Ionising photon production efficiency of LAEs at the tail of the EoR

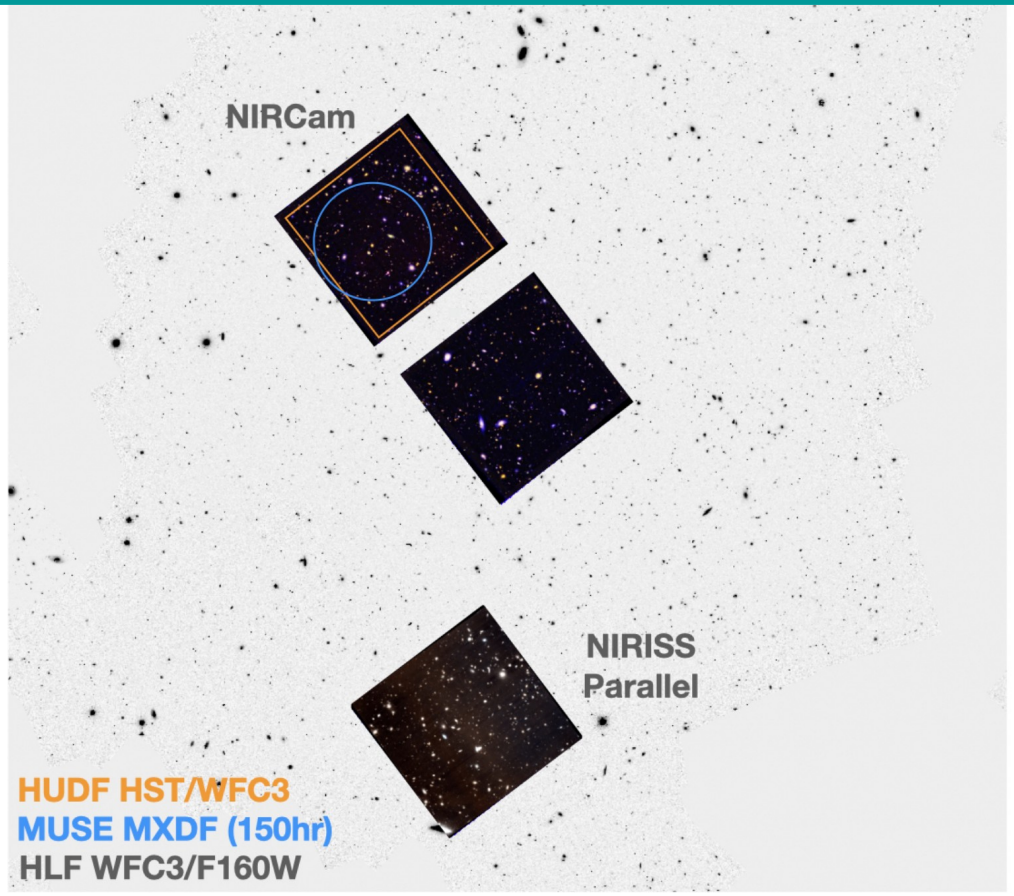
C. Simmonds, C. Williams, S. Tacchella, M. Maseda
+ JADES

muse multi unit spectroscopic explorer

Escape of Lyman radiation from galactic labyrinths

Kavli Institute for Cosmology Cambridge KICC

JEMS: A deep medium-band imaging survey in the HUDF with JWST NIRCam & NIRISS



PIs: C. Williams, S. Tacchella, M. Maseda + 2023

arXiv:2301.09780v1

Filter	integration time	5σ sensitivity	Survey Area
NIRCam	seconds	ABmag	10.1 sq arcmin
F182M	27830	29.3	
F210M	27830	29.2	
F430M	13915	28.5	
F460M	13915	28.3	
F480M	27830	28.6	
NIRISS			5.5 sq arcmin
F430M	27057	28.4	
F480M	27057	28.2	

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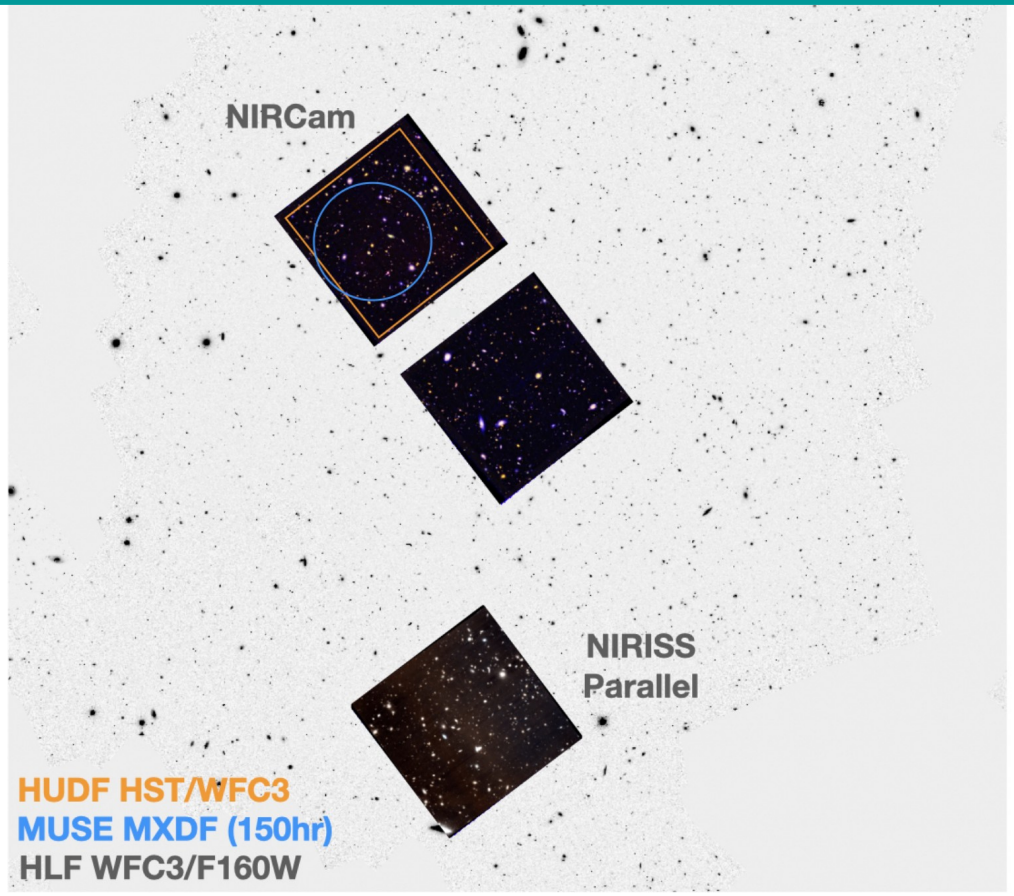

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James Webb Space Telescope Cycle 1 GO Proposal **1963**

UDF medium band survey: Using H-alpha emission to reconstruct Ly-alpha escape during the Epoch of Reionization

Scientific Category:	Galaxies
Scientific Keywords:	Emission Line Galaxies, Galaxy Evolution, Galaxy Formation, High-Redshift Galaxies, Star Formation
Alternate Category:	Intergalactic Medium and the Circumgalactic Medium
Instruments:	NIRISS, NIRCAM
Proposal Size:	SMALL
Exclusive Access Period:	0 months (less than default of 12 months)
Allocation Information (in hours):	
Science Time:	15.5
Coordinated Parallel Time:	15.5
Charged Time:	20.4

MUSE HUDF surveys: DR2 (Bacon+2023)

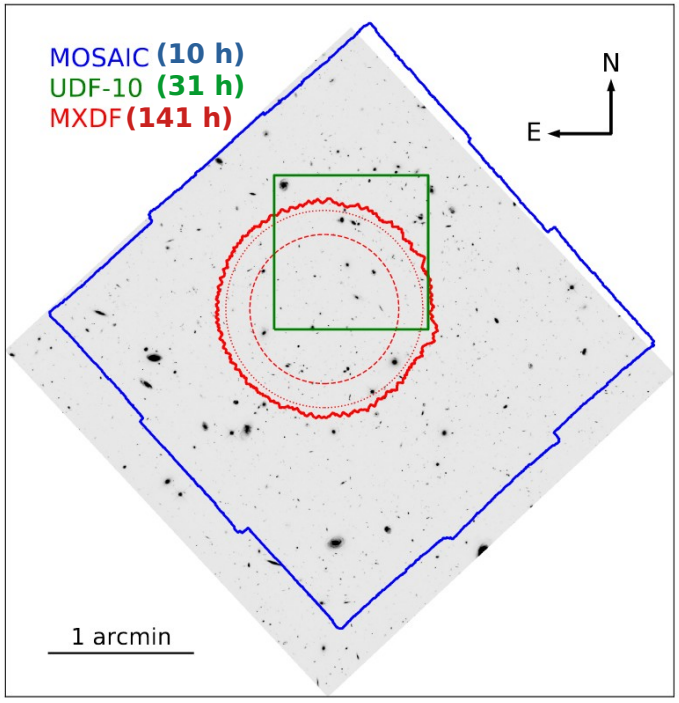
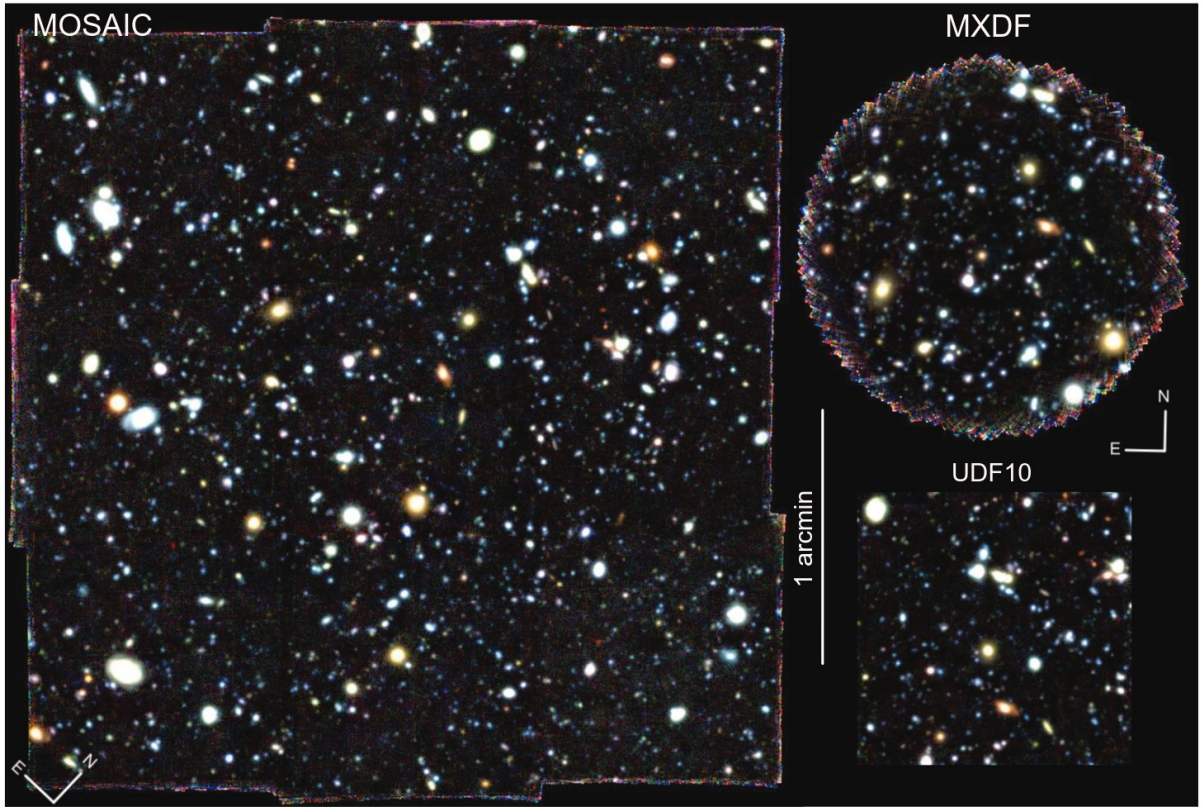


Fig. 2. Location of the three deep fields used in this paper: MXDF (141-h depth), MOSAIC (10-h depth), and UDF-10 (31-h depth) overlaid on the HST *F775W* UDF image. The dotted and dashed red circles show the MXDF 10- and 100-h exposure time isocontours, respectively.



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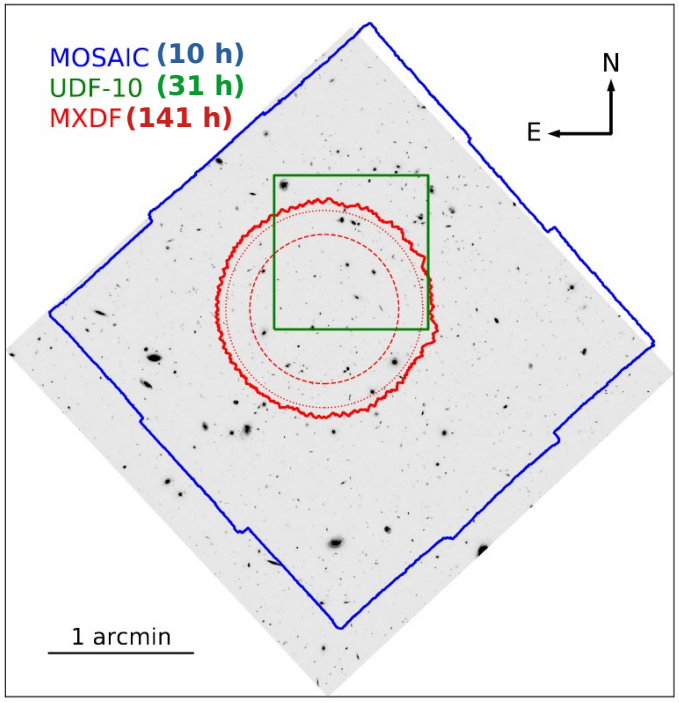

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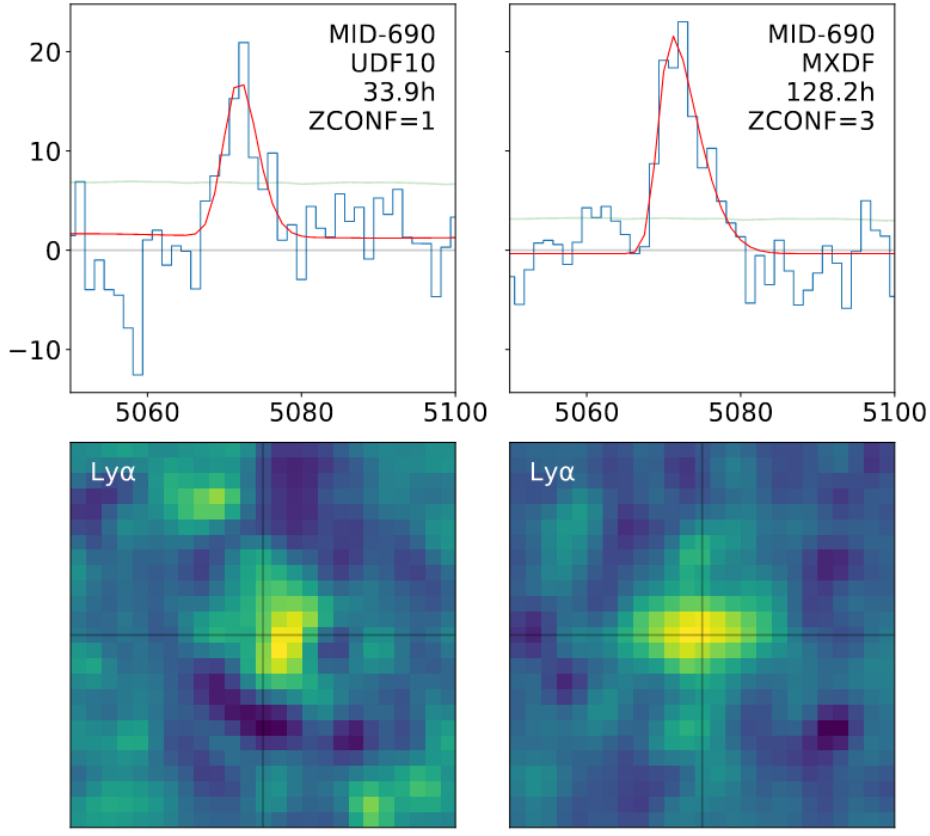
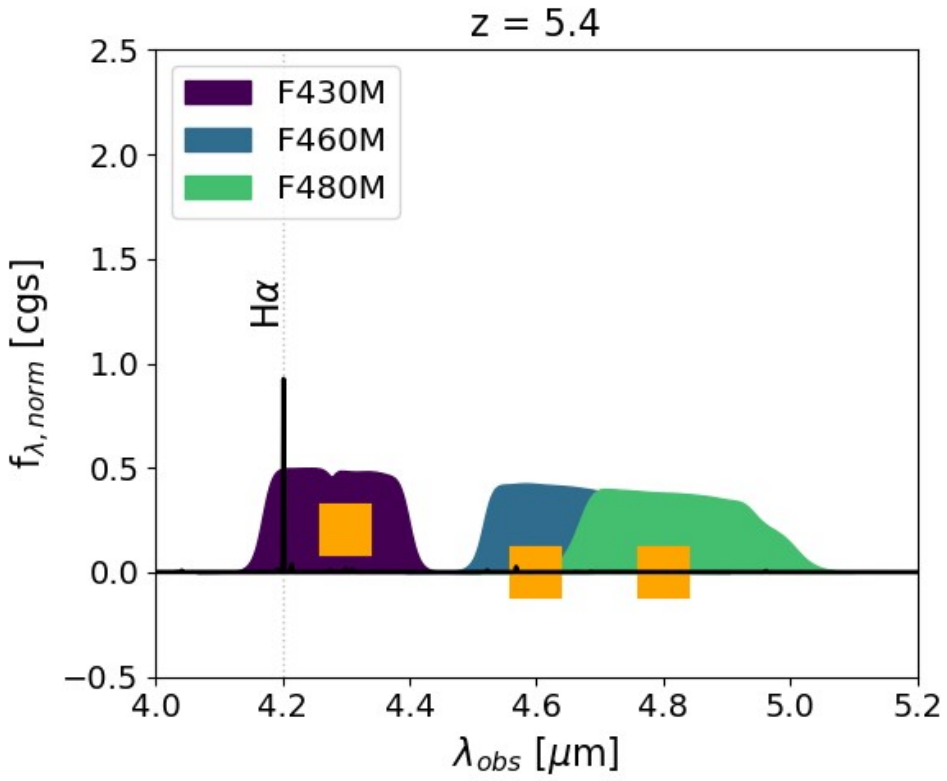


Sample selection criteria

- Have ZCONF = 2 or 3 in MUSE DR2
- 5.4 < z < 6.6
- Hα seen as excess flux in JEMS



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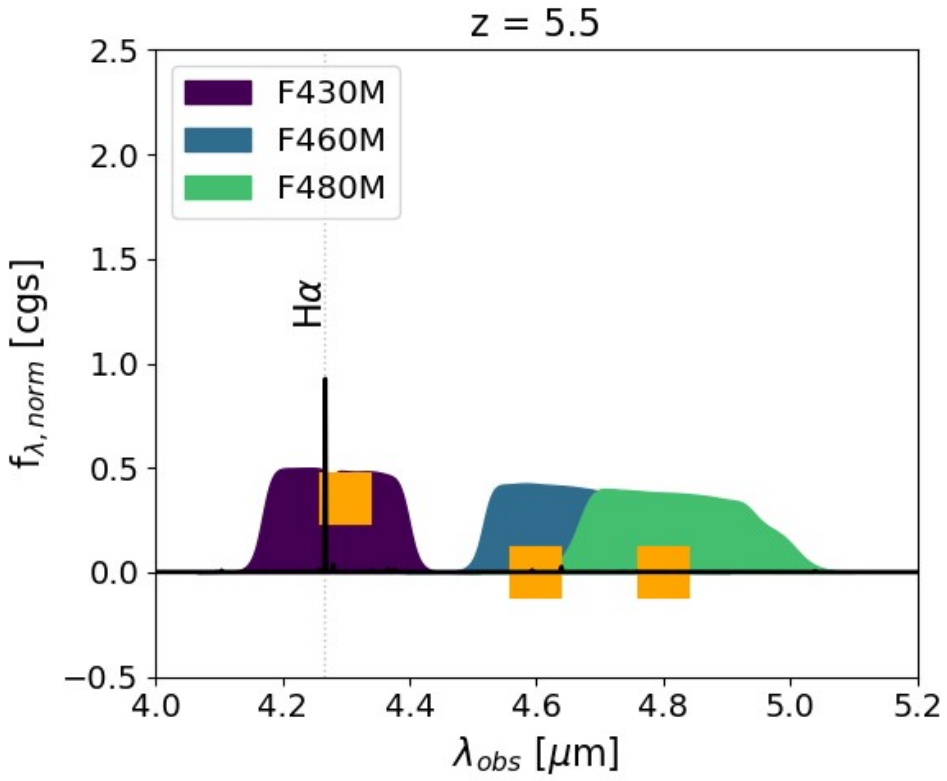

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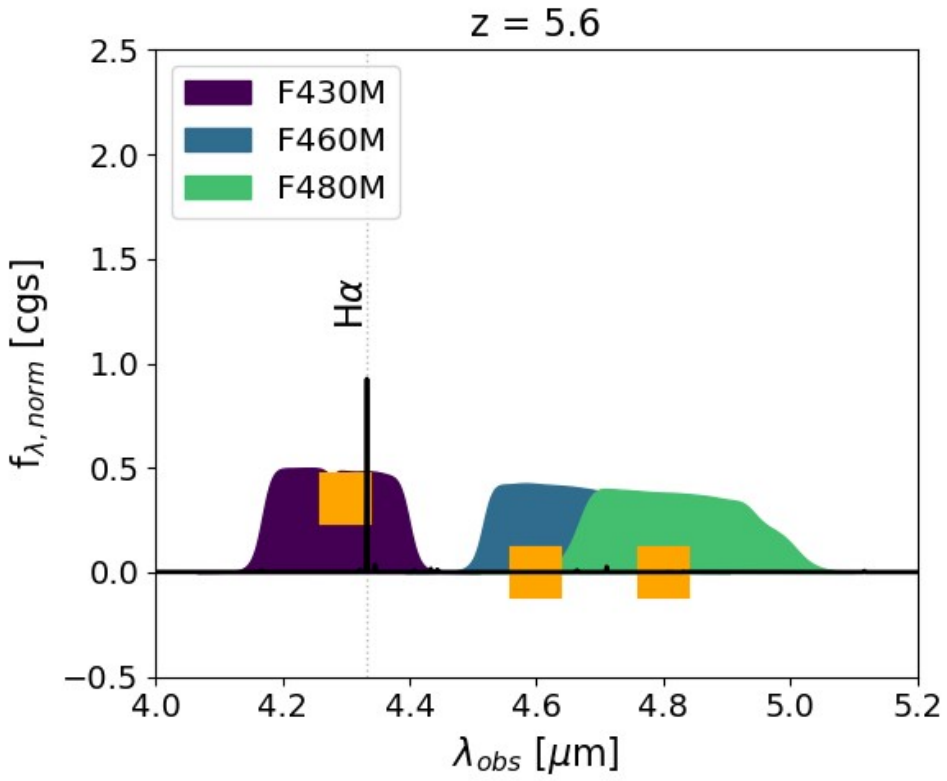

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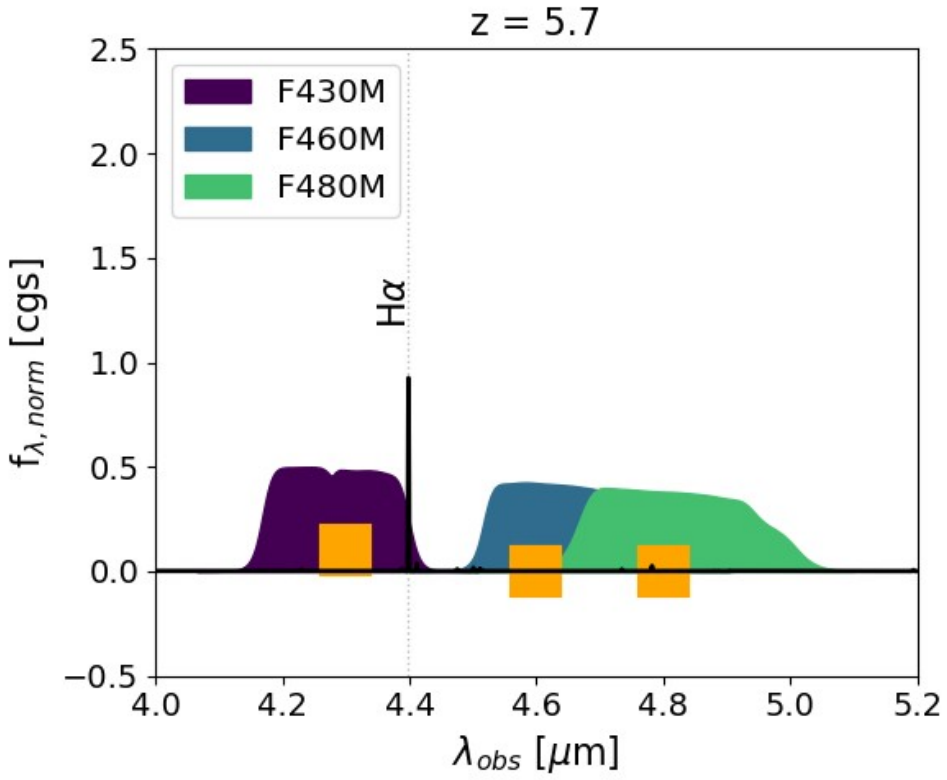

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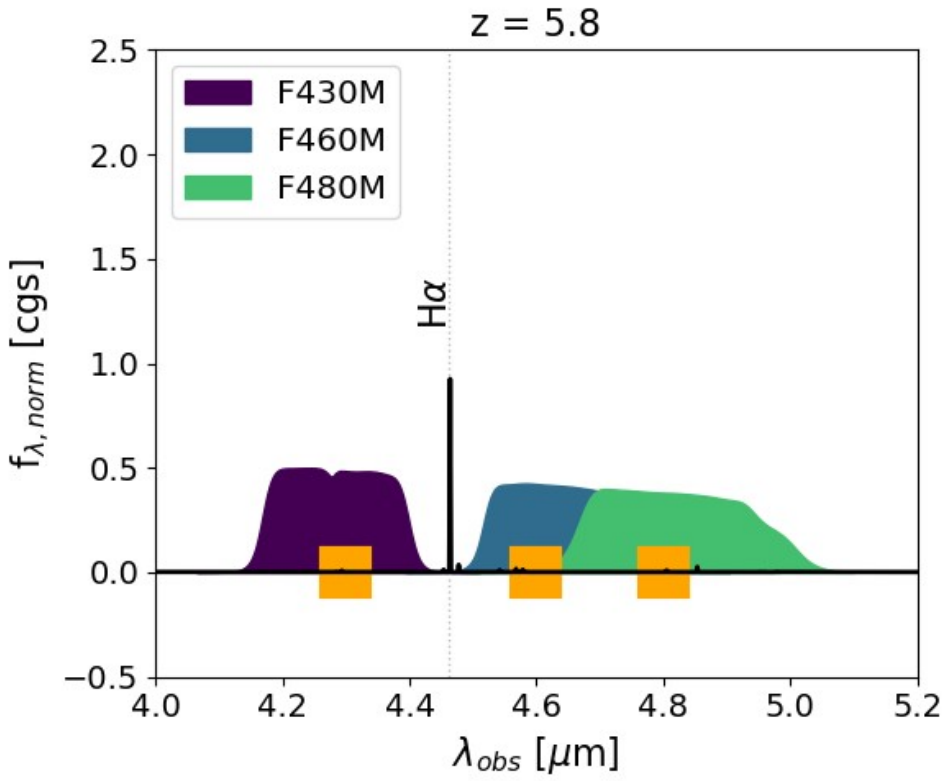

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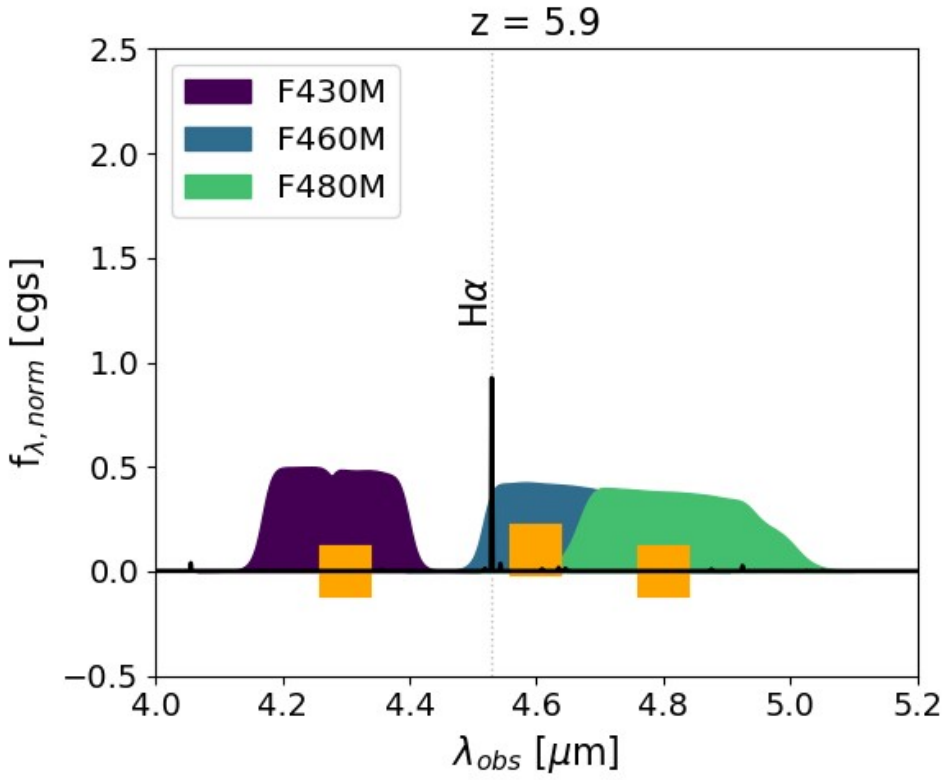

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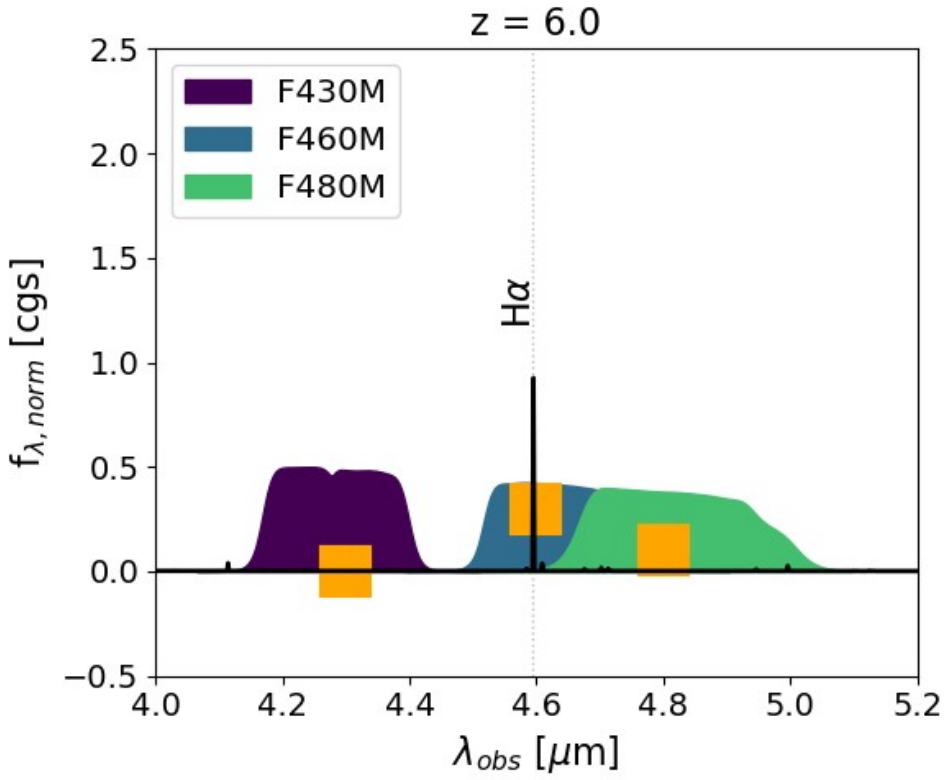

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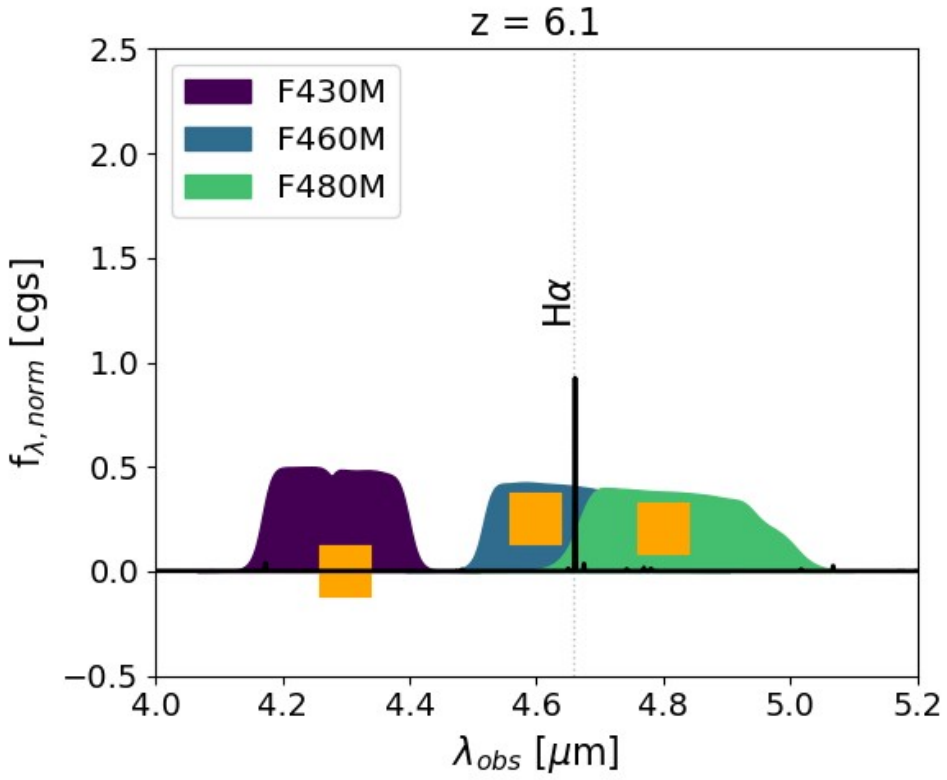

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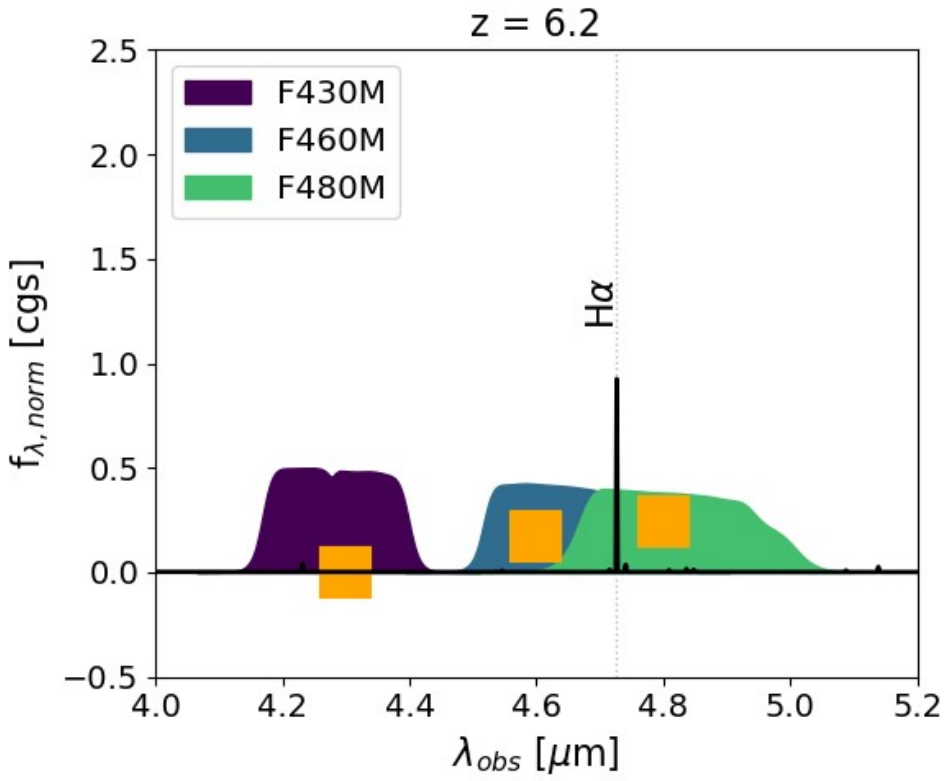

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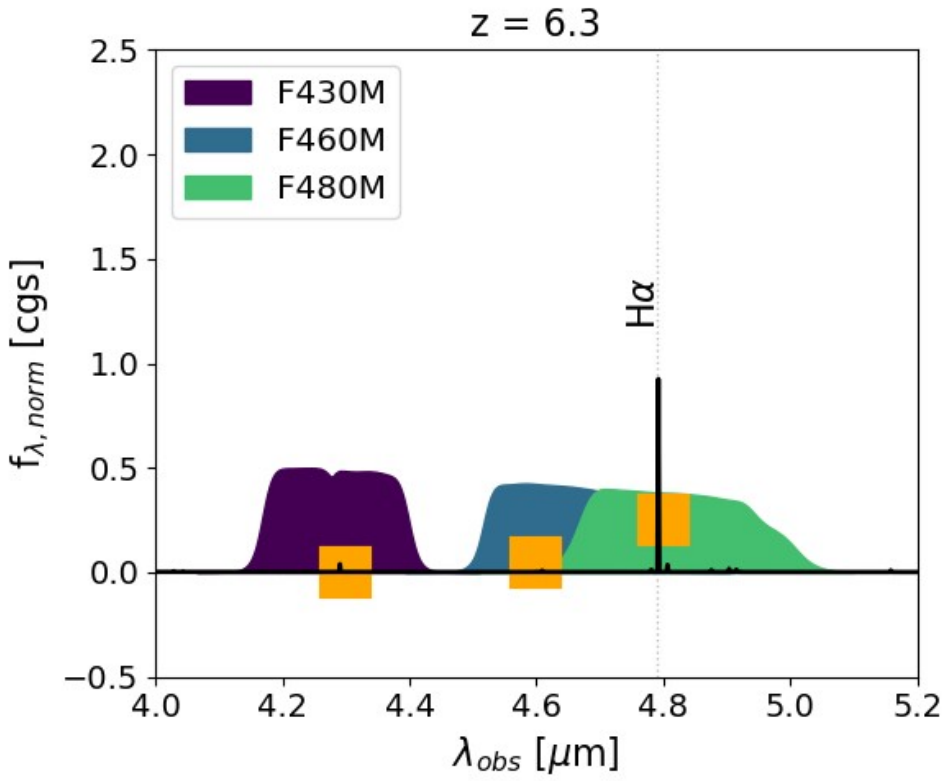

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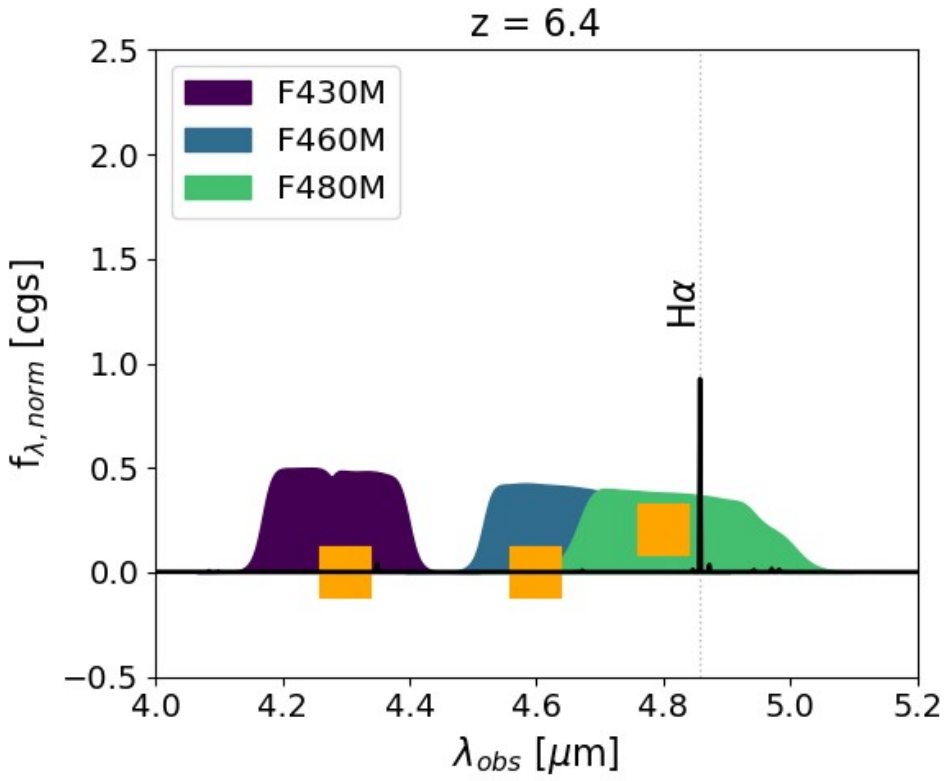

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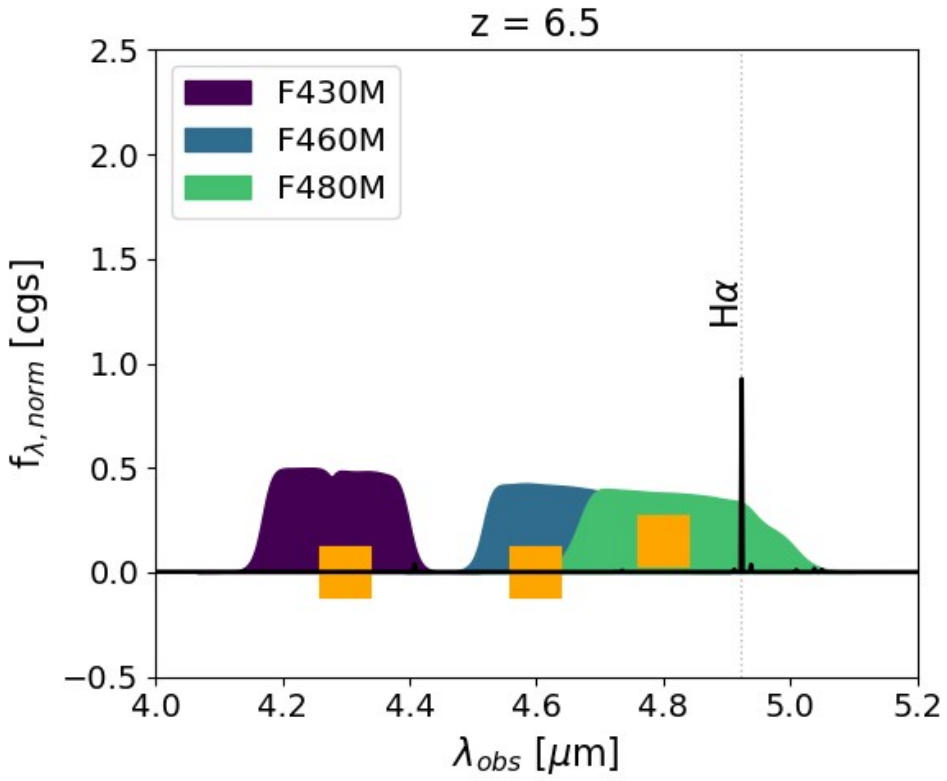

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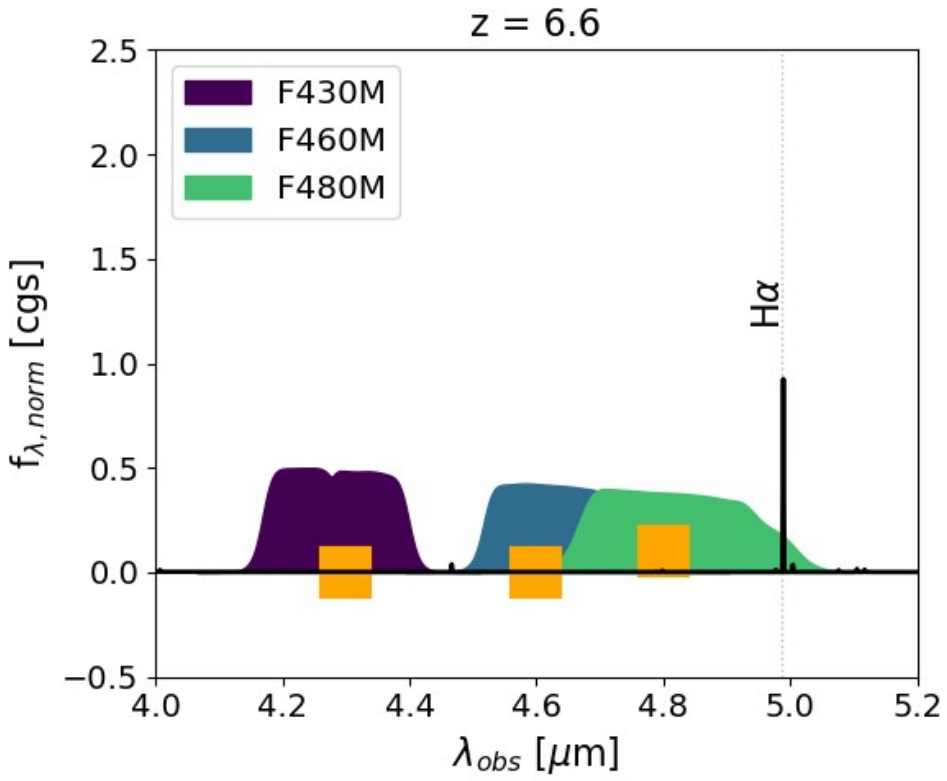

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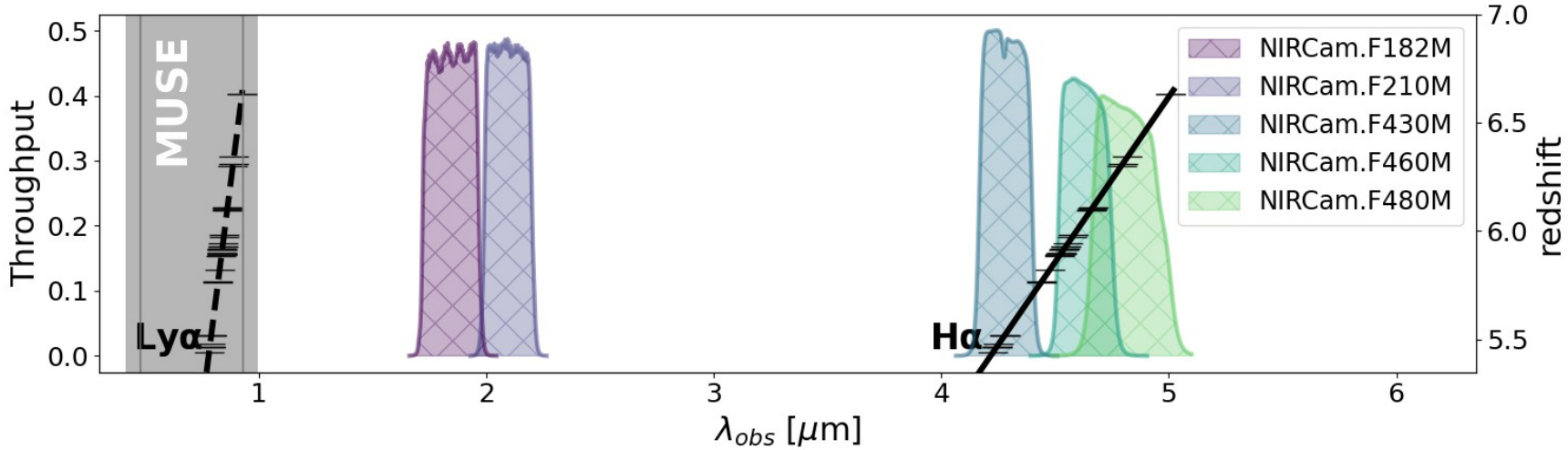
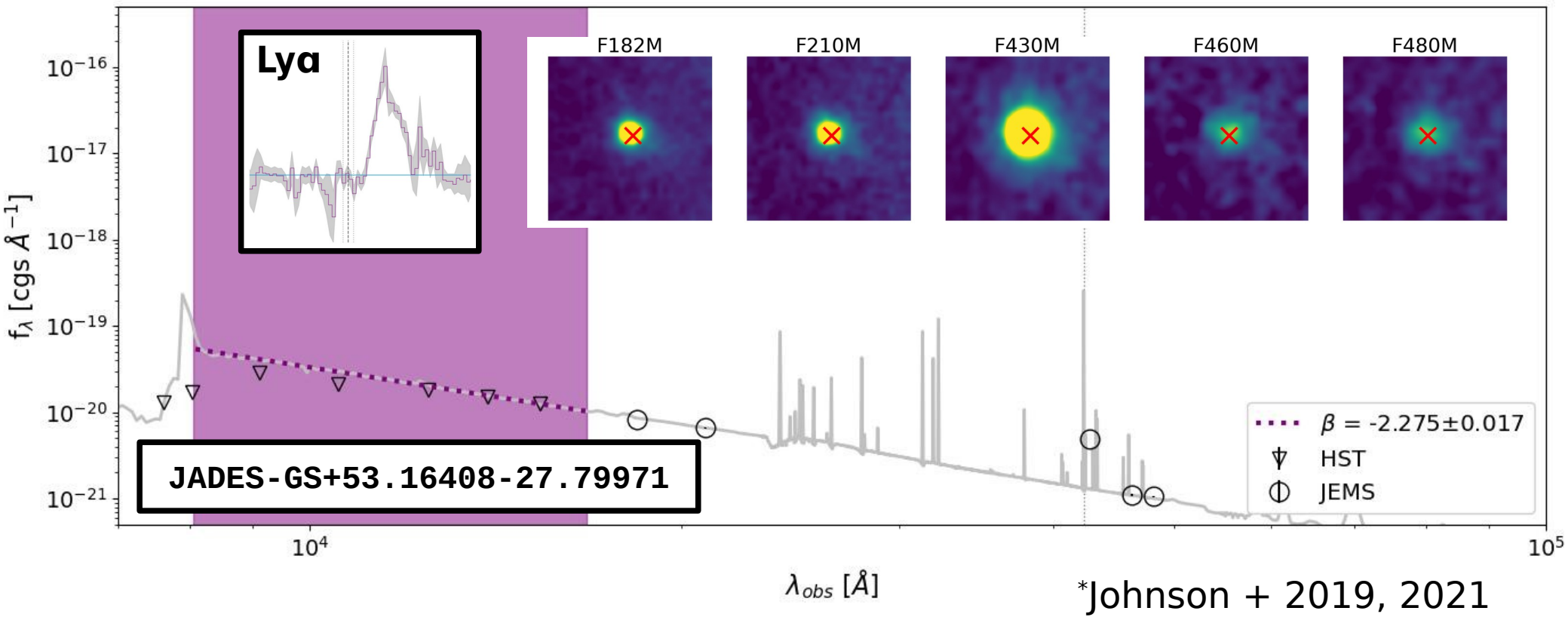
35 LAEs!

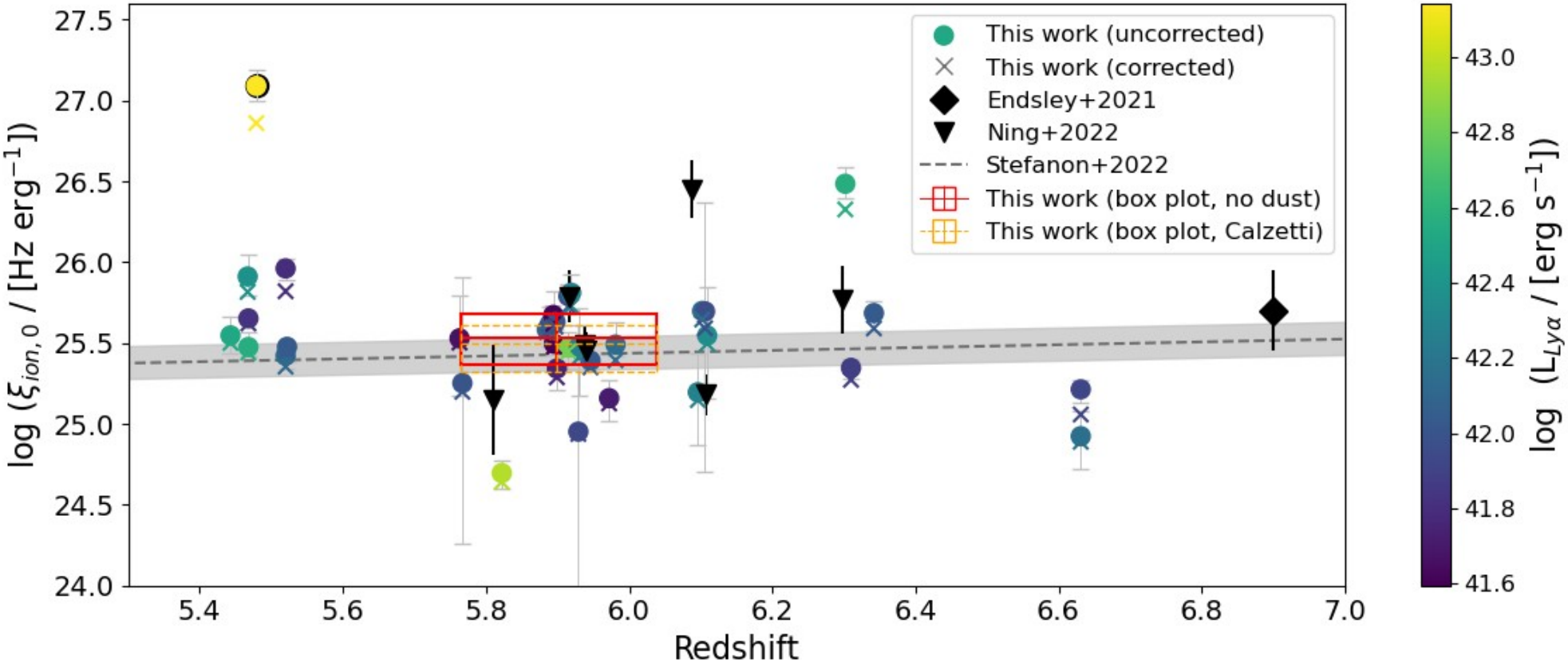


(pretty) Example: JEMS + MUSE + HST + Prospector*



*Johnson + 2019, 2021

Ionising photon production efficiency: $\xi_{ion,0}$



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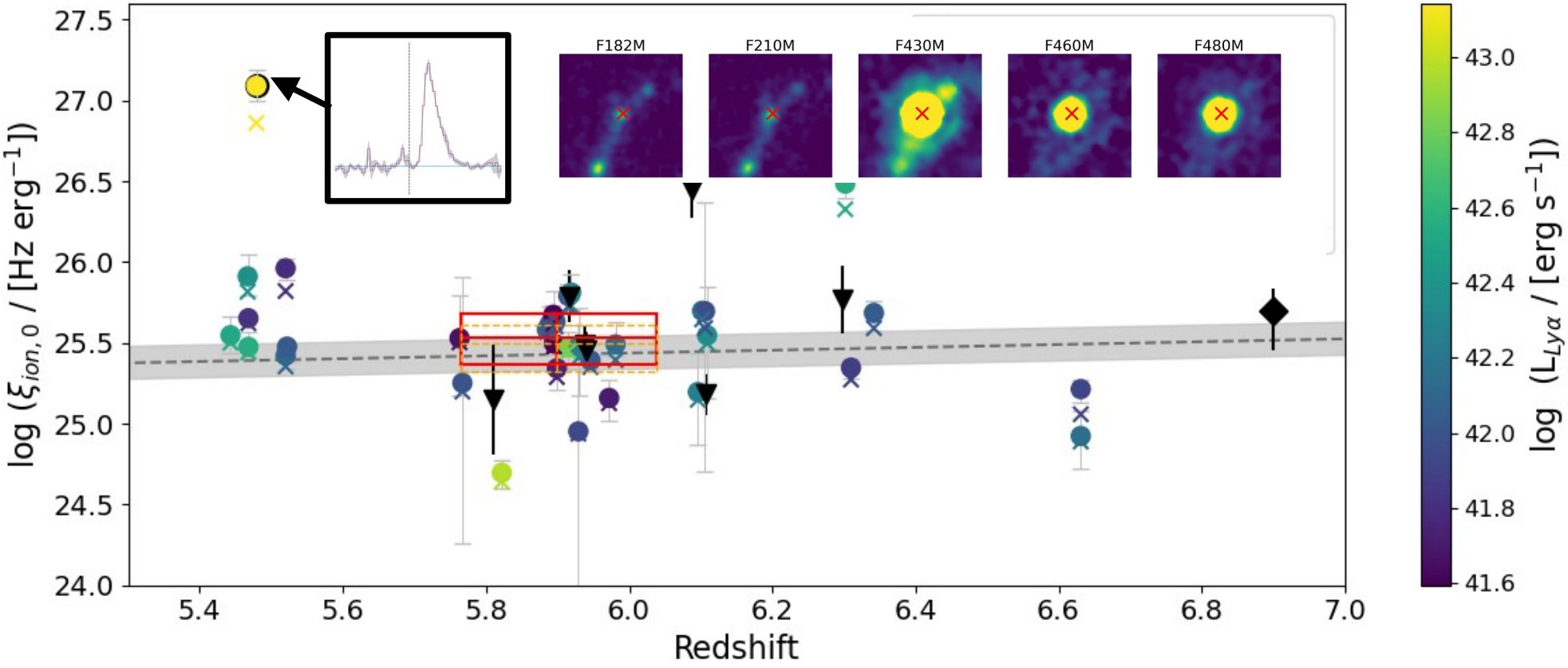
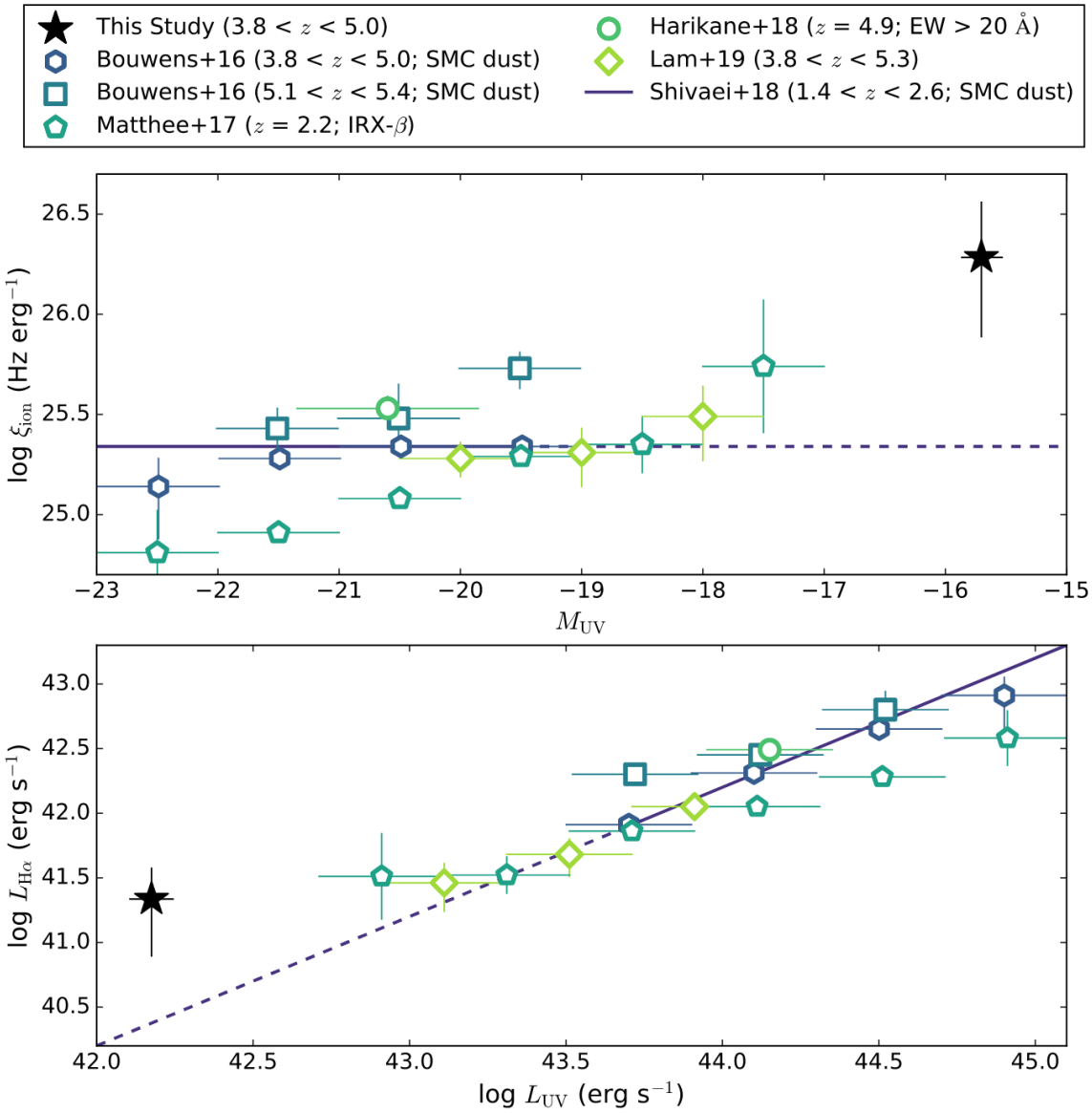


Ionising photon production efficiency: $\xi_{ion,0}$

No clear correlations of $\xi_{ion,0}$ with galaxy properties.

However, we find:

- Blue UV continuum slope → **β~-2.2**
- Metal-poor → **log(Z/Zsun)~-1.5**
- Low-mass → **log(M/Msun) ~ 8.0**
- Young → **log(M/Msun) ~ 8.0**
- Relatively high ionisation potential → **log<U> ~ -2.3**

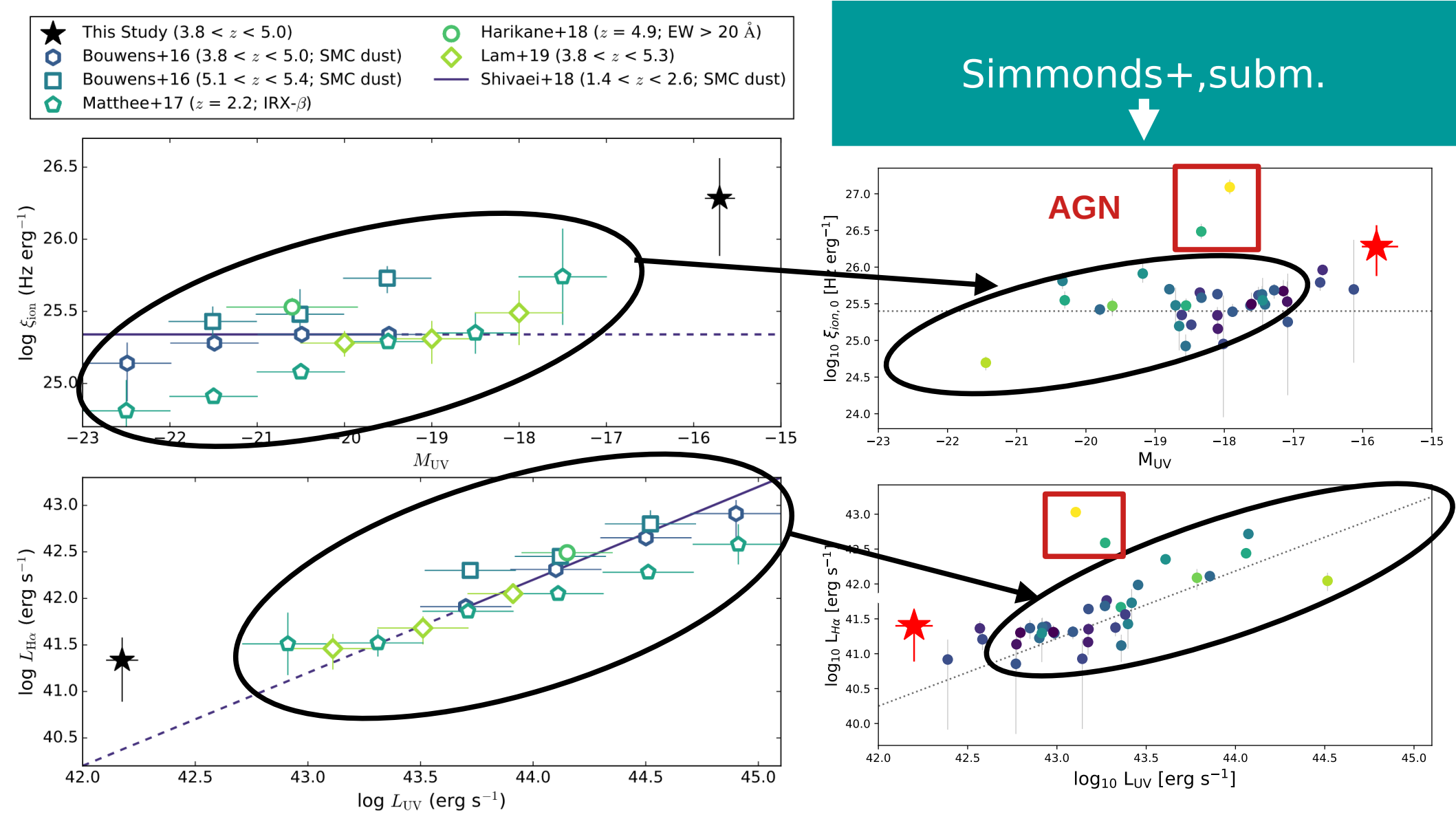


How does our sample compare to previous measurements from literature?

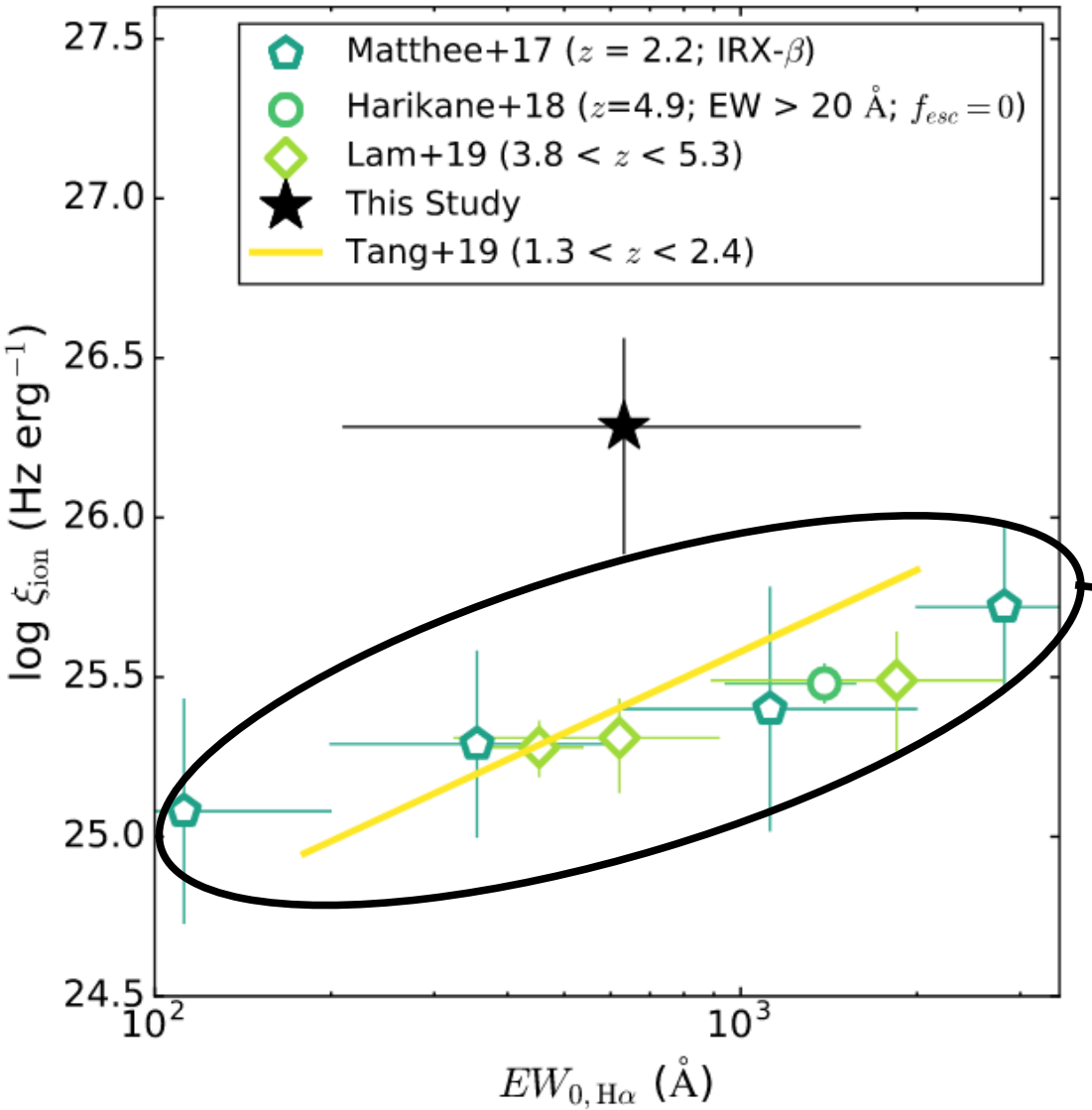
Example:

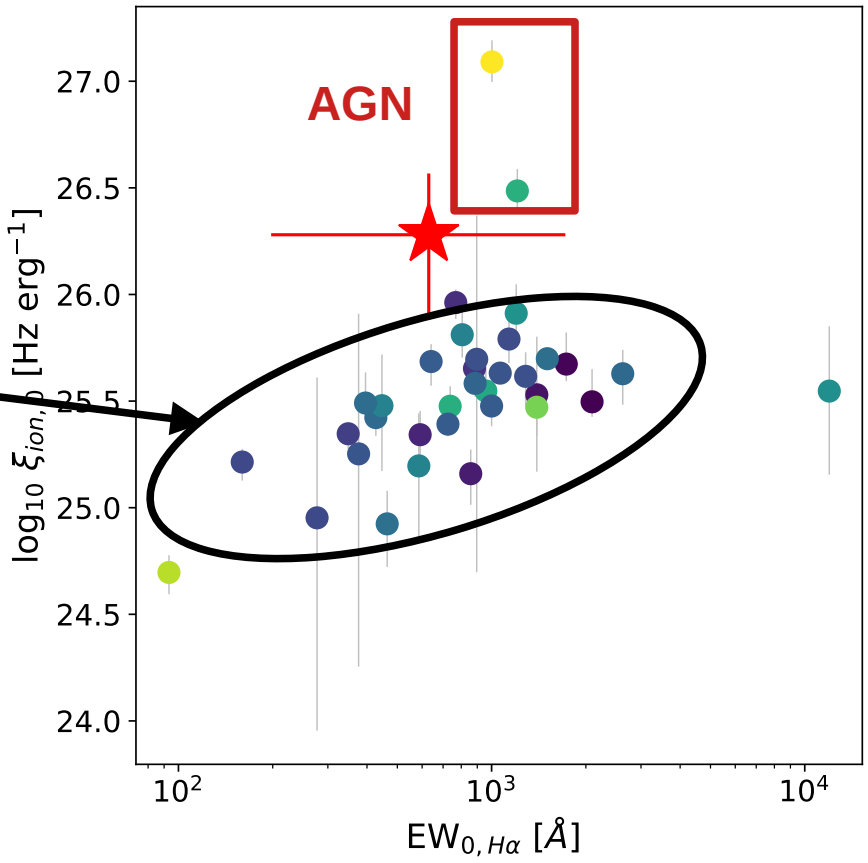
← Maseda+2020

(z ~ 4-5)


This Study (3.8 < z < 5.0)
Bouwens+16 (3.8 < z < 5.0; SMC dust)
Bouwens+16 (5.1 < z < 5.4; SMC dust)
Matthee+17 (z = 2.2; IRX-β)
Harikane+18 (z = 4.9; EW > 20 Å)
Lam+19 (3.8 < z < 5.3)
Shivaei+18 (1.4 < z < 2.6; SMC dust)
log ξion (Hz erg−1)
MUV
log LHα (erg s−1)
log LUV (erg s−1)
Simmonds+,subm.
AGN
log10 ξion, 0 [Hz erg−1]
MUV
log10 LHα [erg s−1]
log10 LUV [erg s−1]

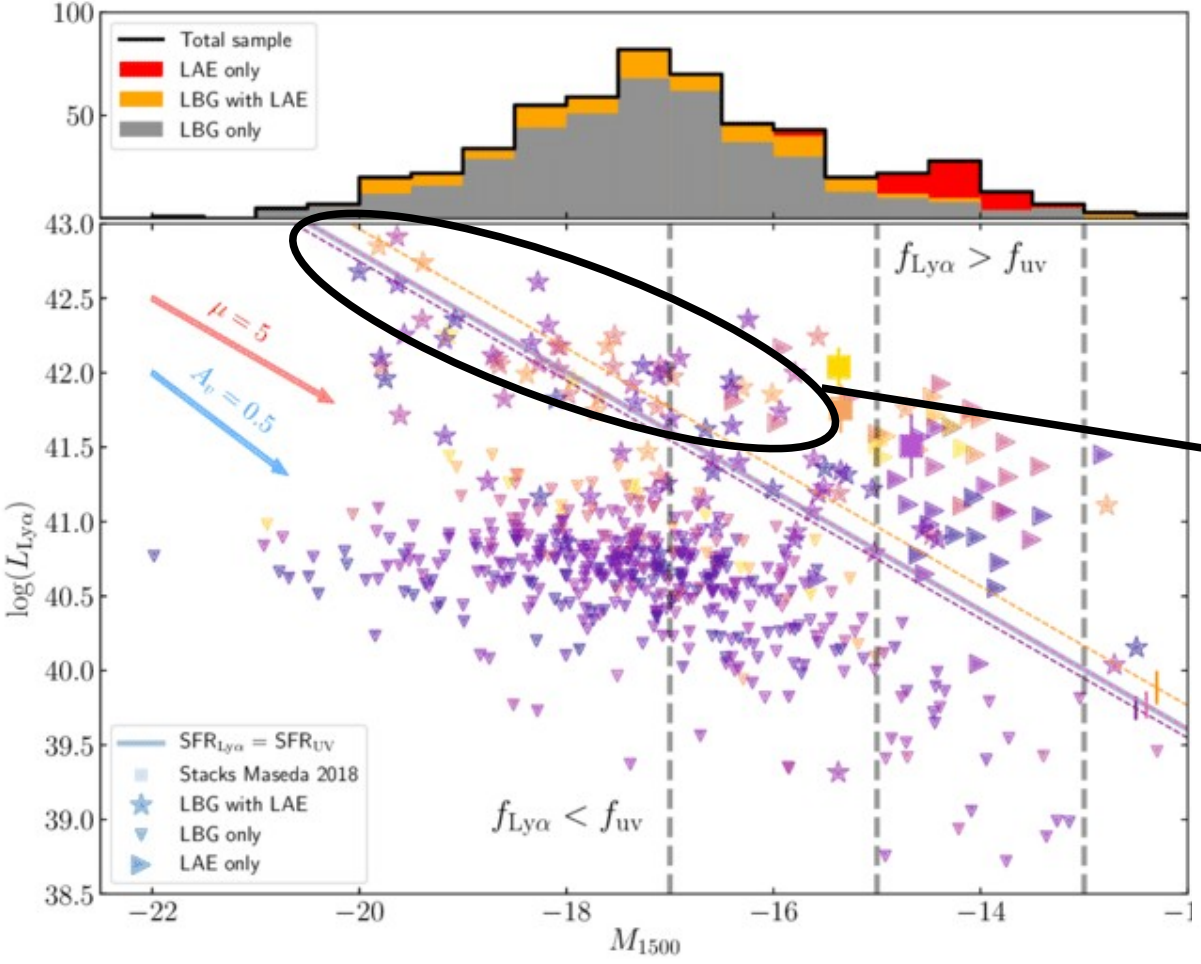
Simmonds+,subm.

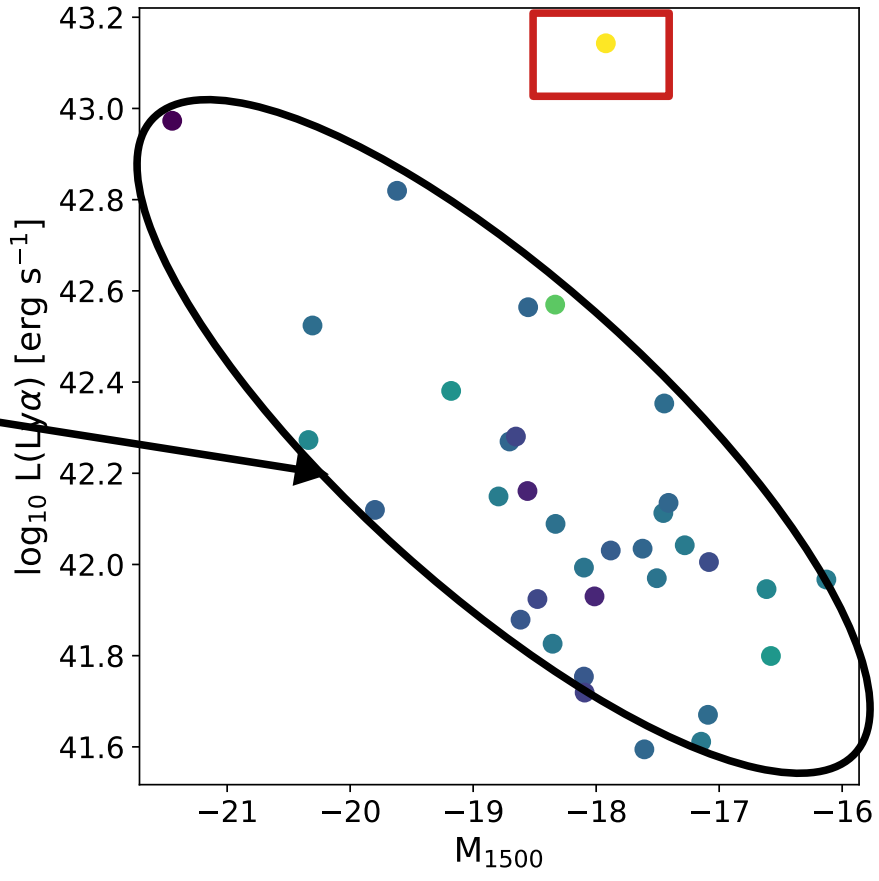




De la Vieuville+2020 (z~3-7)

Simmonds+,subm.





Conclusions + Future prospects

(short term) Investigate our sample further

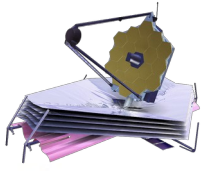
Measure sizes, surface brightness, tracers of LyC leakage (MgII ideally for some selected galaxies!)

(longer term) Study using full JADES dataset

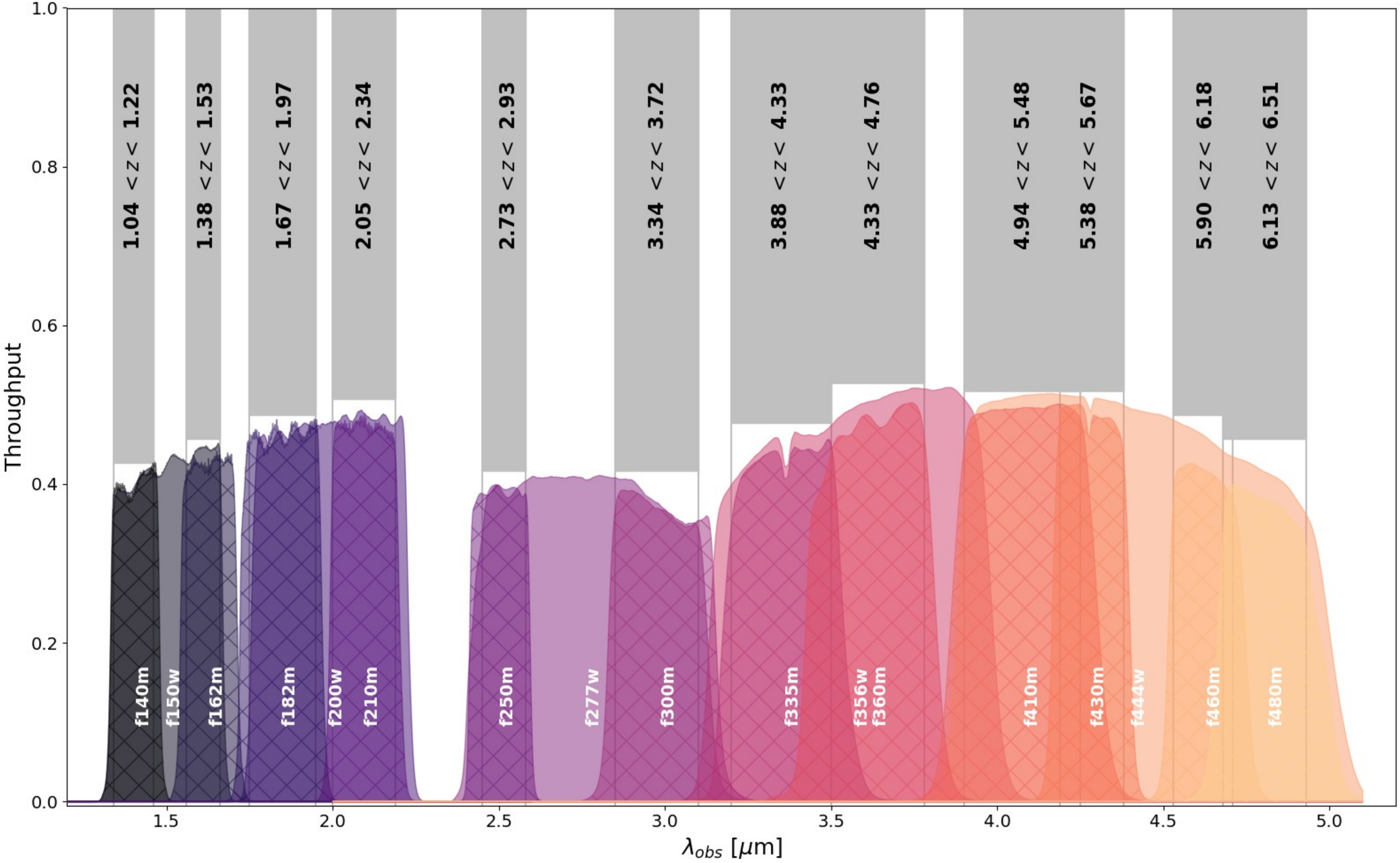
Are mass/redshift $\xi_{ion,0}$ trends more important than fesc for reionisation?

Does $\xi_{ion,0}$ correlate with galactic properties?

→ **Secondary aim:** produce less “circular” plots



THANK YOU!

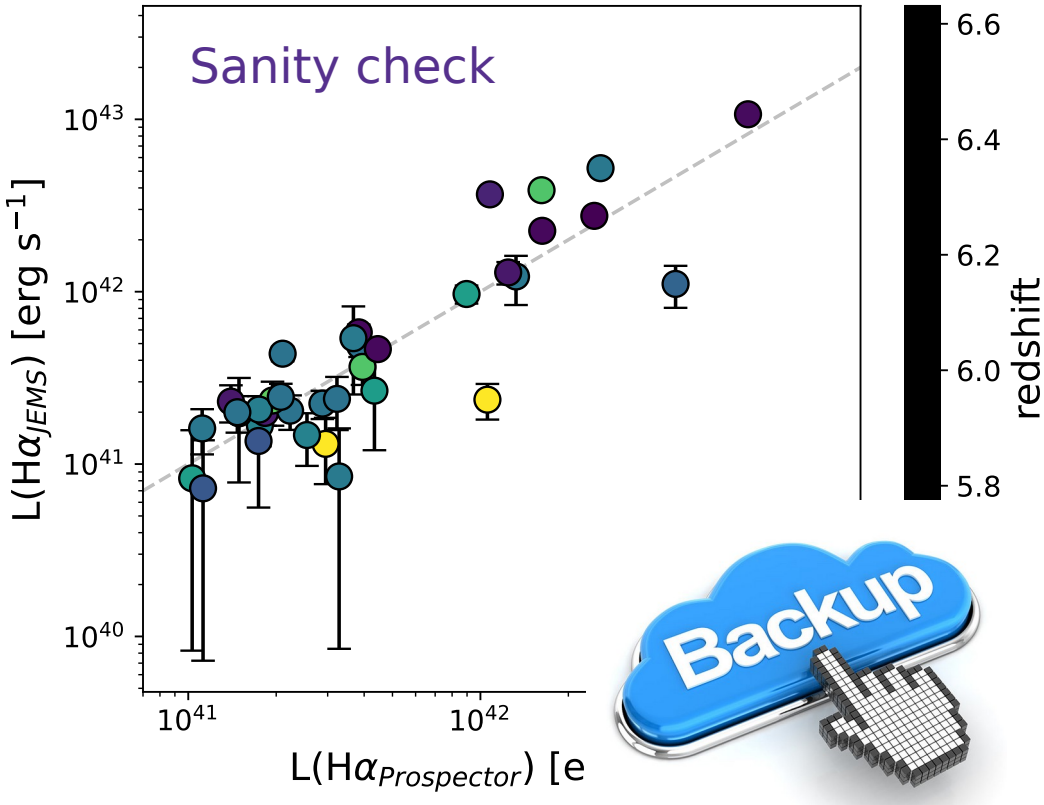


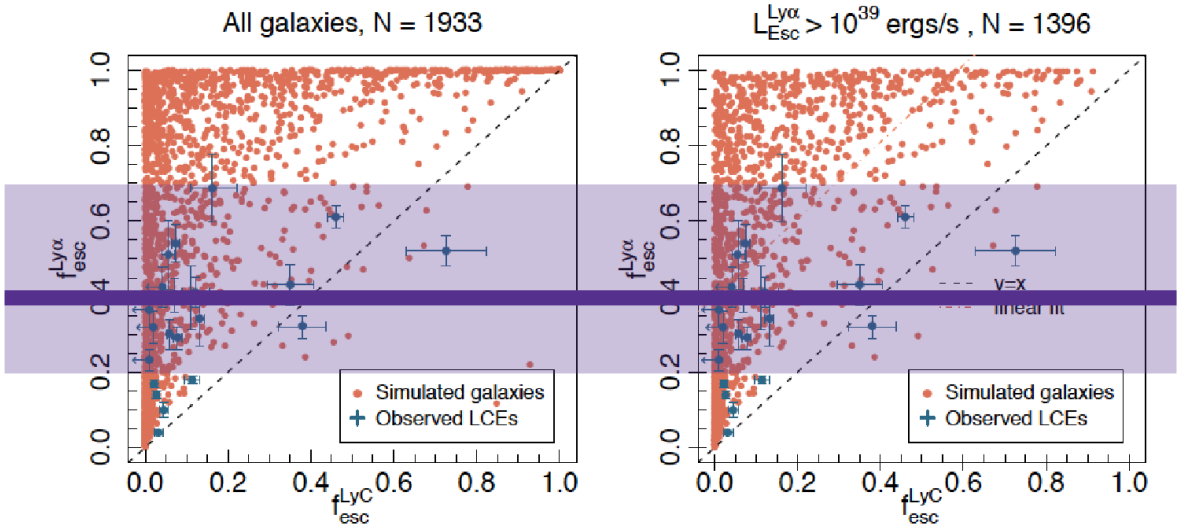
1.04 < z < 1.22
1.38 < z < 1.53
1.67 < z < 1.97
2.05 < z < 2.34
2.73 < z < 2.93
3.34 < z < 3.72
3.88 < z < 4.33
4.33 < z < 4.76
4.94 < z < 5.48
5.38 < z < 5.67
5.90 < z < 6.18
6.13 < z < 6.51
f140m
f150w
f162m
f182m
f200w
f210m
f250m
f277w
f300m
f335m
f356w
f360m
f410m
f430m
f444w
f460m
f480m
Throughput
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
λ_{obs} [μm]

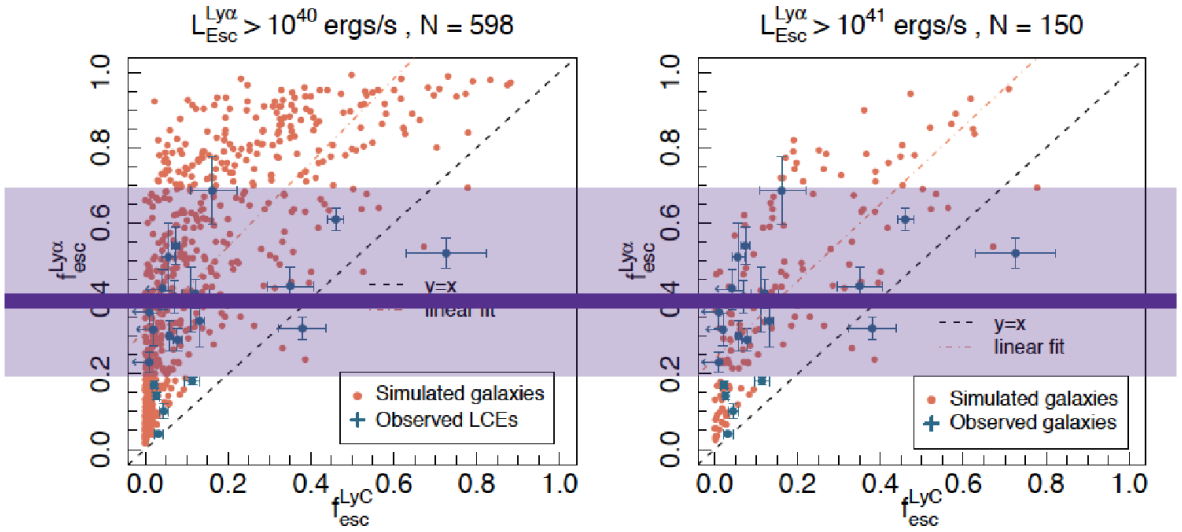
Ionising photon production efficiency: $\xi_{ion,0}$

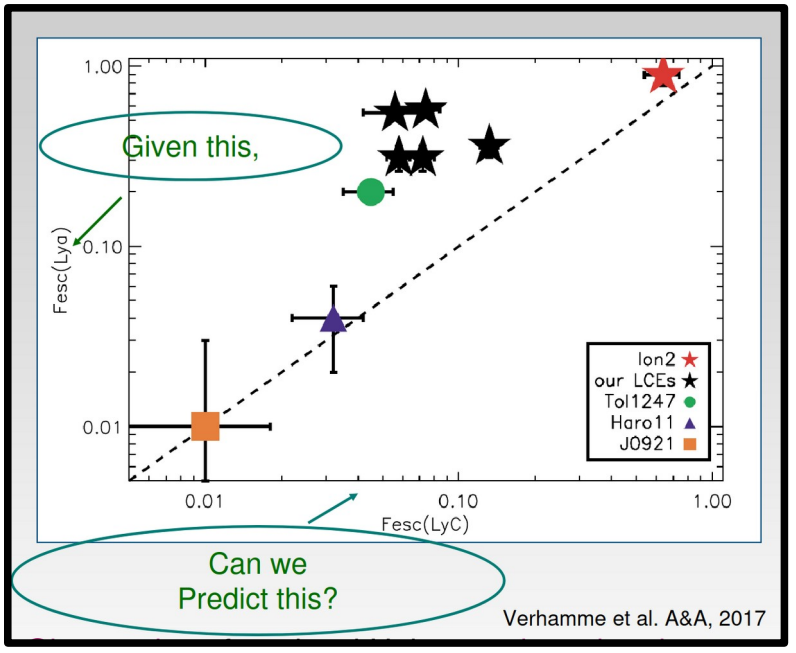
$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$

$$\xi_{ion,0} = \frac{N(H^0)}{L_{UV}},$$









Maji+2022 (SPHINX)