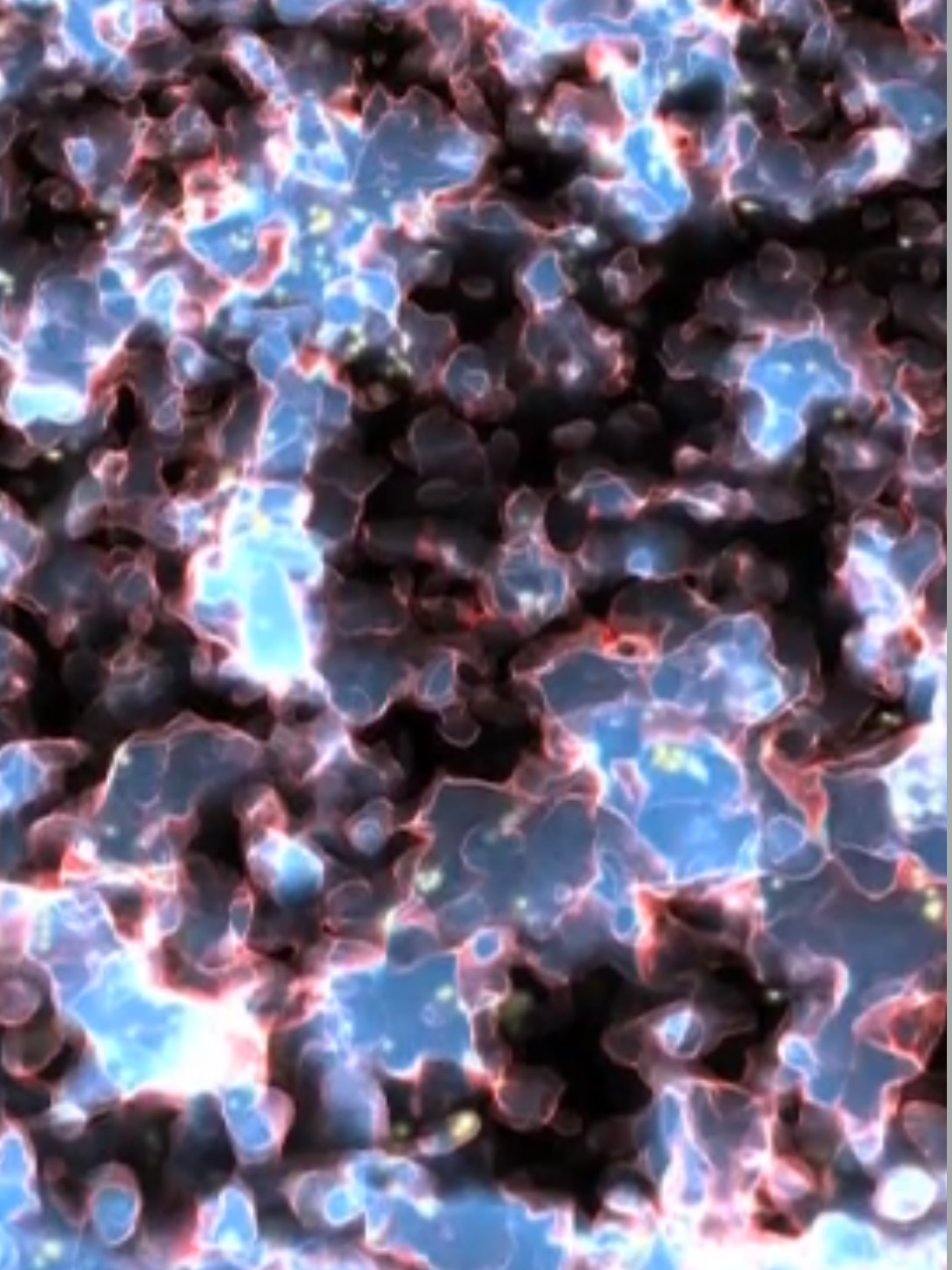
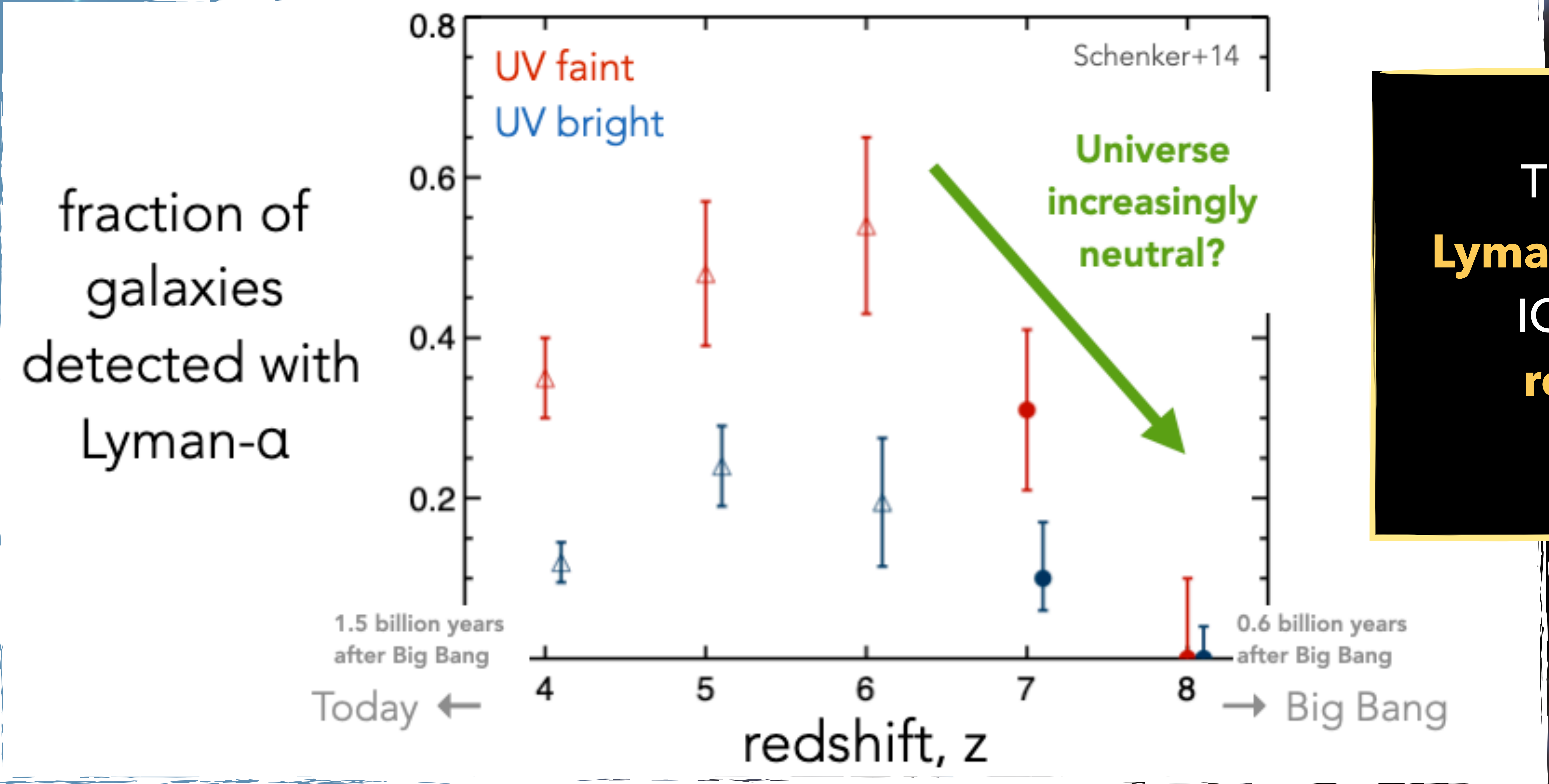


POST-REIONIZATION MODEL FOR EMERGENT LYMAN ALPHA

Gonzalo Prieto-Lyon
Charlotte Mason

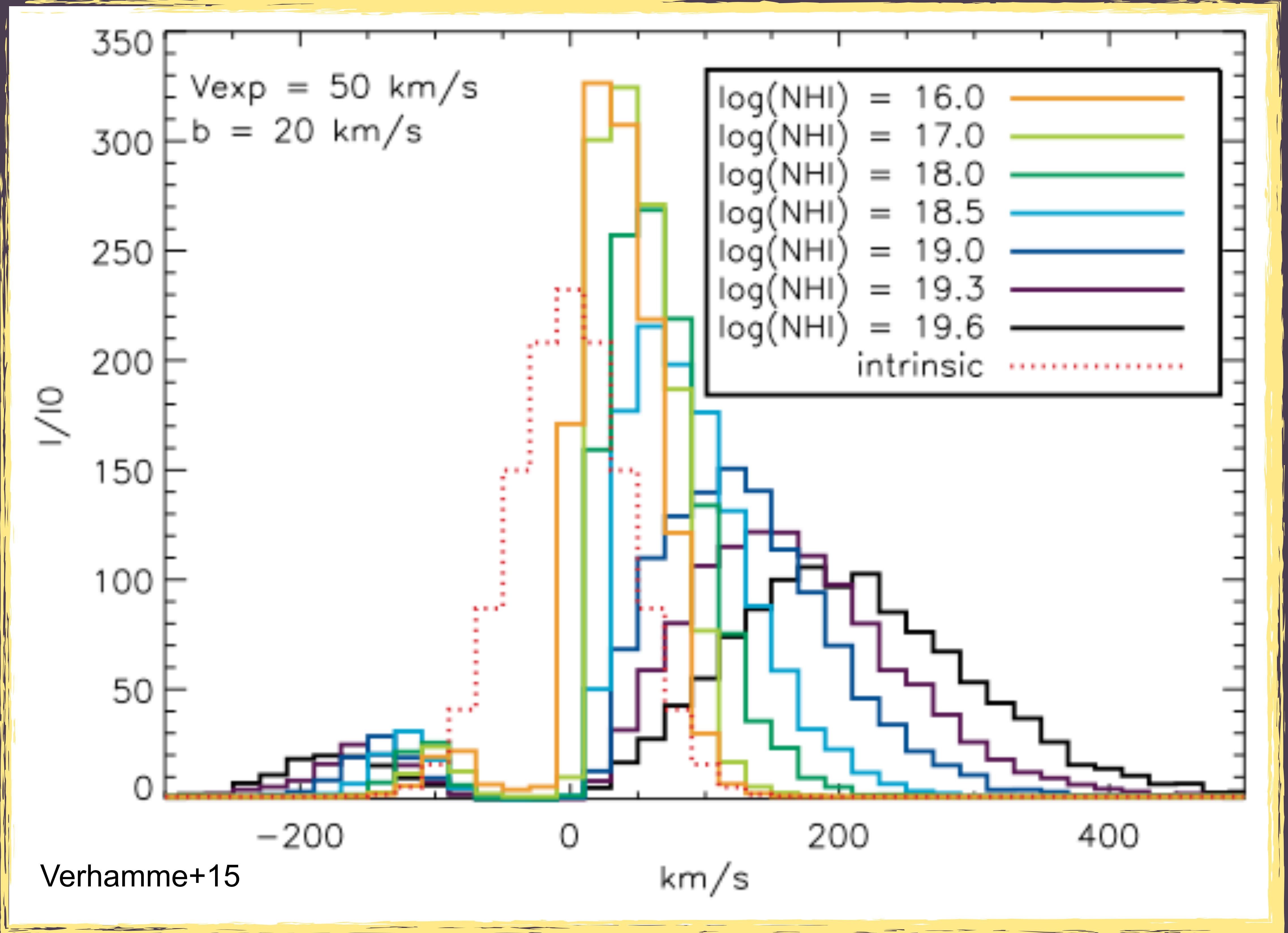
DAWN
UNIVERSITY OF COPENHAGEN



The relation between **Lyman-Alpha** and the neutral IGM can help us trace **reionization history.**

Lya Detection Rates:
e.g. Stark+10, Schenker+14, Pentericci+18, Fuller+20, Stark+11, Treu+13, Mason+19, Jung+19, Bolan+22

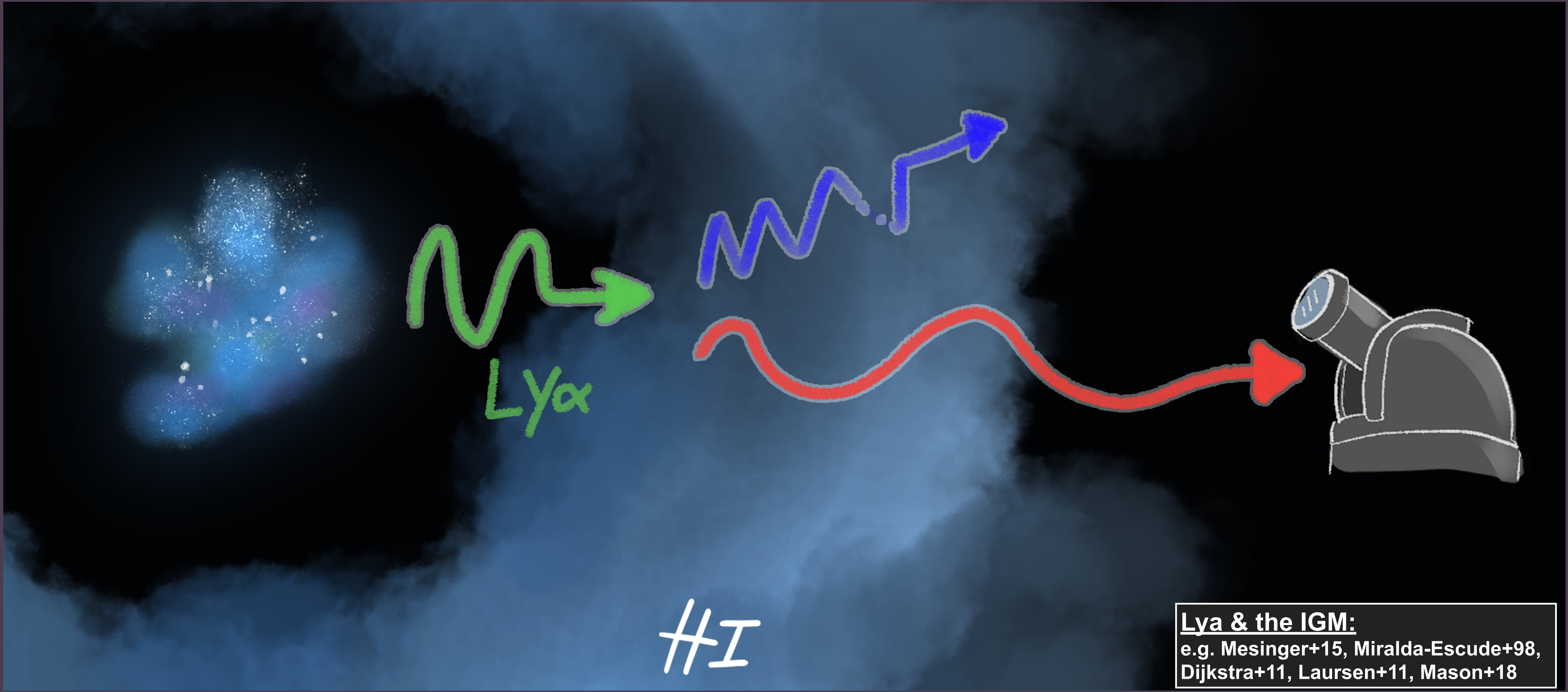
LYMAN ALPHA PRODUCTION AND ESCAPE FROM THE ISM



- Produced from HI around star-forming regions. And resonantly scattered
  - Younger stellar populations promote Lya production.
  - Dustier environments destroy Lya photons.
- Depending on galaxy properties, Lyman-Alpha will have different profiles when it escapes from the ISM.

Lya & the ISM:
e.g. Verhamme+15, Dijkstra+14, Blaizot+23, Neufeld 1990, Verhamme+06

THE TRANSMISSION OF LYMAN ALPHA THROUGH THE IGM



Lya & the IGM:
e.g. Mesinger+15, Miralda-Escude+98, Dijkstra+11, Laursen+11, Mason+18

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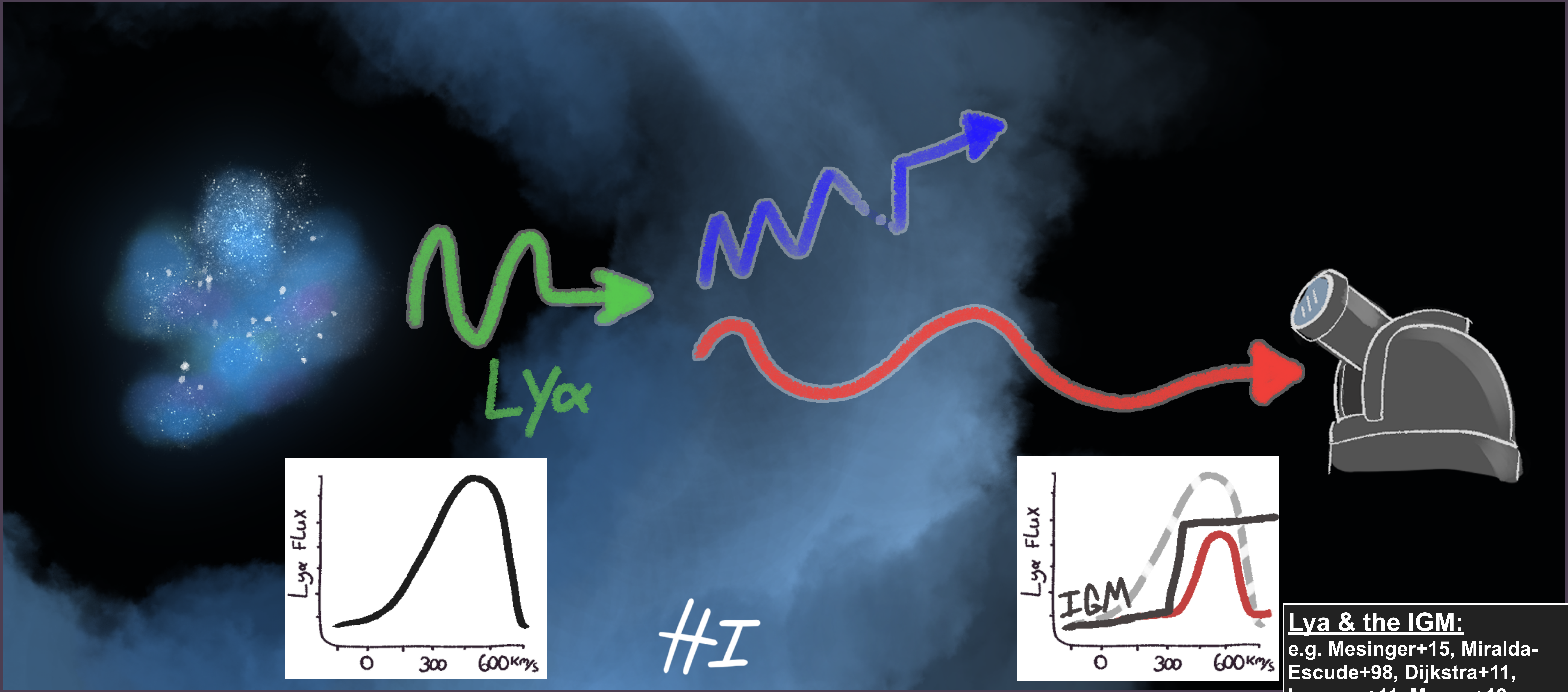

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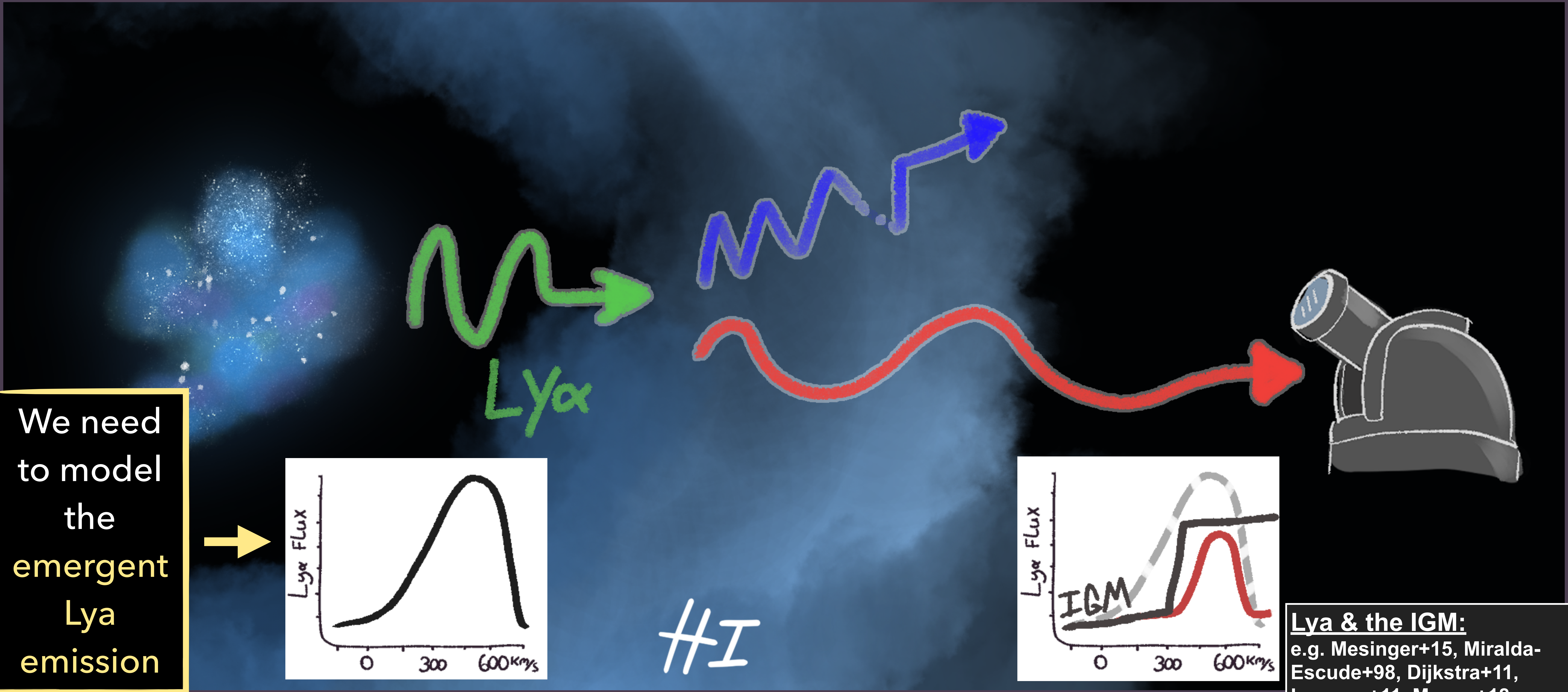

We need to model the emergent Lya emission

Lya & the IGM:
e.g. Mesinger+15, Miralda-Escude+98, Dijkstra+11, Laursen+11, Mason+18

A MODEL FOR EMERGENT LYMAN ALPHA :

THE GOAL

MUV

UV SLOPE

LYMAN ALPHA EQUIVALENT WIDTH

+

VELOCITY OFFSETS
FWHM
ESCAPE FRACTION

- Construct model with observations near the EoR
- Obtain the probability of $EW_{Ly\alpha}$ given Muv and UV slope

Why Muv and UV slope ?

- Easily observable at $z>10$
- We expect galaxies with a faint and blue UV continuum to promote $Ly\alpha$ production and escape.

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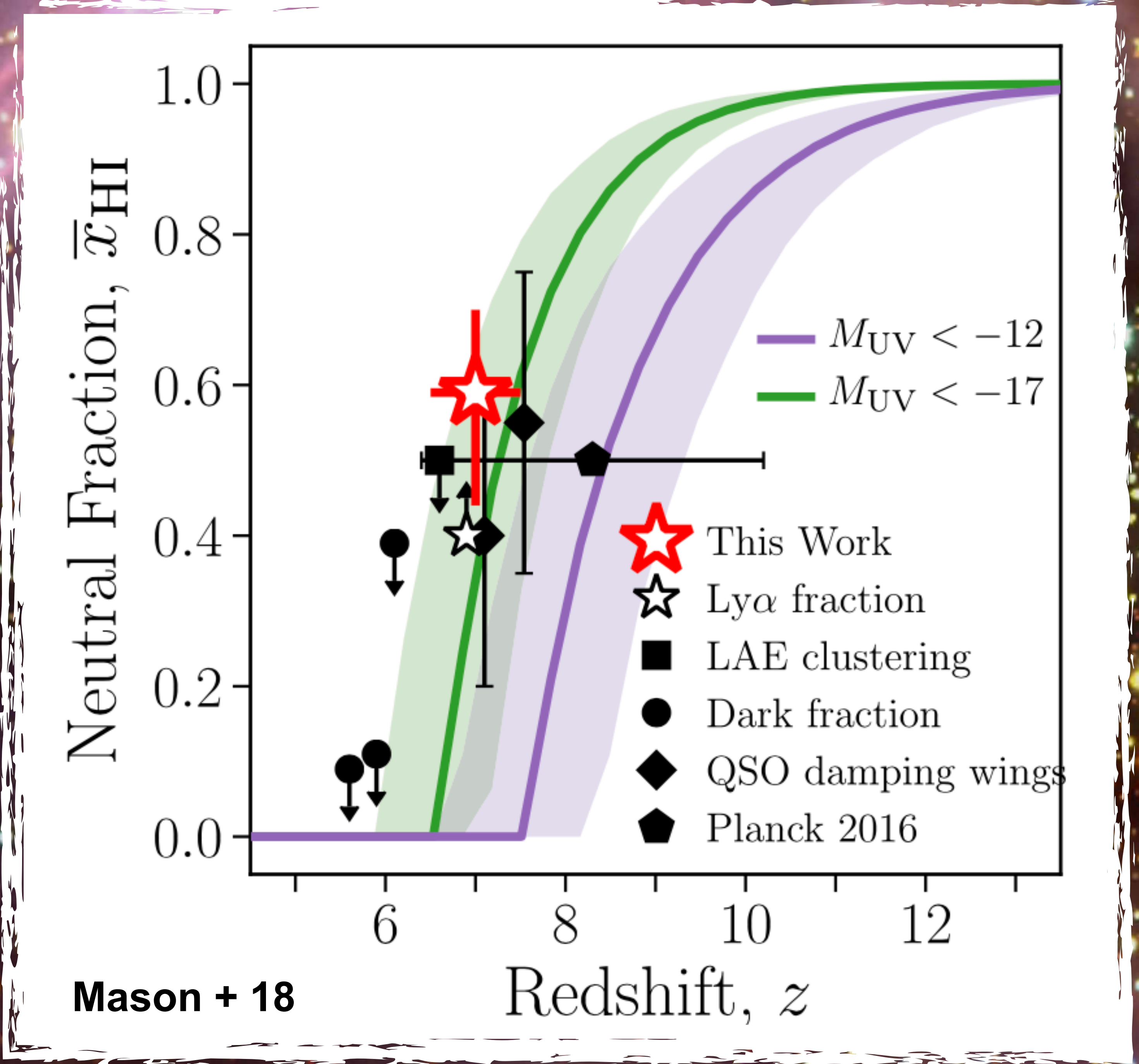
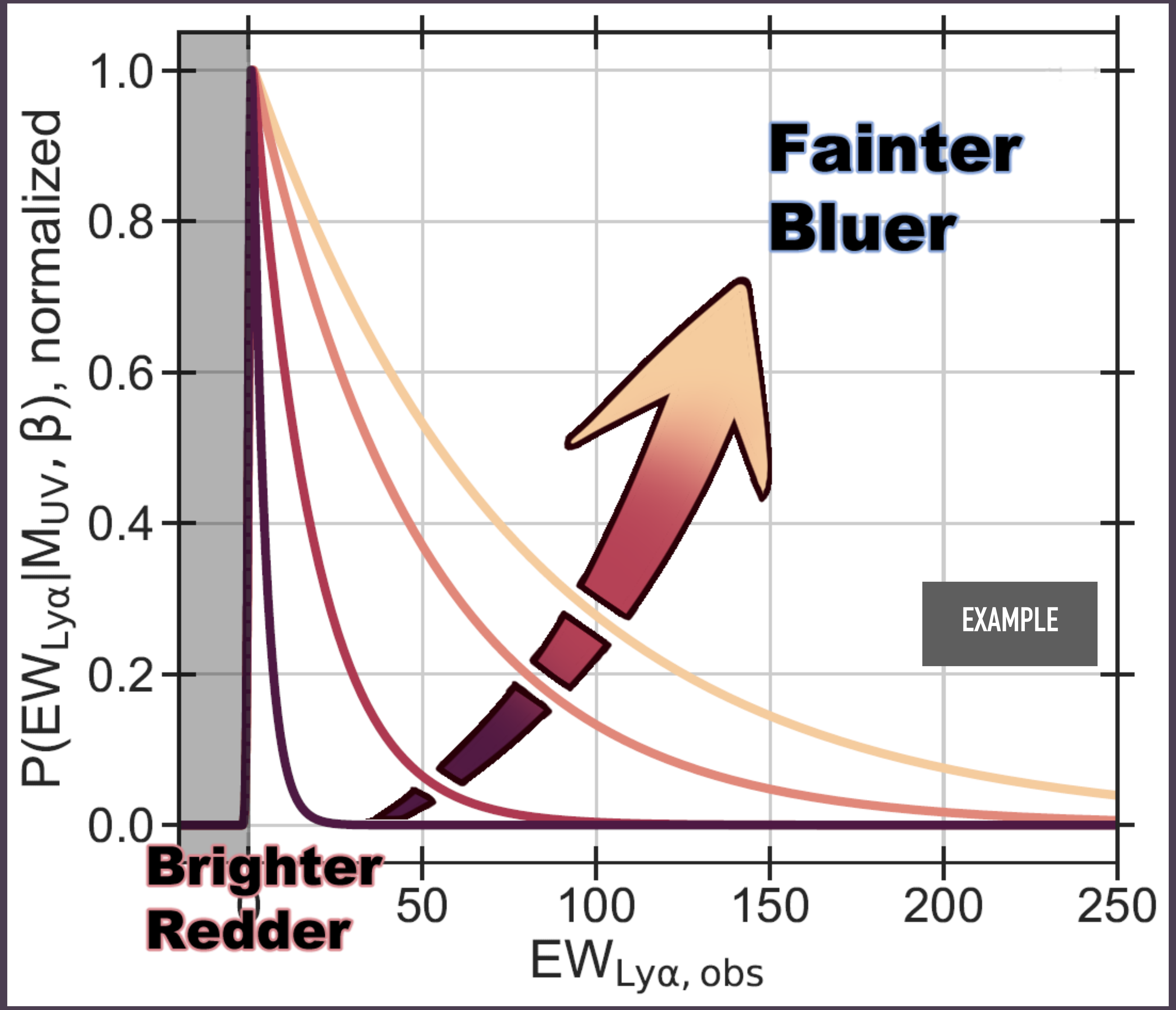


A MODEL FOR EMERGENT LYMAN ALPHA :
THE BAYESIAN MODEL

$$p(\mathrm{EW}_{\mathrm{ly}\alpha}|\mathrm{EW}_{\mathrm{n}} = \{A, W_0\}) = \frac{A}{W_0} e^{-\mathrm{EW}_{\mathrm{ly}\alpha}/W_0} \mathrm{H}(\mathrm{EW}_{\mathrm{ly}\alpha}) + (1 - A)\delta(\mathrm{EW}_{\mathrm{ly}\alpha})$$



- Exponential : Represents the $EW_{Ly\alpha}$ distribution. Distribution peaks at 0 and decays at higher values.
- Delta : Describes population of galaxies with $EW_{Ly\alpha}$ = 0. Mostly based on upperlimits

2 PARAMETERS:

UV SLOPE → EXPONENTIAL PARAMENTER (W0)

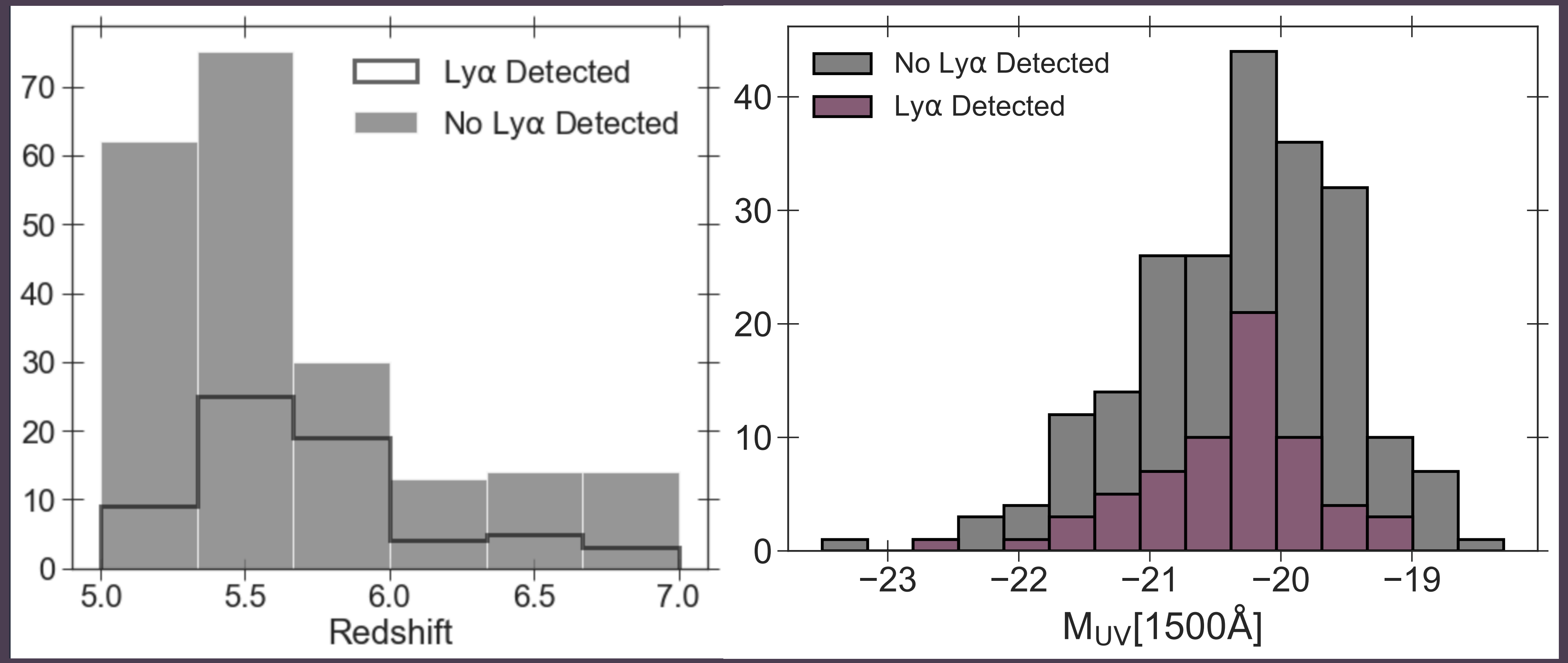
MUV → P(EW>0) (A)

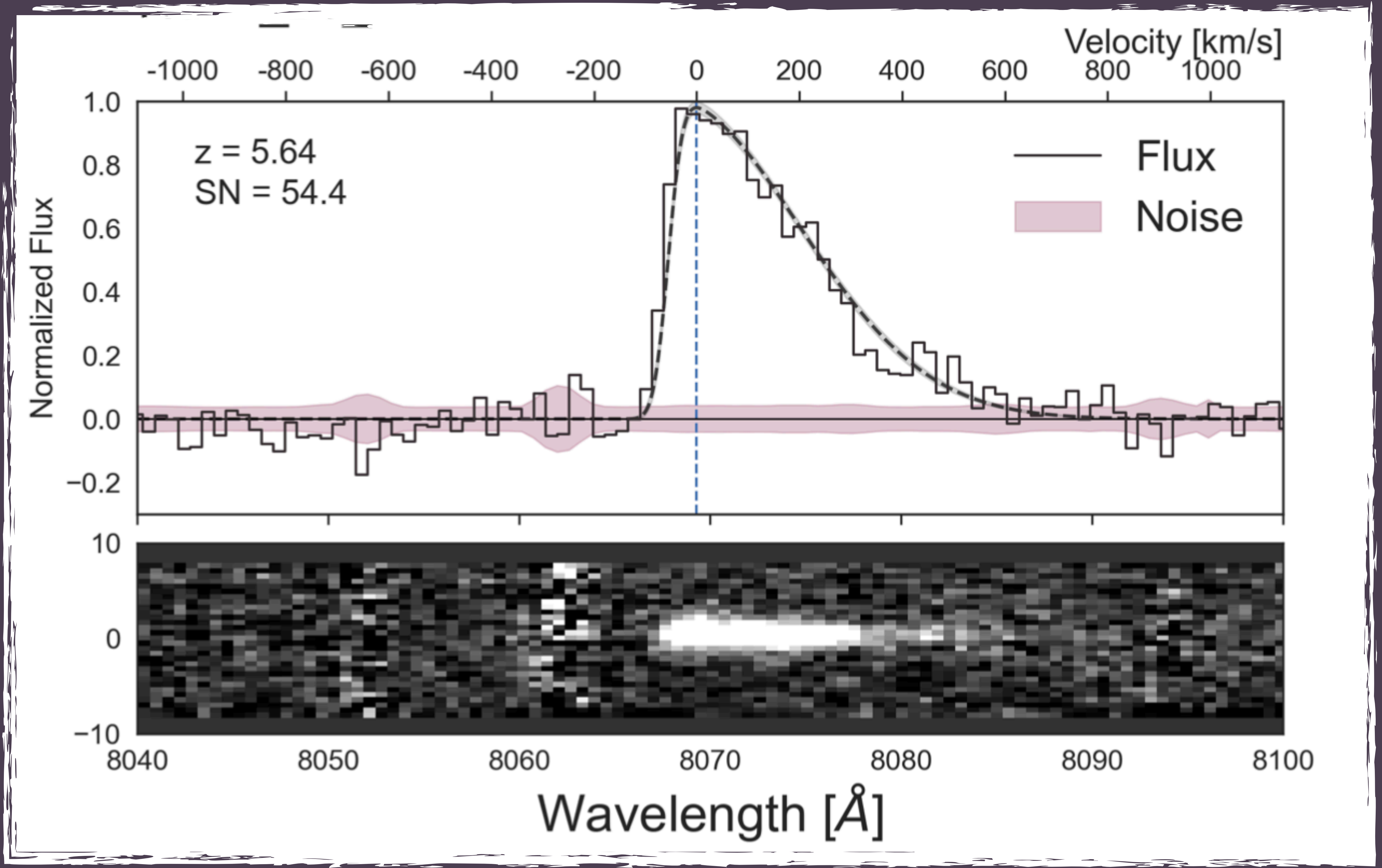
EWLyα models:
e.g. Oyarzun+17,
Tang+24, Mason+18

A MODEL FOR EMERGENT LYMAN ALPHA :
NEW HIGH SPECTRAL RESOLUTION LYA SURVEY AT Z ~ 5 – 7

- MMT / Binospec - Spectra, 0.62 (Å/pix) : PI :Mason
  - 65 Lyα detections
  - 200 non-detections
- JWST / NIRCam [FRESCO] PI :Oesch
  - Slitless spectra of Hα for ~60 sources
  - 12 have Lyα + Hα
- JWST / NIRCam [JADES] : PI :Eisenstein
  - Photometry for UV properties

Prieto-Lyon in prep.





A MODEL FOR EMERGENT LYMAN ALPHA :

NEW HIGH SPECTRAL RESOLUTION LYA SURVEY AT Z ~ 5 – 7 , WITH JWST REST-FRAME OPTICAL OVERLAP

Prieto-Lyon in prep.

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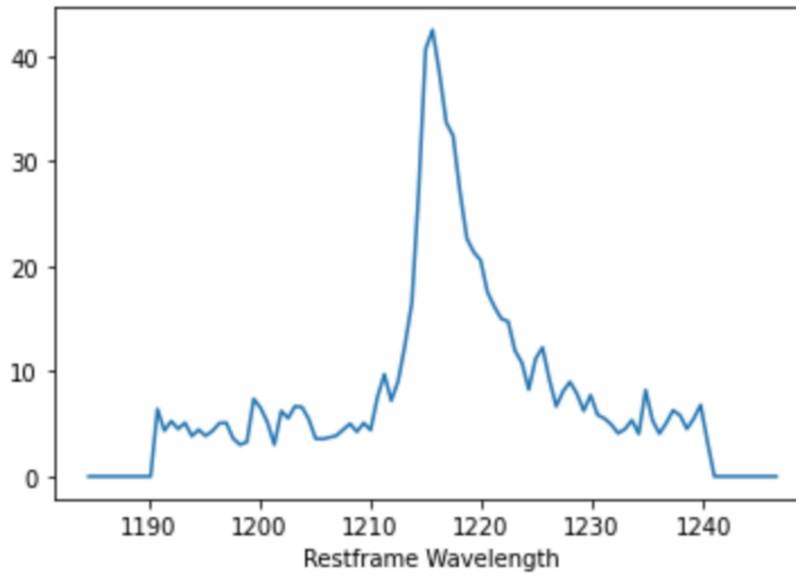
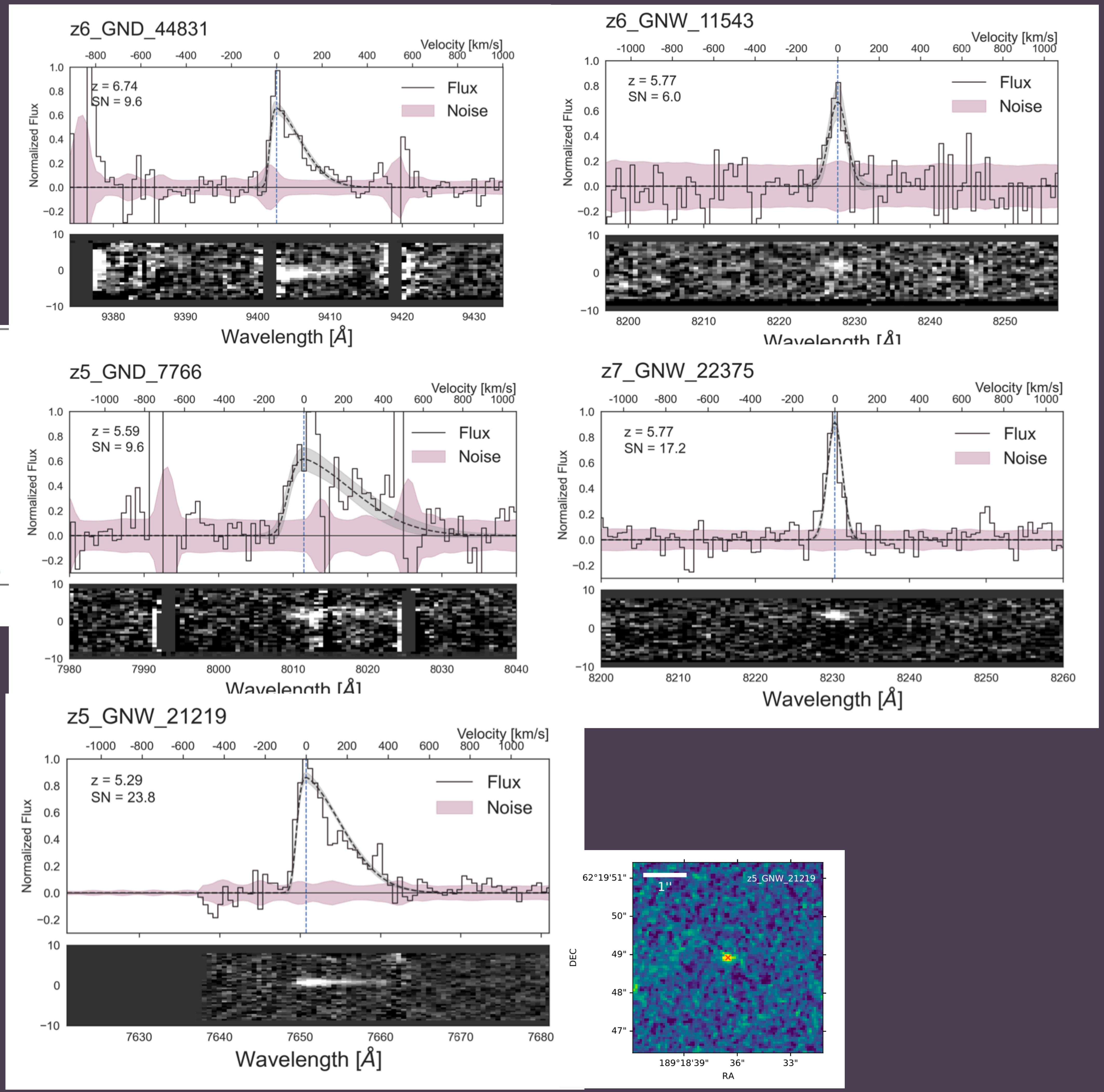
Stacked





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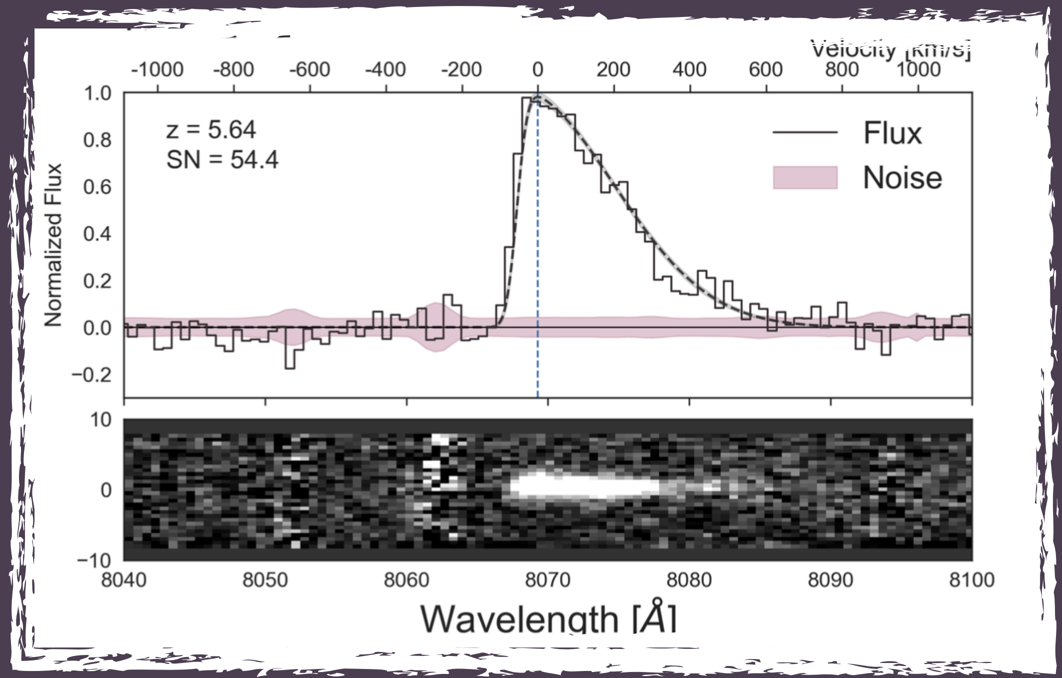
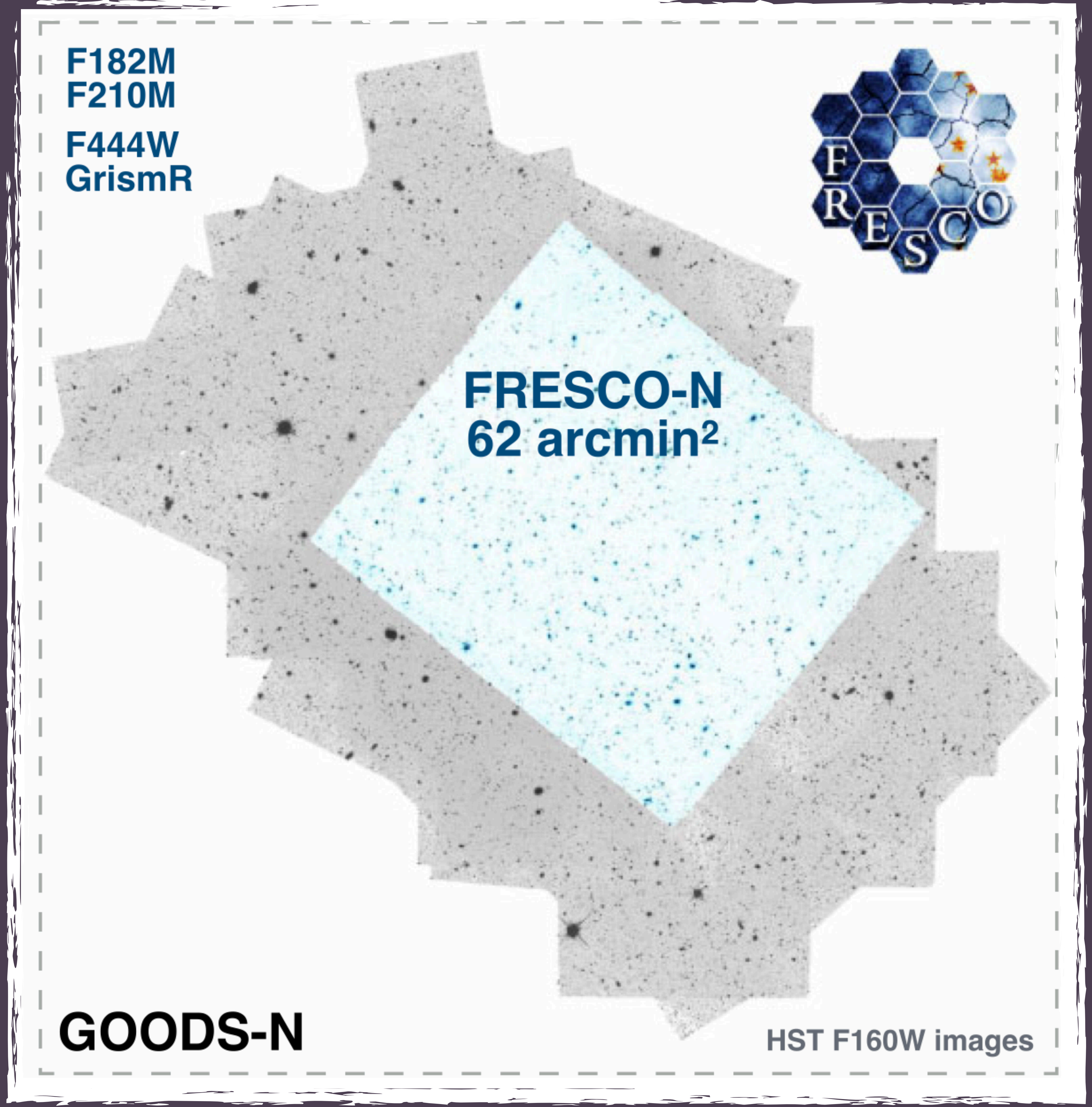
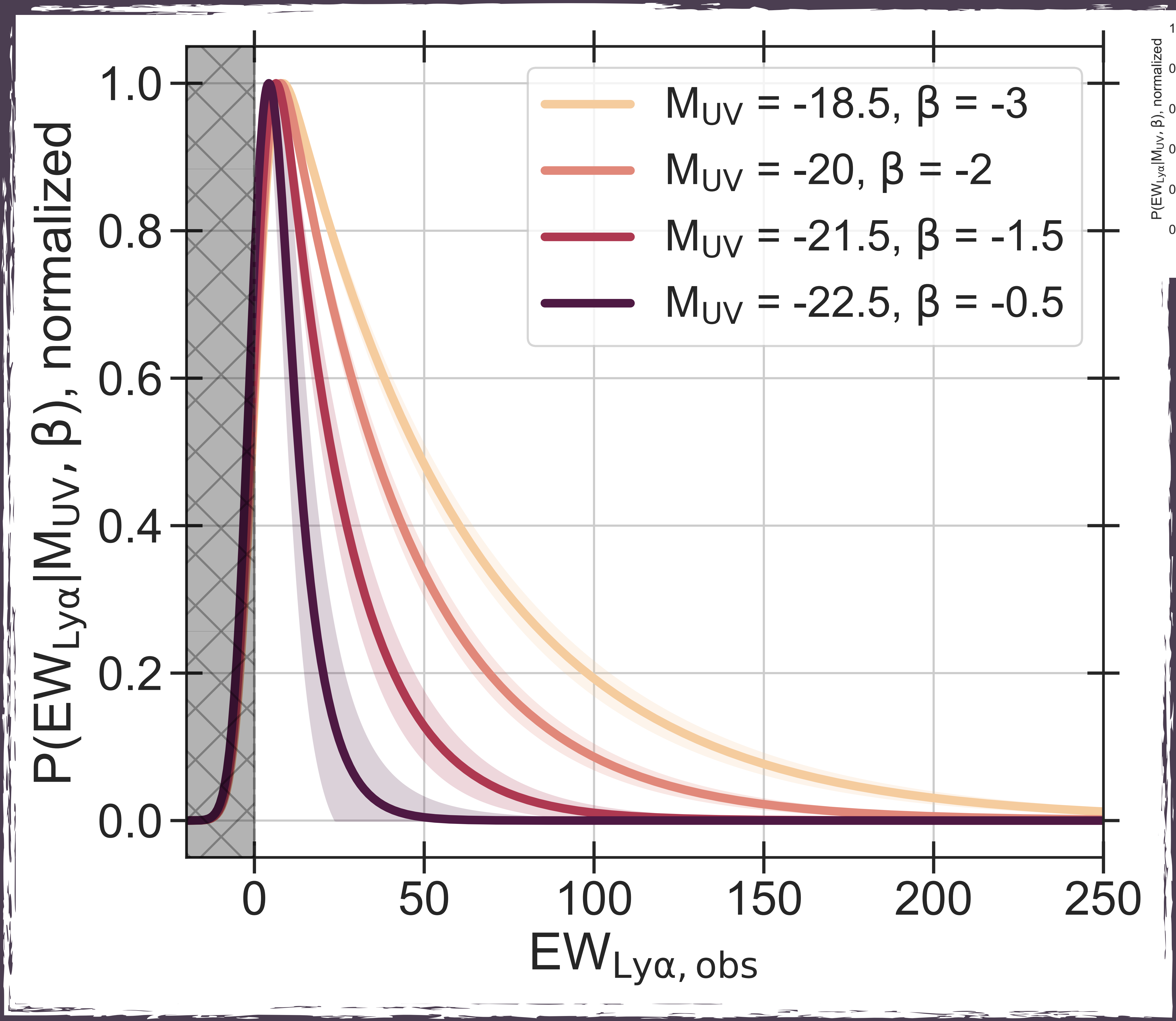


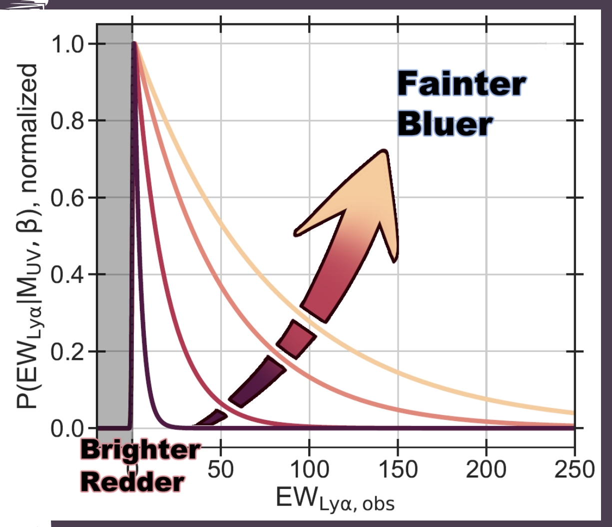


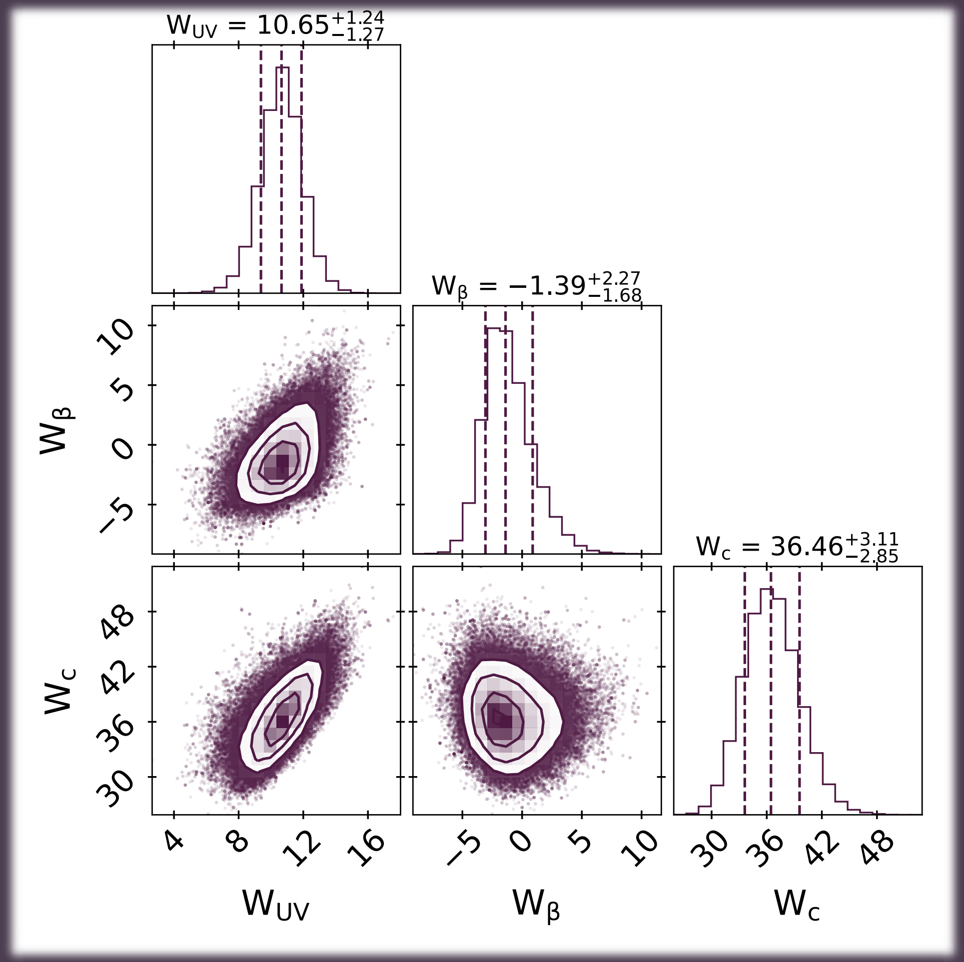
Prieto-Lyon in prep.

BAYESIAN MODEL FOR EMERGENT LYMAN ALPHA EQUIVALENT WIDTH

OUR RESULTS



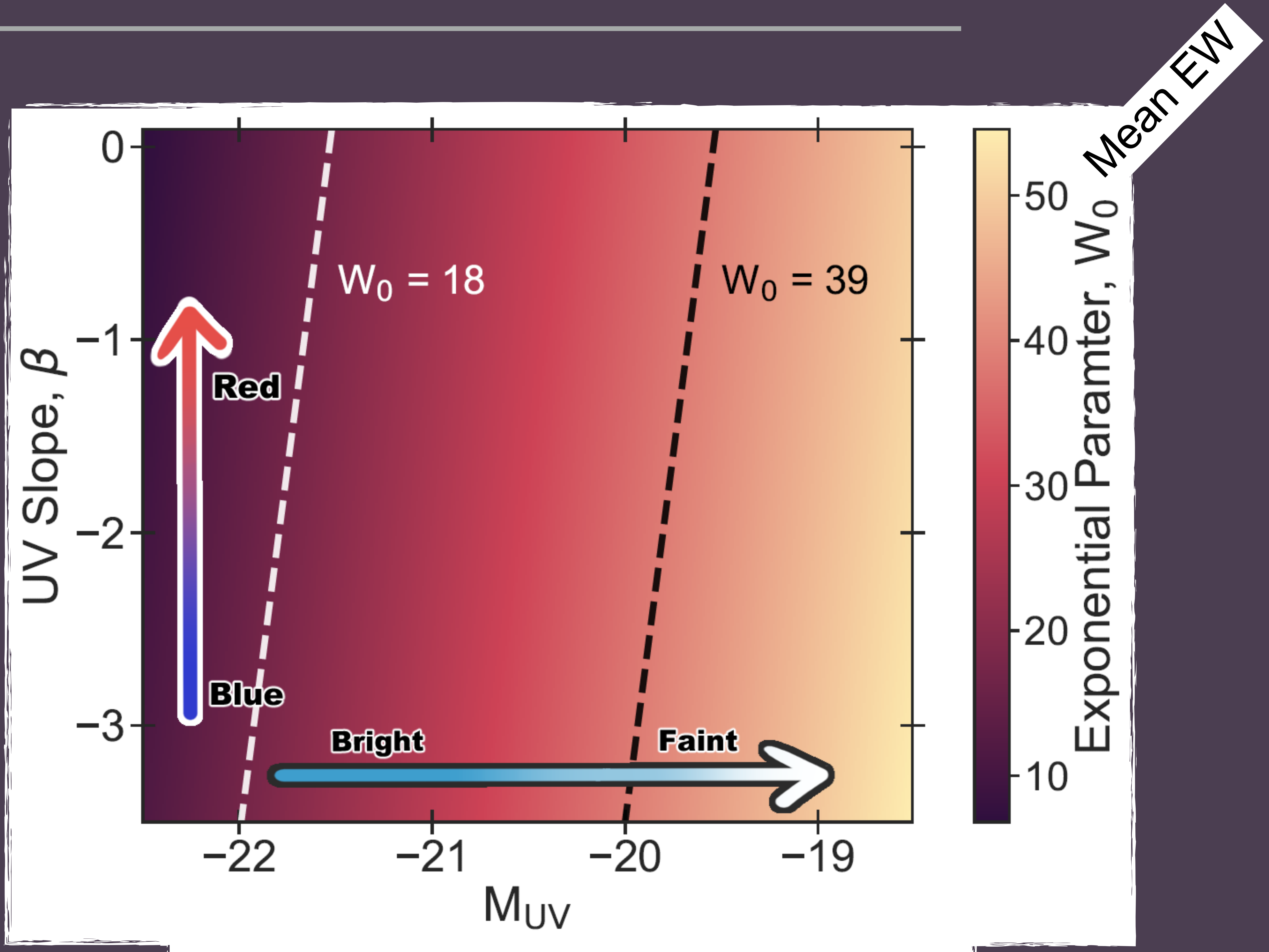




- High probability of strong $EW_{Ly\alpha}$ in faint and/or blue galaxies.
- Model parameters can be predicted to 10% of true values
- Mean EW changes from 10Å to 50Å
- ~40% of galaxies , EW >25Å

Prieto-Lyon in prep.
see also Tang+24

OUR MODEL FOR EMERGENT LYMAN ALPHA EQUIVALENT WIDTH

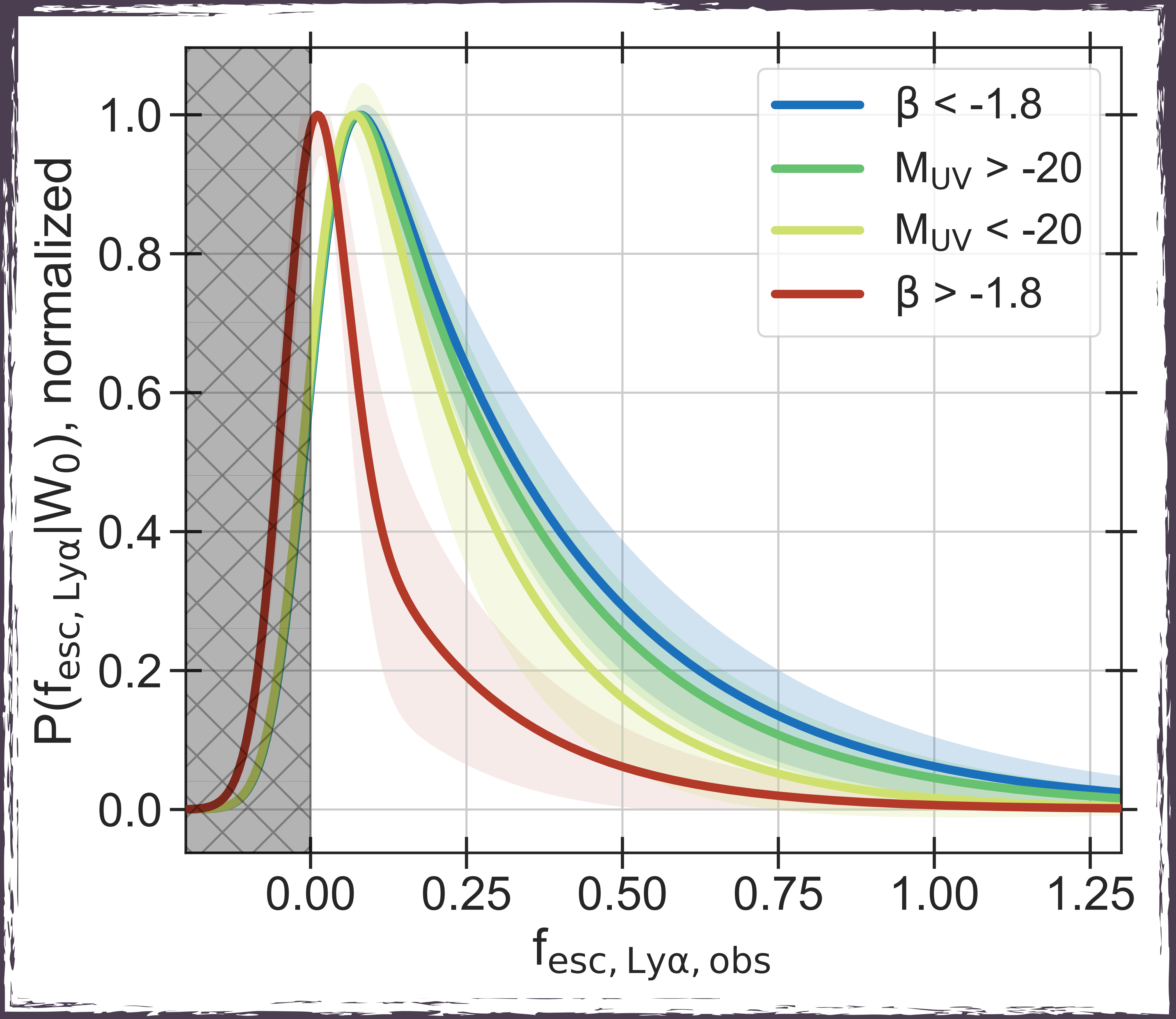


$$W_0 = 10.7^{+1.2}_{-1.2} \cdot (M_{UV} + 20) - 1.5^{+2.1}_{-1.6} \cdot (\beta + 2) + 36.8^{+3.0}_{-2.8}$$

Prieto-Lyon in prep.

- Probability of strong Lyman-Alpha is higher in faint and blue galaxies.
- Dominated by UV magnitude.
  - Beta slope produces a small change on the model

MODEL FOR LYMAN ALPHA ESCAPE FRACTION :

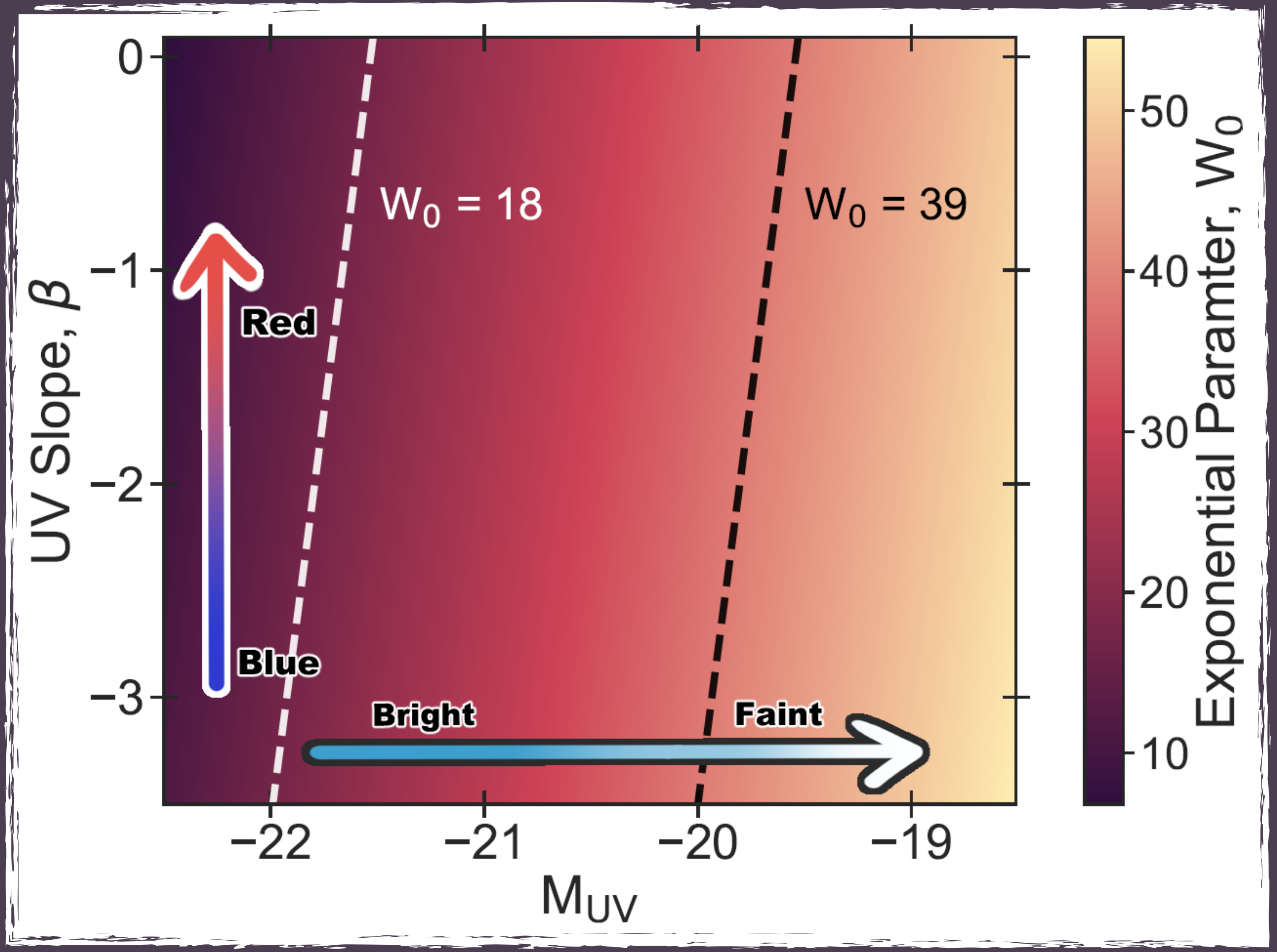


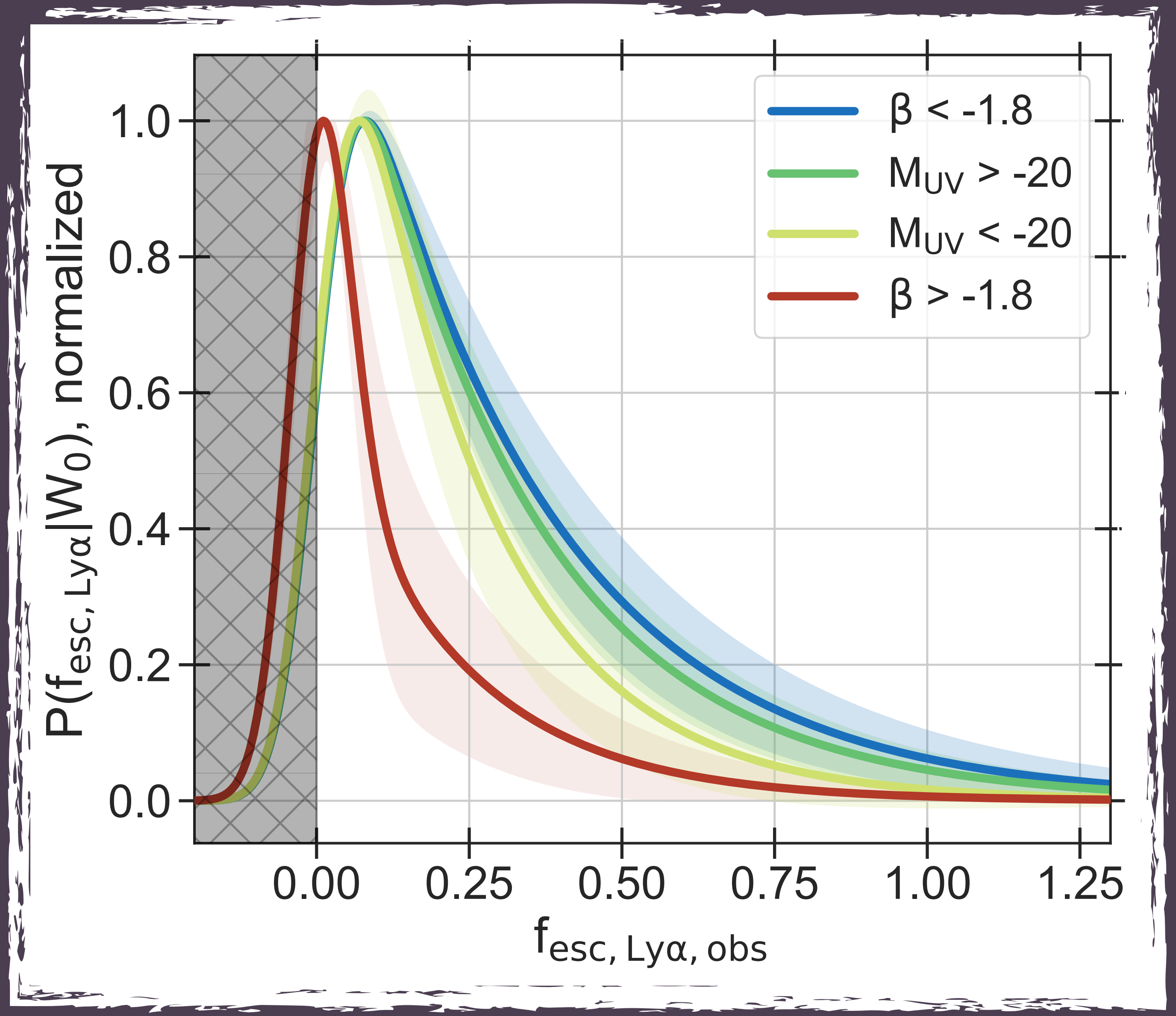
Prieto-Lyon in prep.

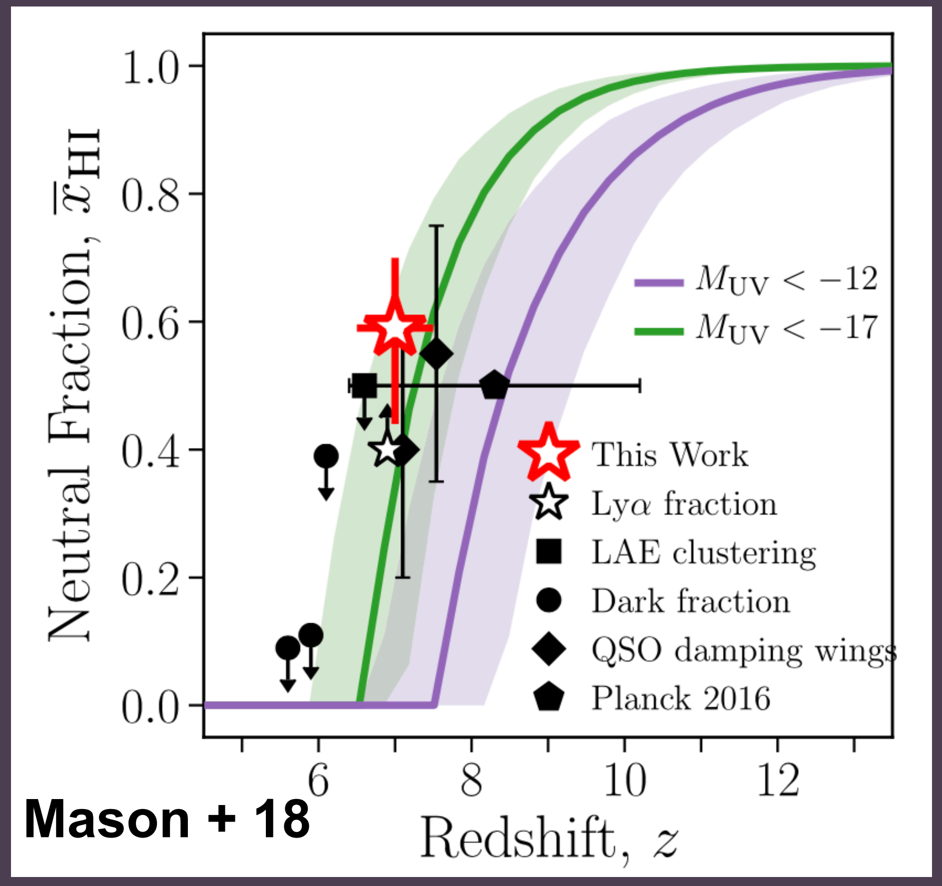
- Data binning needed.
- Higher Escape Fraction more likely in blue and/or faint galaxies.
- Very dusty environments make it unlikely for Lyman-Alpha to escape. Strong trend with UV slope

Lya escape fraction :
e.g. Tang+24, Saxena+24, Jung+24, Osterbrock+89, Hayes+11, Chen+24

THEN WE CAN FORWARD OUR MODEL INTO THE TIMELINE OF REIONIZATION MODEL. JWST HAS ALLOWED FOR MORE ACCURATE MEASUREMENTS OF THE EMERGENT LYMAN ALPHA PROFILE (Z ~ 5– 7)







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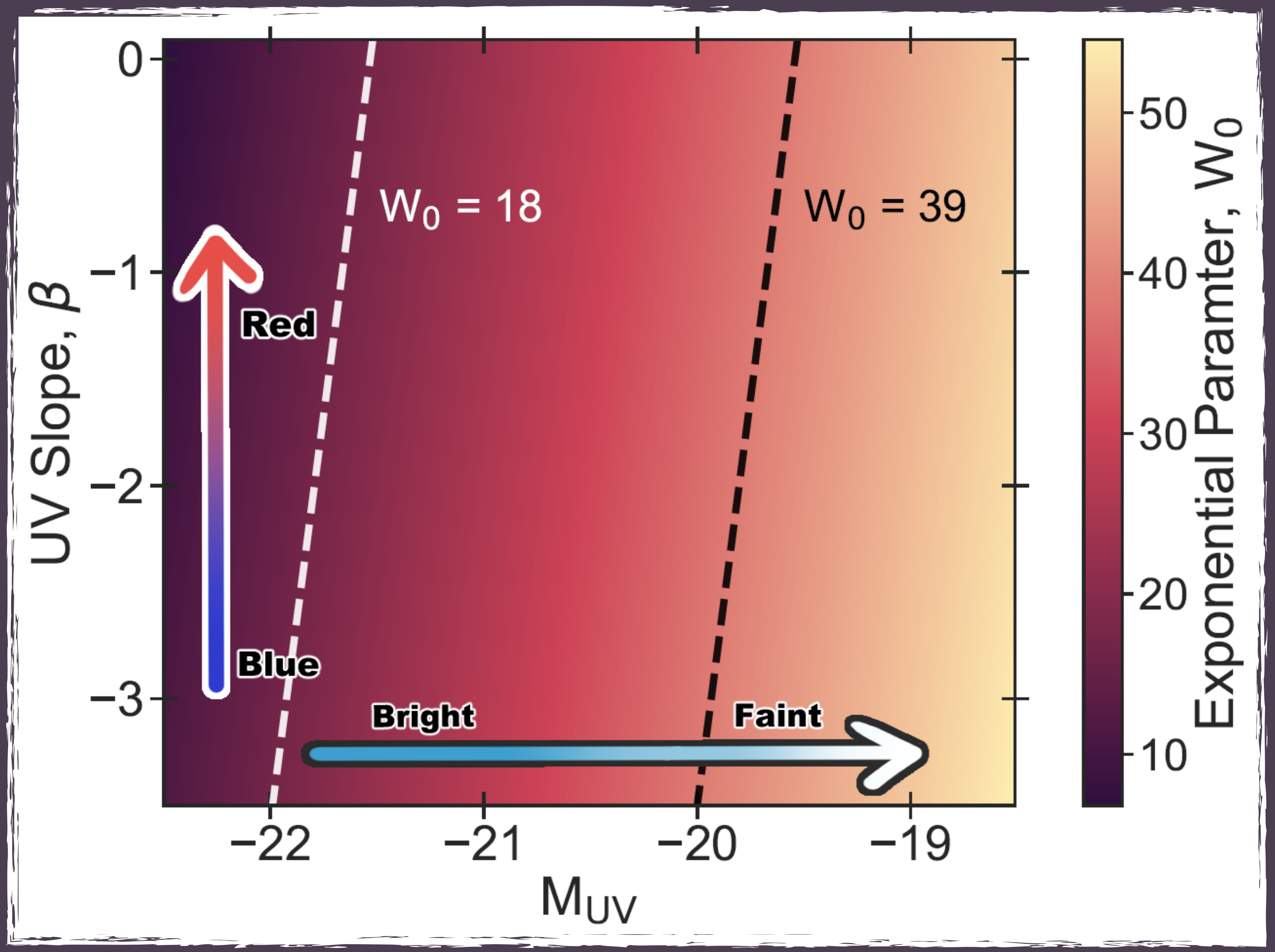
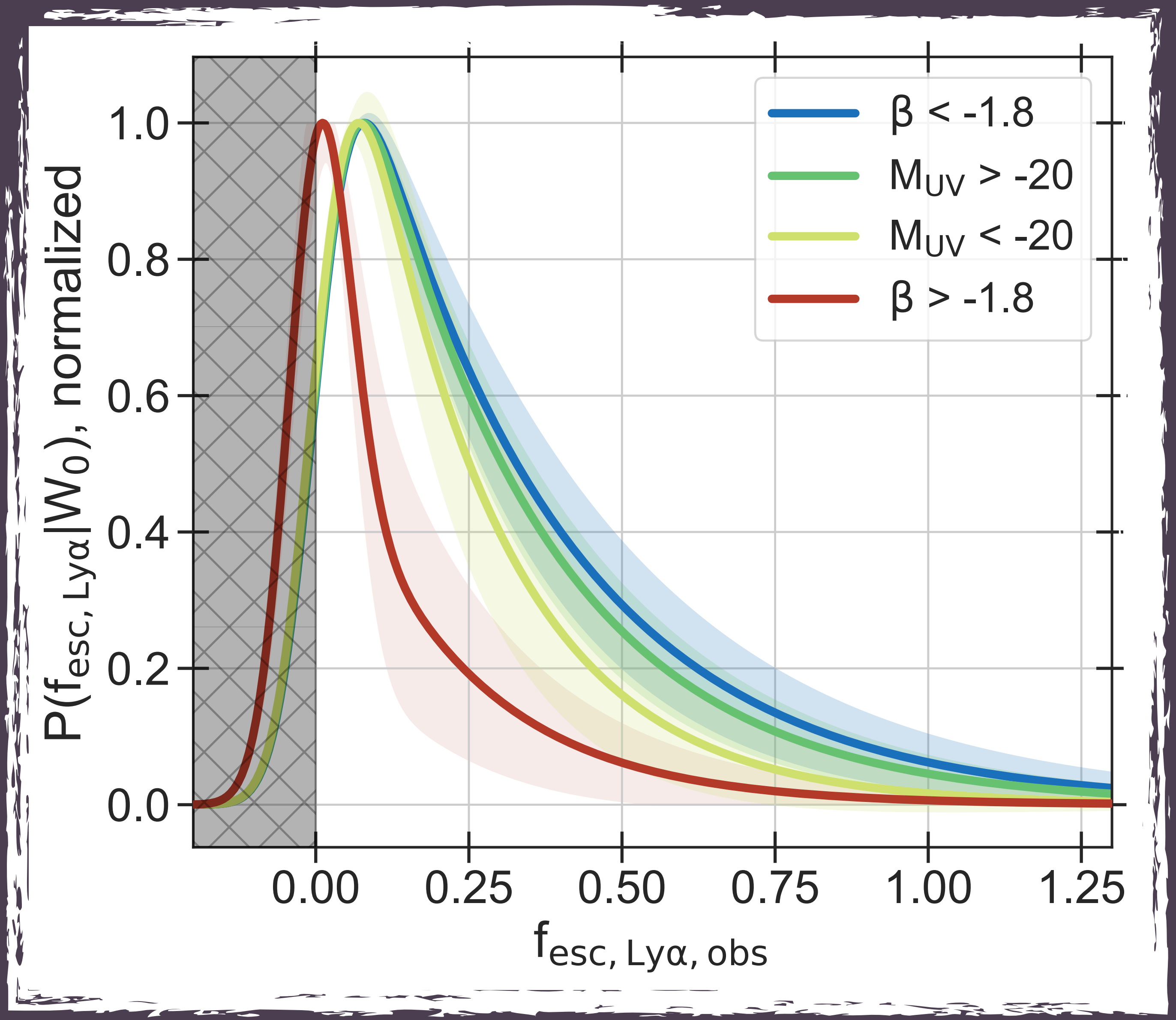
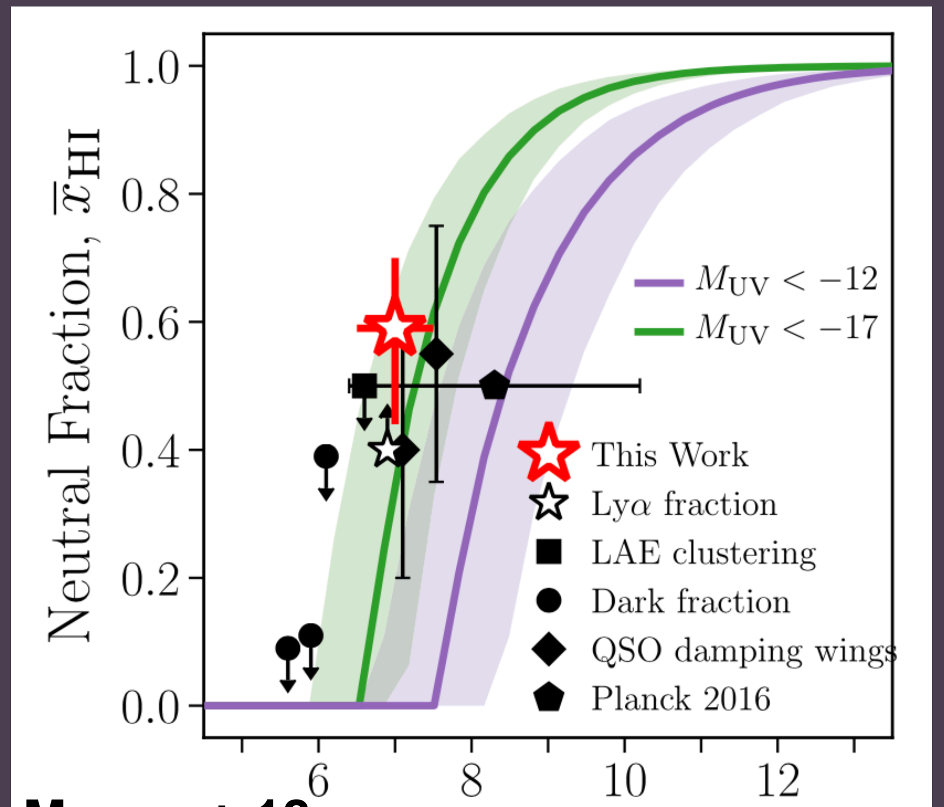
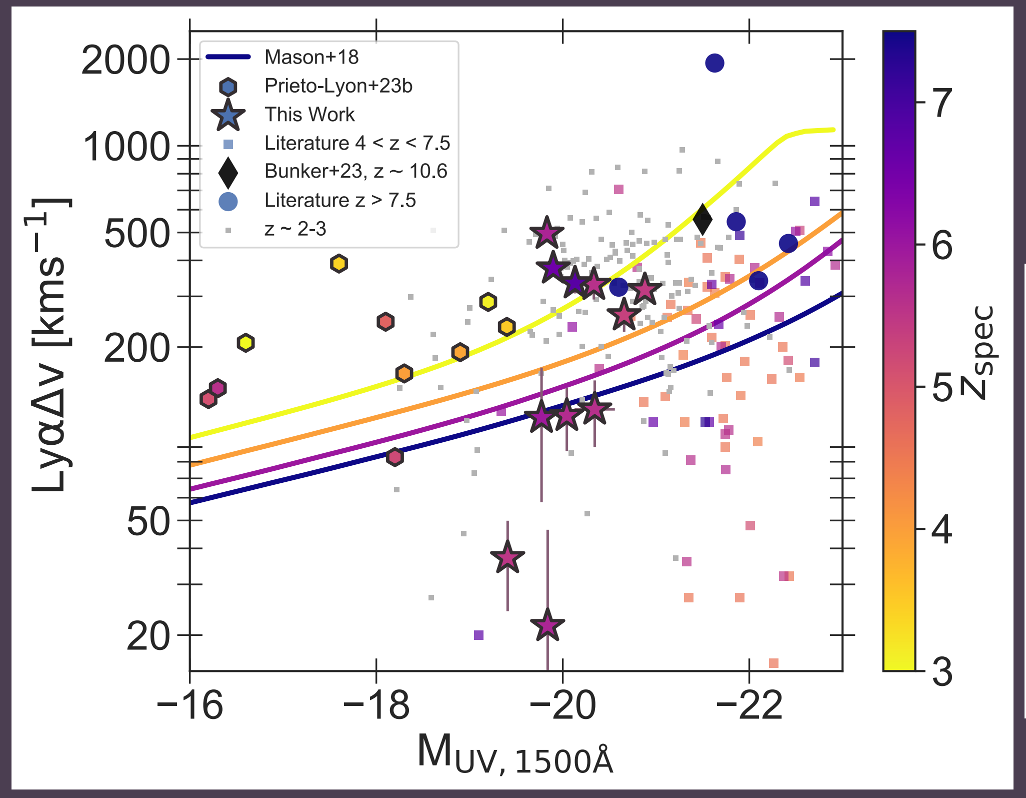
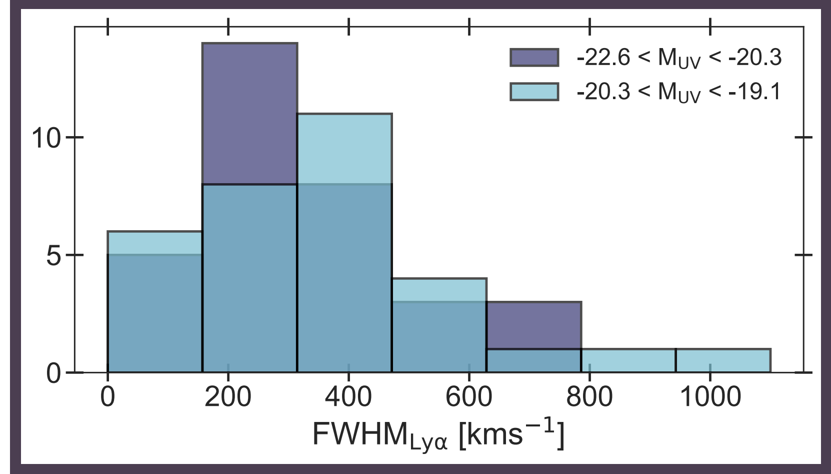






Mason + 18





New Lya JWST results:

e.g. Dan's Talk from Tuesday, Tang+24, Saxena+24, Napolitano+24, Nakane+23, Chen+24, Jung+23

NEW MODELS COMING SOON :

- We have produced a model for the Equivalent Width of Lyman Alpha
- Higher Escape Fraction dominated by reduction of dust (UV slope).
- New JWST spectra results allow us to better trace emergent Lyα (z~5). And will yield more data we can use to infer xHI at EoR