GTC-OSIRIS, tunable filters, and LAE/LBG candidate detection

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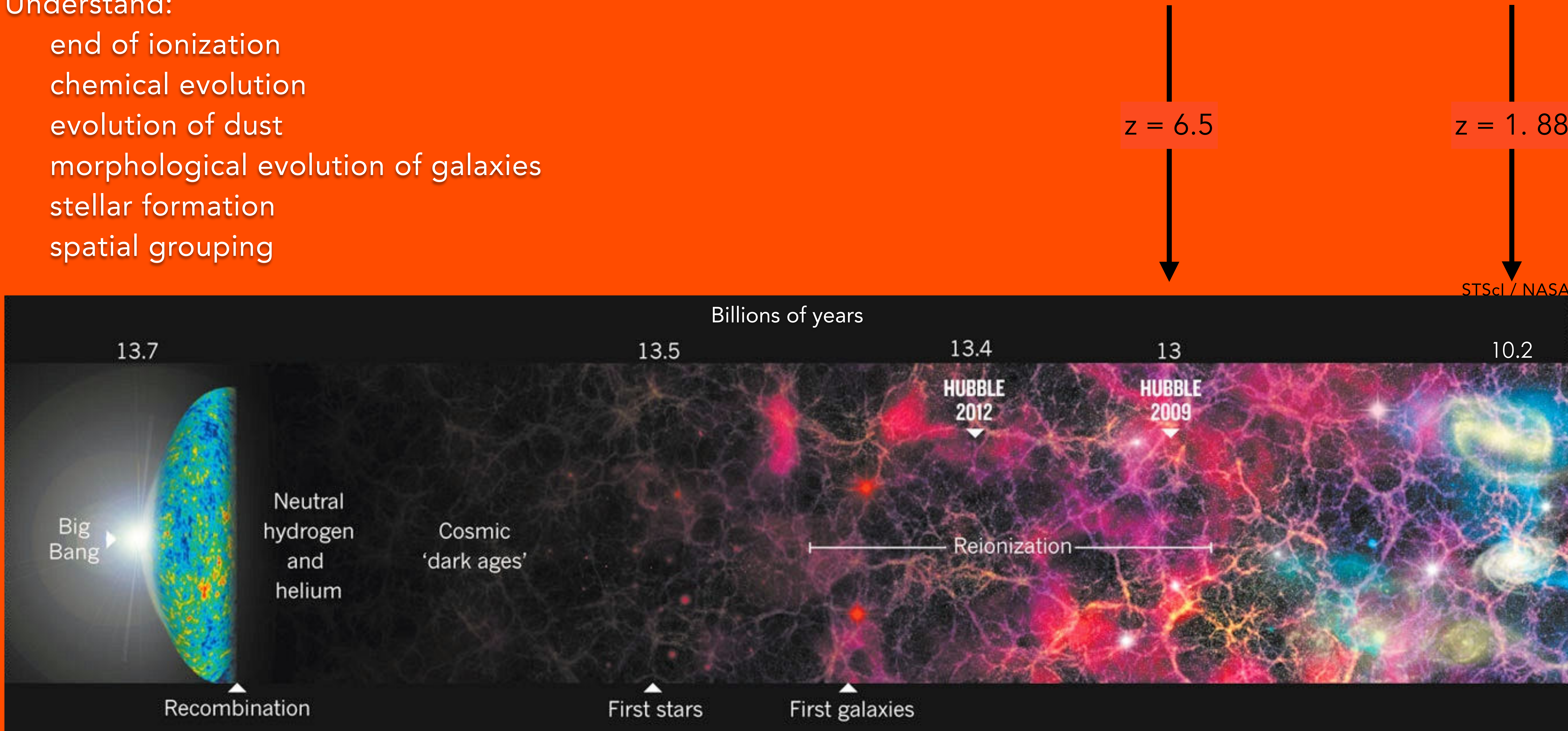
What is it good for?

Understand:

- end of ionization
- chemical evolution
- evolution of dust
- morphological evolution of galaxies
- stellar formation
- spatial grouping



de Diego, De Leo, et al., 2013, AJ, 146 published

Why?

Based on 2 successful methods on their respective fields (TF at low redshift and Lyman Alpha emitter detection in wide filters) joined for high-redshift search

Pilot program of OSIRIS-TF (tunable filters) photometric data to look for LAEs

TFs allow for a maximum signal-to-noise ratio

Obtain characteristics of LAEs during the end of the re-ionization period

Gives very good photometric redshift estimation of candidate emitters

We are not sure on the intrinsic difference (if there exists) between LAEs & LBGs

Data

3 galaxy clusters (MS2053, MS0440, MS1358)

with strong gravitation lensing

& detailed mass models

Verdugo, et al., 2008, ApJ, 664

~6800 Å (*z* ~ 4.6)

~8150 Å (*z* ~ 5.7)

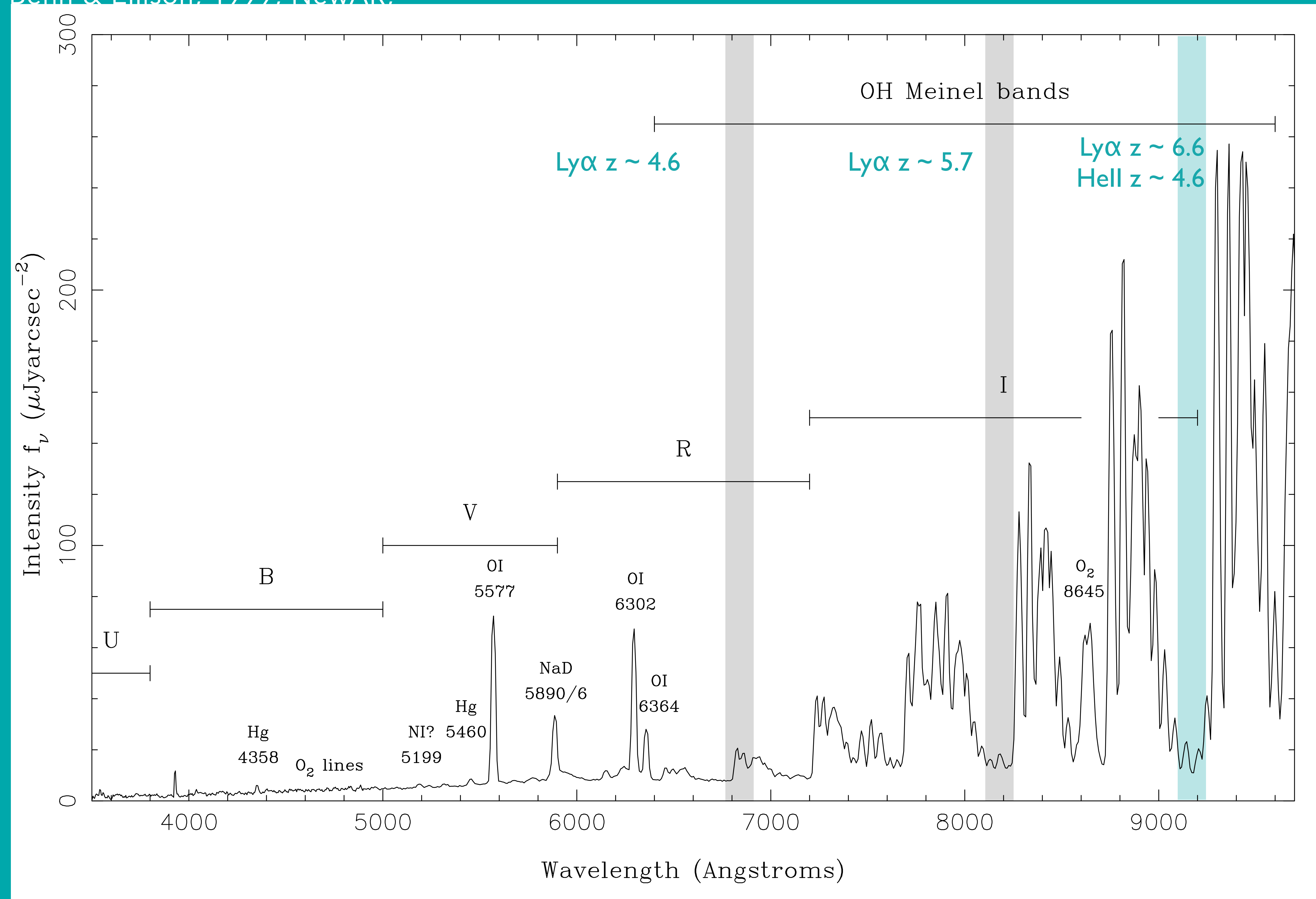
~9100 Å (*z* ~ 6.6)

regions without strong sky emission

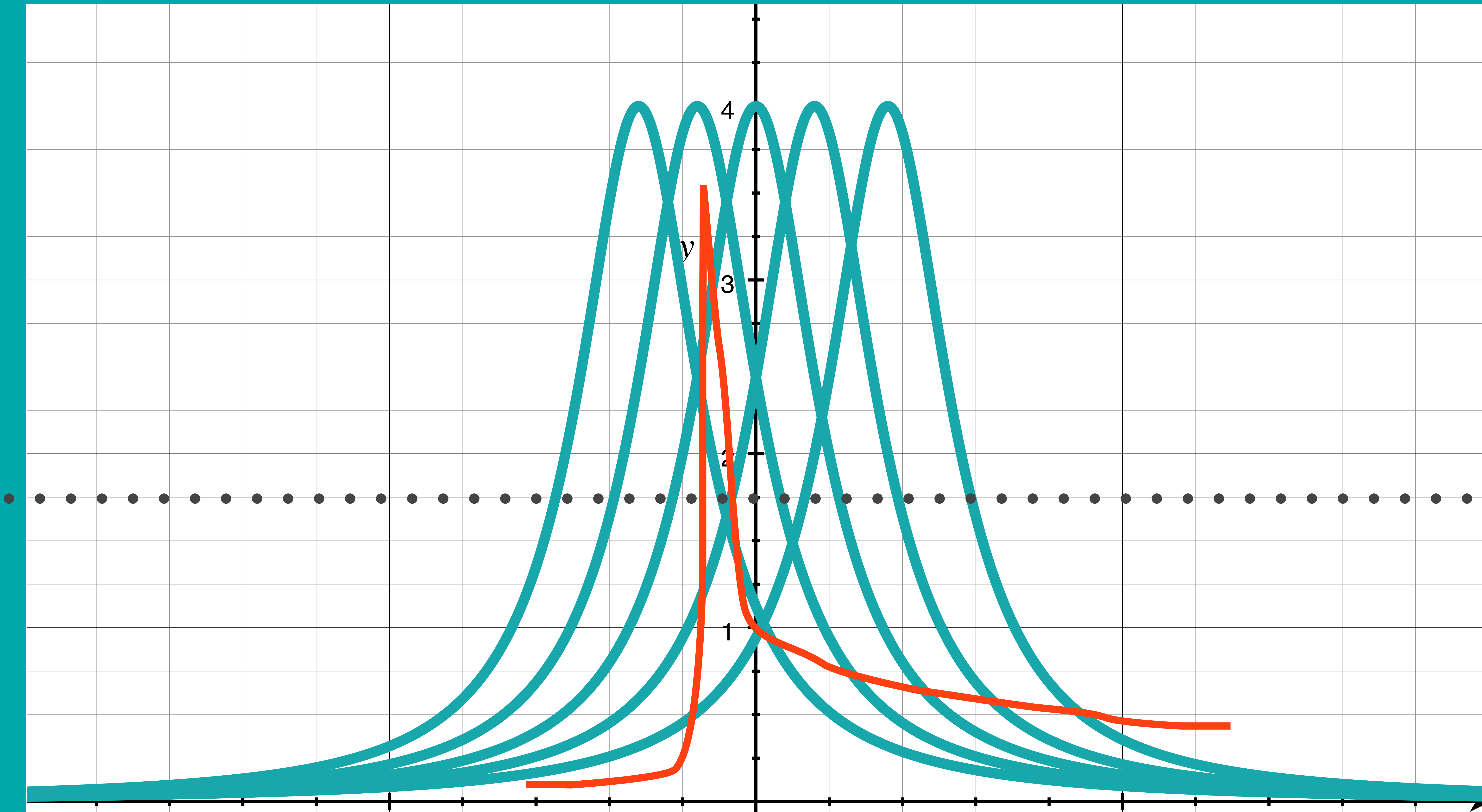
dual emitters Lyα - HeII (1640 Å)

Nagao, et al., 2008, ApJ, 680

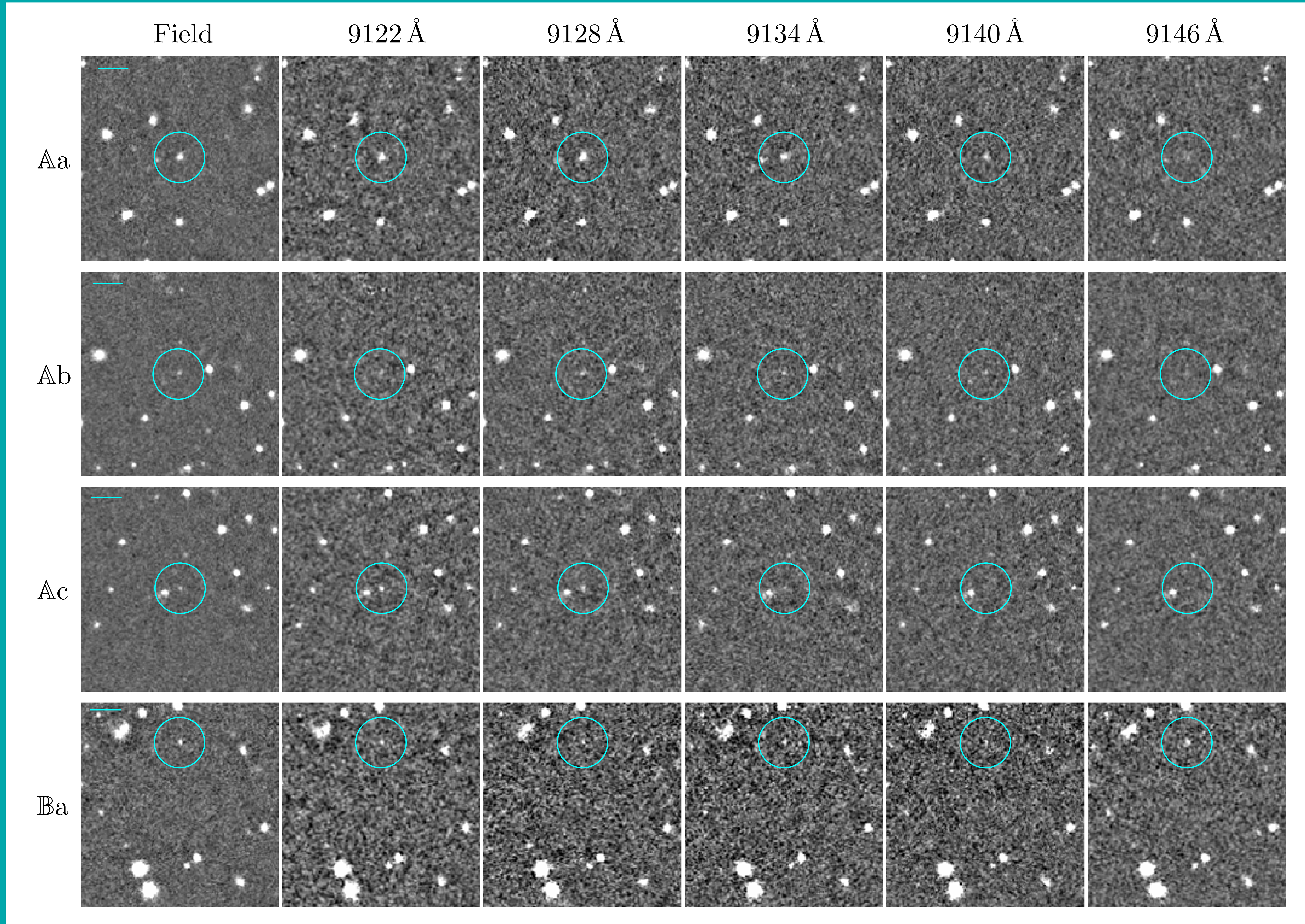
Benn & Ellison, 1999, NewAR.



Method



Candidates



Candidates

Only in MS2053

Only in 5 wavelengths

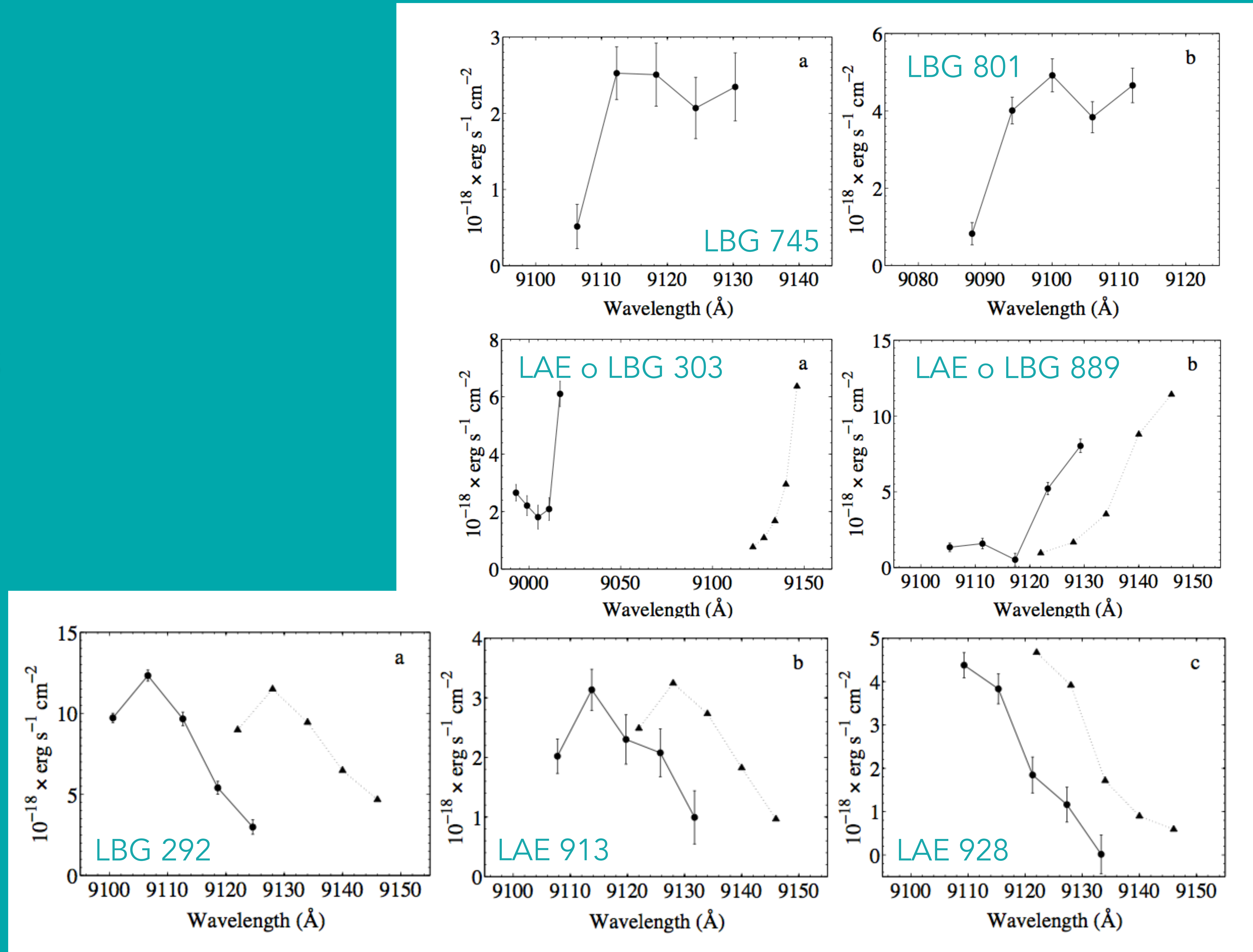
< 0.82″ seeing

5 contiguous filters

Similar simulations, not adjusted in flux

Observations

Simulations



Candidates

Table 2
Candidate Fluxes

Filter	$\mathbb{A}$a	$\mathbb{A}$b	$\mathbb{A}$c	$\mathbb{B}$a	$\mathbb{B}$b	$\mathbb{C}$a	$\mathbb{C}$b
Suprime V	26 ± 2	<0.70	4 ± 1	8.3 ± 0.7	...	36 ± 1	...
F606W	...	...	...	...	...	41 ± 7	...
F702W	...	...	1.5 ± 0.2	...	...	...	...
Suprime i'	7.3 ± 0.3	7.5 ± 0.2	1.3 ± 0.1	11.0 ± 0.3	4.0 ± 0.2	...	9.7 ± 0.2
F814W	...	...	0.5 ± 0.2	...	...	9.0 ± 0.6	...
OSIRIS-TF	38 ± 1	18 ± 2	10 ± 1	22 ± 2	12.0 ± 0.8	15 ± 1	20.9 ± 0-3
Suprime z'	7.3 ± 0.4	21.0 ± 0.6	0.7 ± 0.4	16 ± 2	4.0 ± 0.4	...	17.0 ± 0.3
3.6 μm	0.55 ± 0.03	10.34 ± 0.04	<0.15	0.41 ± 0.06	<0.15	1.86 ± 0.03	0.44 ± 0.02
4.5 μm	0.47 ± 0.03	6.37 ± 0.03	<0.08	<0.08	<0.08	1.15 ± 0.03	0.24 ± 0.03
5.8 μm	0.80 ± 0.07	3.47 ± 0.07	0.69 ± 0.07	<0.14	<0.14	0.77 ± 0.07	0.36 ± 0.07
8.0 μm	<0.17	1.73 ± 0.08	<0.17	<0.17	0.44 ± 0.09	<0.17	<0.17

Note. All the fluxes in units of 10^{-19} erg s^{-1} cm^{-2} Å^{-1}.

SED fitting

HyperZ

Bolzonella, et al., 2000, A&A, 363

Filters used:

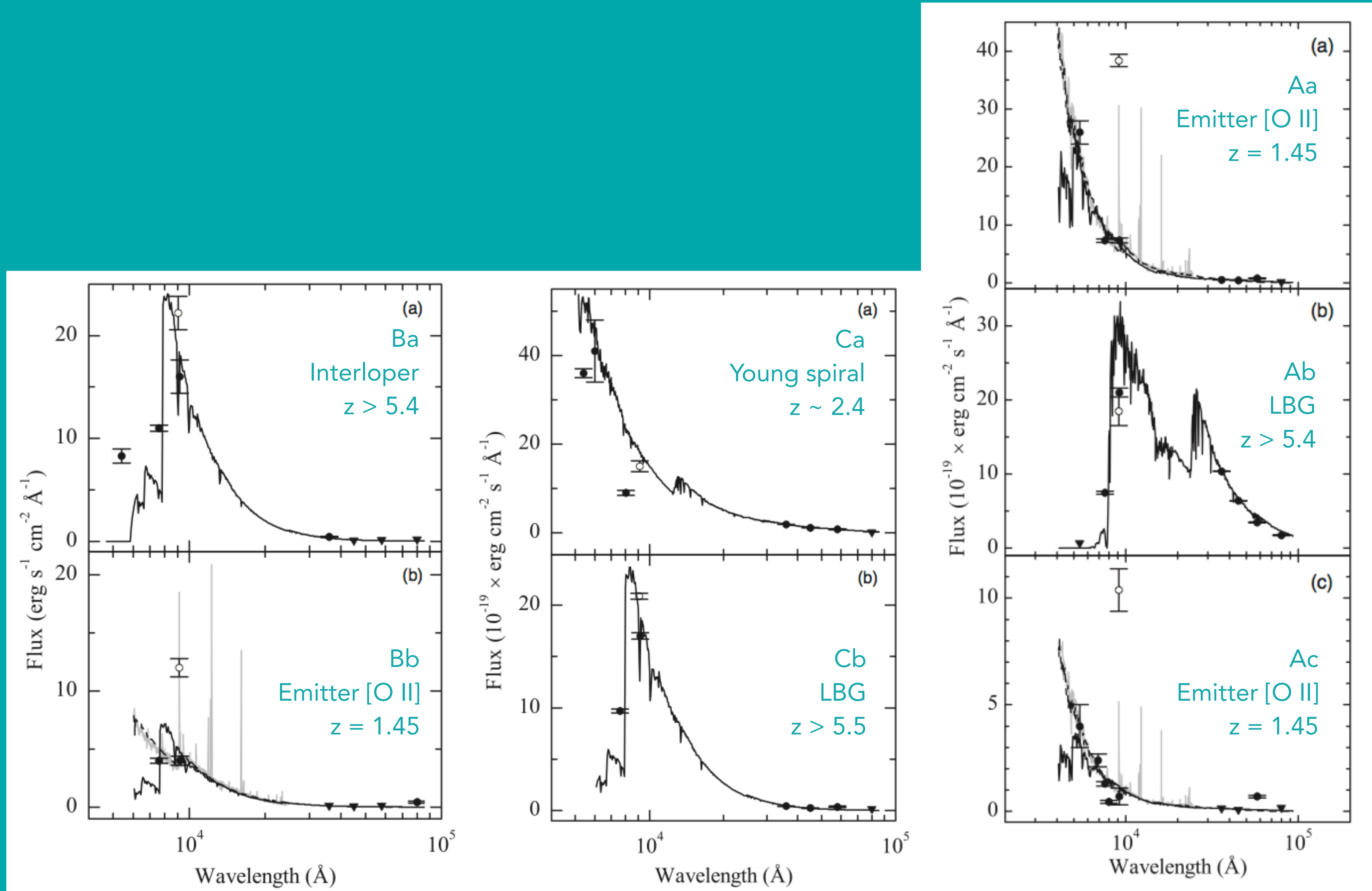
4 Spitzer/IRAC +

3 HST/WFPC2 F606,702,814W +

Subaru Suprime Cam z'

Hollow circles are OSIRIS data

Gray line shows fit for interloper emitter [O II]$_{3726\text{-}9\ \text{Å}}$



Simulations

5000 simulated LAEs

OSIRIS - TFs have Lorentzian profile

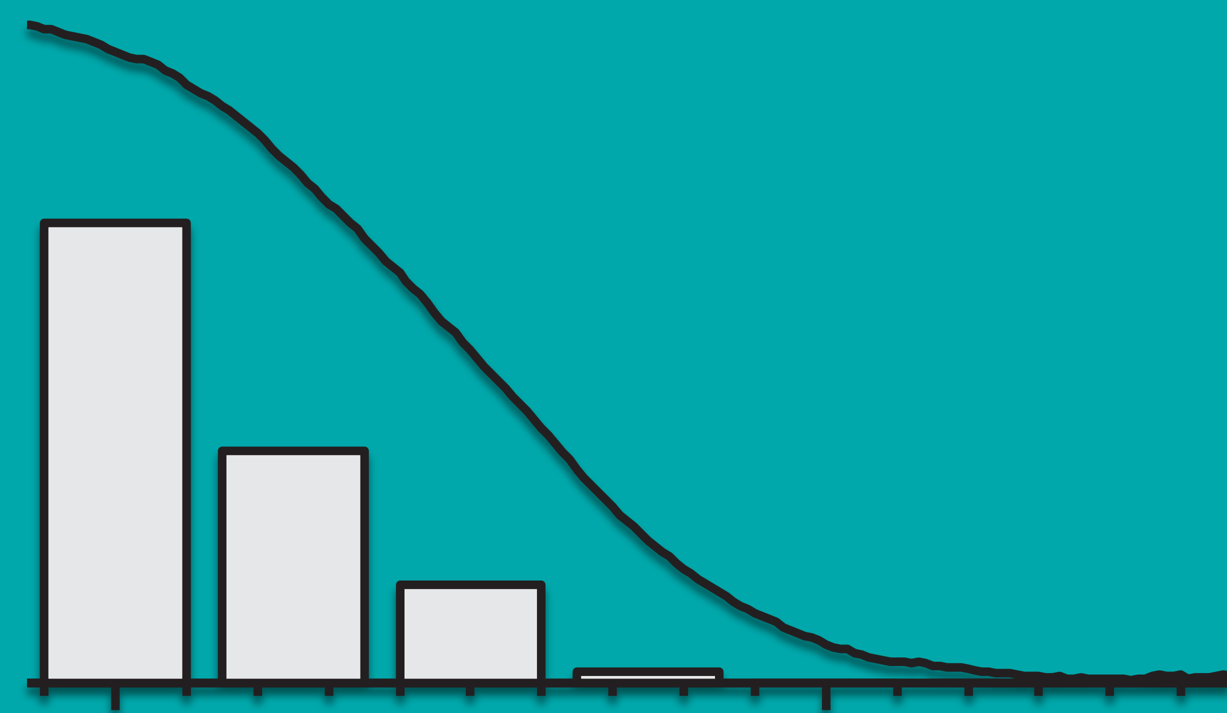
Preserves Lyα's asymmetric profile in pseudo-spectra

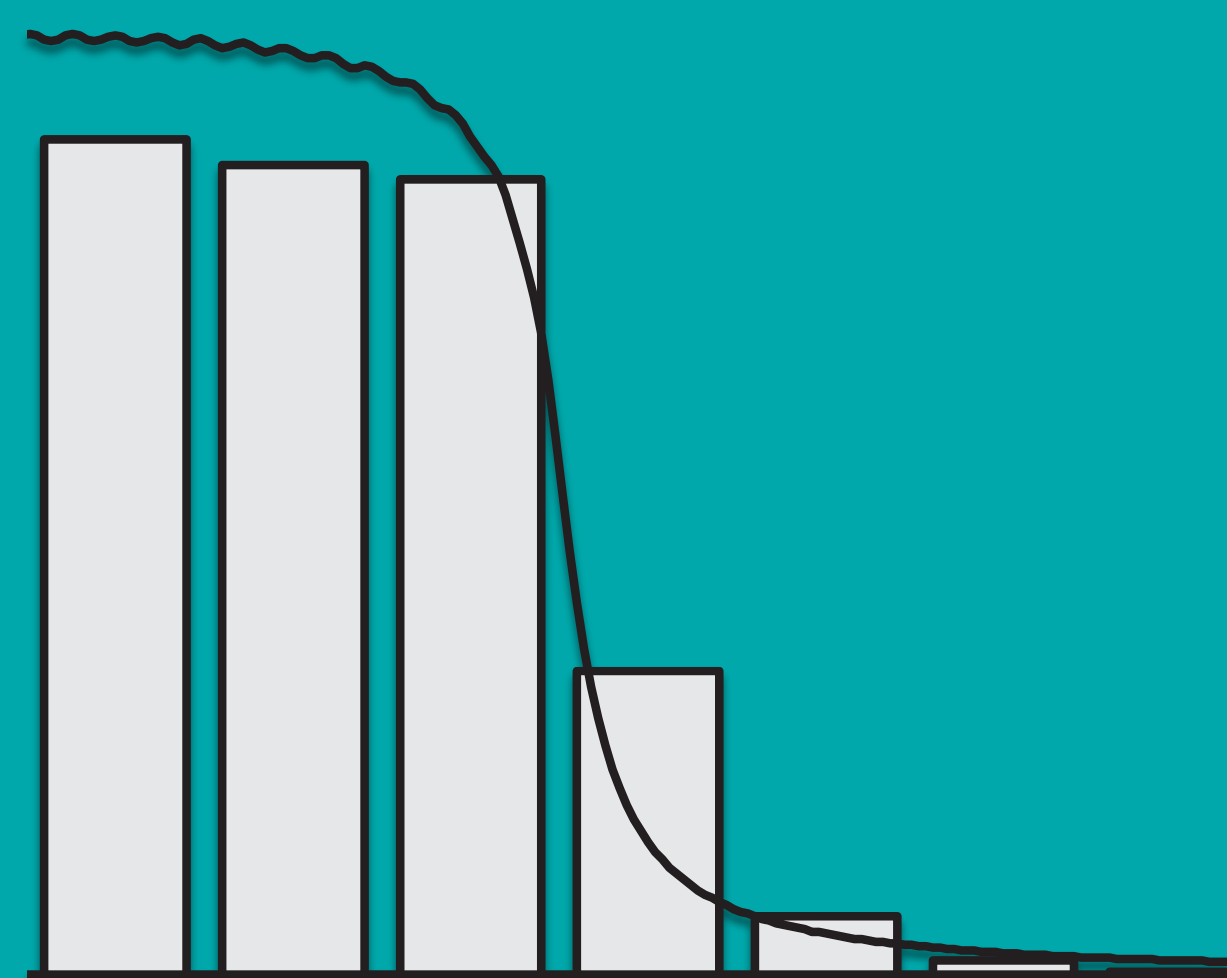
Irr ≥ 9 x 10^{-18} erg s^{-1} cm^{-2} (*frame*)

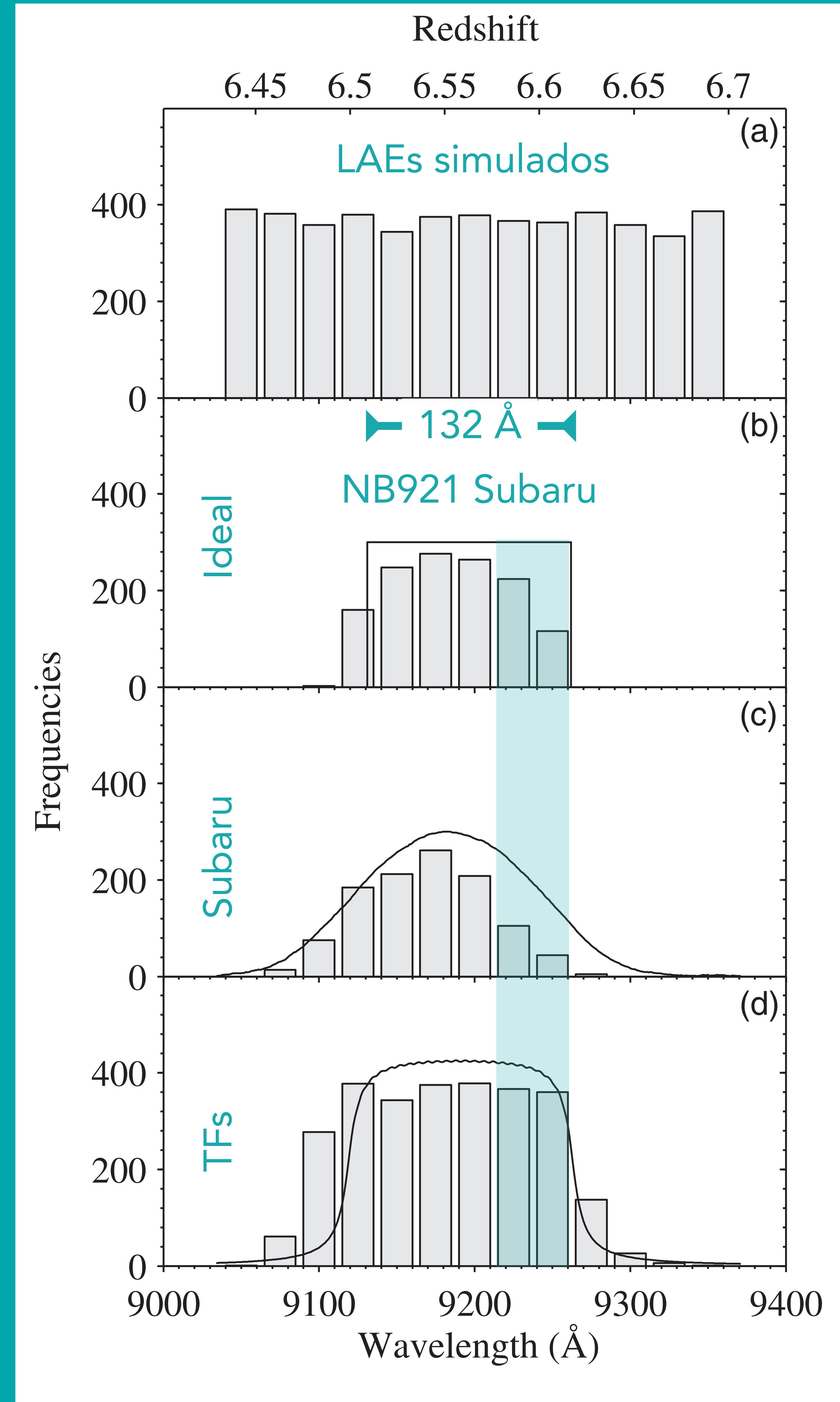
1 magnitude of difference for detection

Similar to detection method by

Ouchi, et al., 2010, ApJ, 723





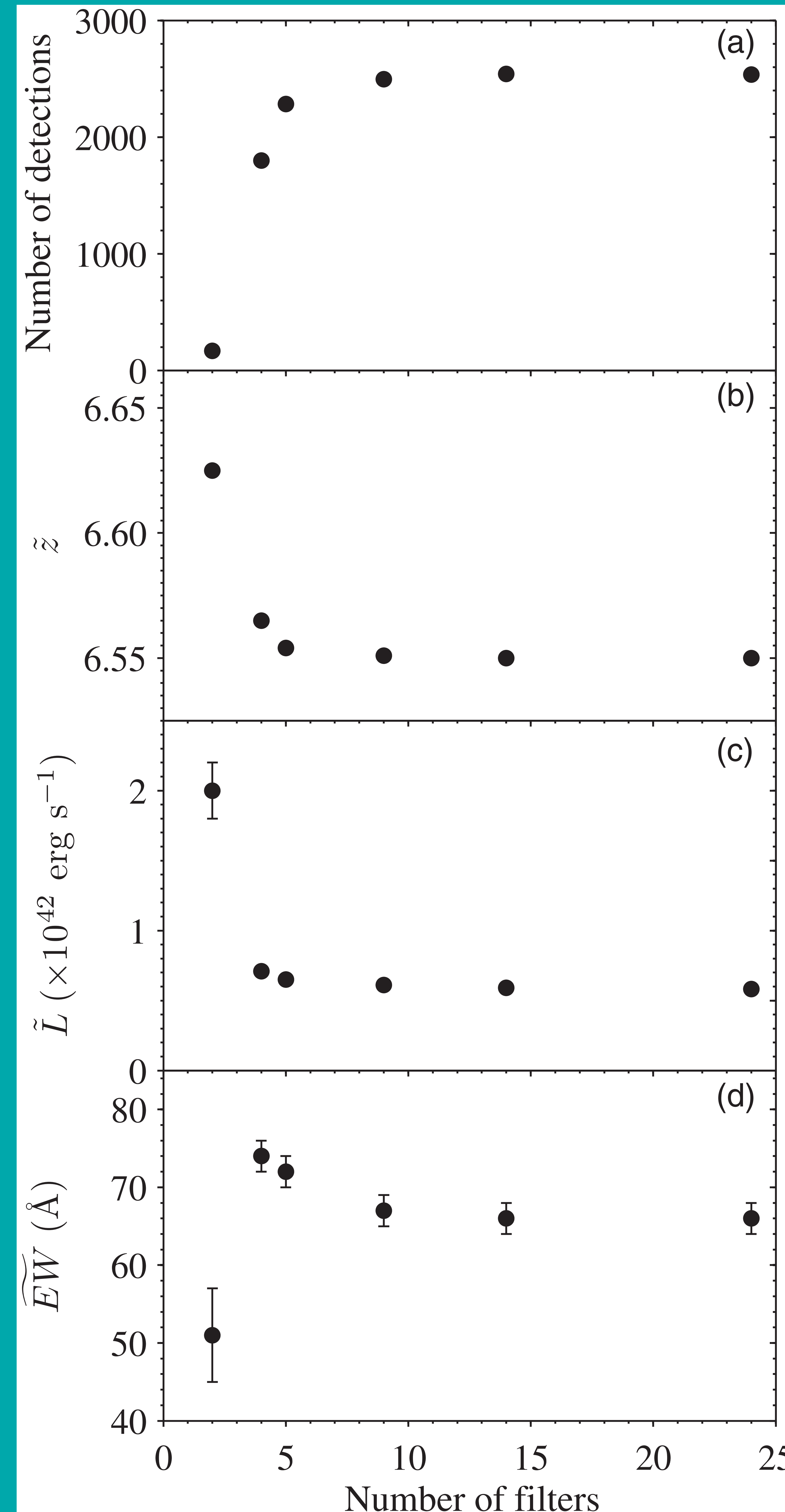


Simulations

2500 objects

Strongly decays with 2 filters

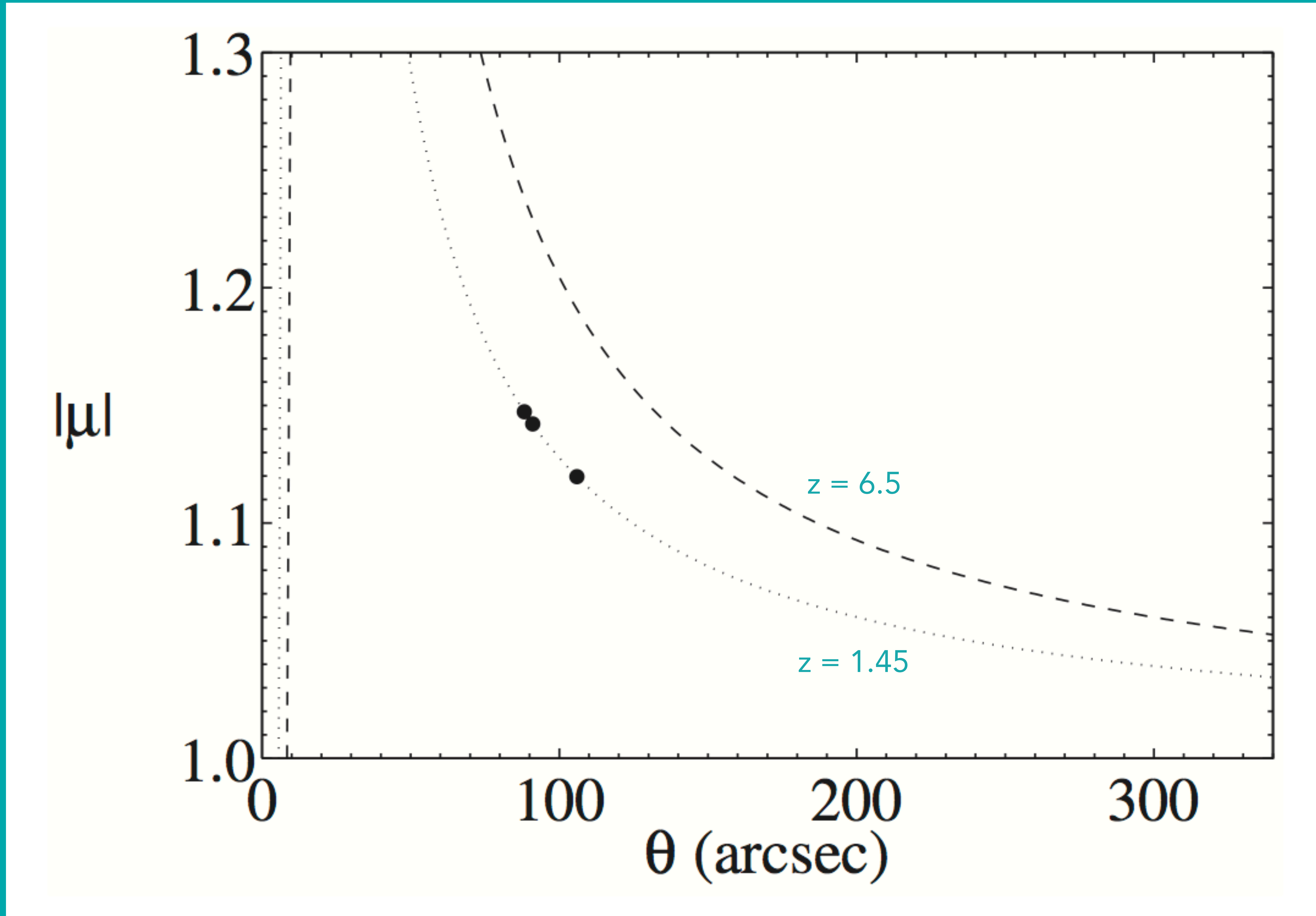
Reaches an optimum number at 9 filters



Magnification

LENSTOOL

Jullo, et al., 2007, NJP, 9



Simulations

Table 6
OSIRIS-TF Survey Expected Quantities

Parameter	Observations[a]	
	Planned	Accomp.
Slices[b]	24	5
Irradiance limit[c]	4	9
$L_{\mathrm{Ly}\alpha}$ limit[d]	2.1	4.7
Volume LAEs[e]	8760	1503
Expected LAEs[f]	4.2	0.1
$L_{[\mathrm{O\,II}]}$ limit[g]	2.9	6.4
Volume [O II][e]	122	21
Expected [O II] (Takahashi)[h]	7.4	0.8
Expected [O II] (Dressler)[i]	2.5	0.2

Notes.
[a] State of the observations: Planned or Accomplished.
[b] Number of wavelength slices.
[c] Irradiance lower limit ($\times 10^{-18}$ erg s^{-1} cm^{-2}).
[d] Lyα luminosity lower limit ($\times 10^{42}$ erg s^{-1}).
[e] Proper volume covered (Mpc^{-3}).
[f] Number of expected LAEs obtained through the Schechter function with Kashikawa et al. (2011) parameters. Numbers are given with a precision of one decimal place, rather than integers, to ensure that at least one significant digit is shown.
[g] [O II] luminosity lower limit ($\times 10^{40}$ erg s^{-1}).
[h] Takahashi et al. (2007).
[i] Dressler et al. (2011).

Conclusions

GTC-OSIRIS-TF

Good photometric redshift (10x spectral resolution than wide filters)

Detects Lyα lines with a smaller EW

Requires more observation time

Sweeps less covolume

SUBARU

Does not detect emitters with small EW

Does not reproduce the asymmetric profile of the Lyα line

Rough redshift estimate

Sweeps more covolume

Both are complimentary strategies

Will benefit from EMIR observations