A Lyman Continuum-selected search for ionizing emitter galaxies in the HUDF

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REJECTED

The Topsy-Turvy LyC-Leaker Survey

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Background: We pre-select galaxies as likely LyC emitters to search efficiently...

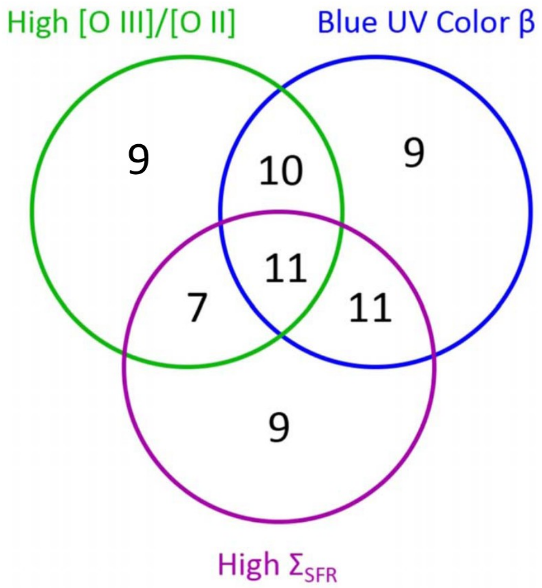


Image: Flury et al., 2022

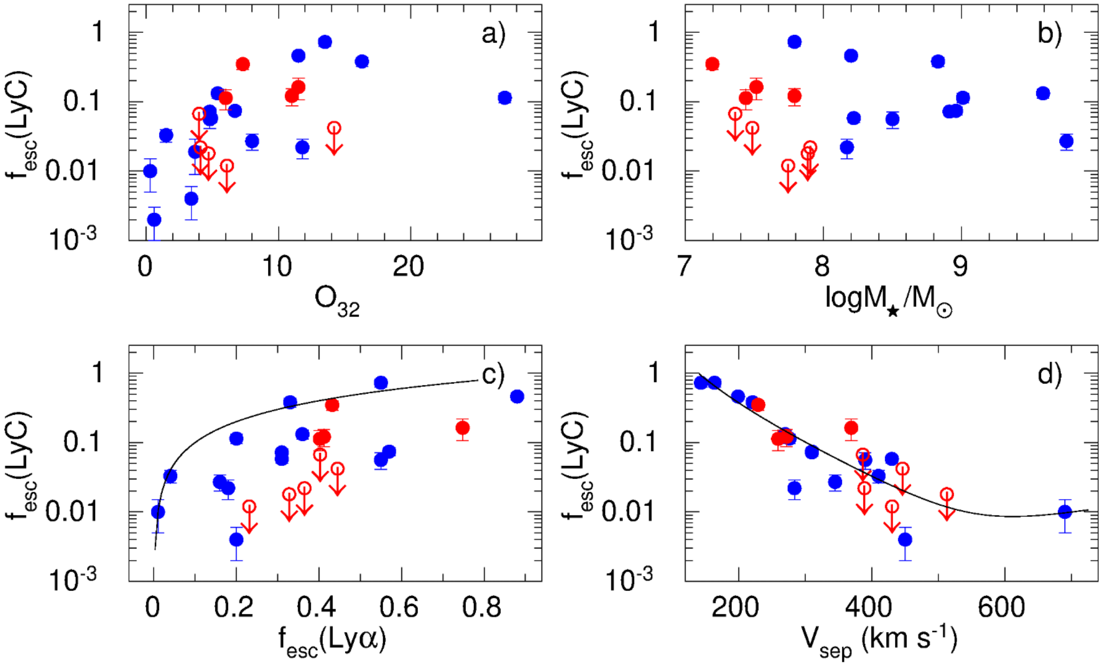
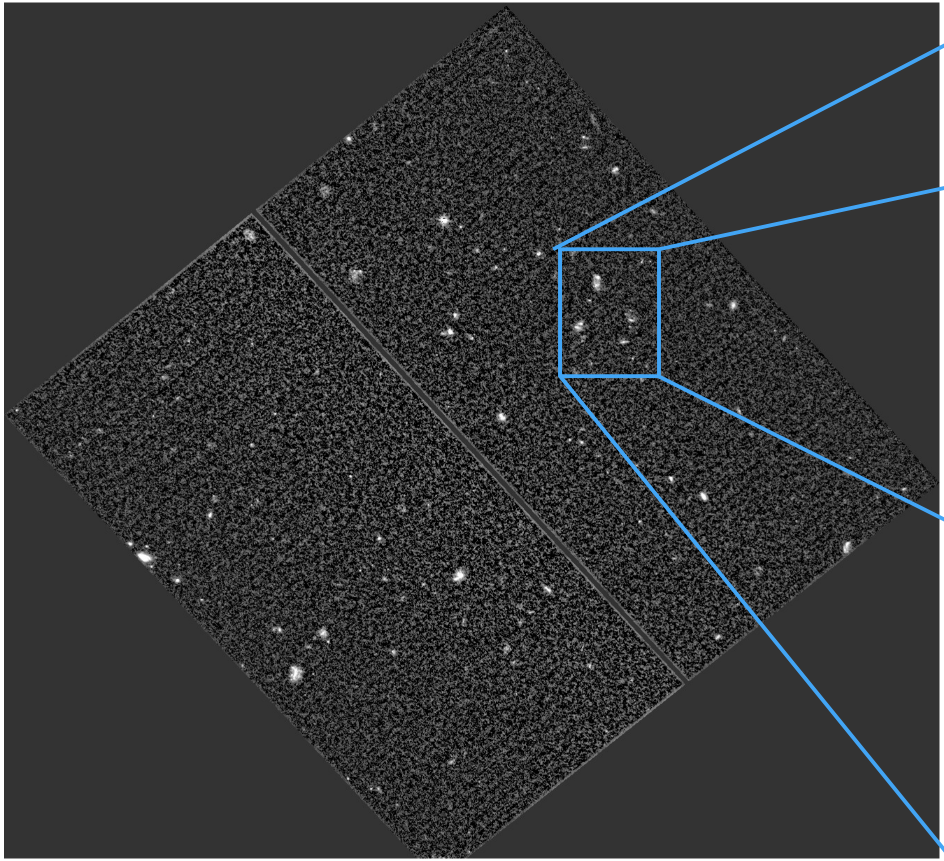
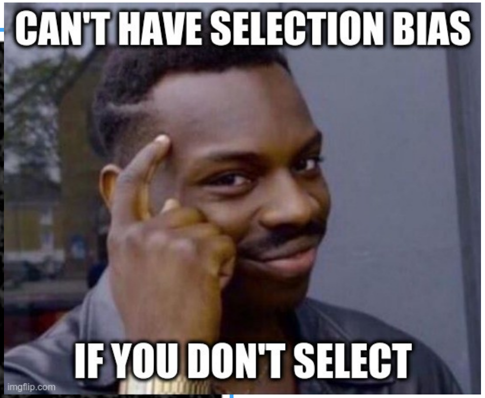


Image: Izotov et al., 2018

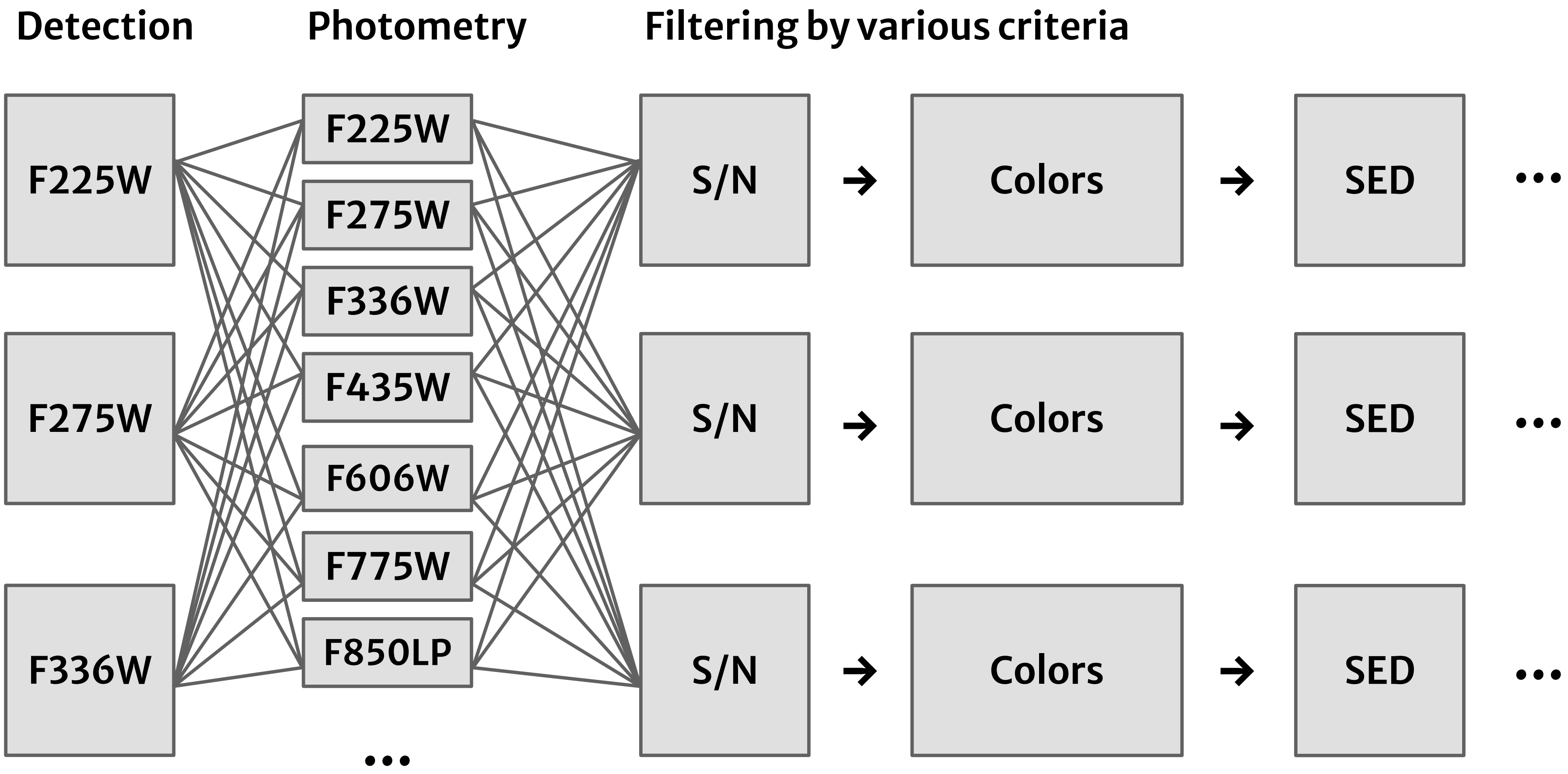
But who knows what we leave out in that pre-selection?

This work: find **everything** in the UV bands, then check each source to see if it is escaping LyC



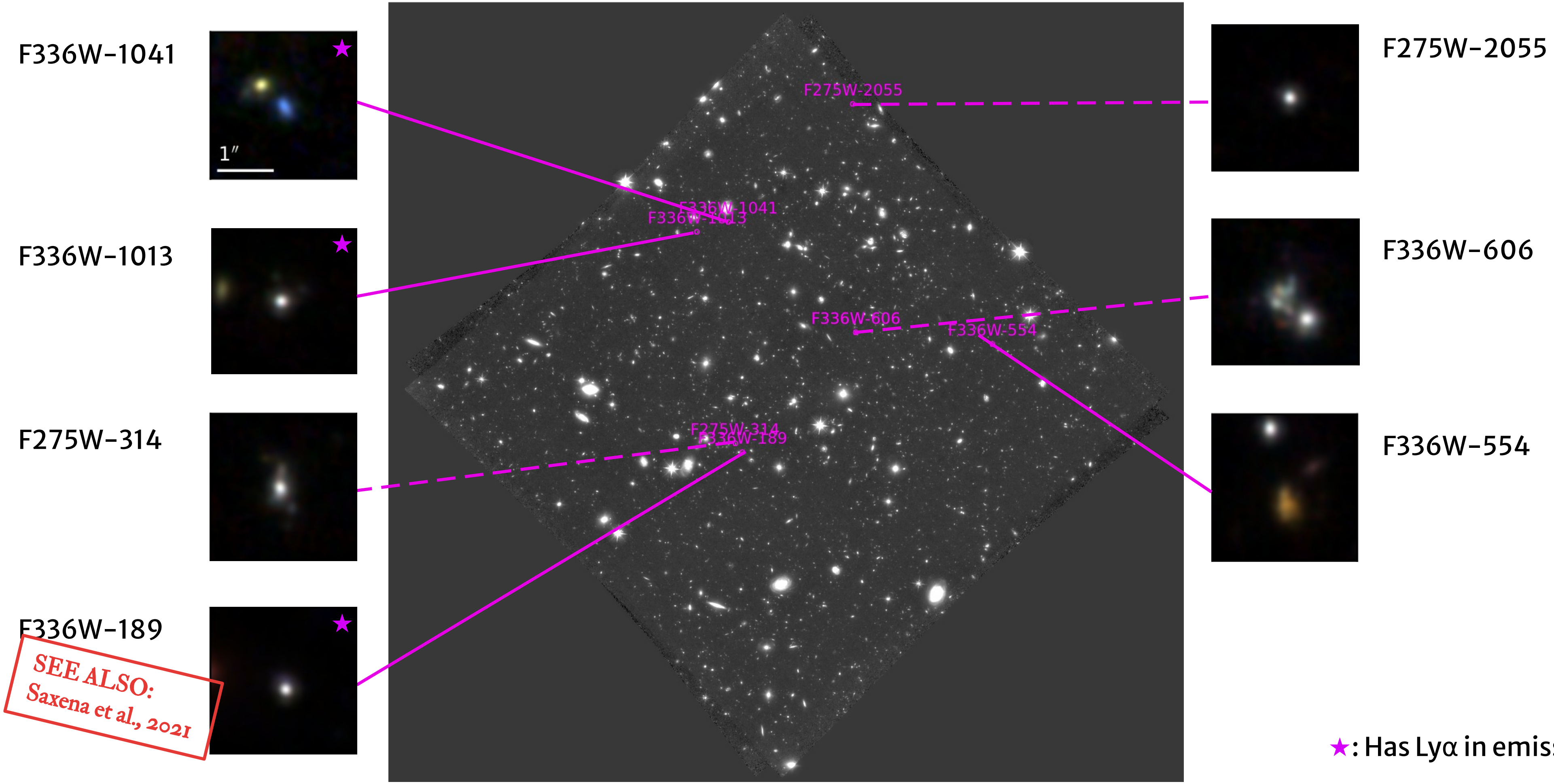


Detect UV sources → define segmentation map → perform photometry → start sorting Müsli



We compared redshifts with catalogs in the literature: Rafelski et al., 2015; Inami et al., 2017

We ended up with 7 candidate leakers; 4 of which we consider "very convincing"



SEE ALSO: Saxena et al., 2021

★: Has Lyα in emission

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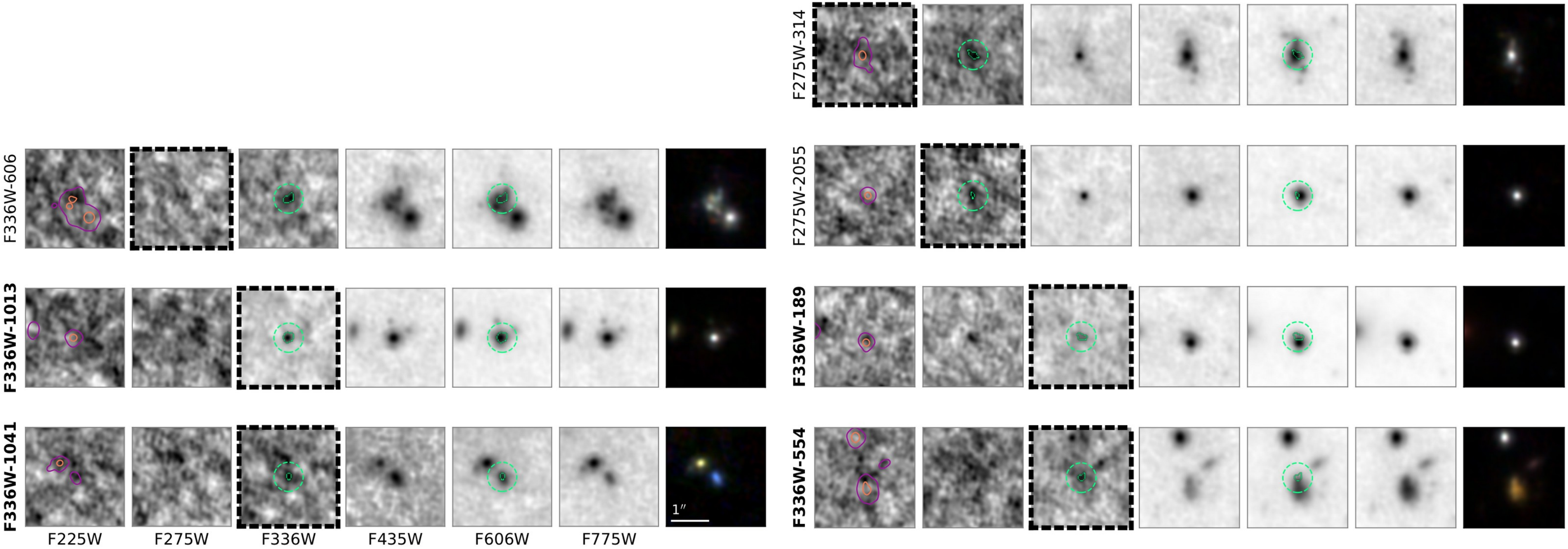
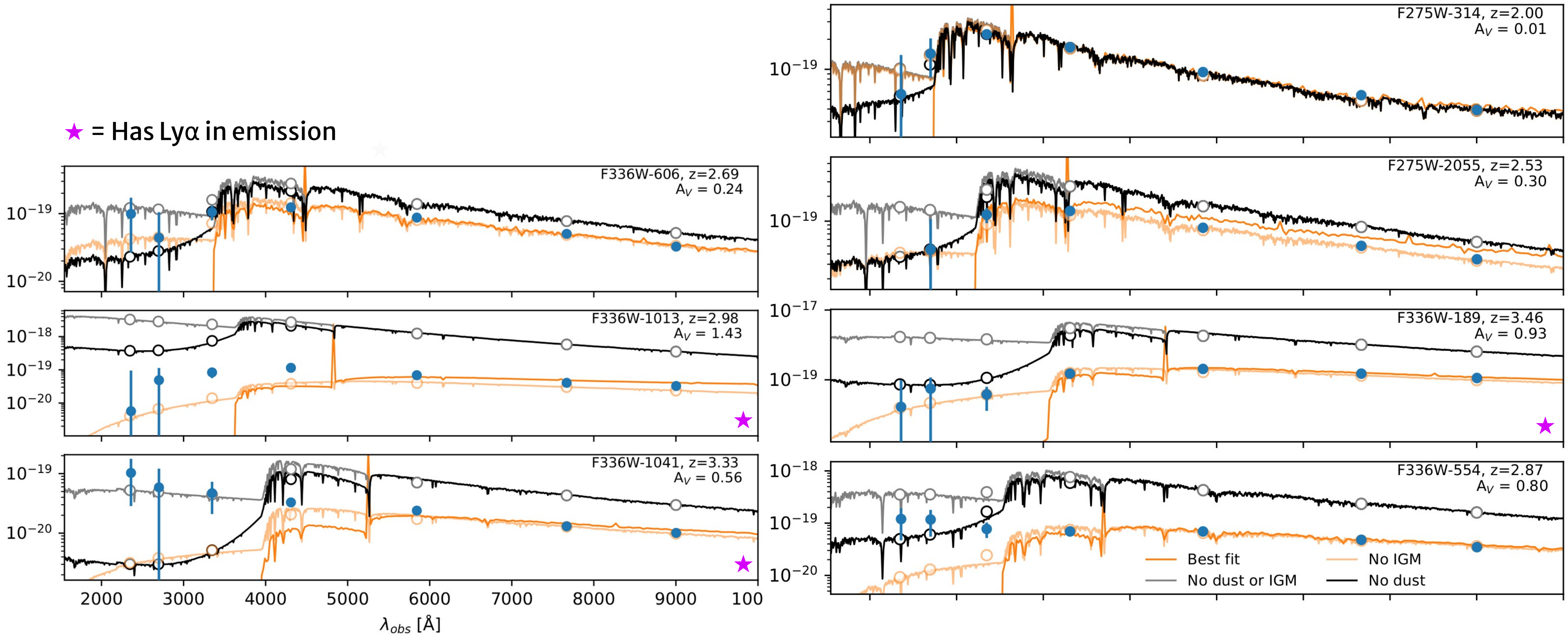
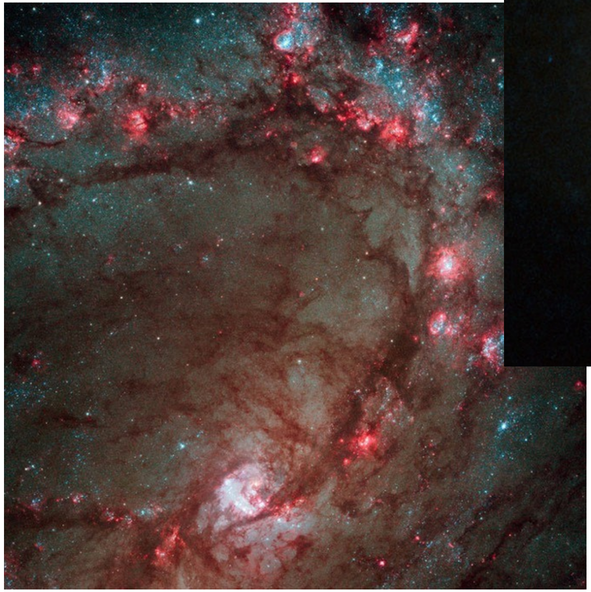


We computed absolute and relative ionizing escape fractions from SED models

★ = Has Lyα in emission



Problem: we convert between absolute and relative escape fractions assuming **a uniform dust screen**



Uniform dust screens

Problem: we convert between absolute and relative escape fractions assuming a uniform dust screen

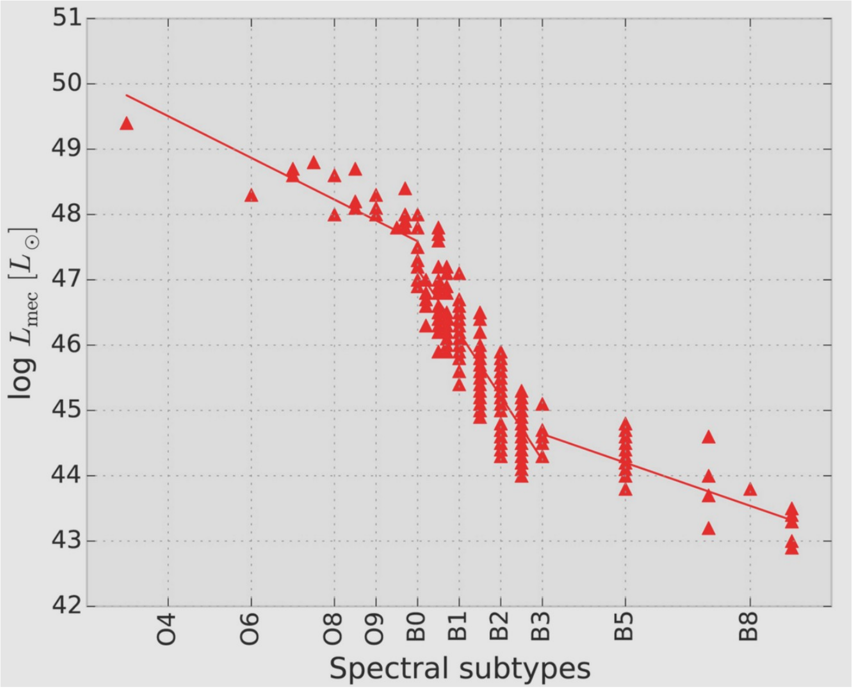
$$f_{\rm esc}^{\rm rel} = \frac{(f_{1500}/f_{900})_{\rm Int}}{(f_{1500}/f_{900})_{\rm Obs}} T_{\rm IGM}, \qquad (1)$$

$$f_{\rm esc}^{\rm abs} = f_{\rm esc}^{\rm rel} \times 10^{-0.4 \times A_{1500}}, \qquad (2)$$

LyC emission is dominated by so few stars that their experienced τ_{dust} can get highly stochastic

SEE ALSO Marta Lorenzos talk yesterday!

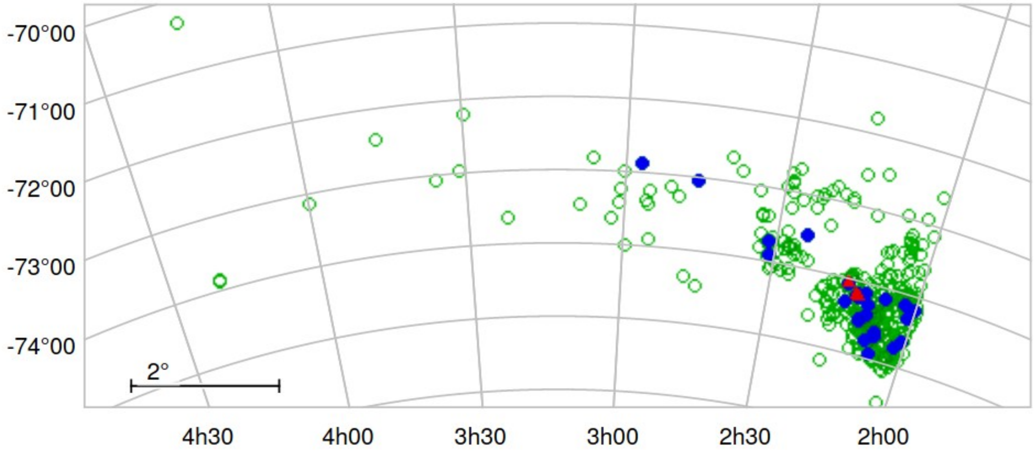
The ionizing output of a galaxy can be dominated by a few very bright stars – as few as a handful.



E.g. V. Ramachandran+, 2019

These stars are not always where the gas and the general population is.

There are O-stars in the Magellanic Bridge!

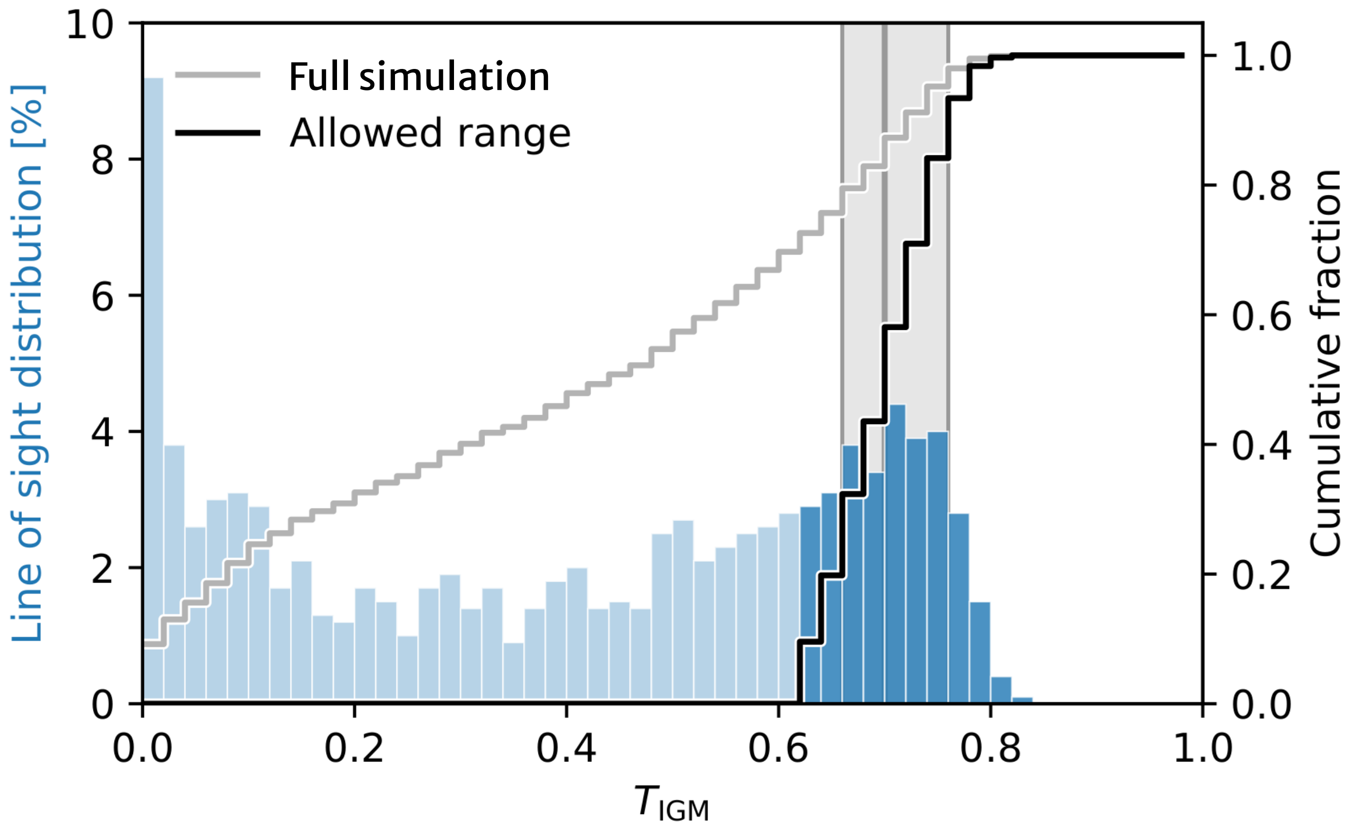


V. Ramachandran+, 2021

Can we really expect the λ_{rest} = 900 Å photons to experience the same dust or gas column as the averaged λ_{rest} =1500 Å photons?

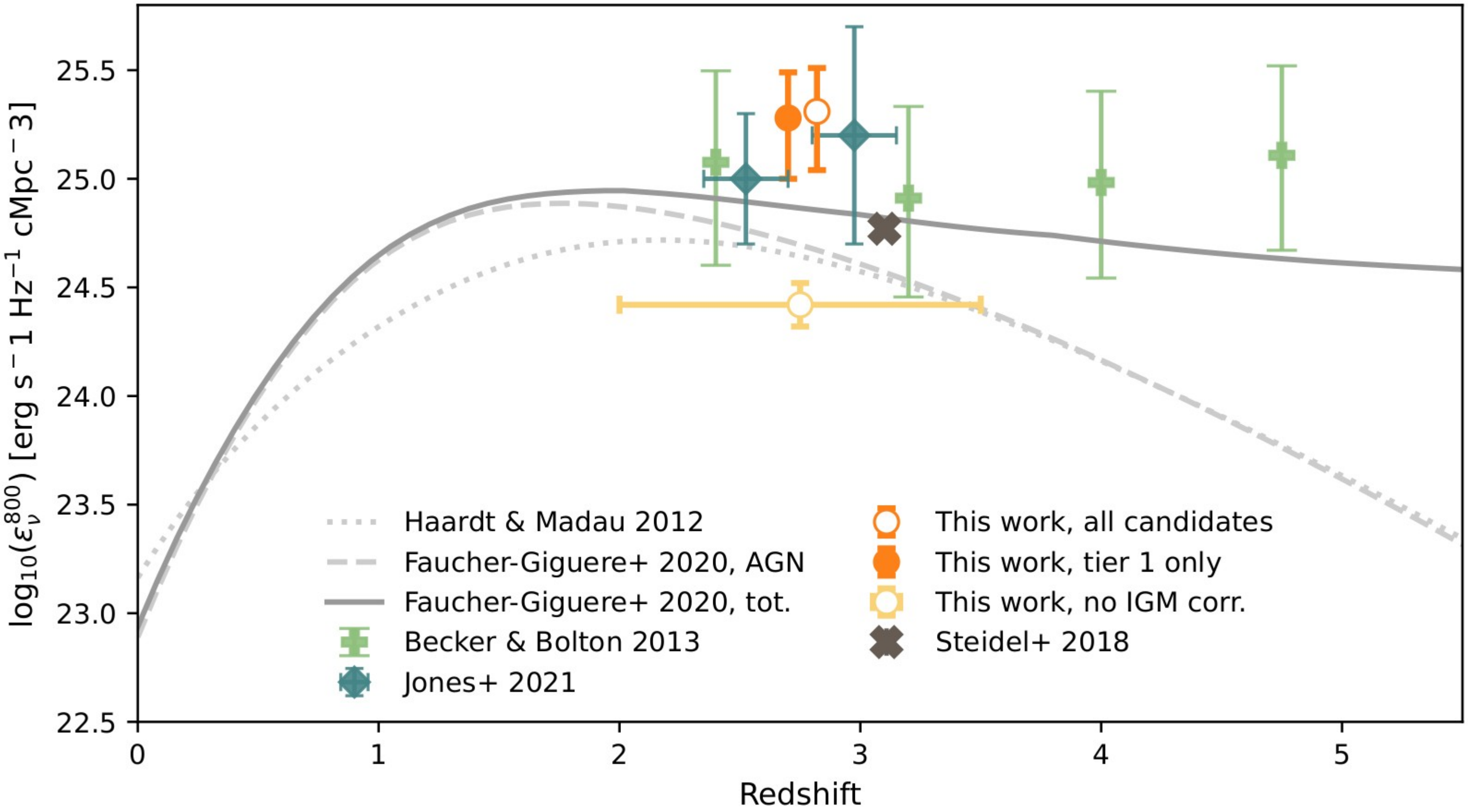
...And what does that mean for our understanding of relative and absolute escape?

Simulated line-of-sight IGM Transmission – might also skew our interpretation



E. Rivera-Thorsen+, 2019

We found a comoving volume emissivity larger than, but consistent with, literature values



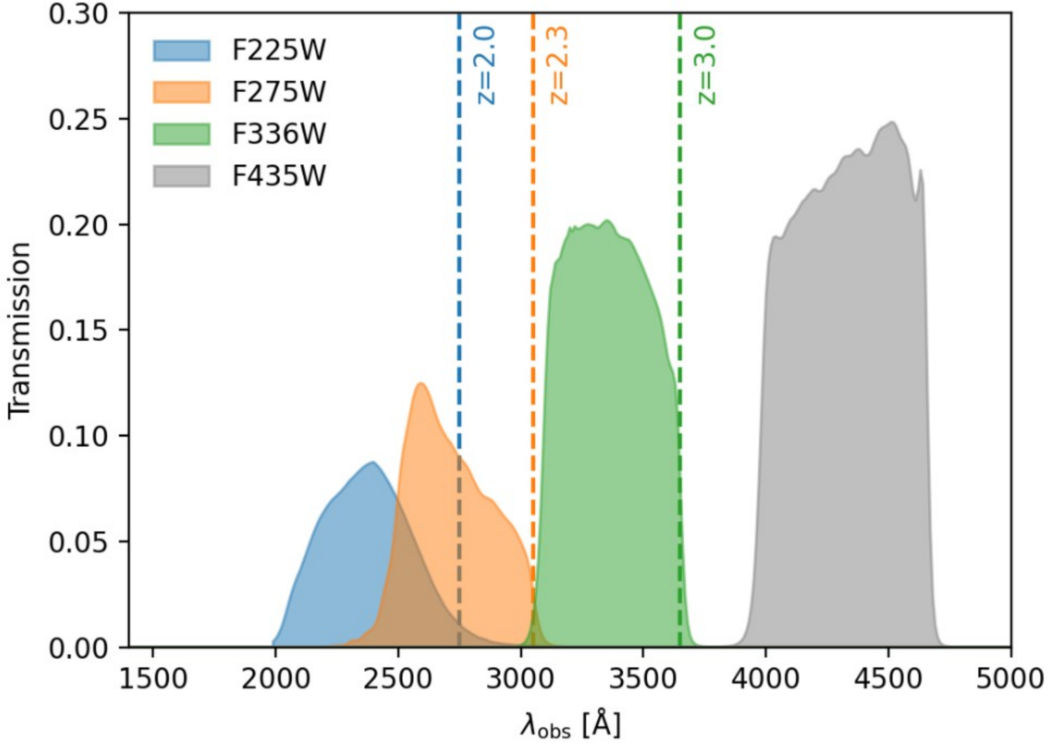
Summary:

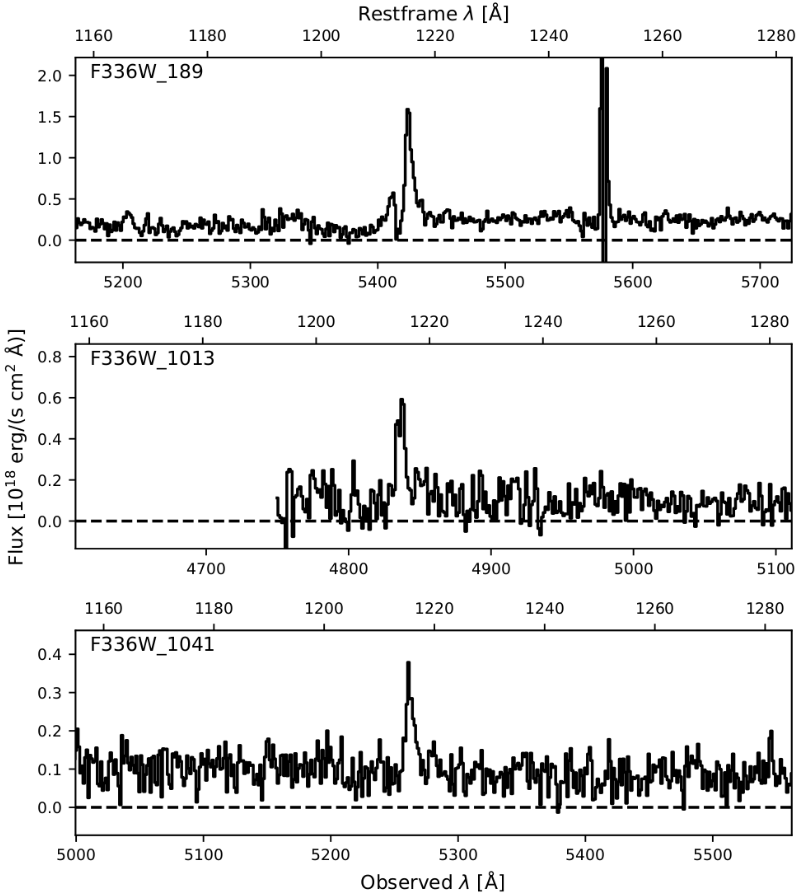
- We found 7 candidates. One was found in other works. We did not find other candidates reported there.
- We found very high $f_{esc,rel}$, but all $f_{esc,abs}$ were $\lesssim$ 100%. We argue that this is due to uneven dust geometry and a small number of stars dominating the LyC emission.
- Only three candidates had detected Lyα emission!
- Only leaker with double-peaked Lyα has $v_{sep} \approx 620$ km/s
- One candidate clearly emits LyC from its outskirts
- 80% of the inferred volume emissivity is contributed by one LAE galaxy, F336W–189 – but highly sensitive to T_{IGM}.

Thank you!

Supplementary slides

Filter overview and Lyα emission





Properties of LCE candidates from this work

Table 4: Best fit physical properties of leaker candidates

Filter Object	$\log_{10}(M_\star)$ $M_\odot$	Age Gyr	τ_{del} Gyr	A_V mag	z	$EW_{Ly\alpha,obs}$ Å
F275W-314	$9.34^{+0.01}_{-0.01}$	$3.20^{+0.03}_{-0.07}$	$6.58^{+2.25}_{-2.35}$	$0.24^{+0.02}_{-0.03}$	2.00^{*}	–
F275W-2055	$9.10^{+0.27}_{-0.34}$	$1.07^{+0.90}_{-0.60}$	$5.69^{+2.96}_{-3.04}$	$0.43^{+0.09}_{-0.12}$	$2.33^{+0.29}_{-0.29}$	–
F336W-189	$9.58^{+0.01}_{-0.03}$	$0.22^{+0.01}_{-0.02}$	$0.13^{+0.01}_{-0.02}$	$0.56^{+0.01}_{-0.01}$	3.46^{*}	127 ± 7
F336W-554	$8.82^{+0.04}_{-0.04}$	$0.15^{+0.02}_{-0.02}$	$3.71^{+4.18}_{-2.99}$	$0.82^{+0.02}_{-0.02}$	2.87^{*}	–
F336W-606	$8.51^{+0.03}_{-0.04}$	$0.10^{+0.02}_{-0.02}$	$0.04^{+0.02}_{-0.01}$	$0.00^{+0.02}_{-0.02}$	$2.73^{+0.01}_{-0.01}$	–
F336W-1013[†]	$8.50^{+0.01}_{-0.01}$	$0.08^{+0.01}_{-0.01}$	$4.57^{+3.73}_{-3.32}$	$0.98^{+0.01}_{-0.01}$	2.98^{*}	118 ± 30
F336W-1041	$9.46^{+0.03}_{-0.03}$	$1.79^{+0.06}_{-0.12}$	$0.48^{+0.03}_{-0.03}$	$0.25^{+0.06}_{-0.04}$	3.33^{*}	210 ± 50

Table 5: Escape fractions and IGM correction

Object	$f_{esc}^{abs} \times T_{IGM}$ [a]	$f_{esc}^{rel} \times T_{IGM}$ [b]	T_{IGM}	f_{esc}^{rel}	f_{esc}^{abs} [c]
F275W-314	51 ± 33%	57%	72 ± 9%	82 ± 12%	77 ± 9%
F275W-2055	57 ± 19%	105%	66 ± 8%	153 ± 14%	76 ± 9%
F336W-189	3 ± 0.8%	23%	7 ± 5%	325 ± 200%	36 ± 22%
F336W-554	28 ± 7%	203%	49 ± 11%	441 ± 110%	67 ± 15%
F336W-606	40 ± 17%	67%	42 ± 3%	146 ± 12%	91 ± 6%
F336W-1013	4 ± 0.6%	103%	24 ± 15%	442 ± 295%	15 ± 10%
F336W-1041	108 ± 30%	397%	100 ± −%	397 ± −%	100 ± −%

Properties of LCE candidates from this work

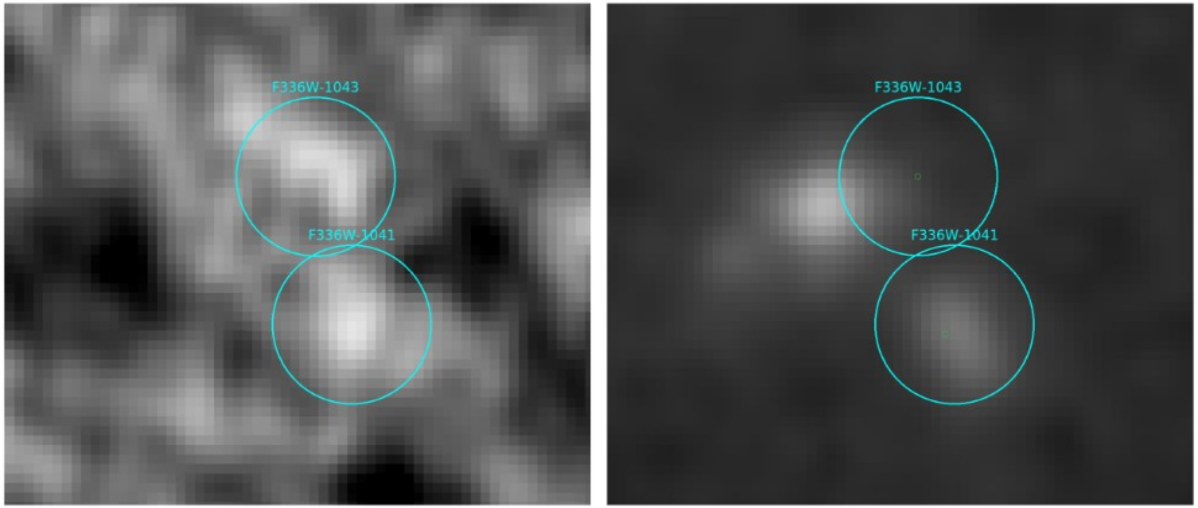


Fig. E.1: Cutouts of F336W-1041 (lower circle) and F336W-1043 (upper circle) in the filters F336W (left panel) and F775W (right panel). The circles are of arbitrary size. The upper feature in F336W is visibly offset from the upper feature in F775W, which is true for the rest of optical and IR data. In contrast, the spatial coincidence of the lower feature in the two filters is clear.