EELGs in the J-PAS: Identifying and Characterizing Low-Redshift Analogues of Cosmic Reionization

Escape of Lyman radiation from galactic labyrinths

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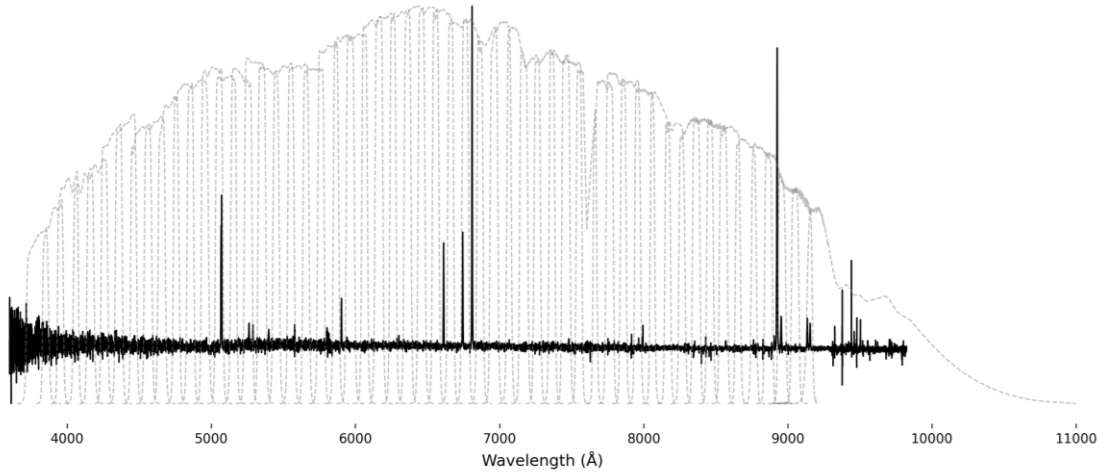
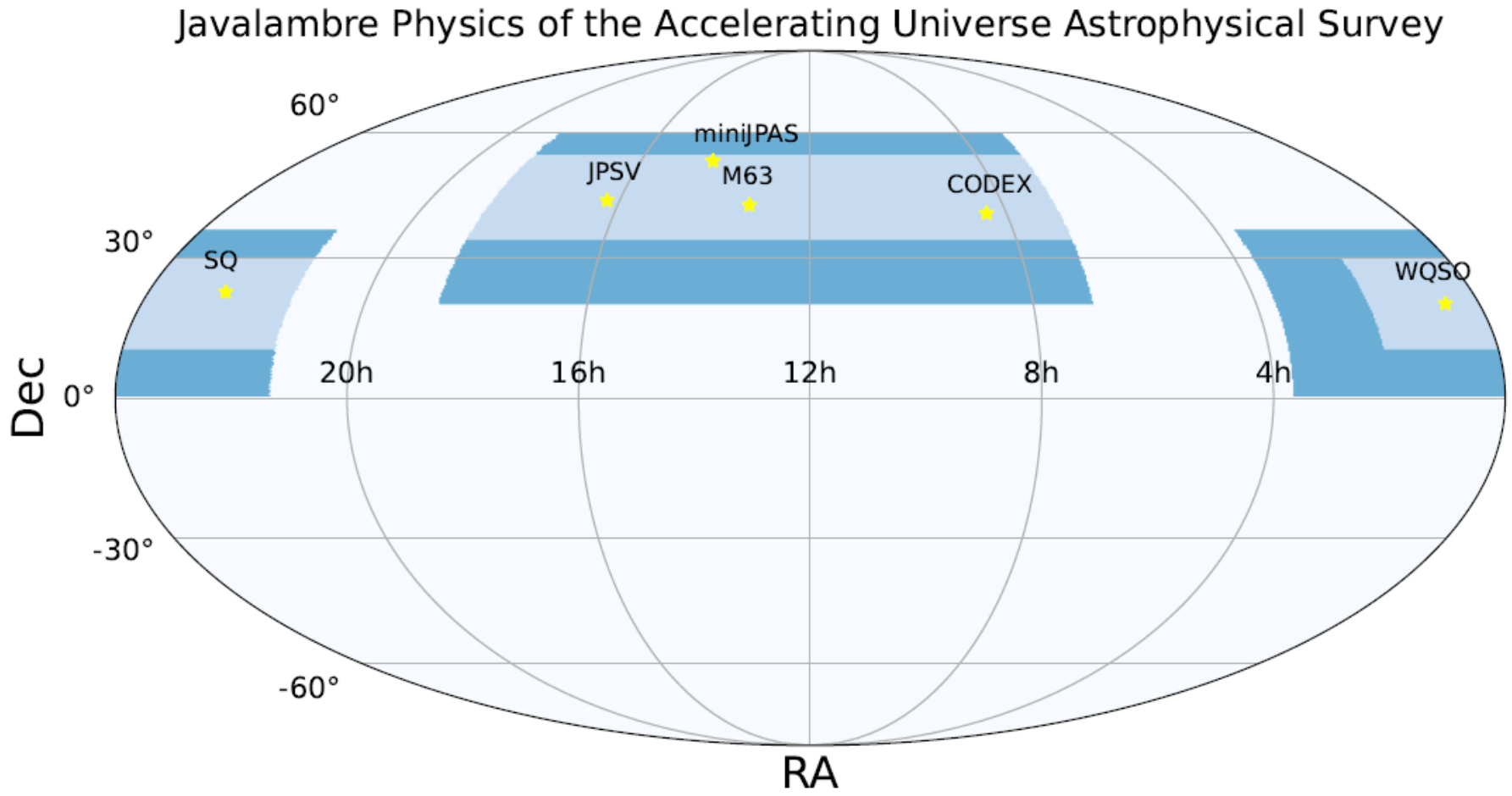
J-PAS Survey

M1 diameter	2.55m
FOV diameter	3deg (476mm physical size)

- **J-PAS** (Javalambre Physics of the Accelerating Universe Astrophysical Survey) will cover **8500 deg^2** in approximately 5 years, using an unprecedented system of **54 narrow-band filters**, supplemented by two medium-band and one broad-band filter to cover the full optical range.
- Full width at half maximum (FWHM) of **145 Å** and average spatial resolution with a FWHM < 1.5”

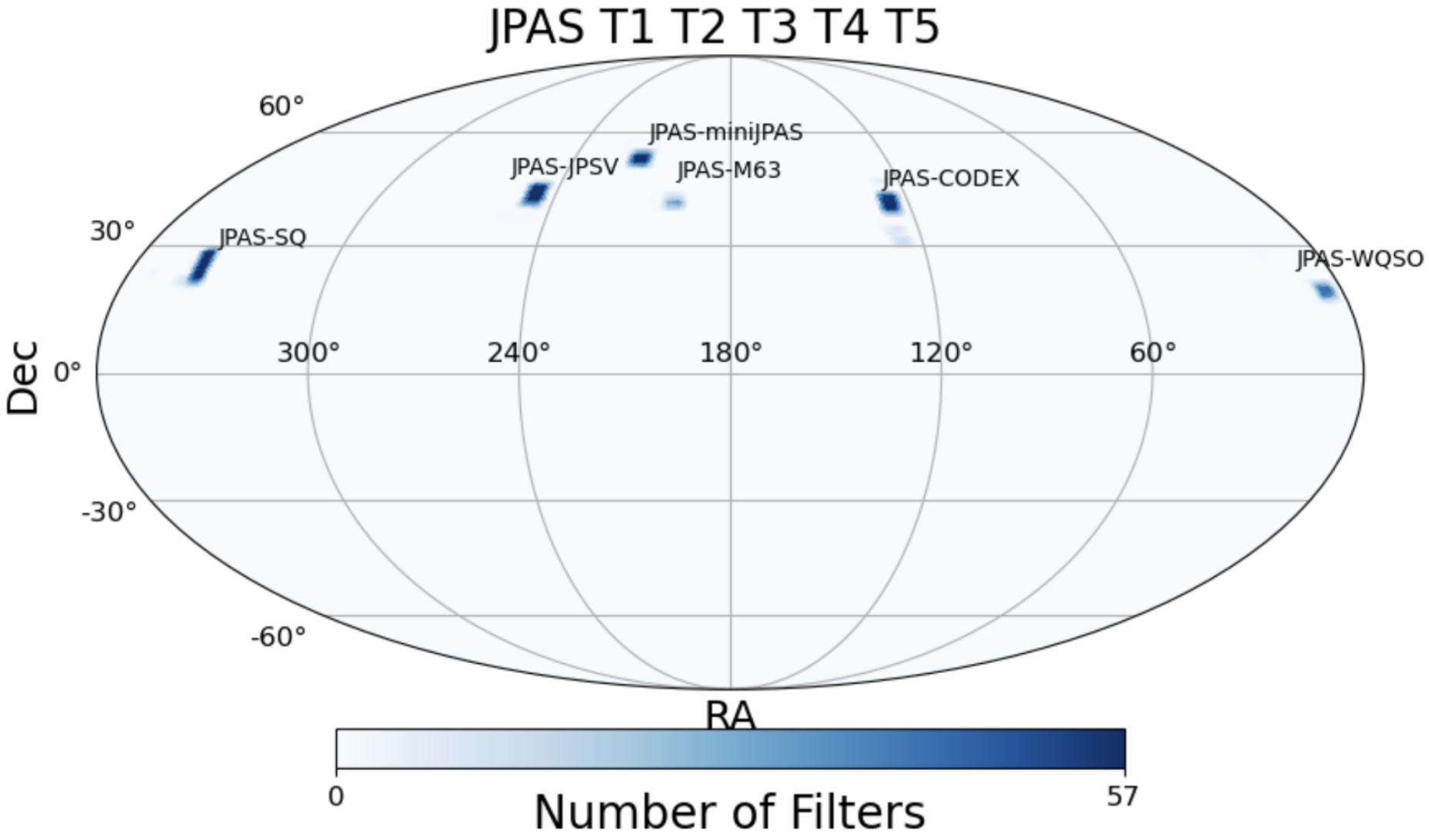


J-PAS Survey


Javalambre Physics of the Accelerating Universe Astrophysical Survey
60°
30°
0°
-30°
-60°
Dec
20h
16h
12h
8h
4h
RA
miniJPAS
JPSV
M63
CODEX
SQ
WQSO

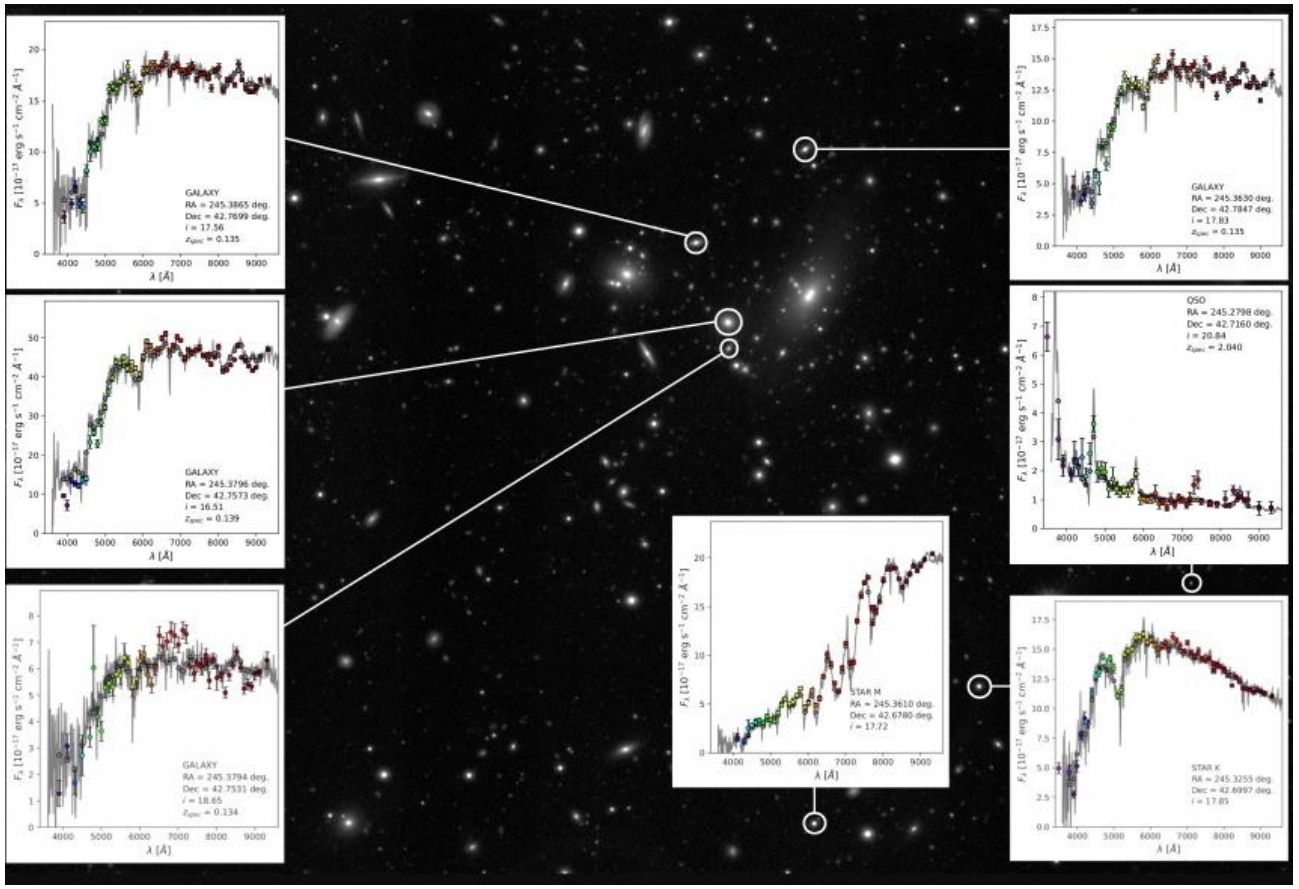
J-PAS Survey

29 deg^2 in the last IDR
18 deg^2 in the Public data release



J-PAS Survey: key points

- Images & Photo-spectra **(IFU-like)**
- No bias in selection function
- Limit magnitude **>23** in iSDSS
- Sextractor (Bertin & Arnouts 1996) defines apertures **in i-band**



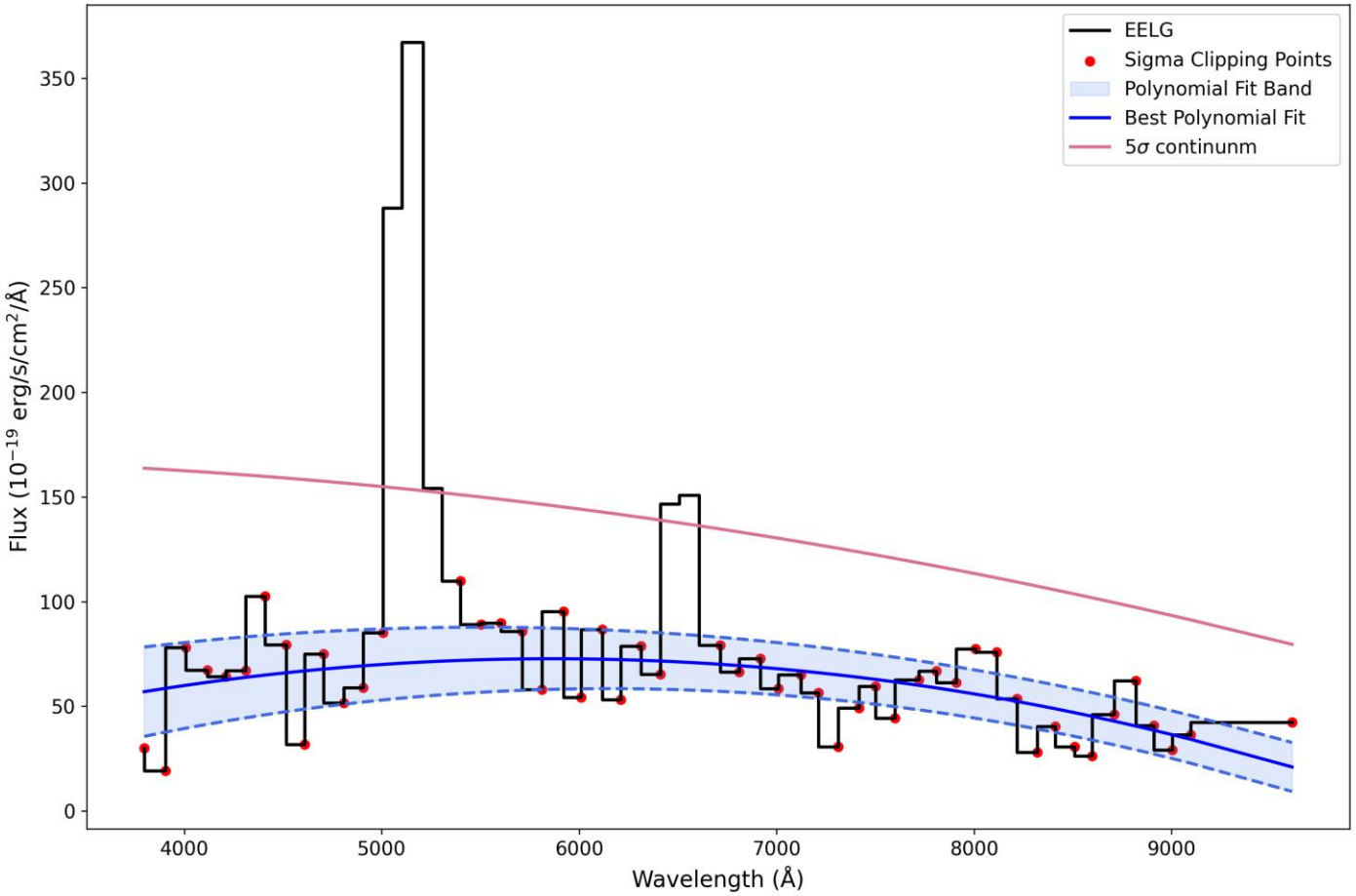
Why to search?

High redshift Galaxies →
- Strongly star forming
- Metal poor
- Increasingly compact
- Harder radiation fields

← **Low-Redshift EELGs Are ideal laboratories**

- Photometry
  - Excess in one of the IRAC bands as a proxy for the equivalent width (Castellano+17; Endsley+21…)
  - Van der Wel+11 used broad band photometry to select ≈ **70 EELGs** in the CANDELS fields
  - Lumbreras-Calle+22 found **466** EELGs within J-PLUS survey
  - Iglesias-Paramo+22 found **17** EELGs with mini-JPAS
- Spectroscopy
  - Amorín+15 characterized a sample of ≈ **180** zCOSMOS at a redshift of $0.11 \leq z \leq 0.93$ selected on *EW*([O[III])

Looking for EELGs in JPAS I



Steps for a classical selection

I. Removing emission lines or artifacts and model the continuum.

II. Emission line must be **5σ above the continuum** to be considered

III. **EW>300** AA (Iglesias-Paramo+22):

$$F_L(\lambda) - F_C(\lambda) \geq \frac{EW}{EW + \Delta_F} \times F_L(\lambda),$$

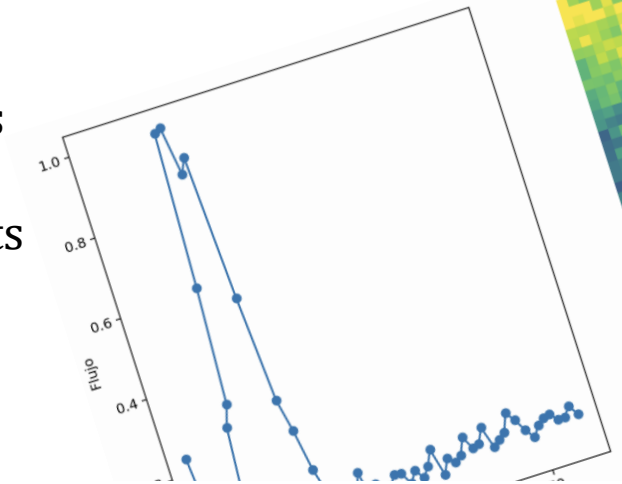
IV. **SNR>8** in datapoints

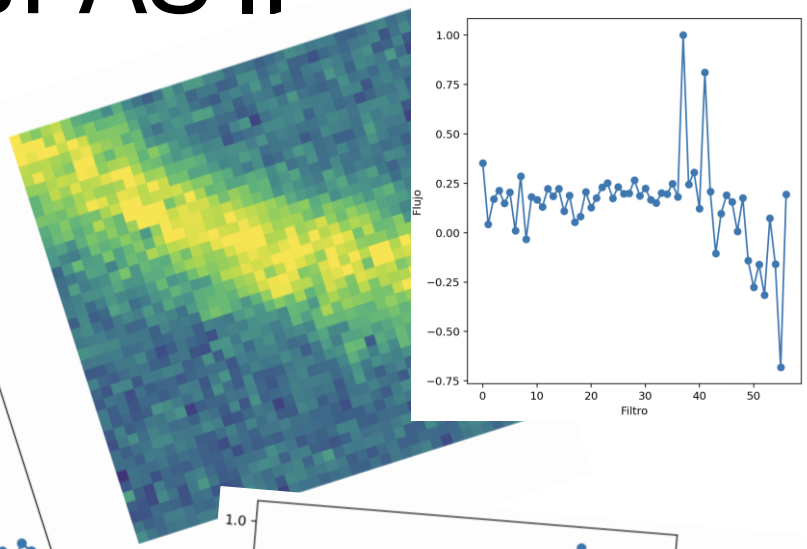
Looking for EELGs in JPAS II

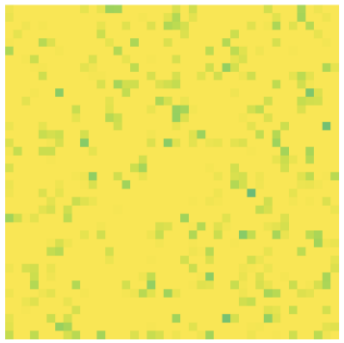
I. Removing QSOs

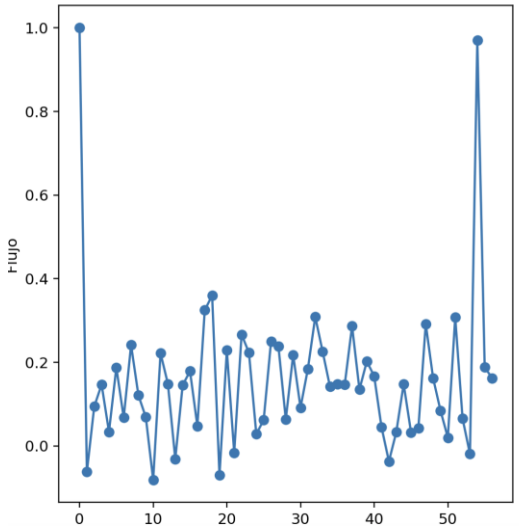
II. Cosmetic defects

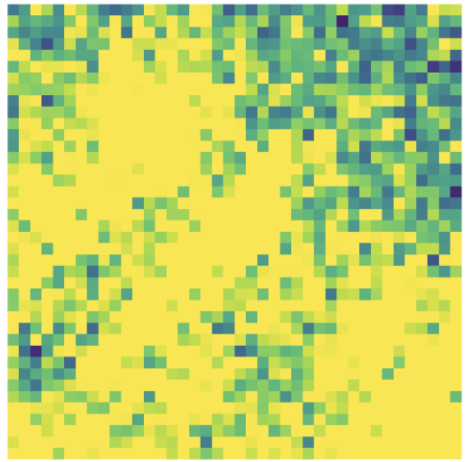
III. Contamination

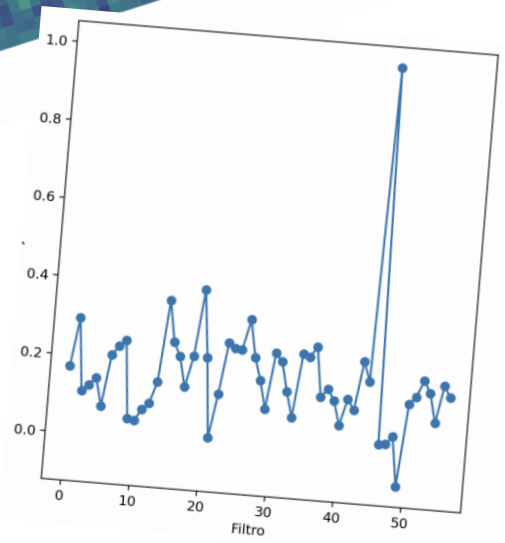


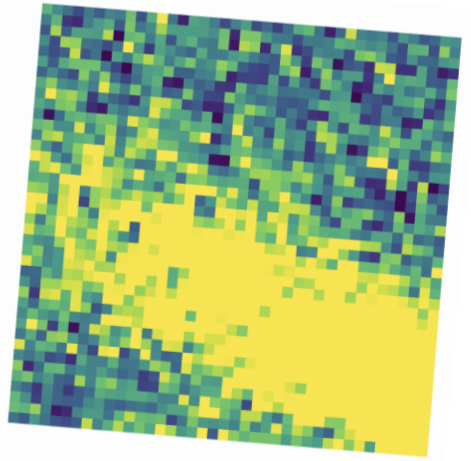






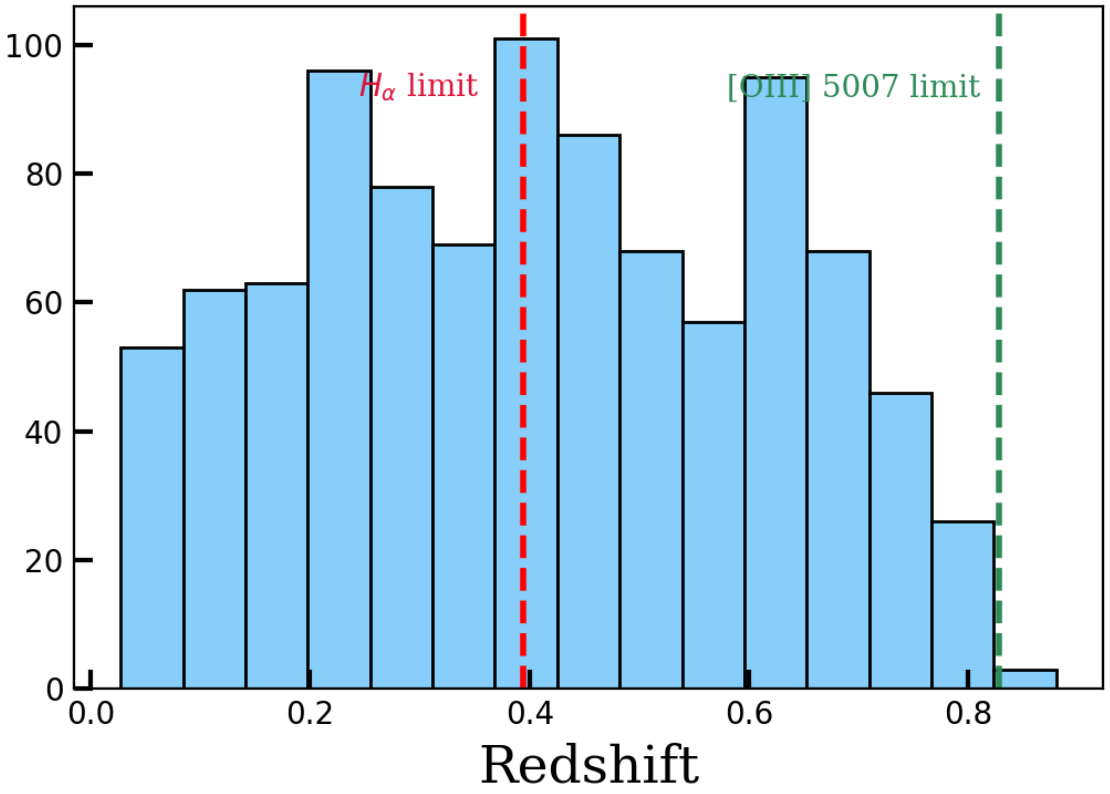


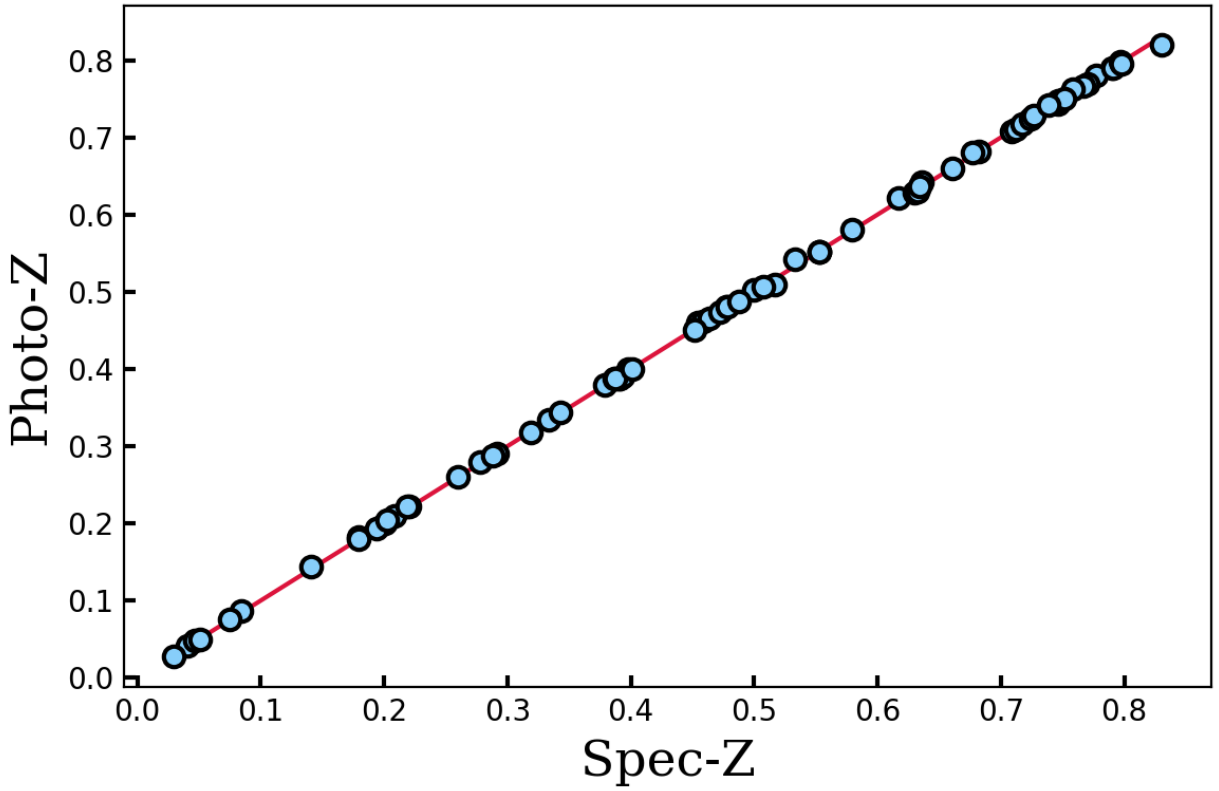




Sample and Characterize

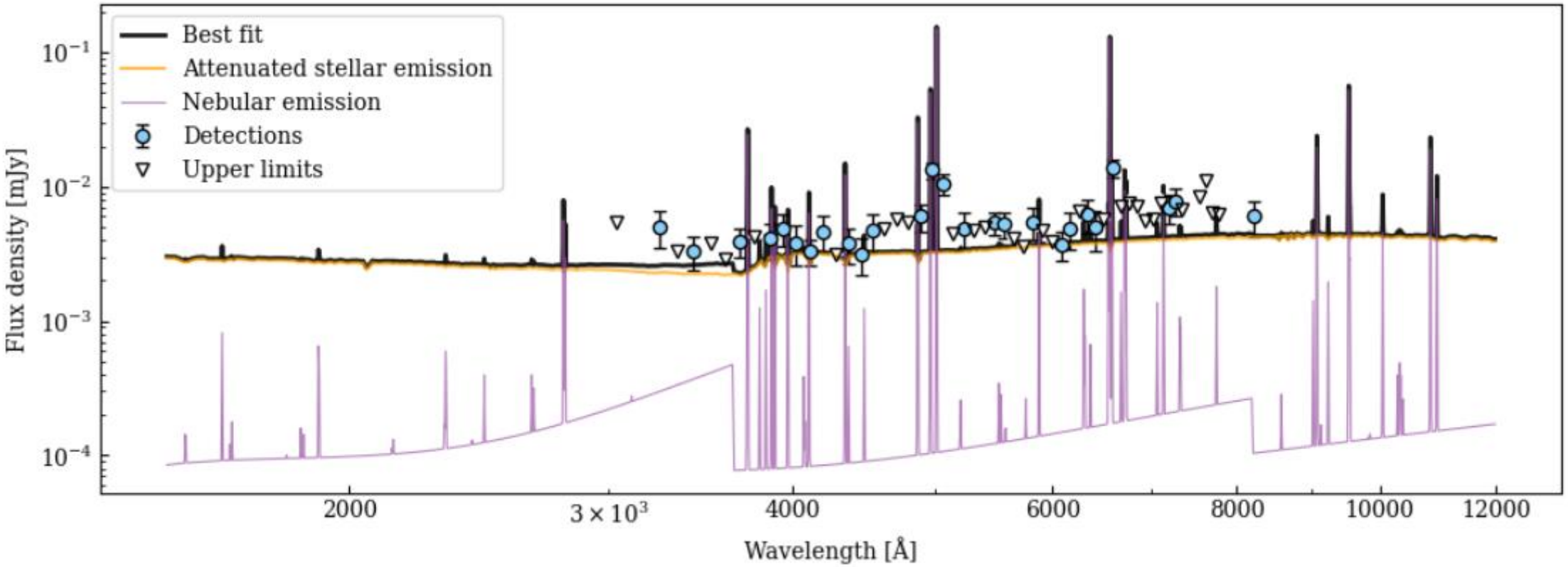
979 Galaxies found
$\sim$ **30** per deg^2





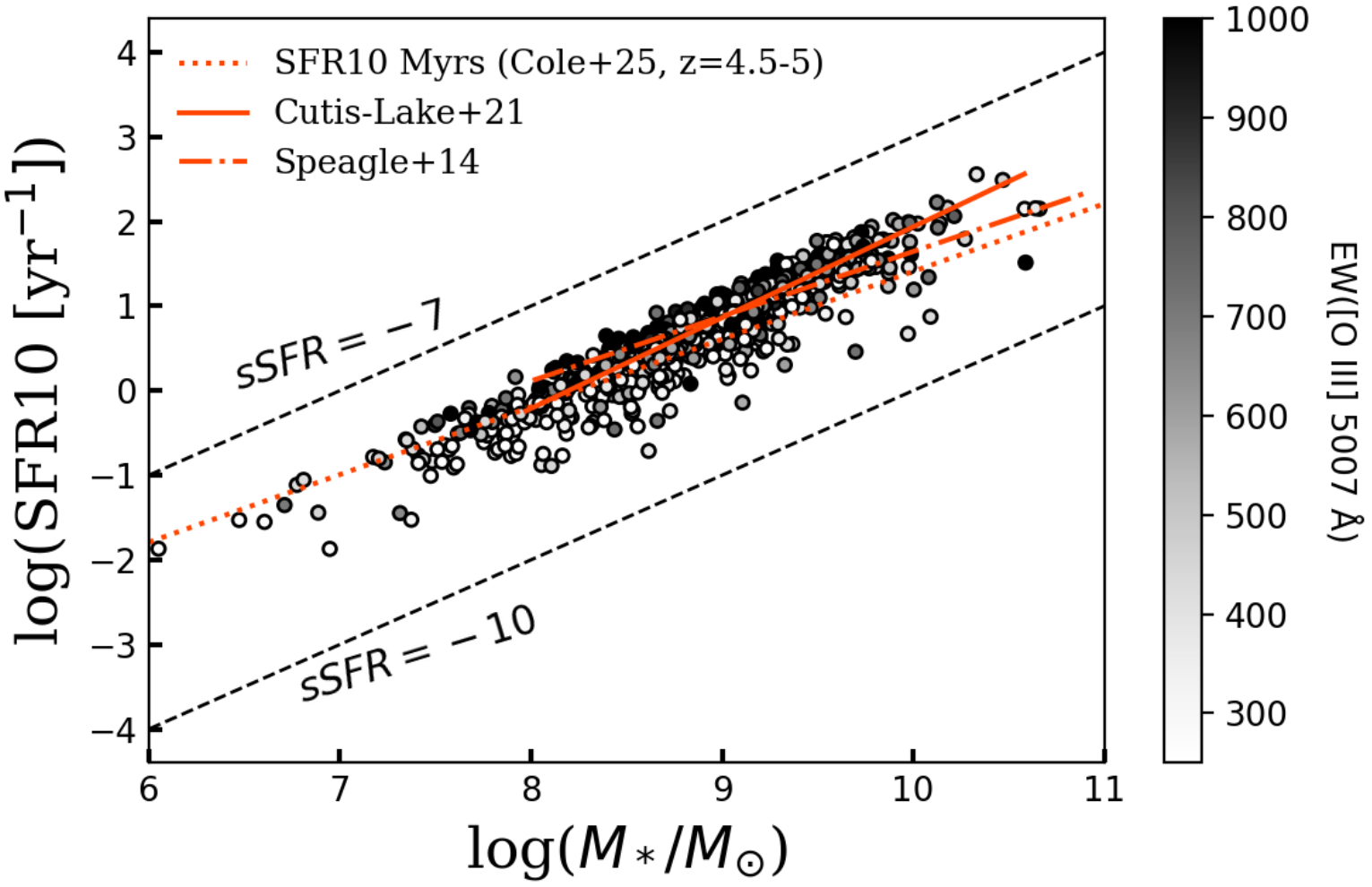
Boquien, Burgarella+19

Sample and Characterize



Chabrier & Calzetti & 2-star population (old and a burst) & F escape = 0

Sample and Characterize



- We identify an extreme population located on the main sequence of high-redshift galaxies.
- Trend with EW [OIII]

Sample and Characterize

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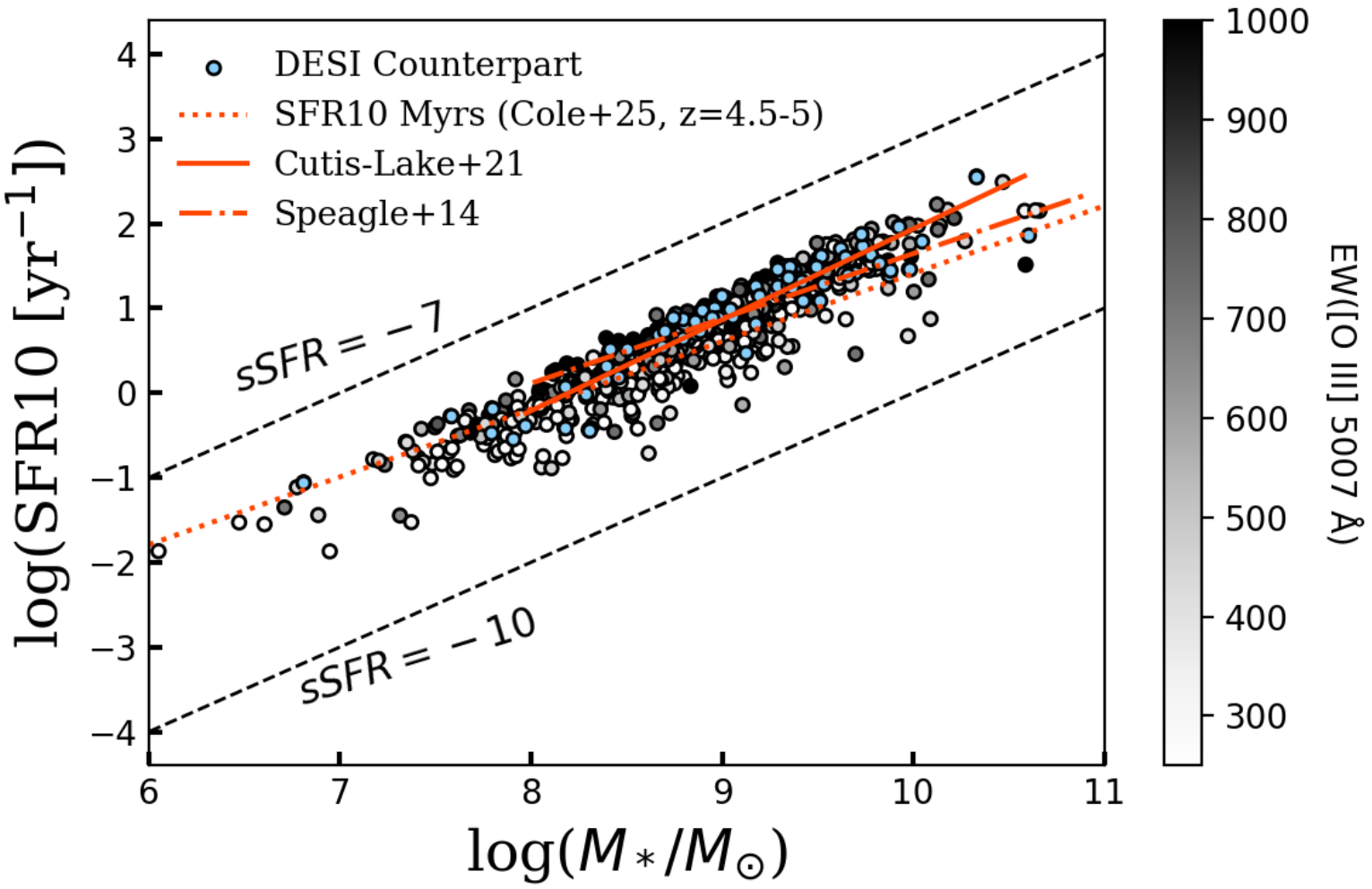
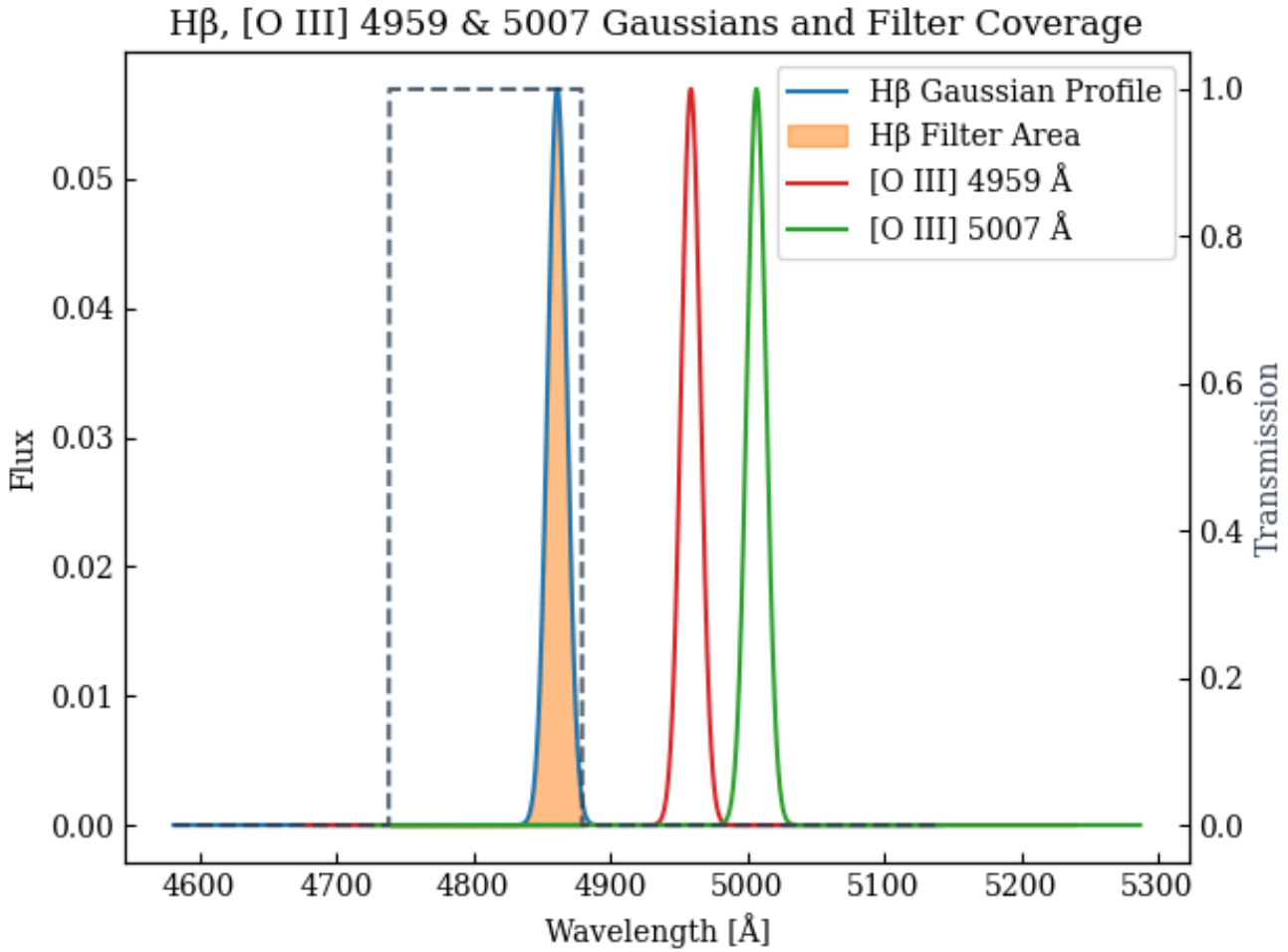
$\sim$ **30** per deg^2



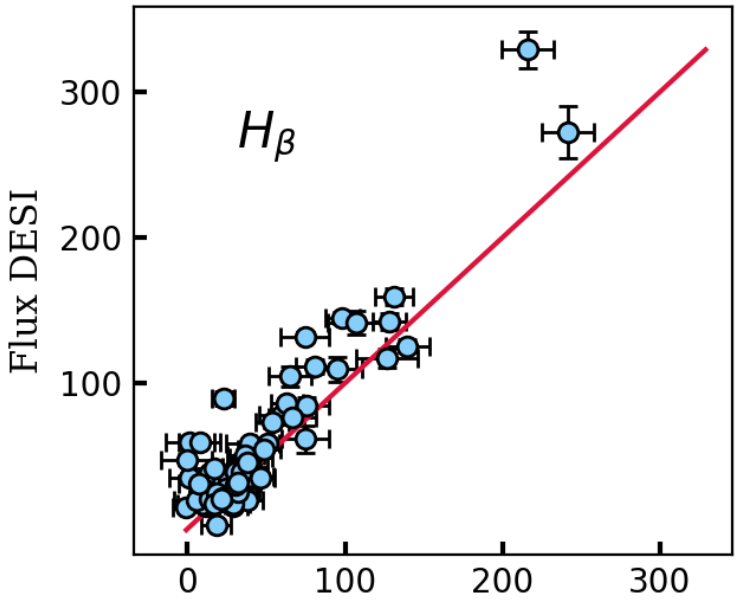
- We identify an extreme population located on the main sequence of high-redshift galaxies.
- Trend with EW [OIII]
- 79 DESI DR1 Counterpart

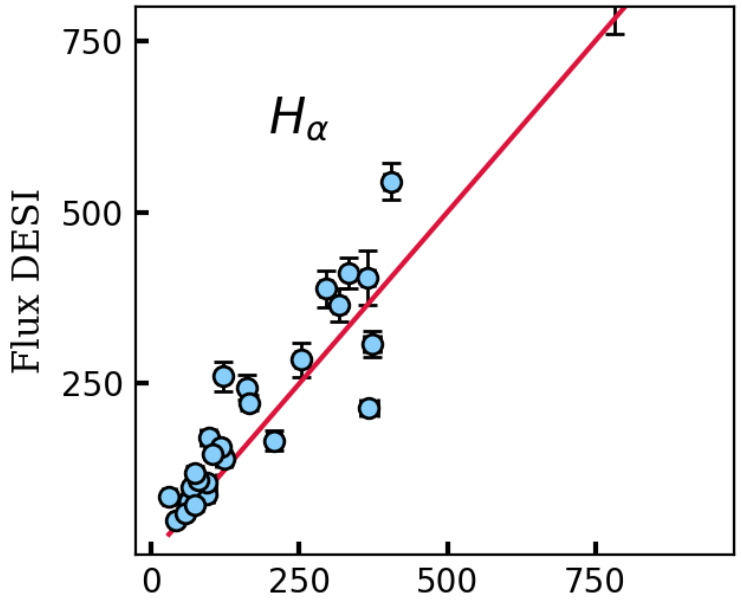
Sample and Characterize

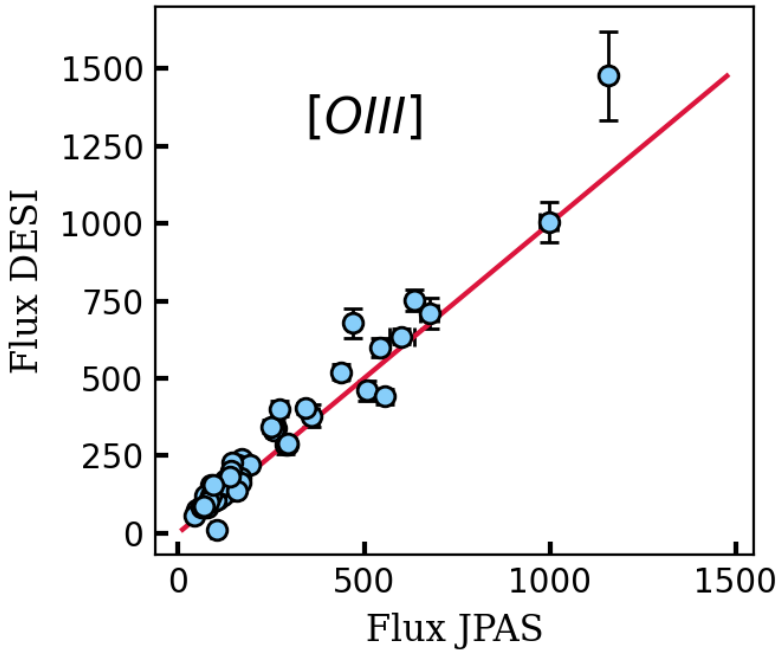


- **Emission Line Profile:** Assumed a conservative Gaussian width of σ= 7
- **Flux Recovery:** Required ≥95% of the line flux within the filter's transmission curve
- **Continuum Subtraction:** Estimated with CIGALE to isolate emission line flux

Sample and Characterize





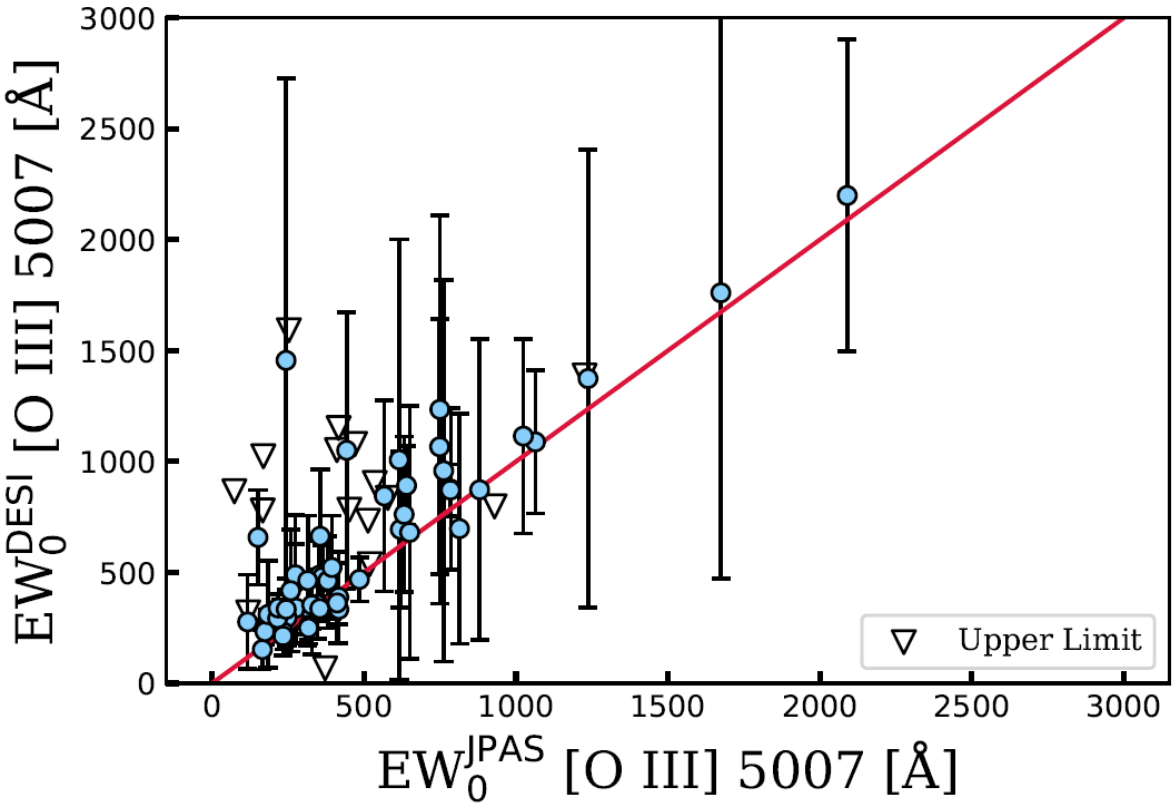


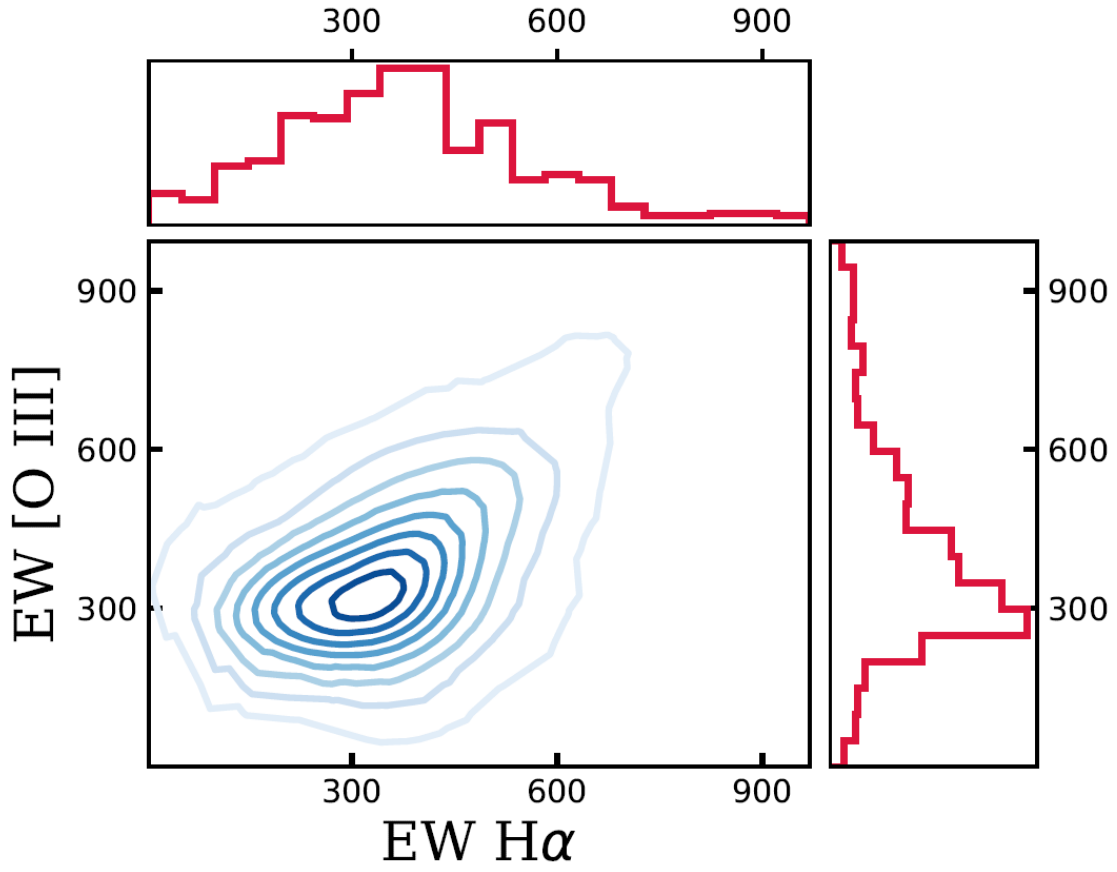
Hβ: Straightforward; watch for contamination by [O III] 4959 Å

Hα: Easily measured; corrected for [N II] using [N II]/Hα ≈ 0.07[N II]

[O III] 5007: Avoid blending with [O III] 4959 Å. **If Blended:** Use [O III] 4959 = 1/2.95 × [O III] 5007 to separate contributions

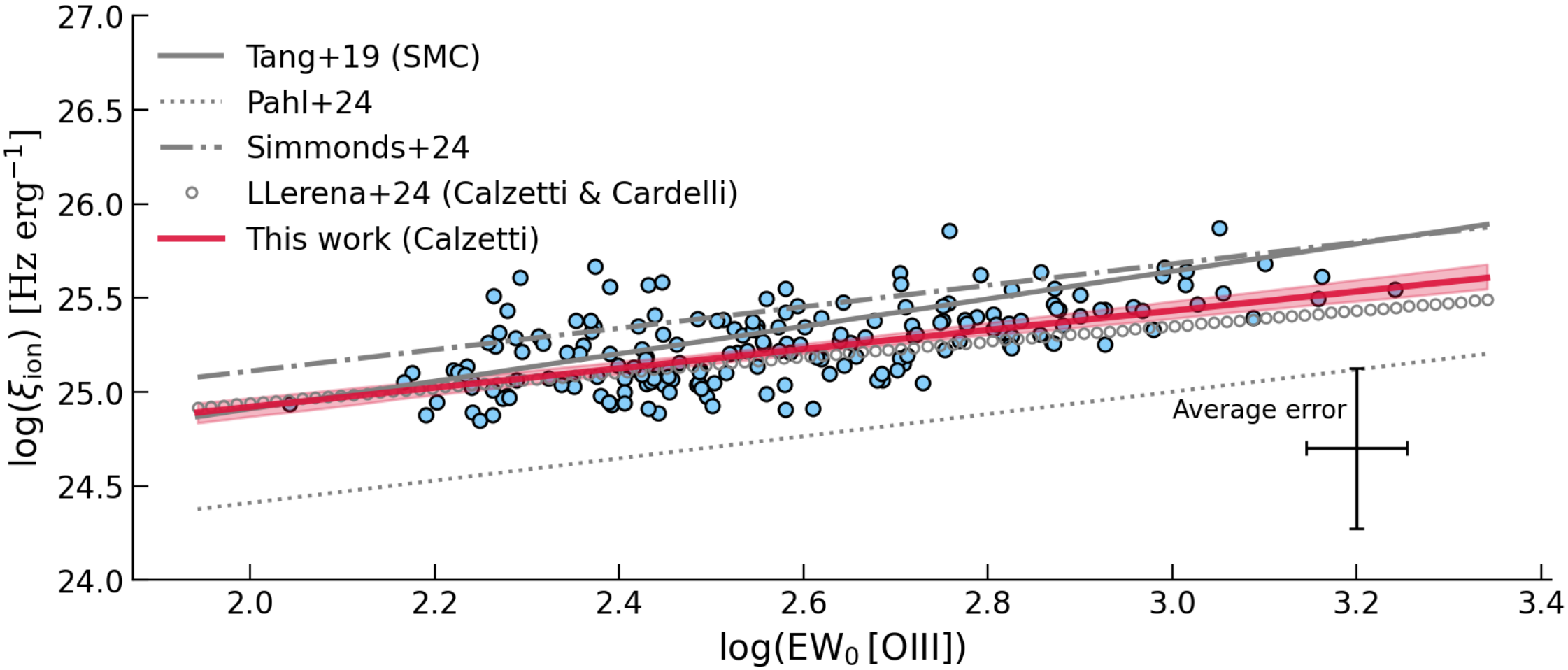
Sample and Characterize





Ionizing photons productions

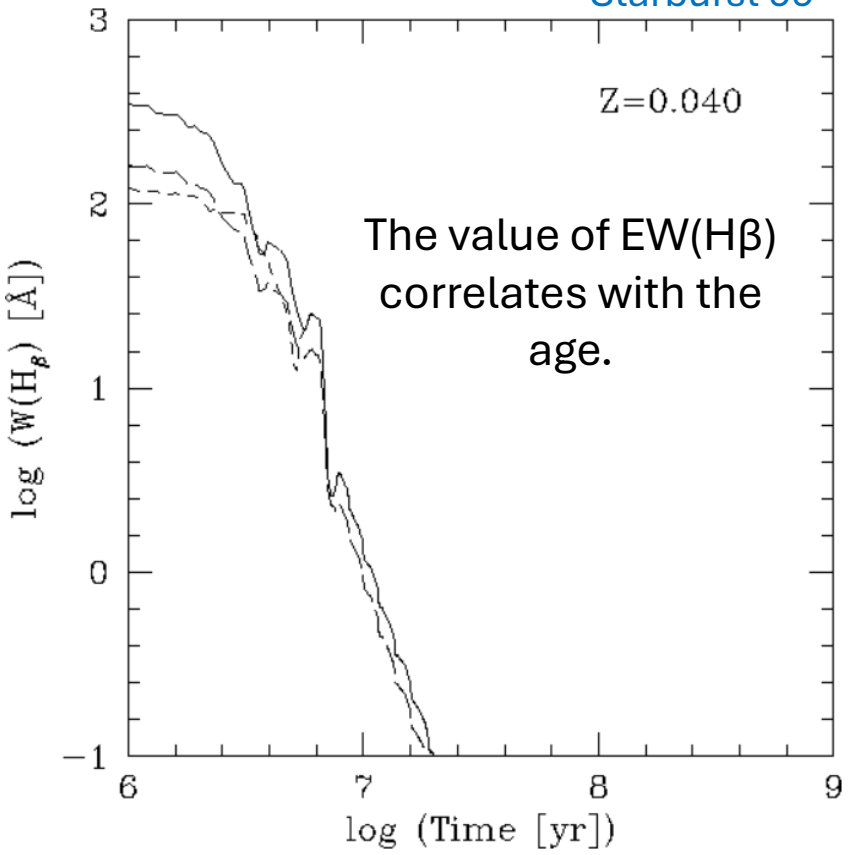
$$\xi_{ion}[Hz\ erg^{-1}] = \frac{N(H^0)}{L_{UV}},$$

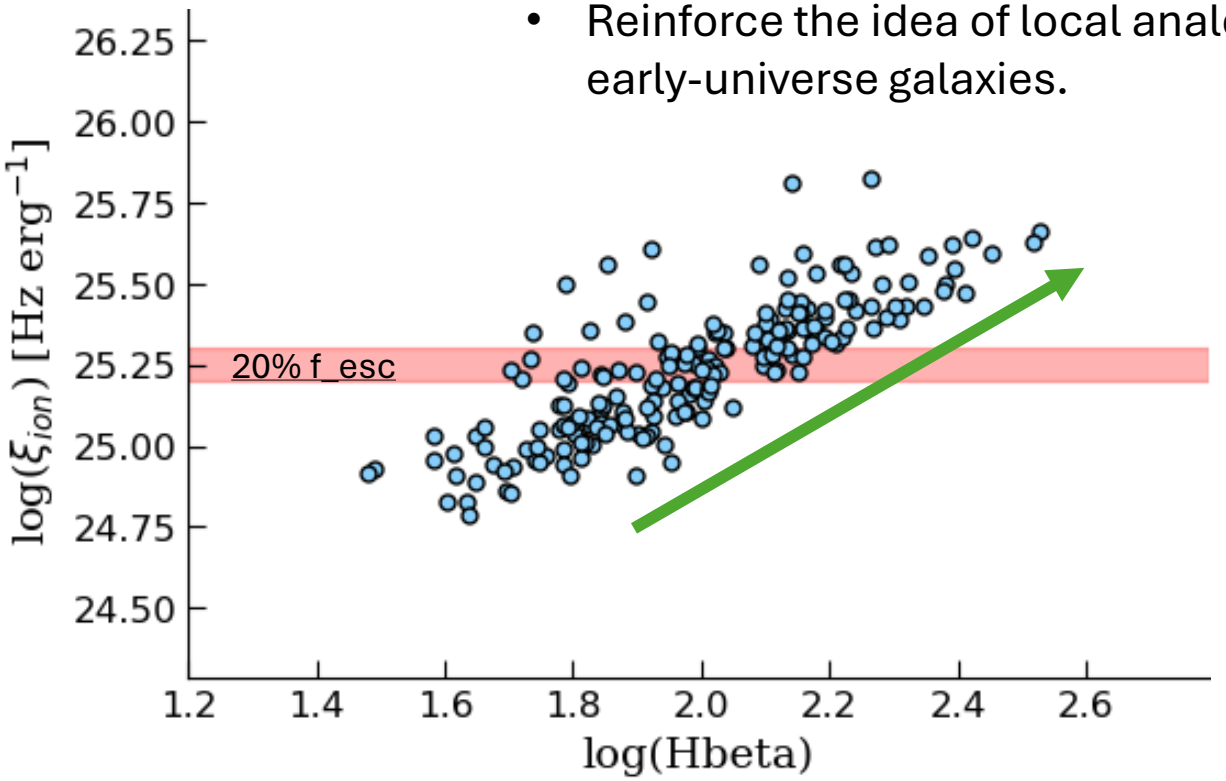


Ionizing photons productions

- **Youngest galaxies** produce the maximum ionizing photons.
- At high-z, starburst episodes are more common -> younger.
- Reinforce the idea of local analogues of early-universe galaxies.

Starburst 99

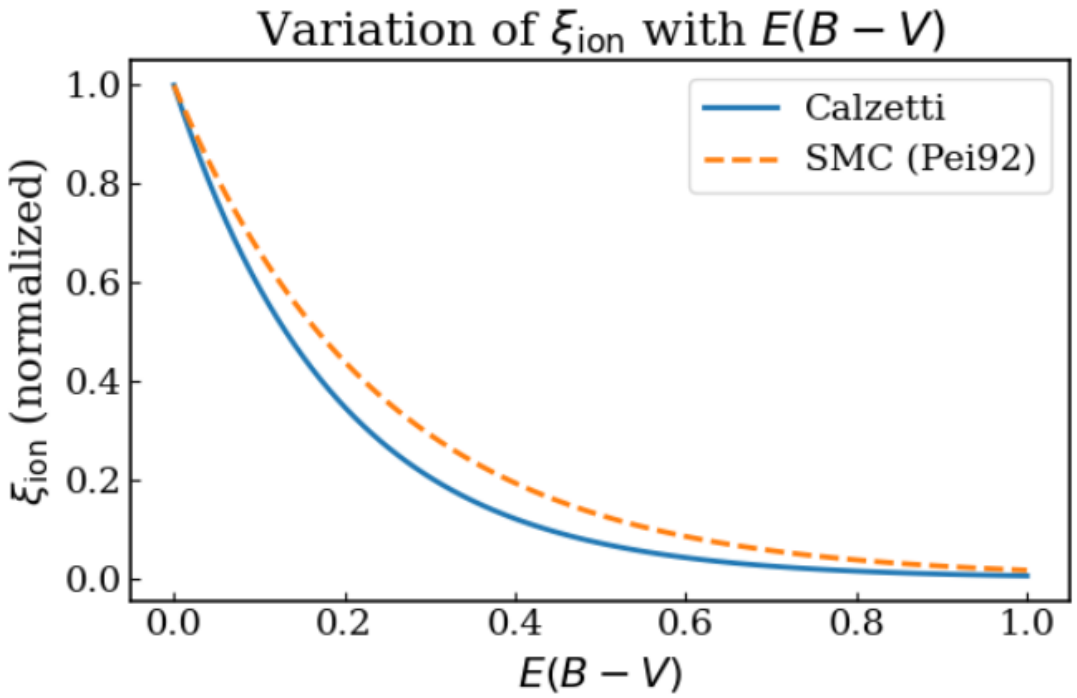




Shivaei+20
Izotov+17
Reddy+18a

Caveats

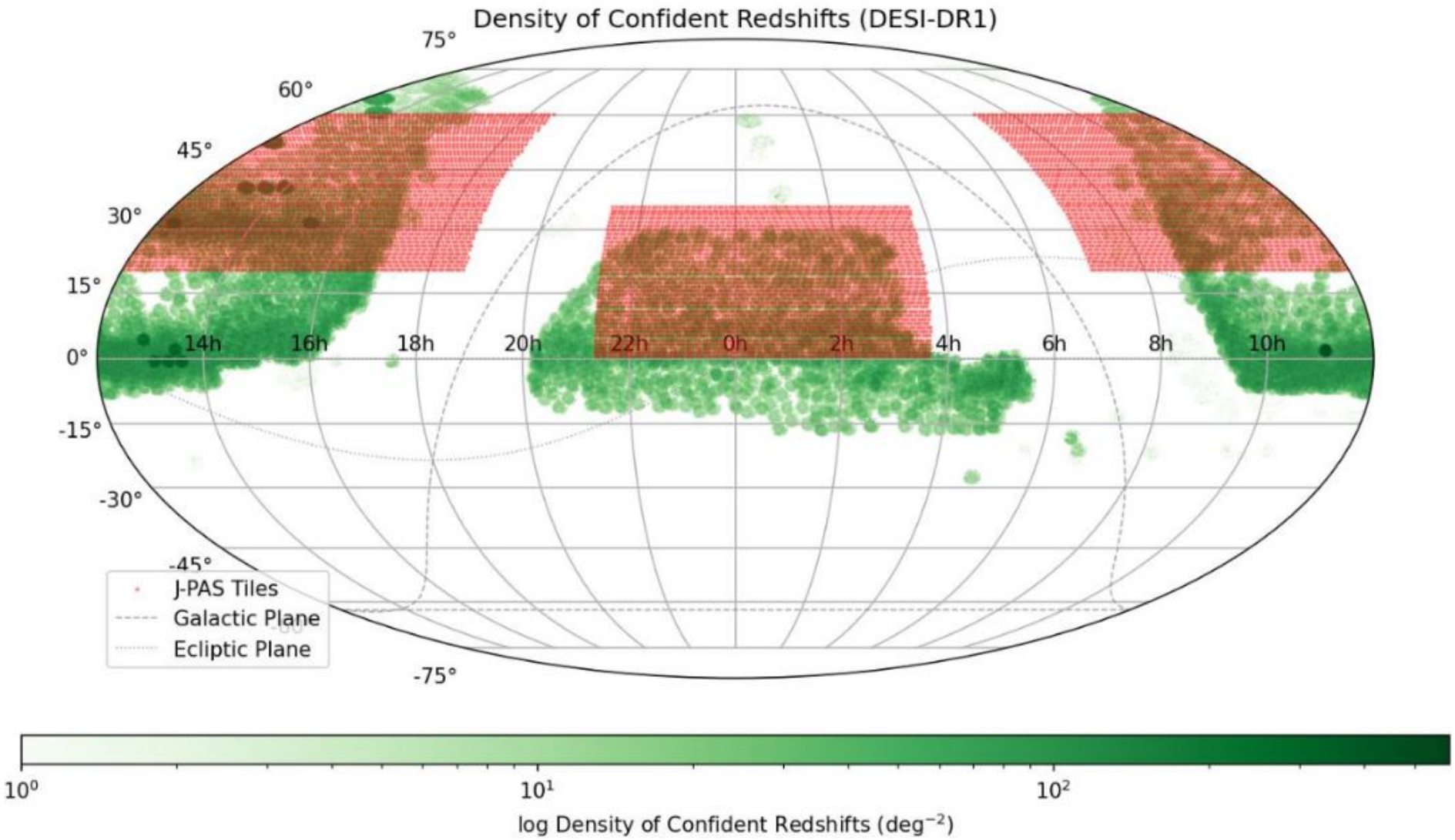
- Attenuation law/curve (SMC, Cardelli, Calzetti…)
- Size of dust grains
- Escape fraction
- IMF

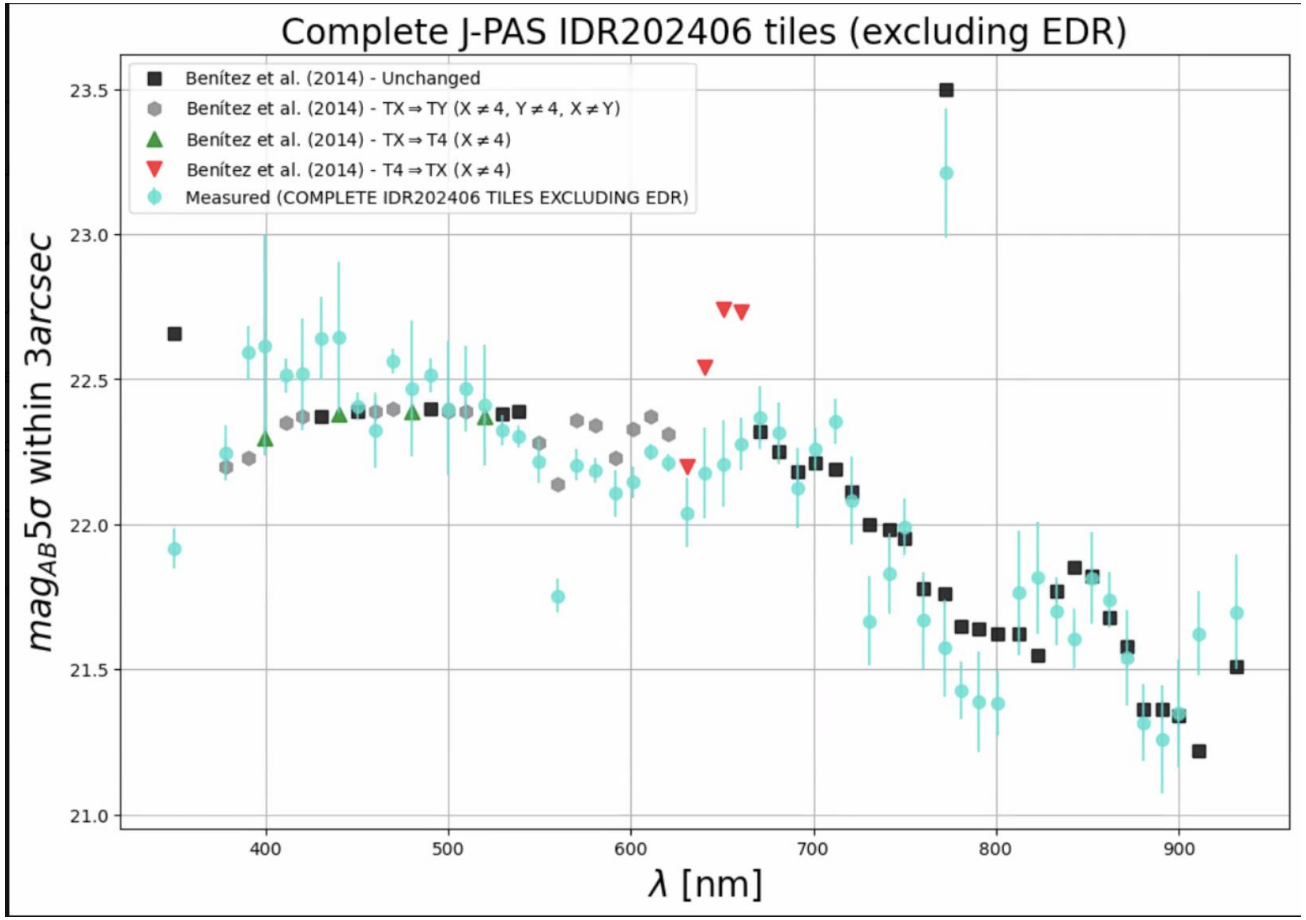


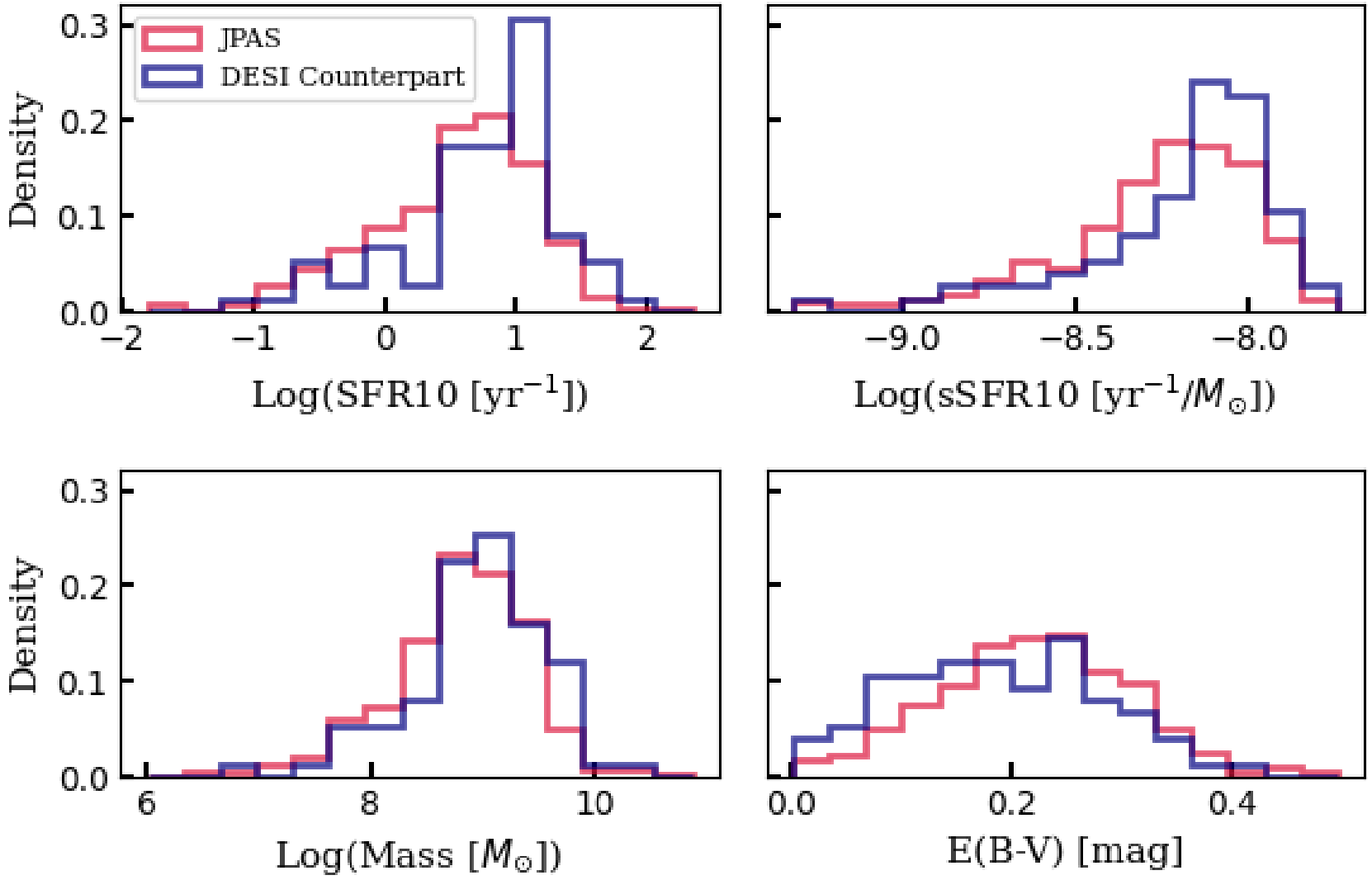
Take away messages

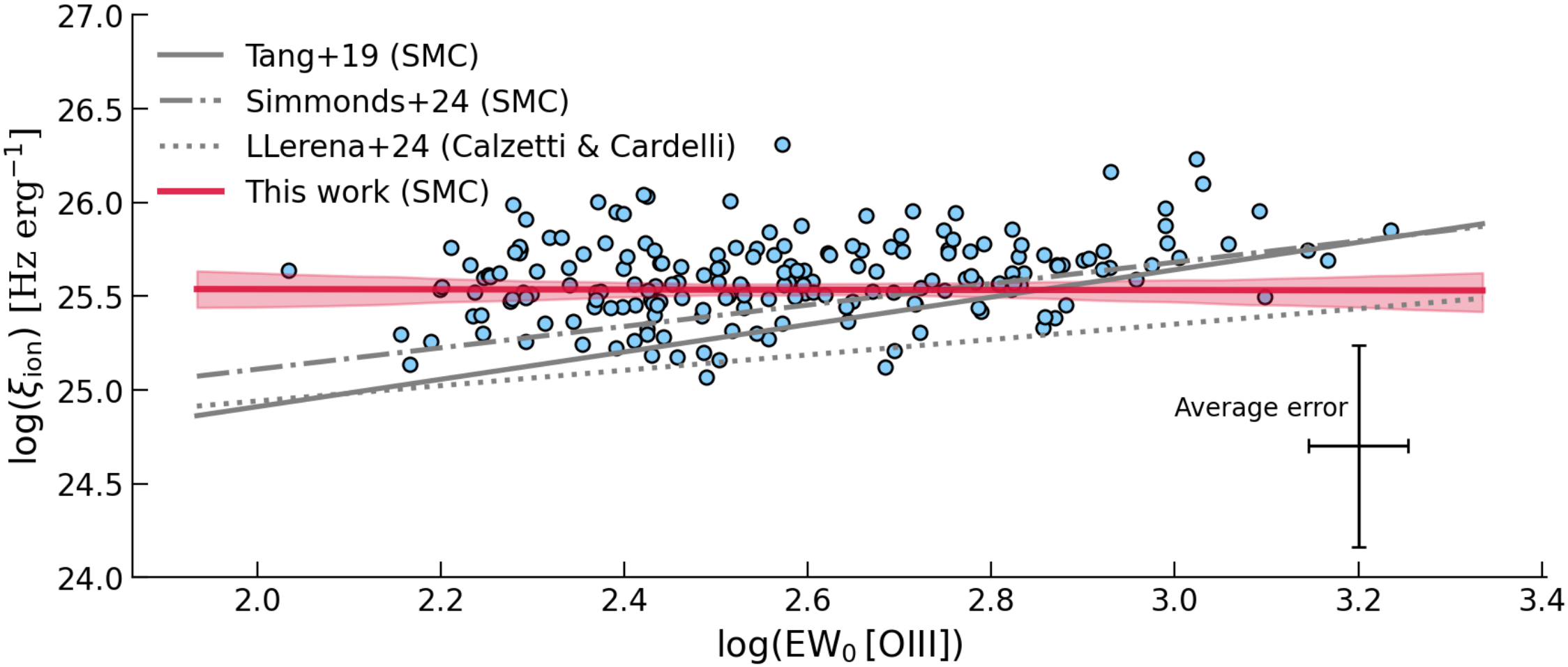
- **J-PAS will scan 8,000 deg^2 of the sky**
- **Unbiased detection and characterization** of Extreme Emission Line Galaxies
- **Reliable fluxes and EW** from narrow-band photometry
- **We observe a trend in ξ consistent with previous literature**
- Polis is the perfect host

BACKUP


Density of Confident Redshifts (DESI-DR1)
75°
60°
45°
30°
15°
0°
-15°
-30°
-45°
-75°
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
10h
J-PAS Tiles
Galactic Plane
Ecliptic Plane
10^0
10^1
10^2
log Density of Confident Redshifts (deg^{-2})


Complete J-PAS IDR202406 tiles (excluding EDR)
Benítez et al. (2014) - Unchanged
Benítez et al. (2014) - TX ⇒ TY (X ≠ 4, Y ≠ 4, X ≠ Y)
Benítez et al. (2014) - TX ⇒ T4 (X ≠ 4)
Benítez et al. (2014) - T4 ⇒ TX (X ≠ 4)
Measured (COMPLETE IDR202406 TILES EXCLUDING EDR)
$mag_{AB}5\sigma$ within 3arcsec
23.5
23.0
22.5
22.0
21.5
21.0
400
500
600
700
800
900
λ [nm]


JPAS
DESI Counterpart
Density
0.0
0.1
0.2
0.3
−2
−1
0
1
2
Log(SFR10 [yr^{-1}])
−9.0
−8.5
−8.0
Log(sSFR10 [yr^{-1}/$M_\odot$])
Density
0.0
0.1
0.2
0.3
6
8
10
Log(Mass [$M_\odot$])
0.0
0.2
0.4
E(B-V) [mag]


Tang+19 (SMC)
Simmonds+24 (SMC)
LLerena+24 (Calzetti & Cardelli)
This work (SMC)
Average error
log(ξion) [Hz erg−1]
log(EW0 [OIII])
27.0
26.5
26.0
25.5
25.0
24.5
24.0
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4