Testing the MgII-LyC connection with MUSE and ASTROSAT

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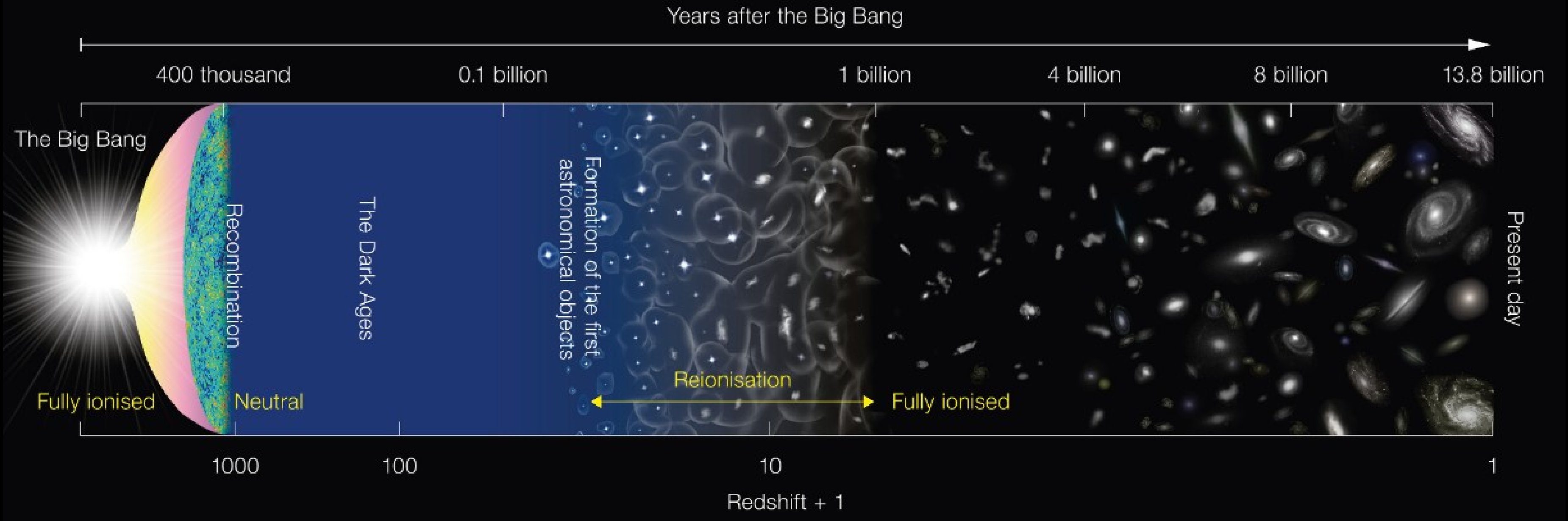
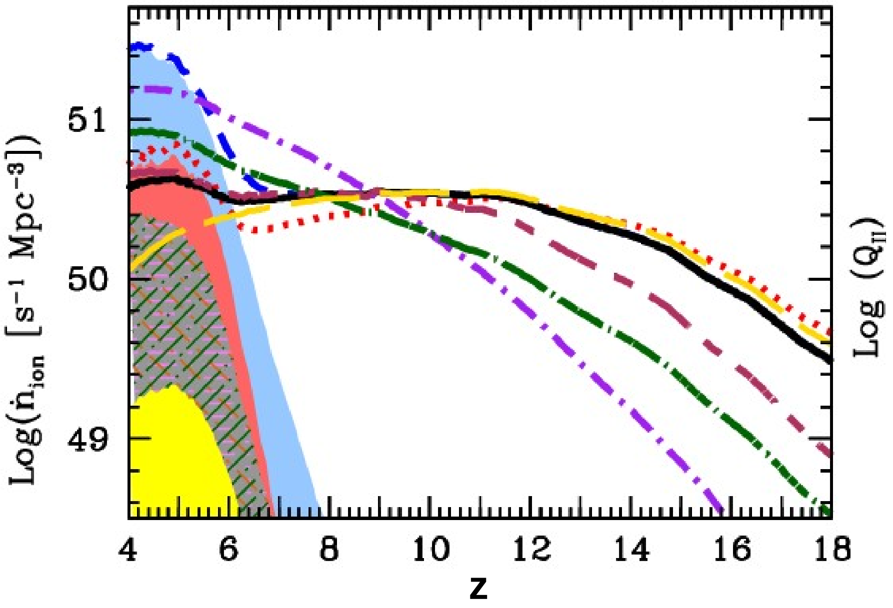
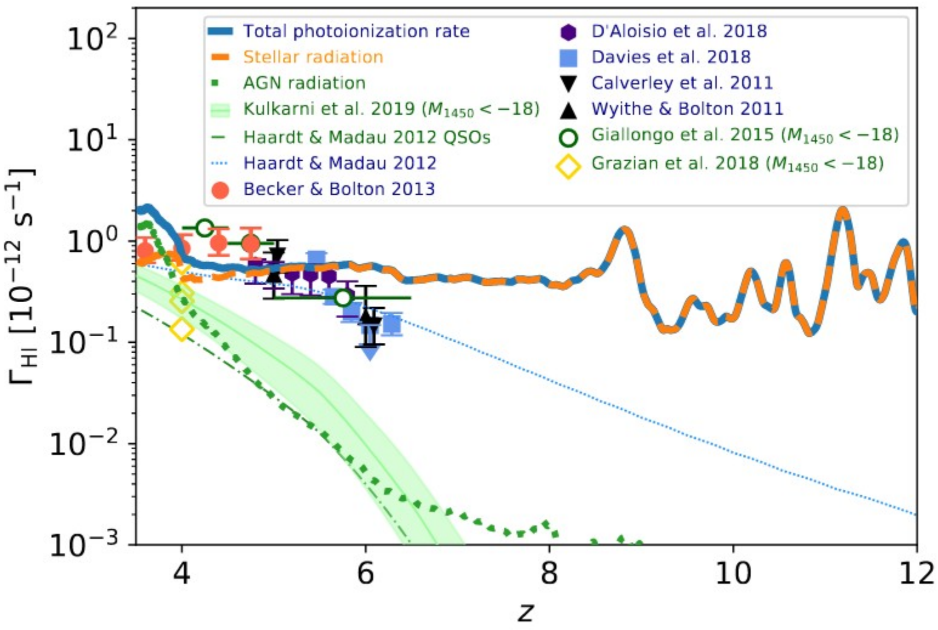


SPHINX/RASCAS-Triple Meeting

Reionization of the Universe: SF versus AGN



Evolution of escaping HI ionizing photon emissivity.
Shaded regions = AGN. Lines = AGN+SF
(Dayal+2020)

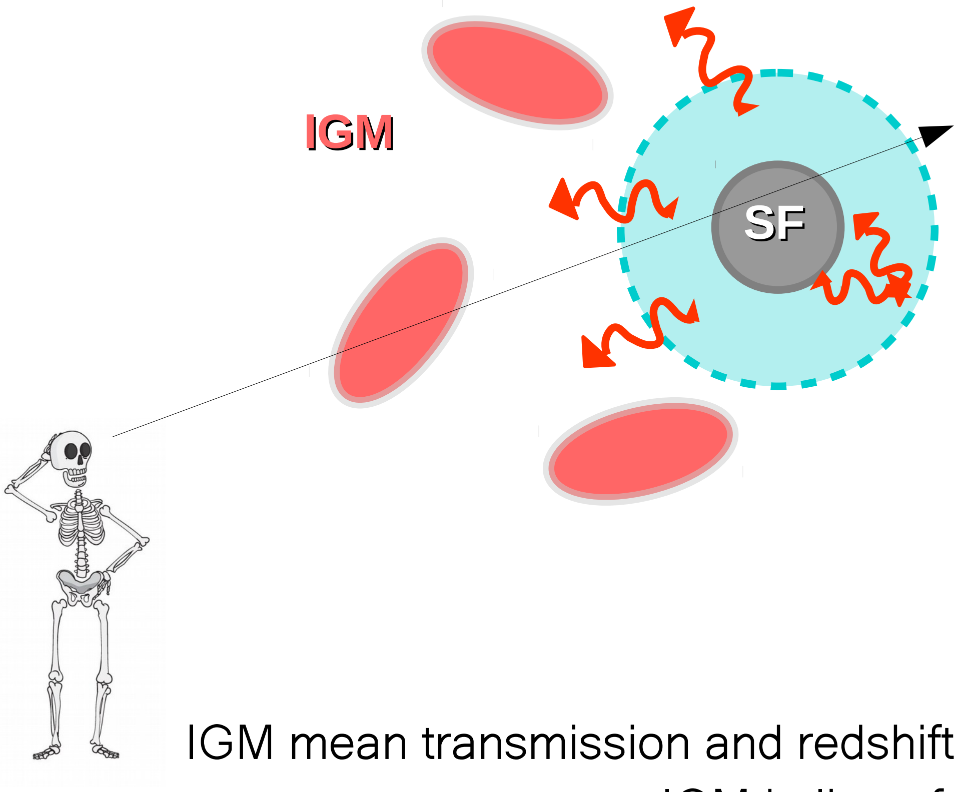


Evolution of HI ionization rate.
Orange = SF. Green dotted = AGN
(Trebitsch+2020)

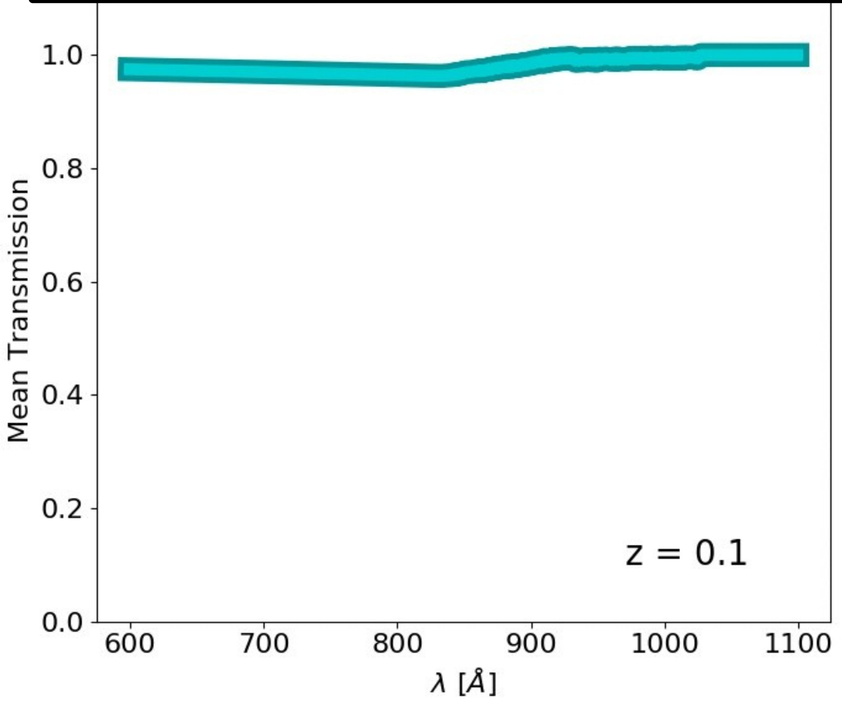
We need an indirect tracer of LyC

1. Work at high redshift (IGM and telescope-wise)

2. Trace LyC

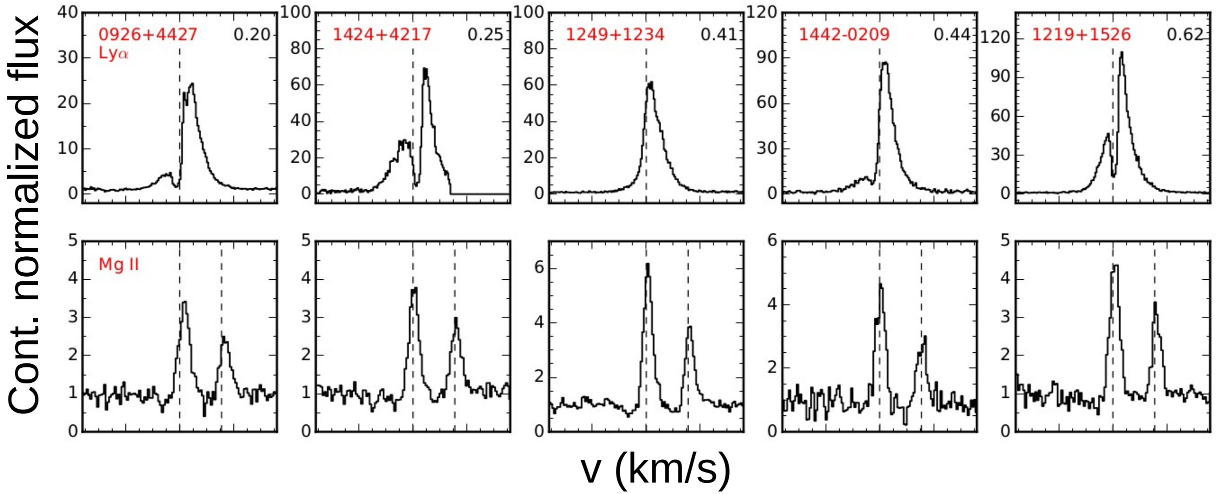


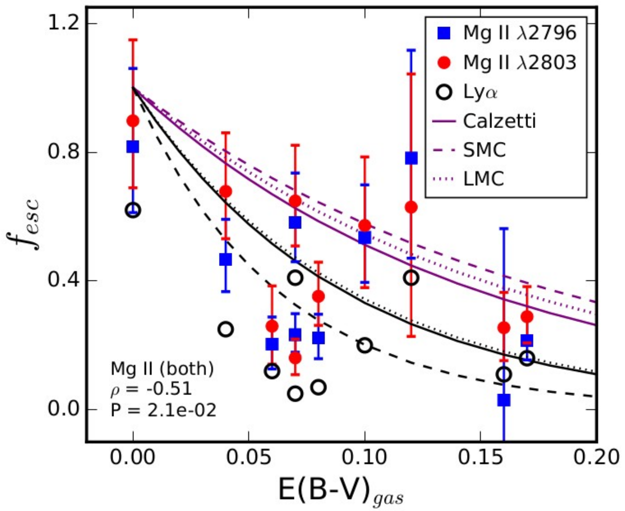
Lya is a good tracer but gets absorbed by the IGM



IGM mean transmission and redshift. Ionizing radiation is heavily absorbed by IGM in line of sight (Inoue, 2014)

Relationship between Lya and MgII in green peas (Henry+2018)





1. MgII escape fraction is higher when dust extinction is lower

2. MgII trend mirrors relation seen in Lya

3. The fact that many measurements fall below the ext. curves is expected for resonant lines, which are more susceptible to dust extinction than non-resonant lines

Relationship between Lya and MgII in green peas (Henry+2018)

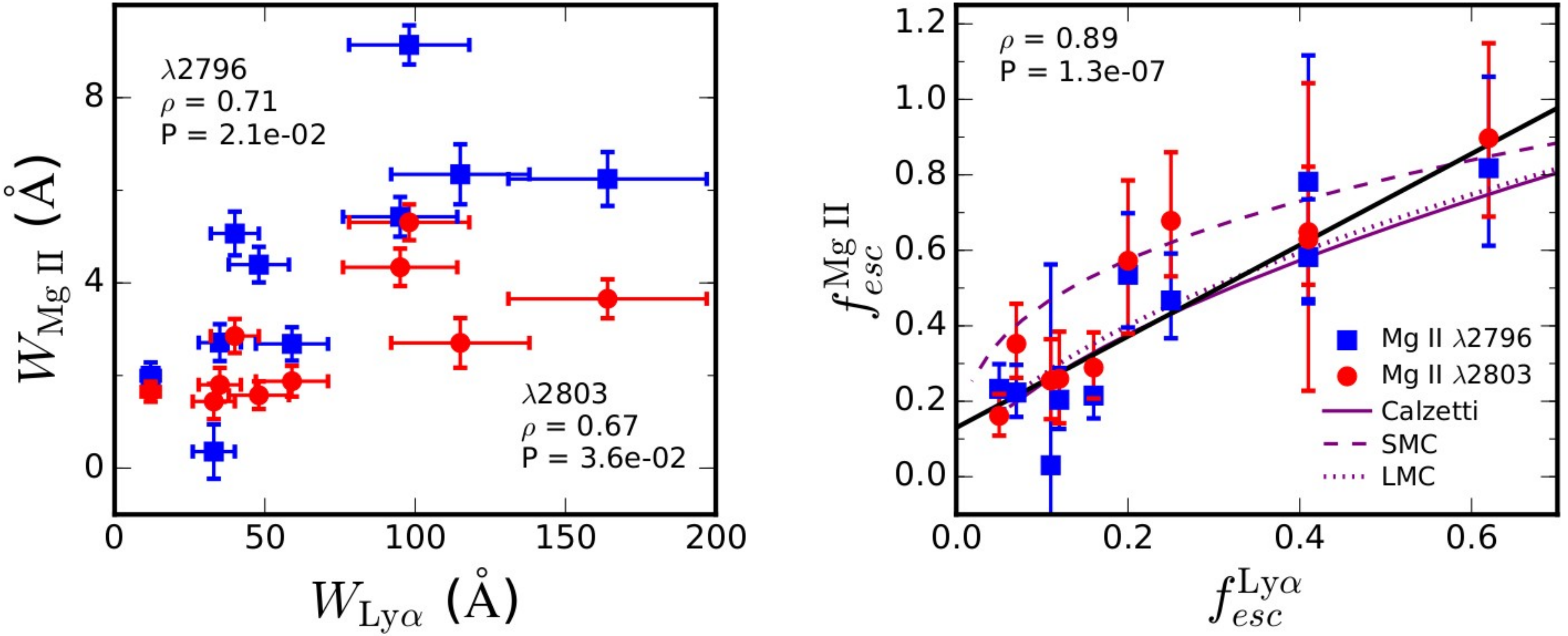


Figure 10. The equivalent widths and escape fractions correlate for Lyα and Mg II. The Pearson correlation coefficient and probability of the null hypothesis are shown in each panel, for the Mg II lines separately in the equivalent width panel (left), or for combined set of measurements in the escape fraction panel (right). The black line shows a linear fit to the relation, given by Equation 5. The purple curves show the expectation from dust extinction *without* resonant scattering. We note that neither the Lyα or Mg II escape fractions are corrected for any extended emission that may fall outside the spectroscopic apertures.

MgII as an indirect tracer of LyC

1. Work at high redshift (IGM and telescope-wise)

   MgII is not absorbed by IGM

   $N_{MgII} \sim 10^{-5} N_H$ → resonant like Lya but scatters less

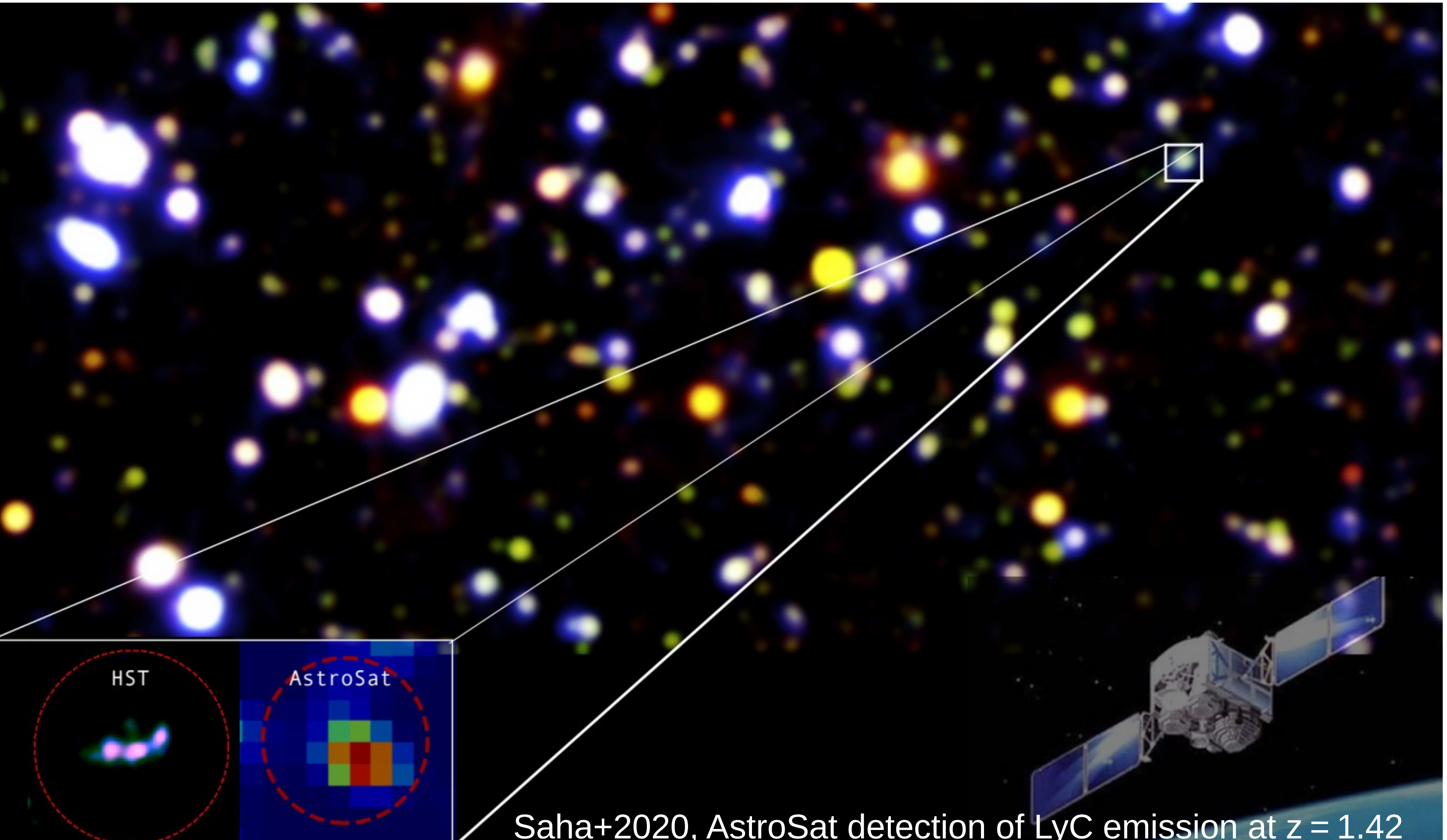
   Will be able to be seen (hopefully) at high-z with JWST

2. Trace LyC

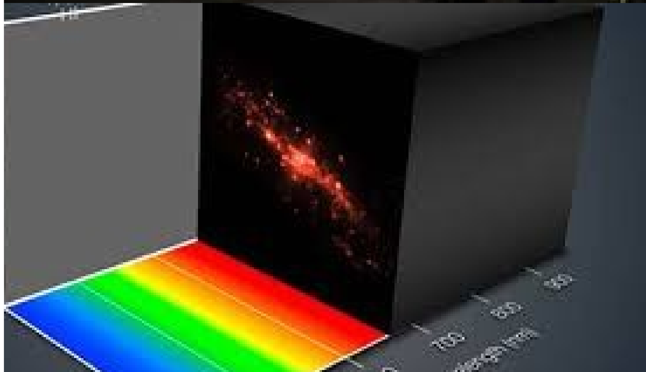
   MgII has a ionization potential close to H (15eV vs 13.6eV)

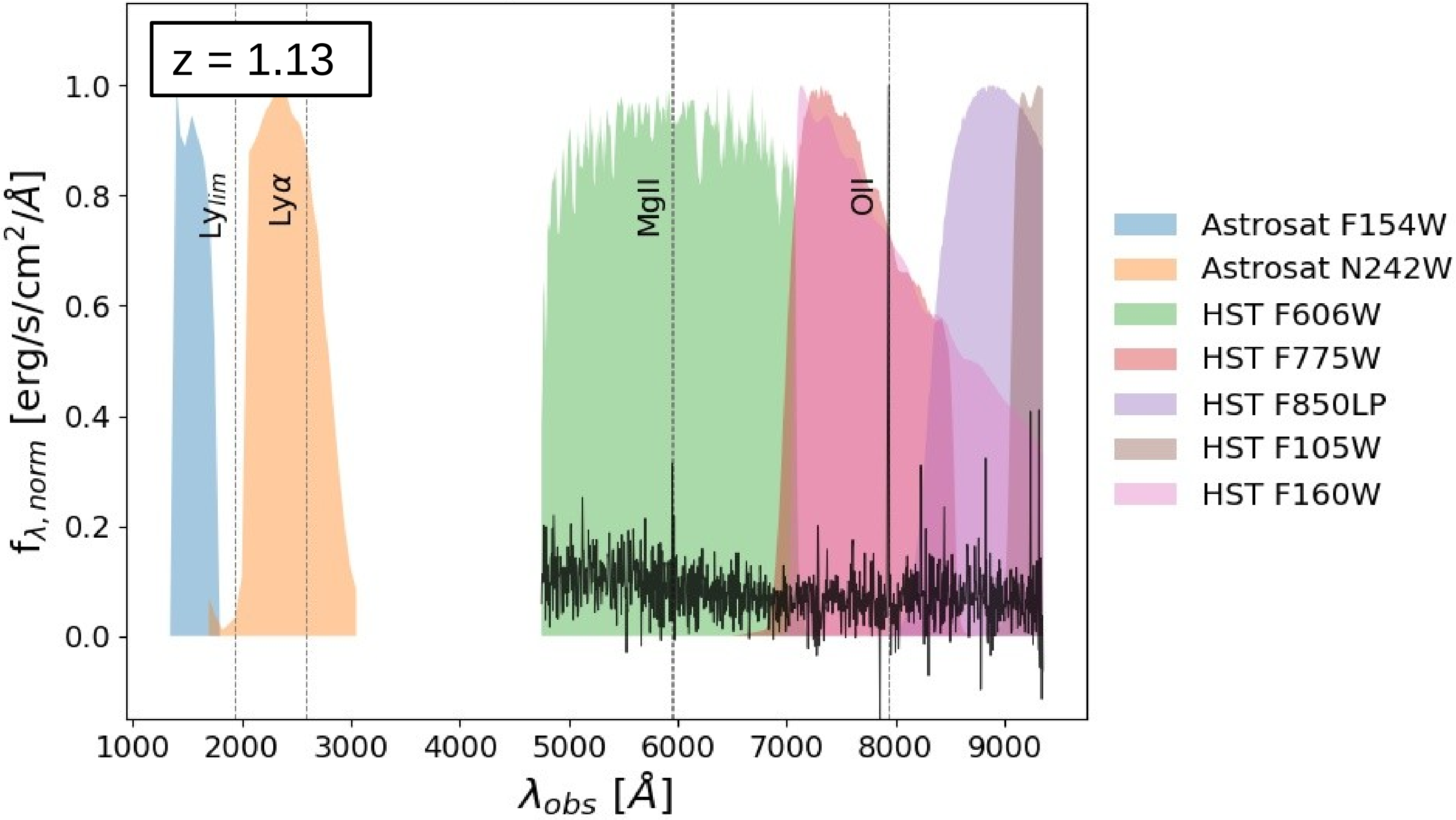
   Lya and MgII escape appear to be governed by radiation transport in the same gas, so in theory, MgII would trace LyC escape

ASTROSAT + MUSE WIDE

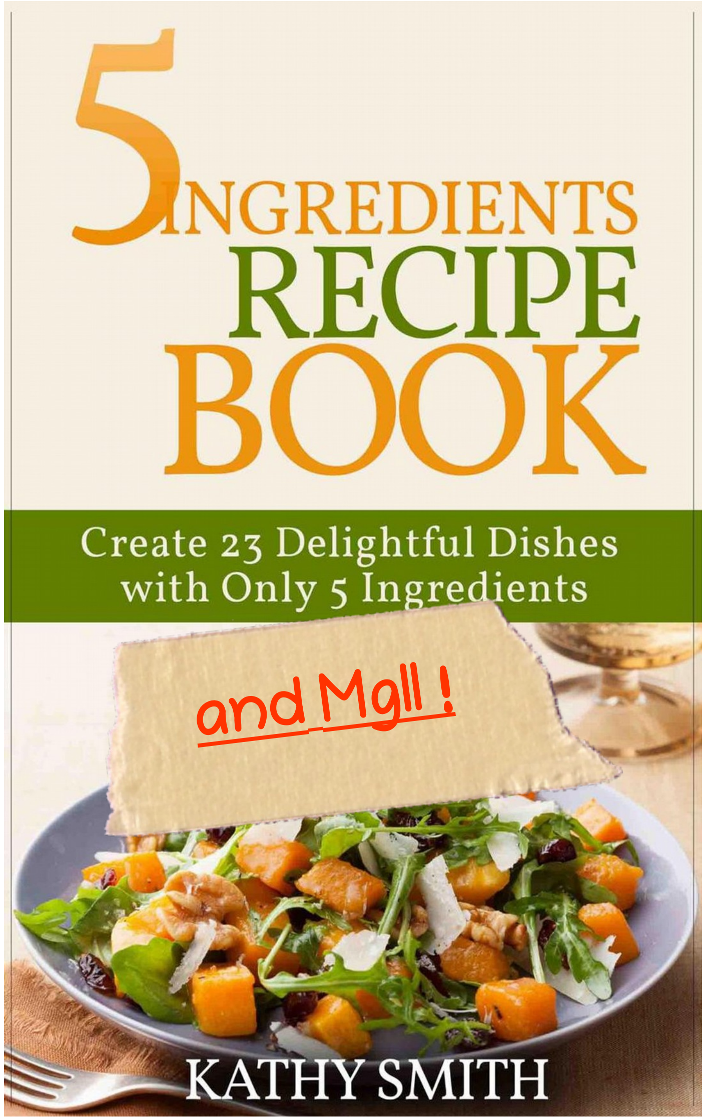


Saha+2020, AstroSat detection of LyC emission at z = 1.42





z = 1.13
Ly_{lim}
Lyα
MgII
OII
$f_{\lambda, norm}$ [erg/s/cm²/Å]
λ_{obs} [Å]
1.0
0.8
0.6
0.4
0.2
0.0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Astrosat F154W
Astrosat N242W
HST F606W
HST F775W
HST F850LP
HST F105W
HST F160W



Can MgII be used as a tracer of LyC leakage?

1. Select a sample criteria

2. Correlate MUSE Wide* and AstroSat catalogues

3. Blind detection of LyC leakage

4. Classify galaxies as MgII emitters, absorbers (or not)

5. Bring all information together and make (delicious) conclusions

Criteria for sample selection

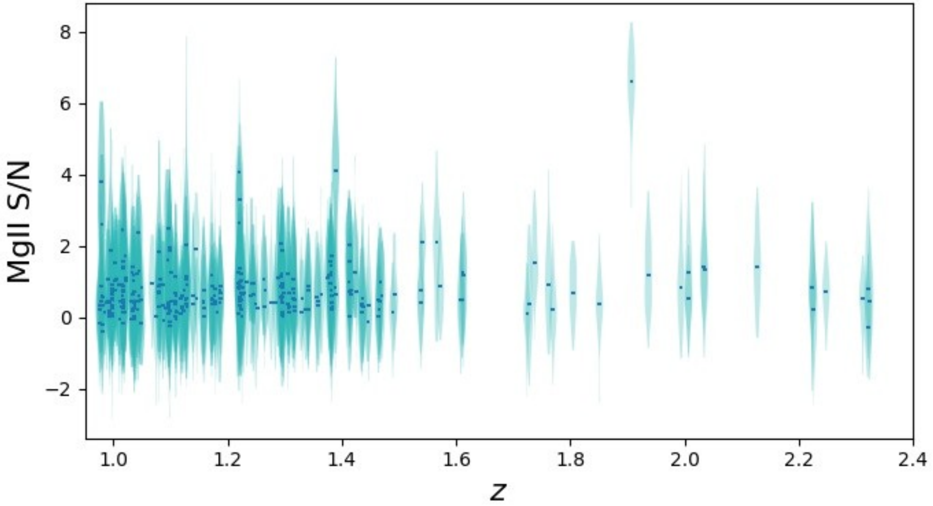
1. Redshift range where MgII is seen in MUSE and LyC is seen in Astrosat (0.97-2.34)

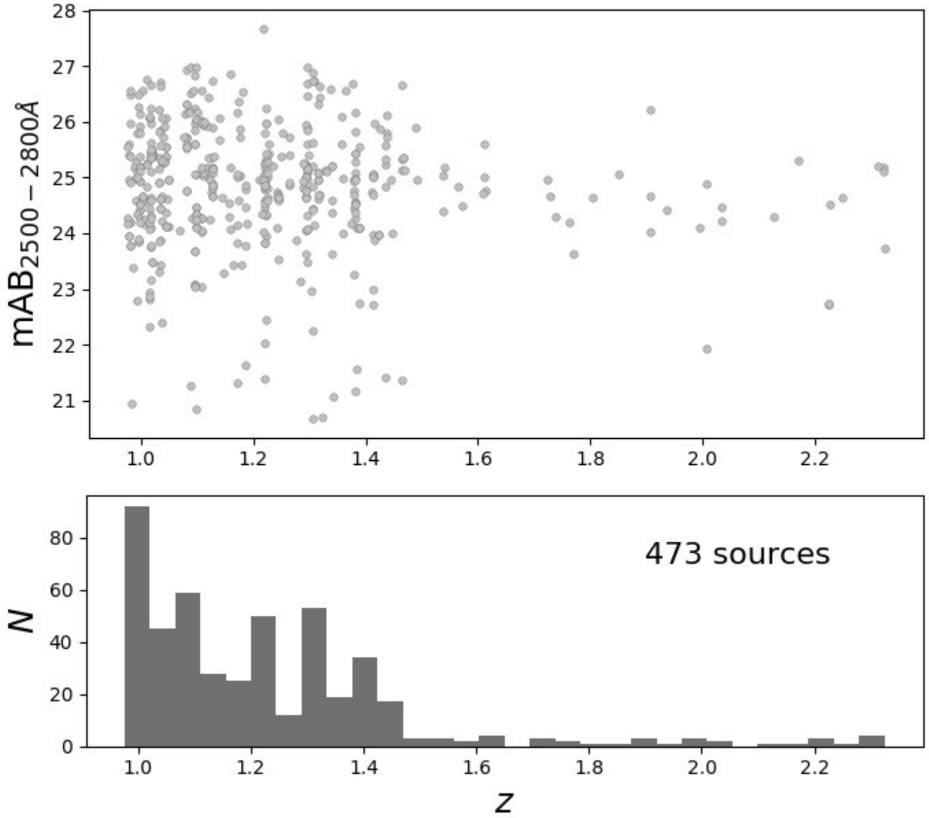
2. No QSOs

3. No foreground contamination inside AstroSat PSF (1.6'')

Sample properties

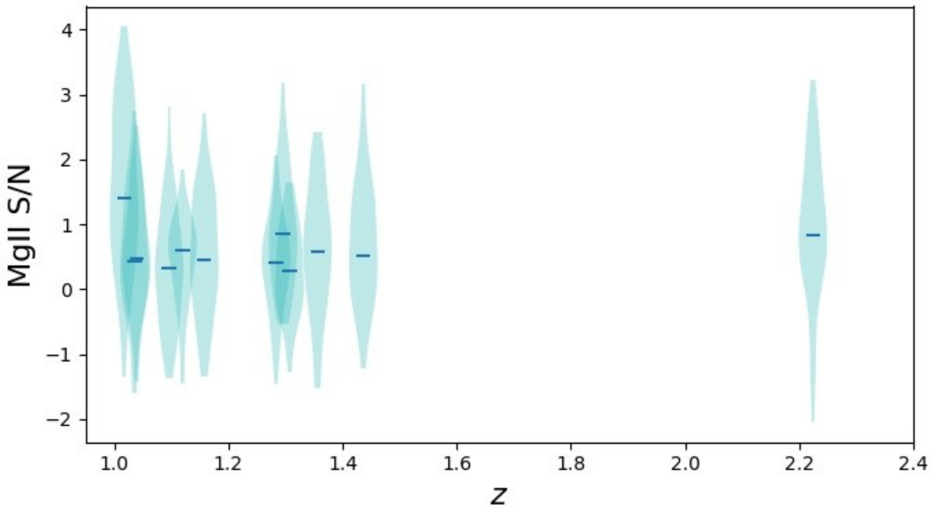
473 galaxies in sample

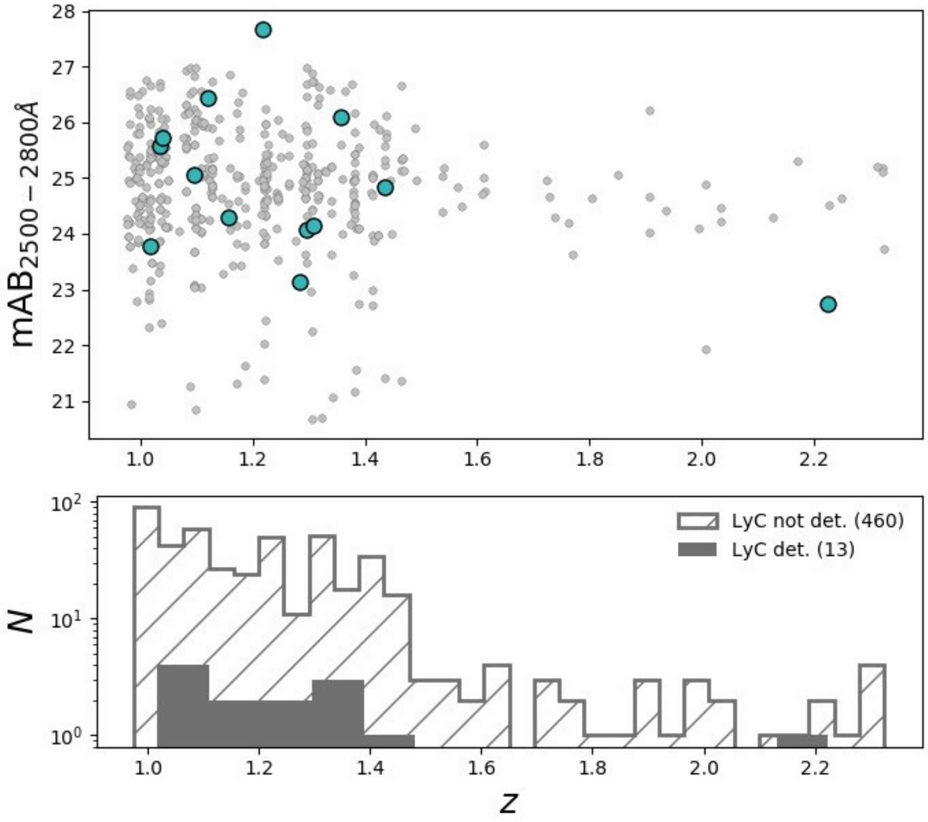


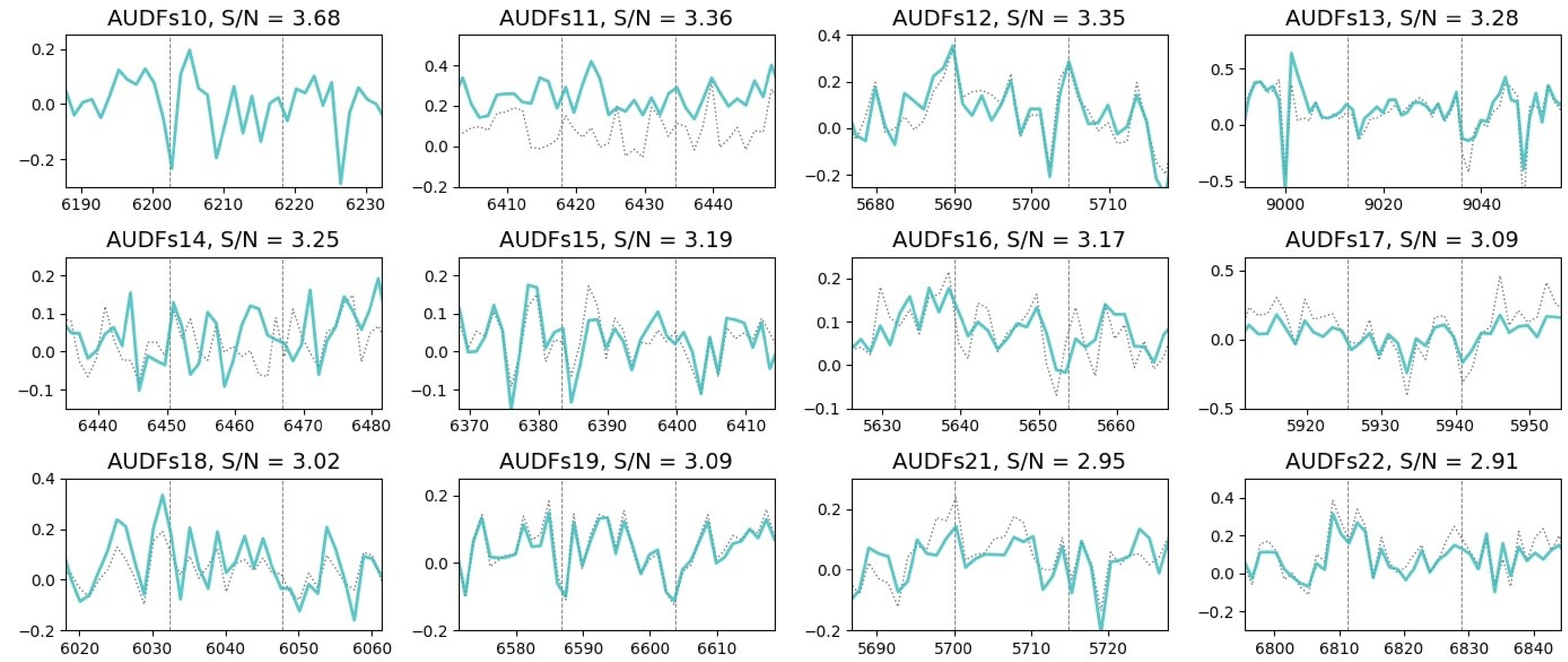


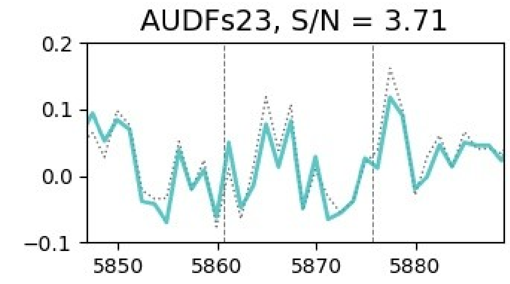
Sample properties – LyC detected

13 have LyC detection in Astrosat!



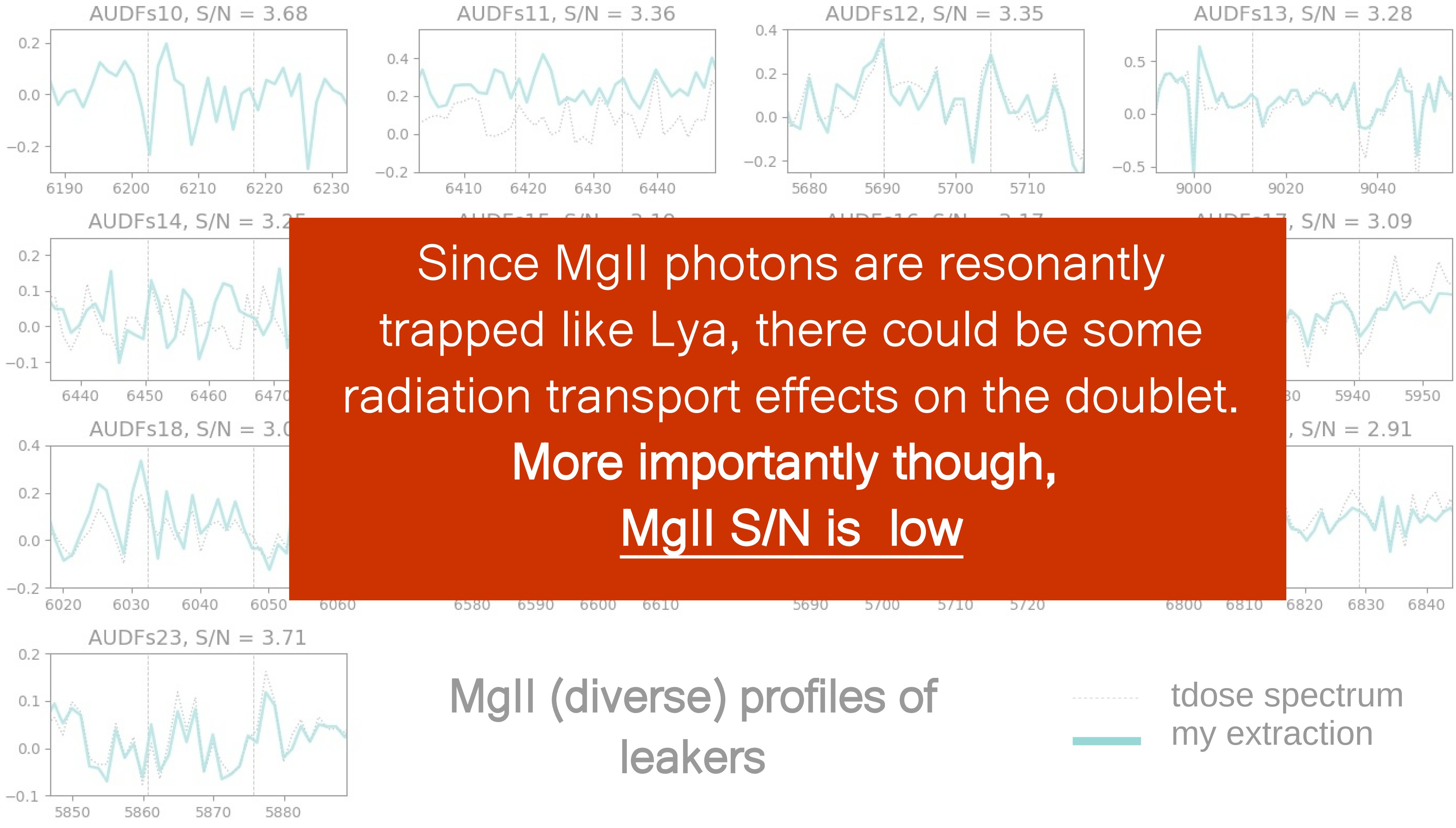






MgII (diverse) profiles of leakers

tdose spectrum
my extraction

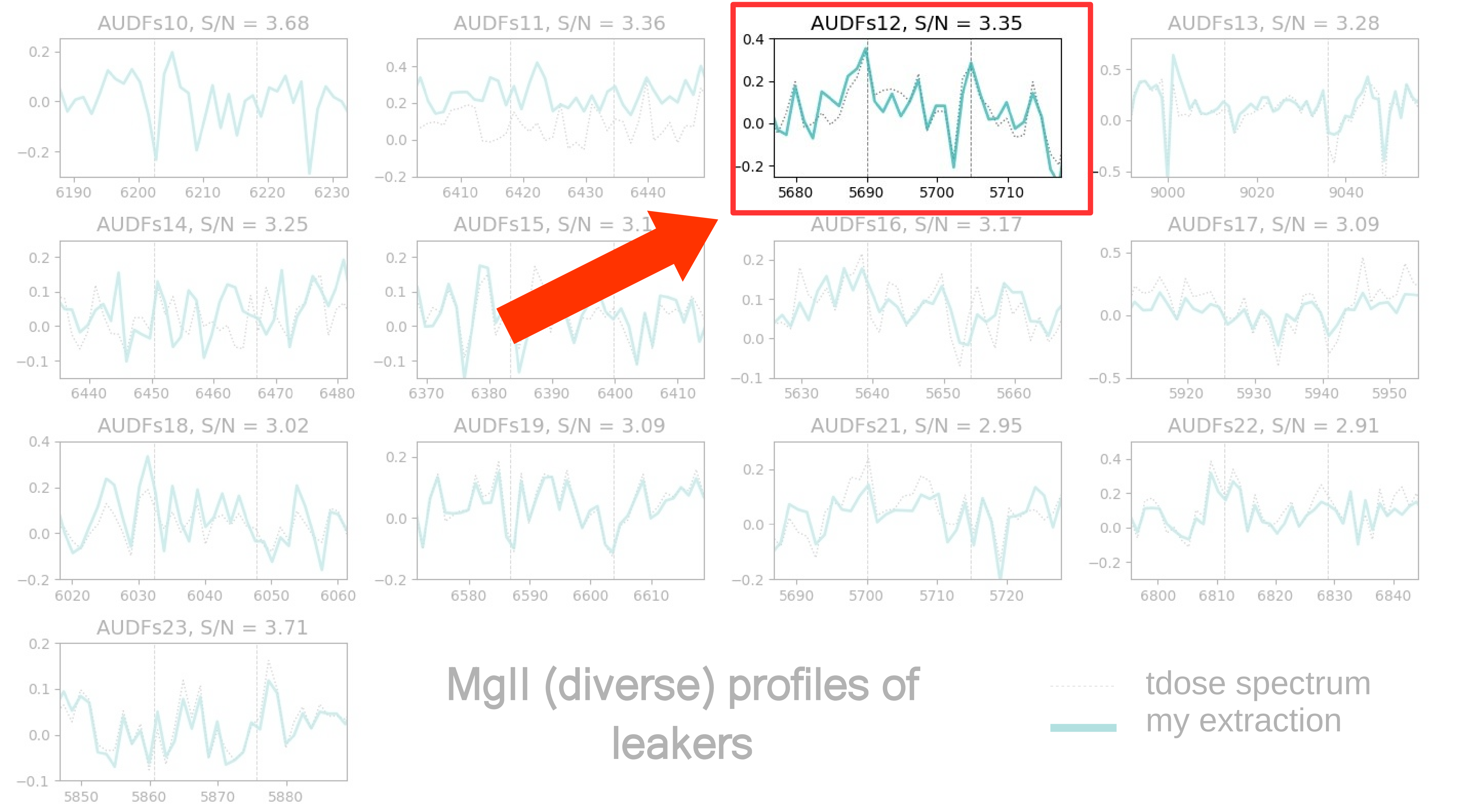


Since MgII photons are resonantly trapped like Lya, there could be some radiation transport effects on the doublet.

More importantly though,

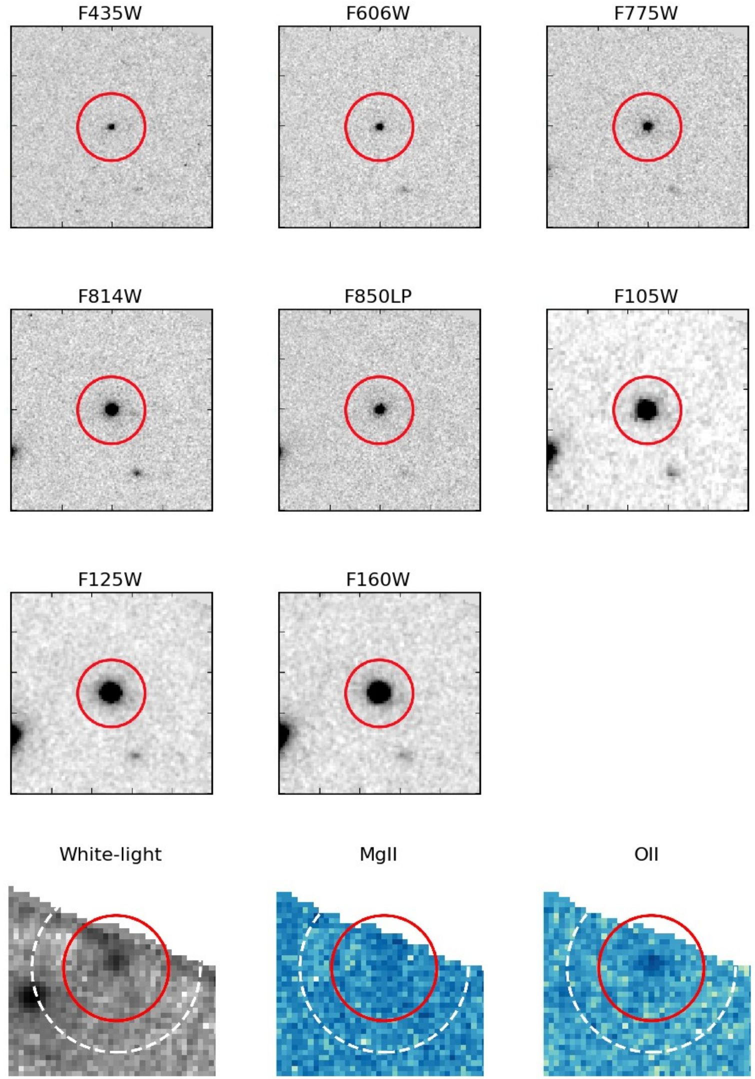
MgII S/N is low

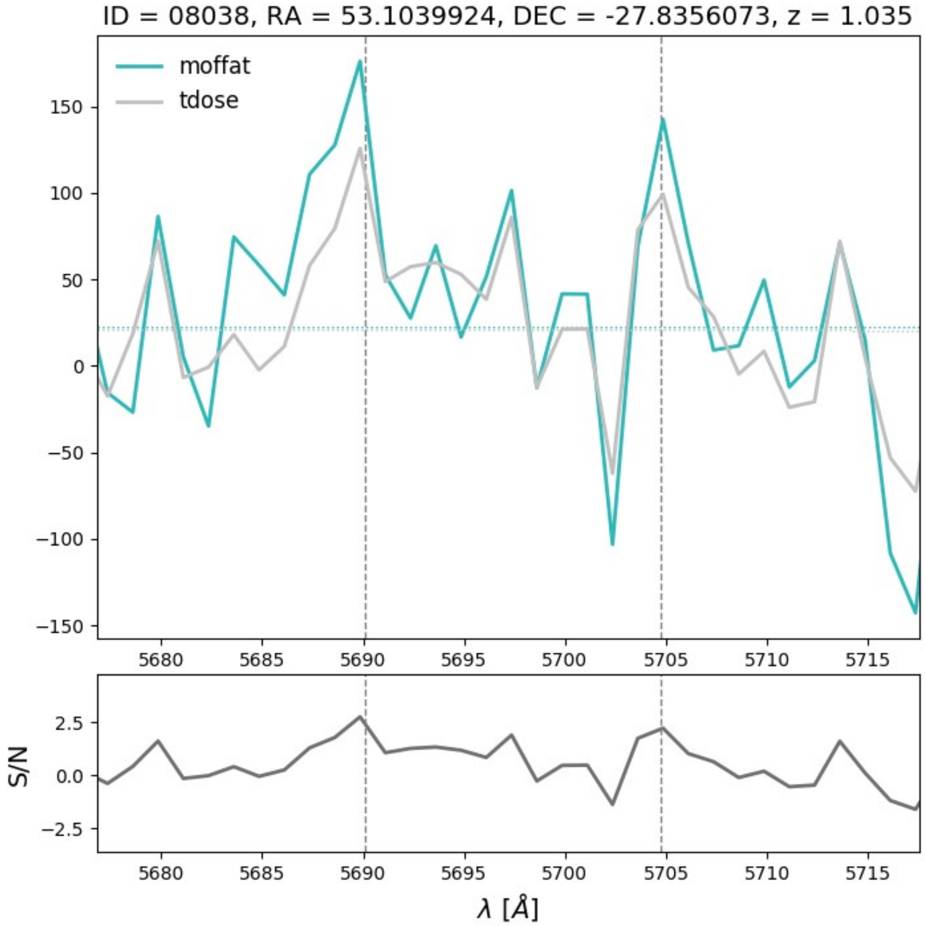
MgII (diverse) profiles of leakers

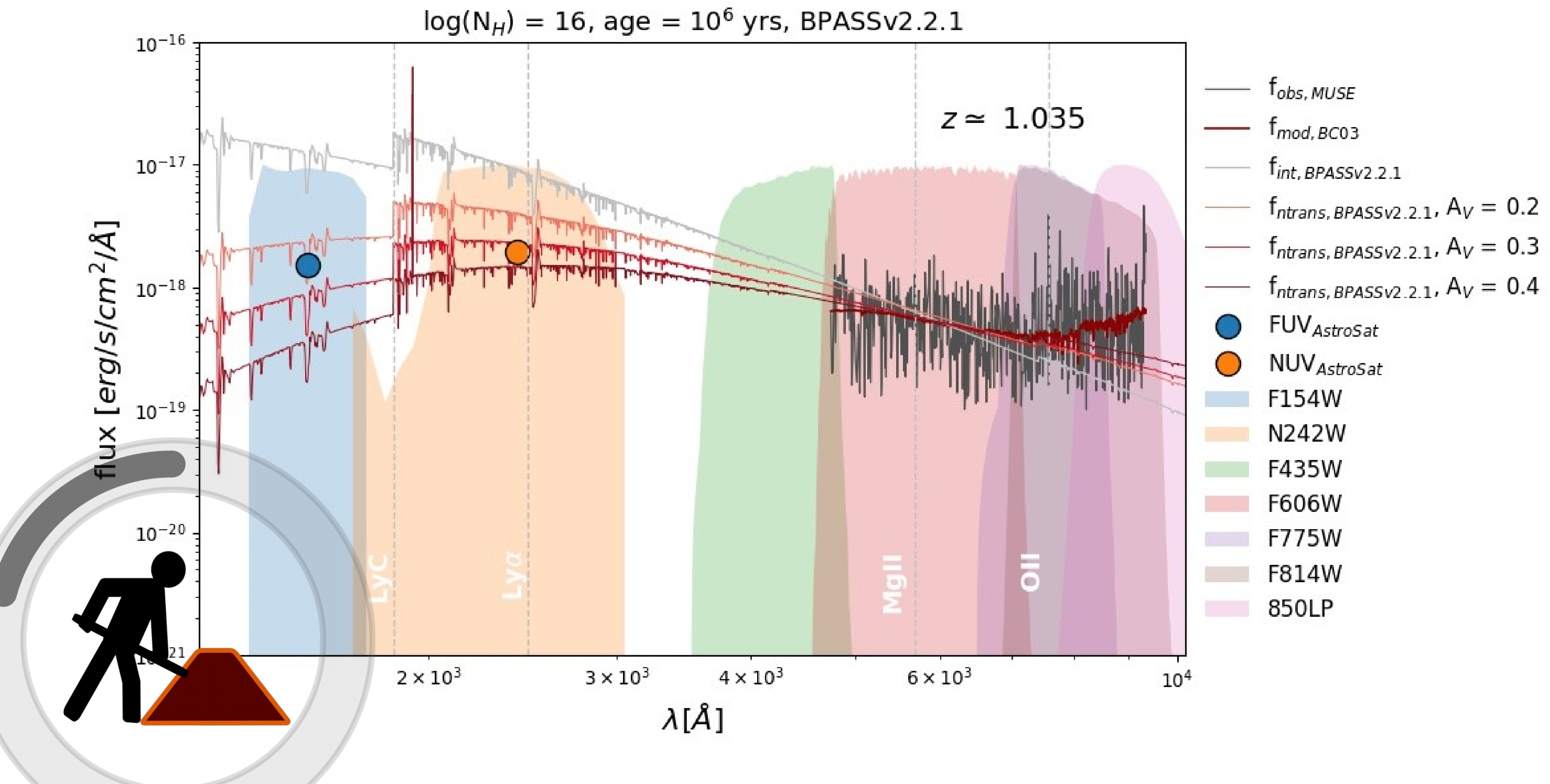

AUDFs10, S/N = 3.68
AUDFs11, S/N = 3.36
AUDFs12, S/N = 3.35
AUDFs13, S/N = 3.28
AUDFs14, S/N = 3.25
AUDFs15, S/N = 3.1
AUDFs16, S/N = 3.17
AUDFs17, S/N = 3.09
AUDFs18, S/N = 3.02
AUDFs19, S/N = 3.09
AUDFs21, S/N = 2.95
AUDFs22, S/N = 2.91
AUDFs23, S/N = 3.71
MgII (diverse) profiles of leakers
tdose spectrum
my extraction

HST

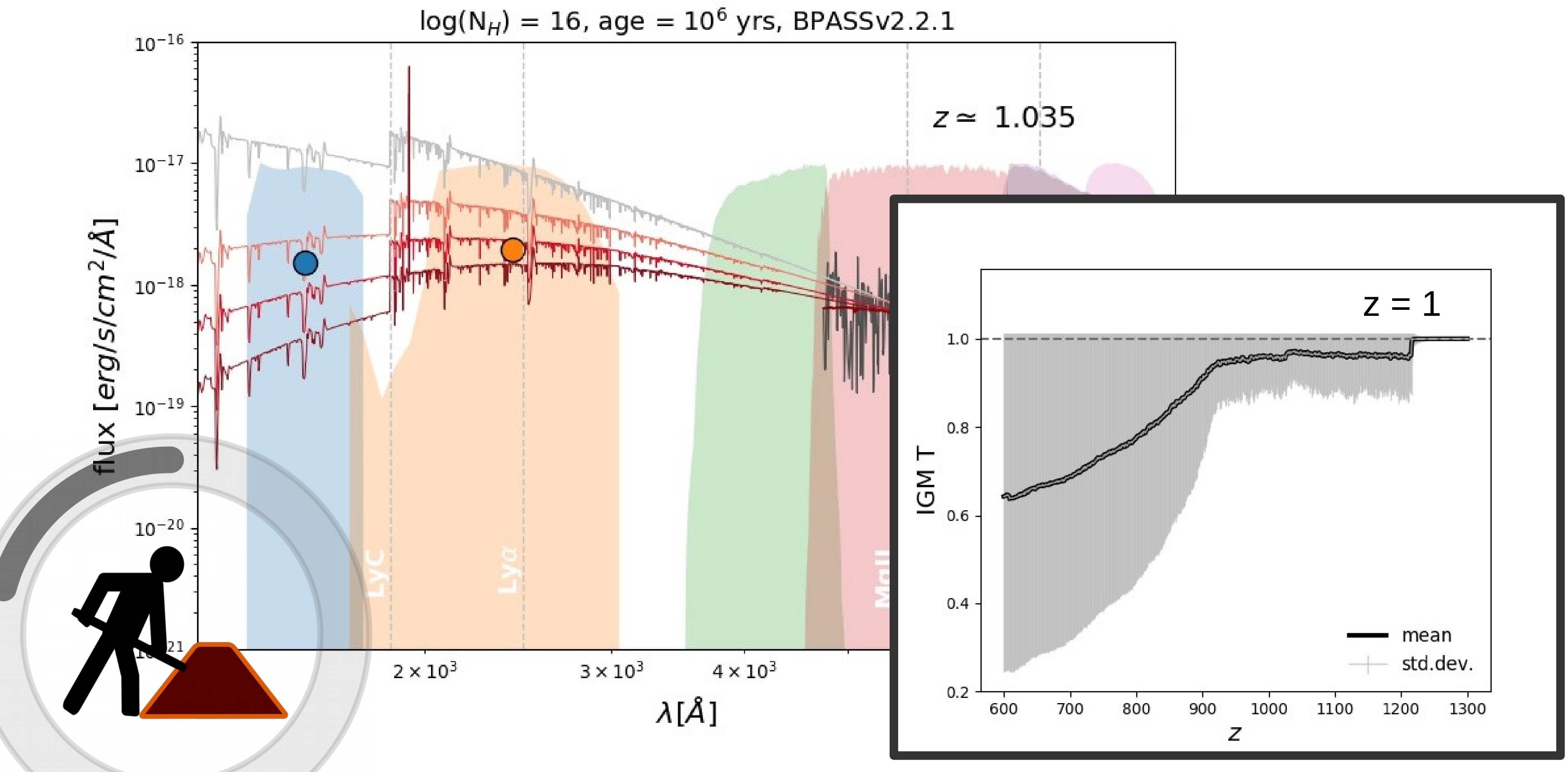
MUSE


F435W
F606W
F775W
F814W
F850LP
F105W
F125W
F160W
White-light
MgII
OII


ID = 08038, RA = 53.1039924, DEC = -27.8356073, z = 1.035
moffat
tdose
150
100
50
0
−50
−100
−150
5680
5685
5690
5695
5700
5705
5710
5715
S/N
2.5
0.0
−2.5
λ [Å]

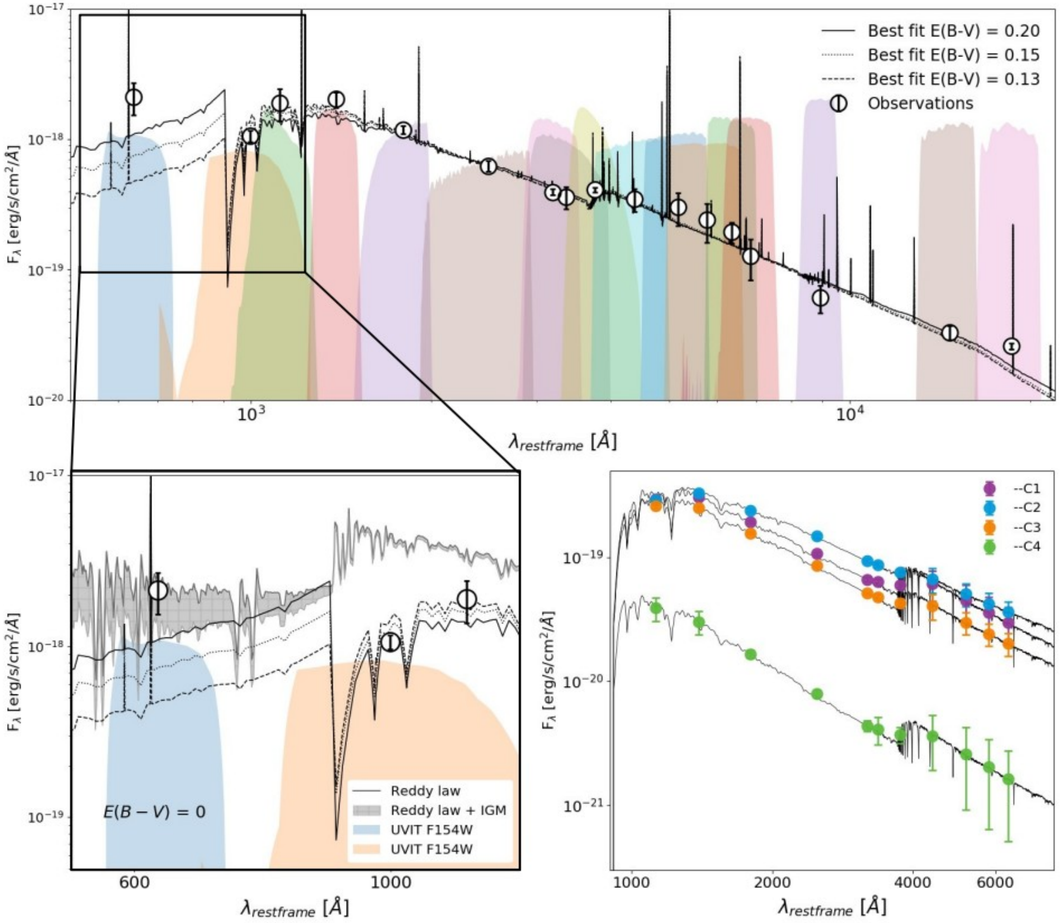


log(N_H) = 16, age = 10^6 yrs, BPASSv2.2.1
z ≃ 1.035
flux [erg/s/cm^2/Å]
λ[Å]
10^-16
10^-17
10^-18
10^-19
10^-20
10^-21
2 × 10^3
3 × 10^3
4 × 10^3
6 × 10^3
10^4
LyC
Lyα
MgII
OII
f_obs, MUSE
f_mod, BC03
f_int, BPASSv2.2.1
f_ntrans, BPASSv2.2.1, A_V = 0.2
f_ntrans, BPASSv2.2.1, A_V = 0.3
f_ntrans, BPASSv2.2.1, A_V = 0.4
FUV_AstroSat
NUV_AstroSat
F154W
N242W
F435W
F606W
F775W
F814W
850LP



log(N_H) = 16, age = 10^6 yrs, BPASSv2.2.1
z ≃ 1.035
flux [erg/s/cm^2/Å]
λ[Å]
10^-16
10^-17
10^-18
10^-19
10^-20
2 × 10^3
3 × 10^3
4 × 10^3
Lyc
Lyα
z = 1
IGM T
z
mean
std.dev.
1.0
0.8
0.6
0.4
0.2
600
700
800
900
1000
1100
1200
1300

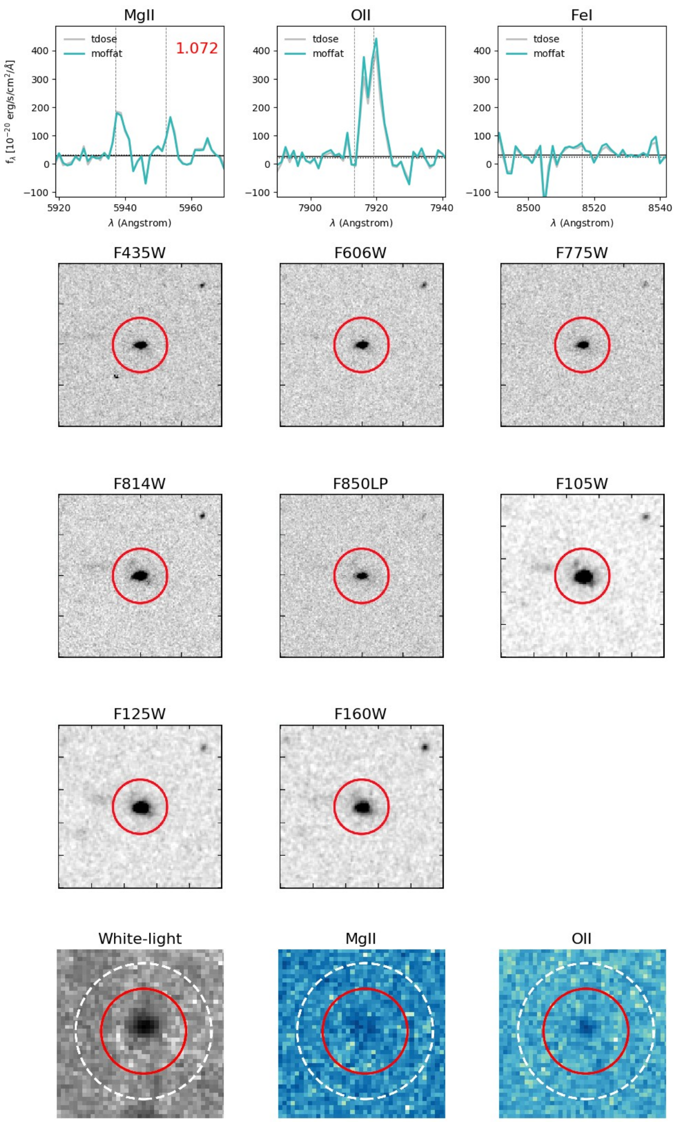
AstroSat detection of Lyman continuum emission from a z = 1.42 galaxy (Saha+2020)

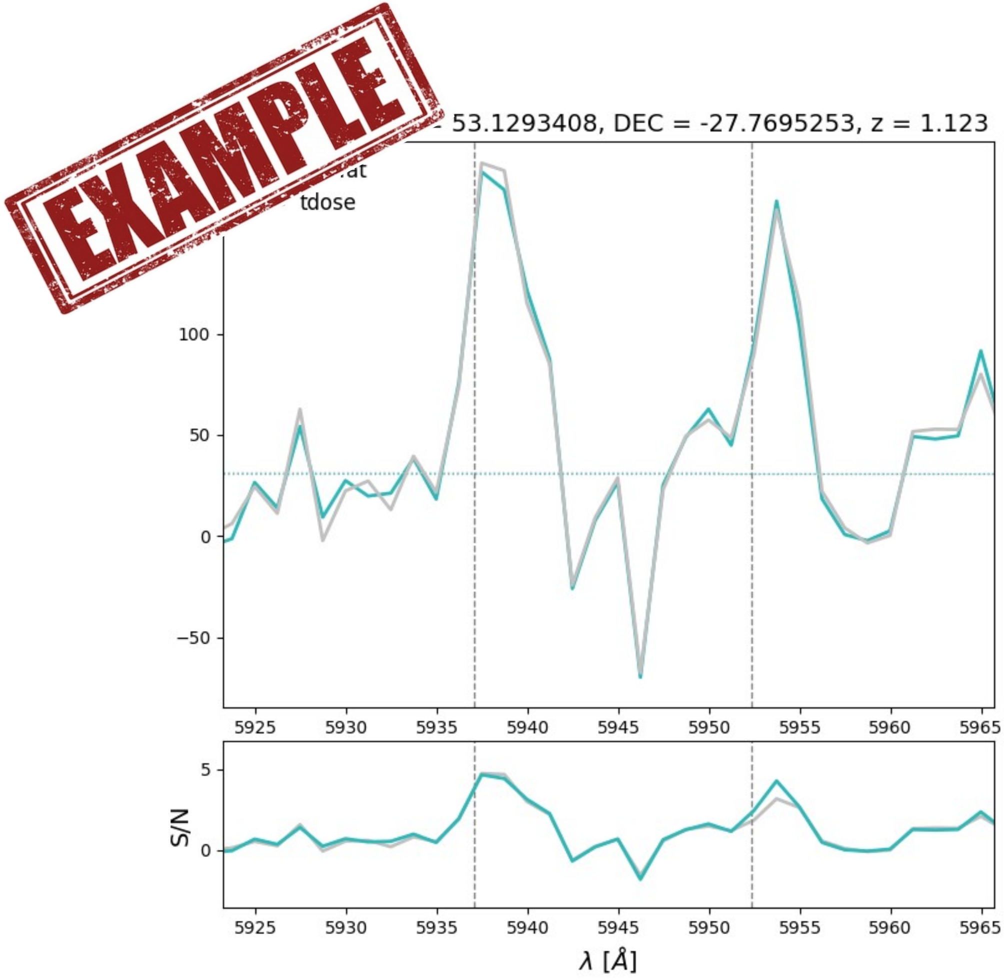


Could our galaxy be like this beast?

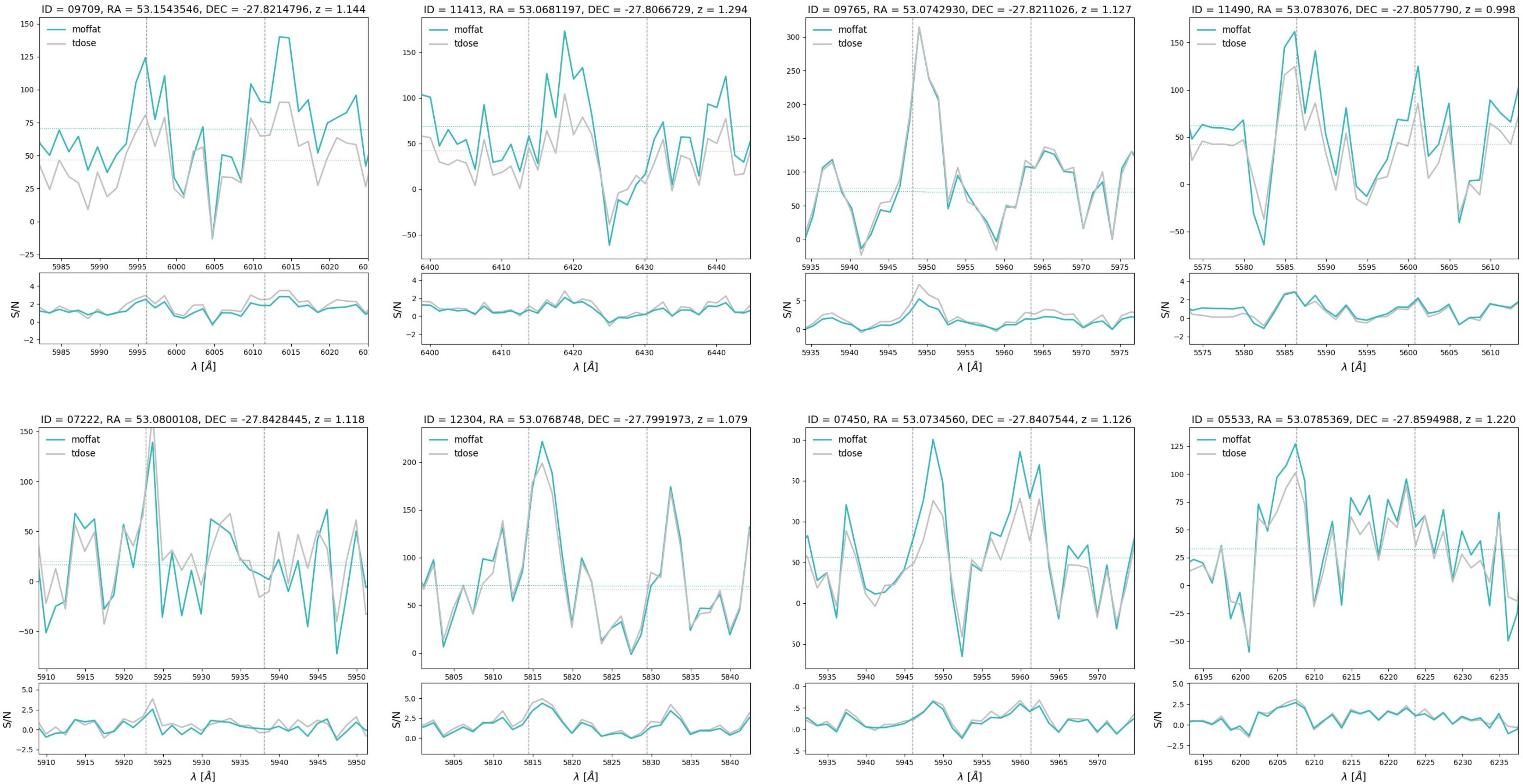
We see a similar FUV excess (promising), **but** it needs to be analyzed in more detail

What about MgII emitters with no LyC detection?





Some more examples of MgII profiles without LyC detection



To do...

Analyze the 13 leakers individually

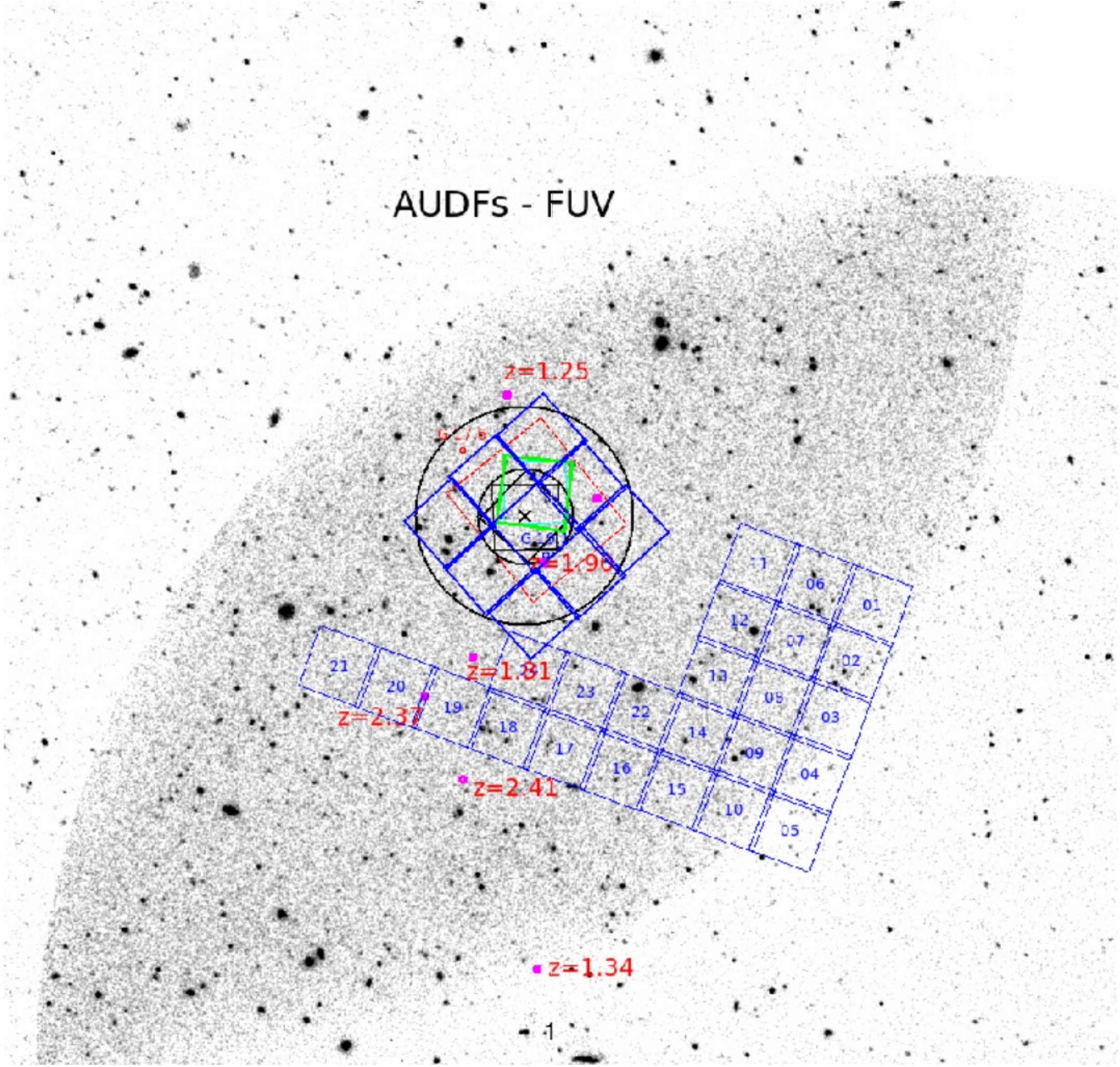
In parallel, classify the sample according to MgII profiles.

IMPORTANT: find an appropriate MgII S/N threshold

Also, write proposal(s) for deeper observations of leakers in order to get better MgII S/N → check if MgII EWs correlate with LyC flux strengths

If we had better resolution in the future we could measure the MgII peak separations and therefore optical thickness → relate it to LyC escape (as in Lya, Henry+2020)

Gracias


AUDFs - FUV
z=1.25
z=1.96
z=1.81
z=2.37
z=2.41
z=1.34
11
06
01
12
07
02
13
08
03
14
09
04
15
10
05
21
20
19
18
17
16
23
22