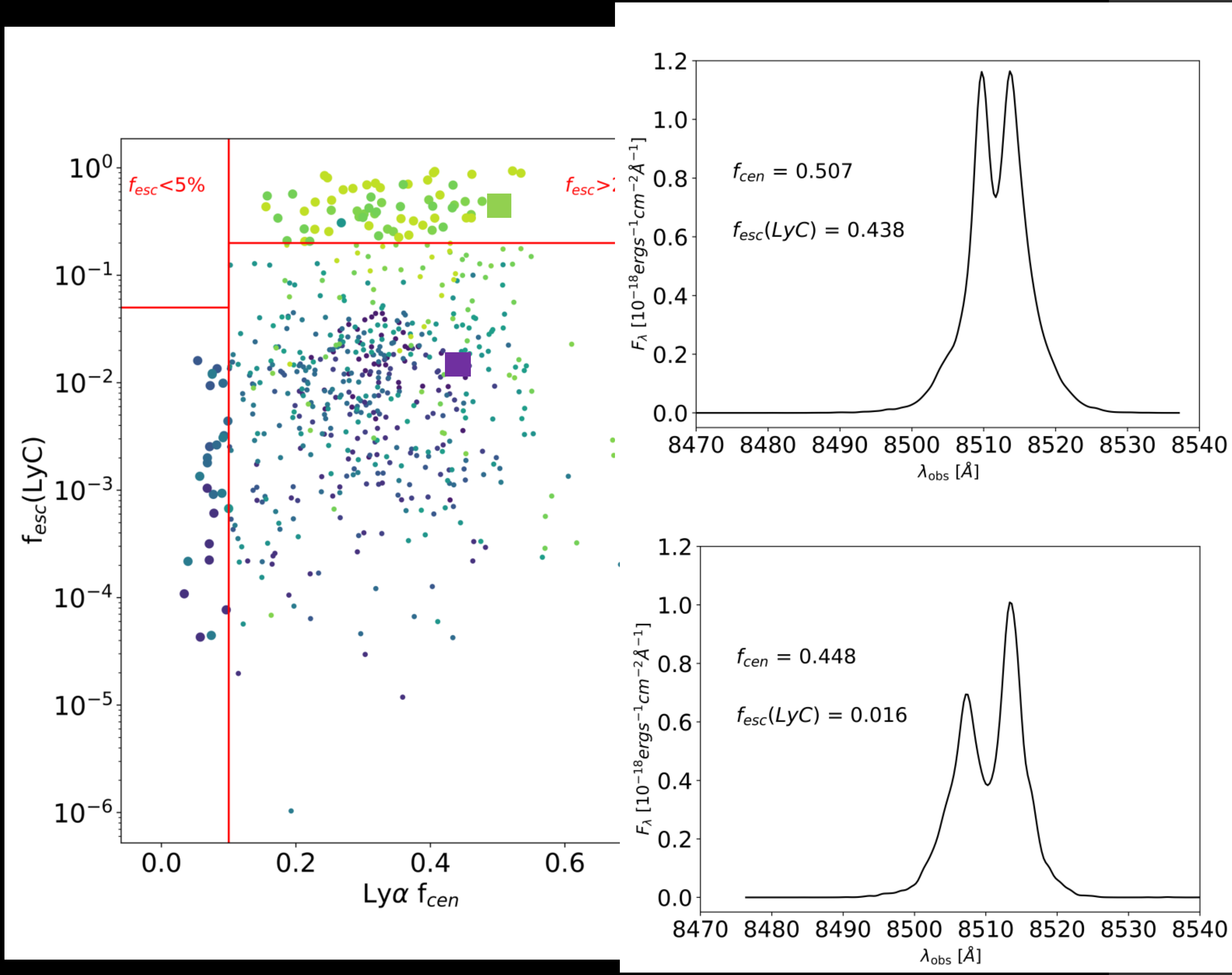
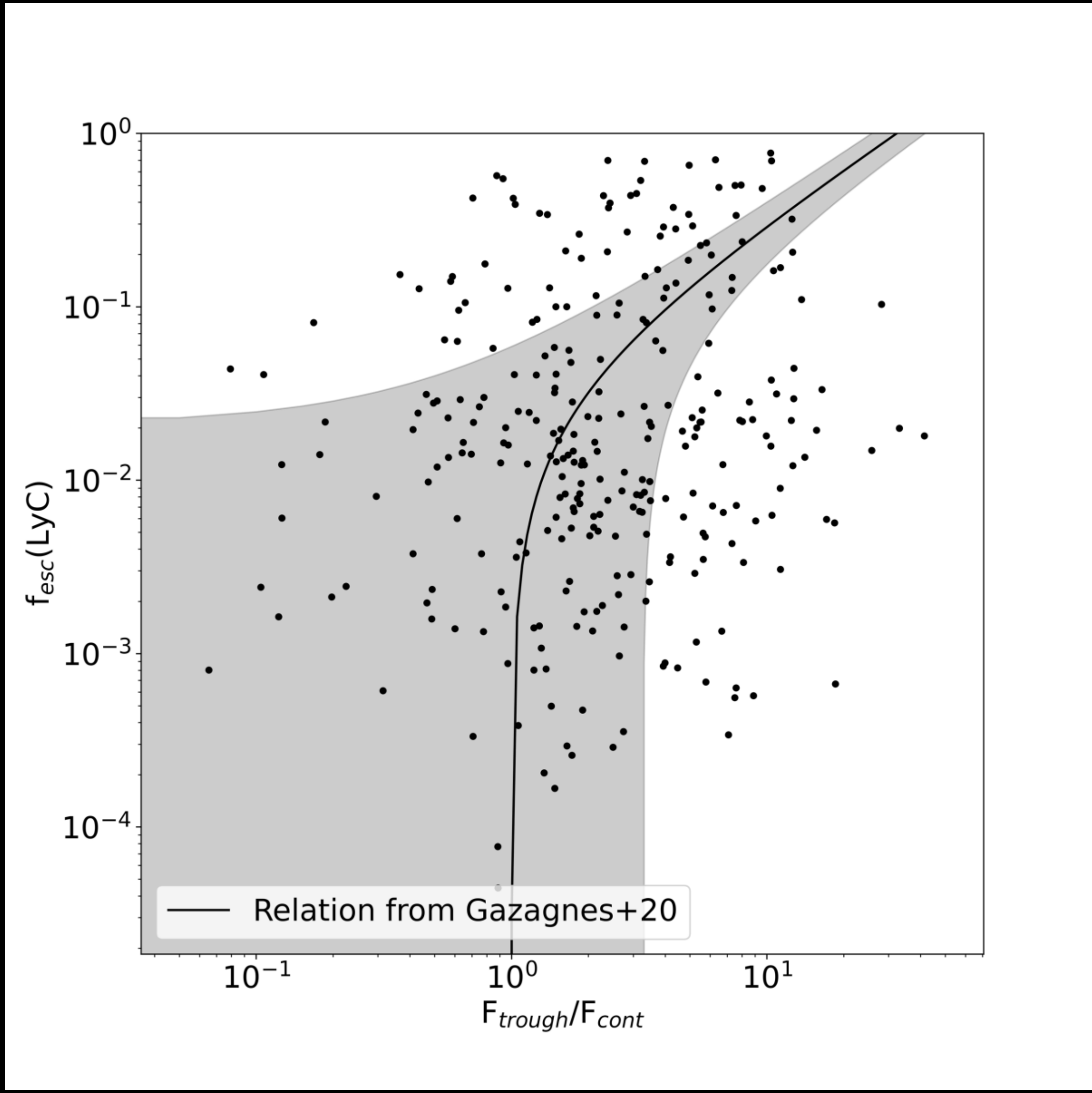


Ftrough/Fcont

Most double peaked spectra fall within the errorbars of the relation identified by Gazagnes+20 but still substantial number of outliers, especially at high escape fractions.



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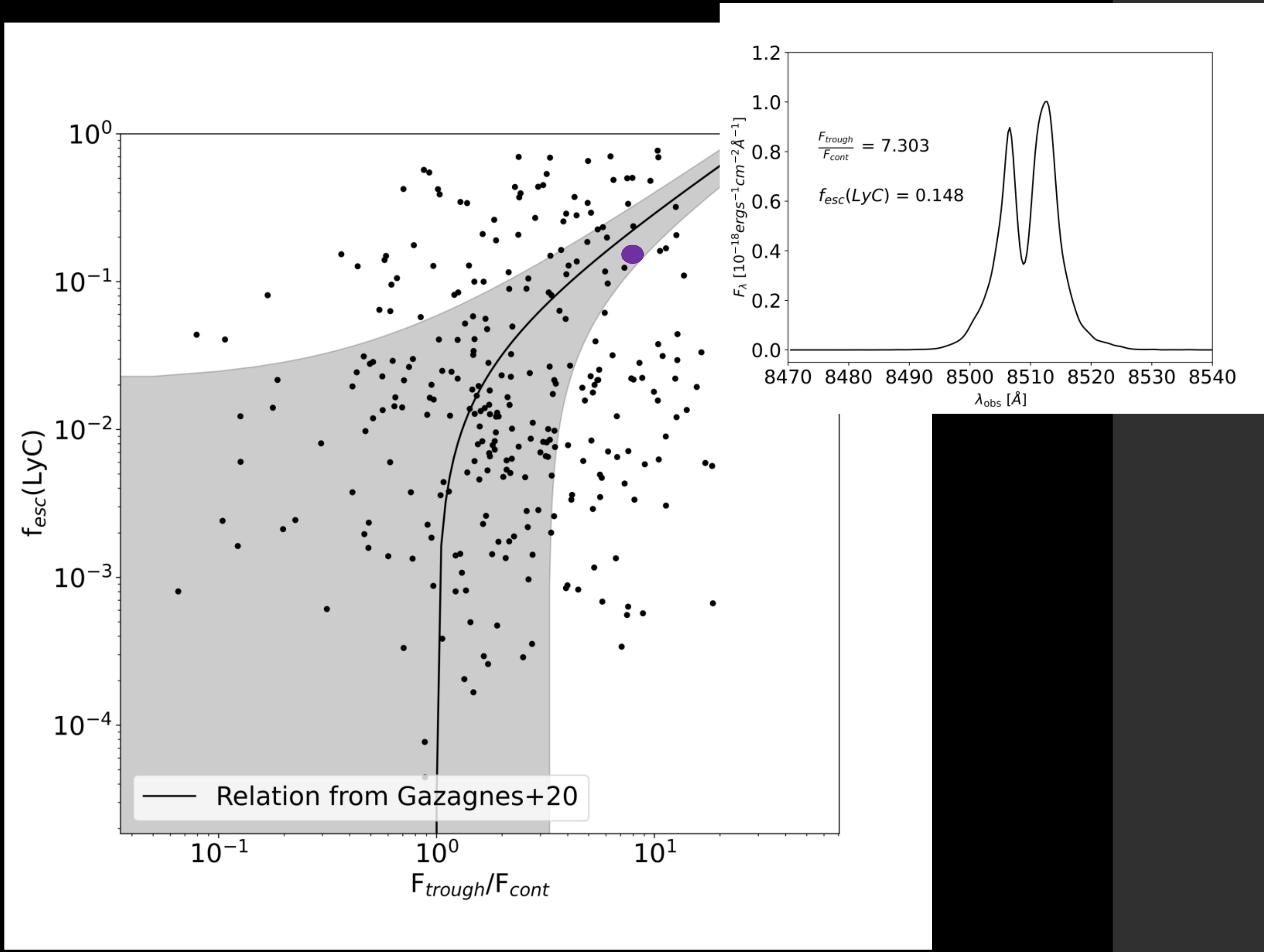

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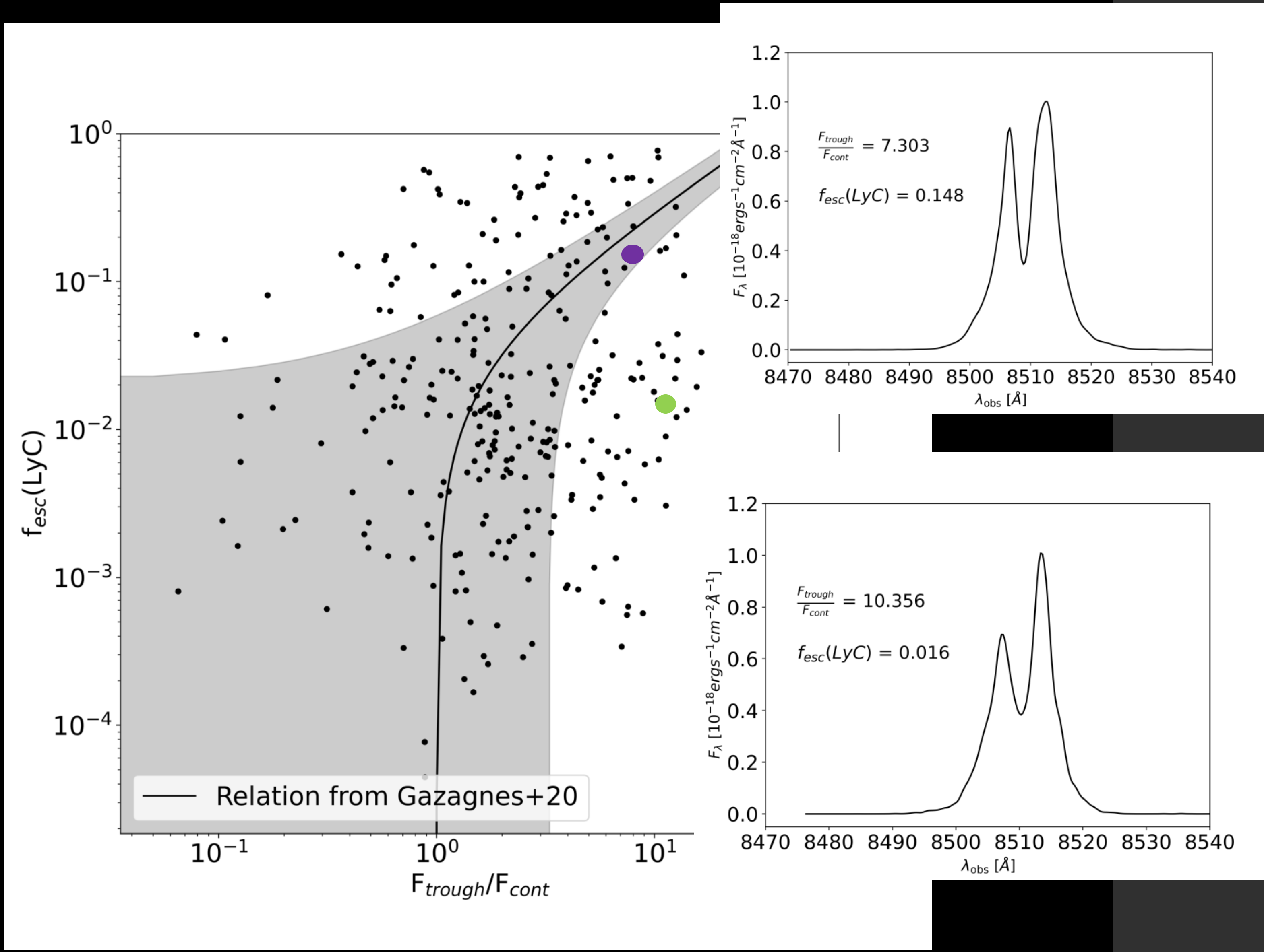
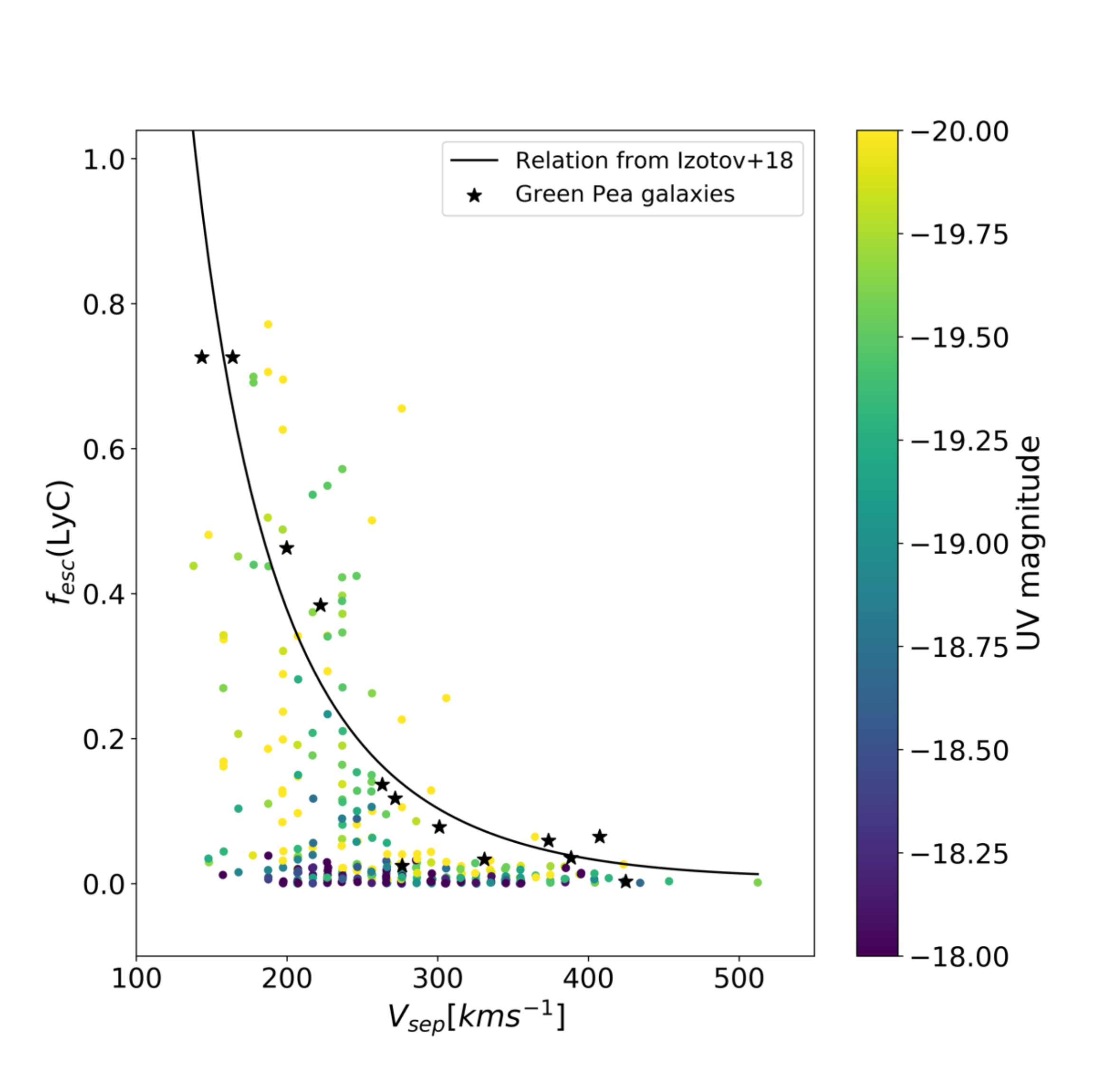


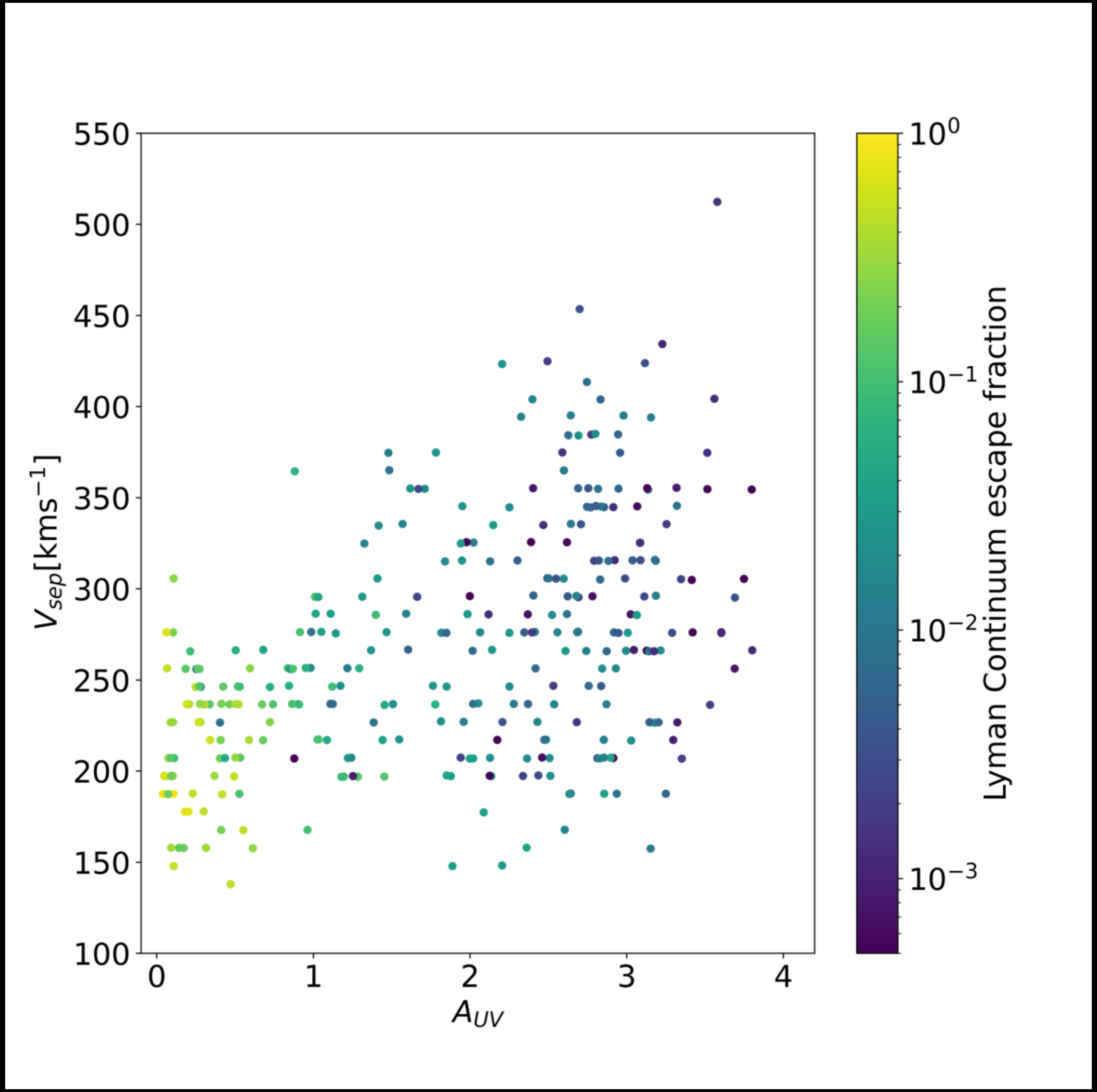
Peak Separation

Comparison of our data points with the relation from Izotov+18 and the Green Pea galaxies used to calibrate the relation. Higher magnitude points seem to follow the relation better.



Adding dust

Taking into account dust attenuation, it should be possible to more robustly determine high LyC escape fractions.



Conclusions

- Due to the resonant nature of Lyman-α, spectra from different viewing angles of the same galaxy can be very different, making it difficult to study galaxy properties from the Lyman-α line.
- Lyα properties seem robust with a change in dust model, which is very encouraging as self-consistent dust models are complicated to implement.
- The comparison of $f_{esc}(LyC)$ to observationally calibrated relations between $f_{esc}(LyC)$ and Lyα properties shows that only part of the galaxies are in agreement, although the addition of dust attenuation seems to improve the fit.

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Thank you for your attention!

Extras

Peak Separation

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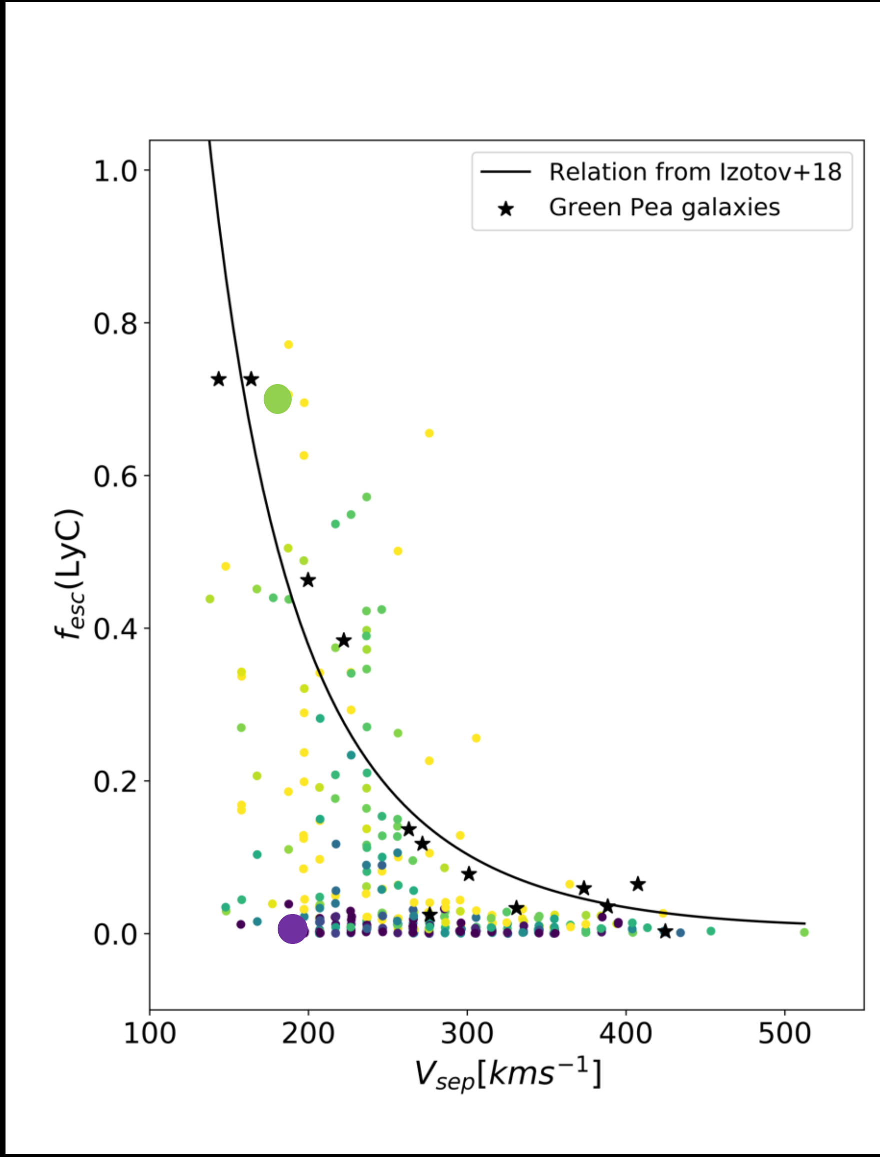
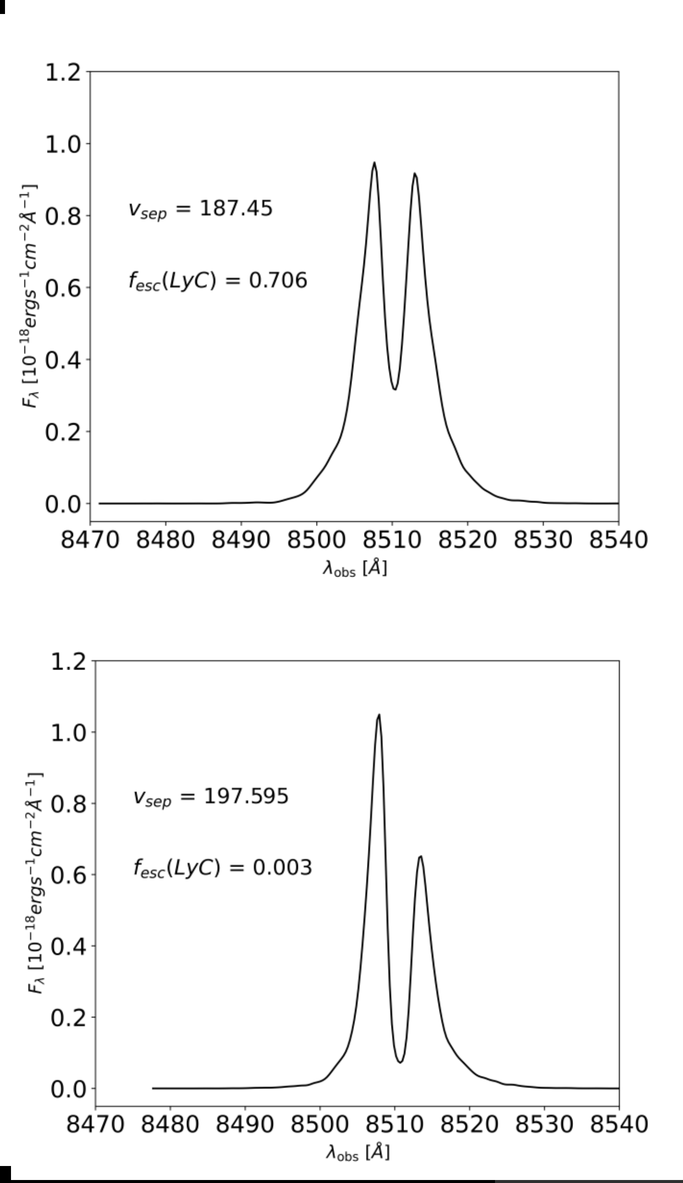
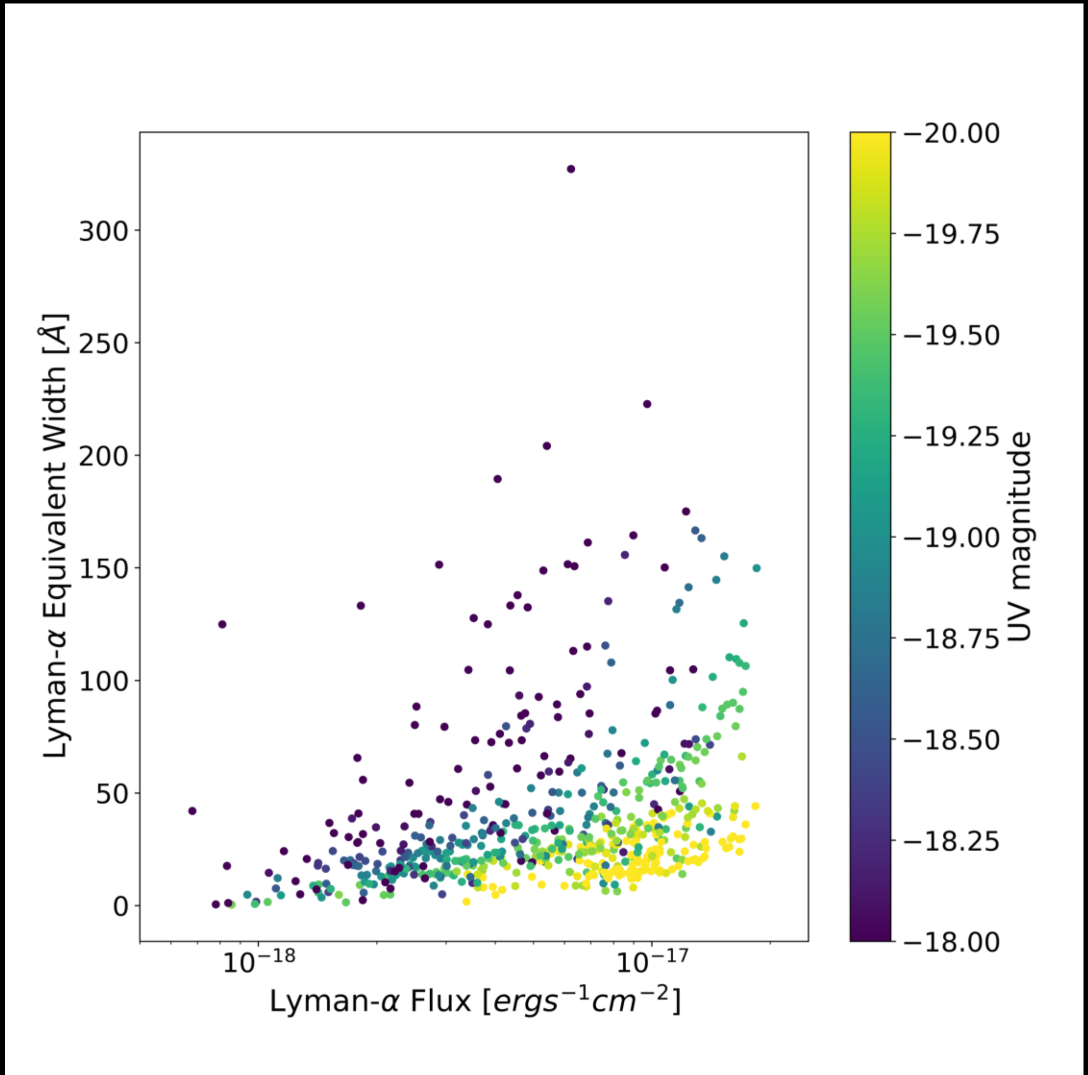




Lyα EW vs Lyα flux

Lower Lyman-α equivalent width for galaxies with higher observed UV magnitude



Lyα EW vs $f_{esc}(Ly\alpha)$

Higher $f_{esc}(LyC)$ for higher $f_{esc}(Ly\alpha)$ at a given EW. Possible indication that LyC and Lyα escape from the same channels.