

A Systematic Census of Strongly Lensed Pop III Candidates at $z \approx 6-7$

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VENUS Collaboration

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Approaching Pop III Galaxies

Simulations show Pop III star formation as low as $z \sim 6$, especially in chemically pristine environments

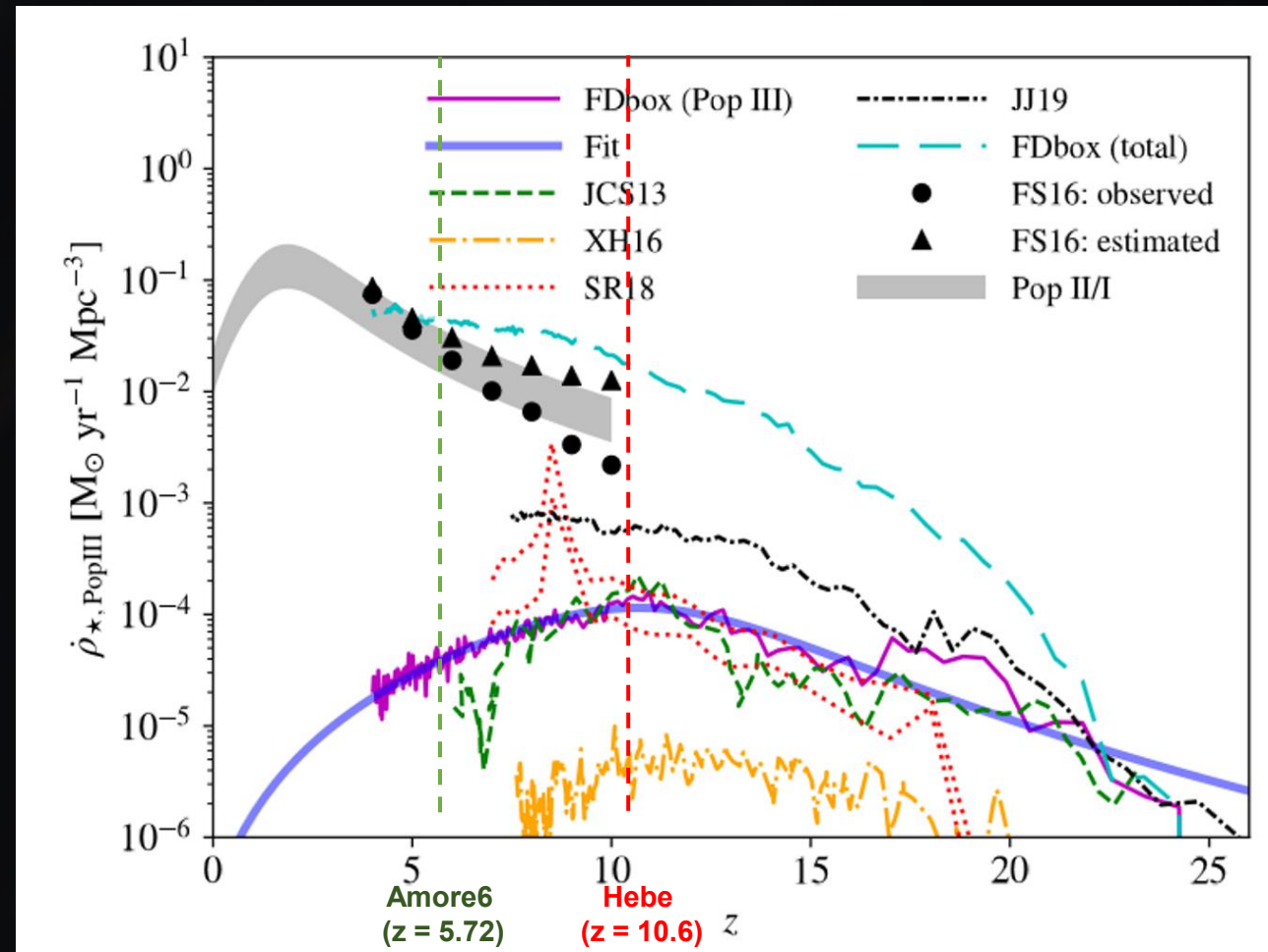
(H. Katz et al. 2023; A. Venditti et al. 2023, 2024).

Multiple PopIII candidates have been identified in the JWST era

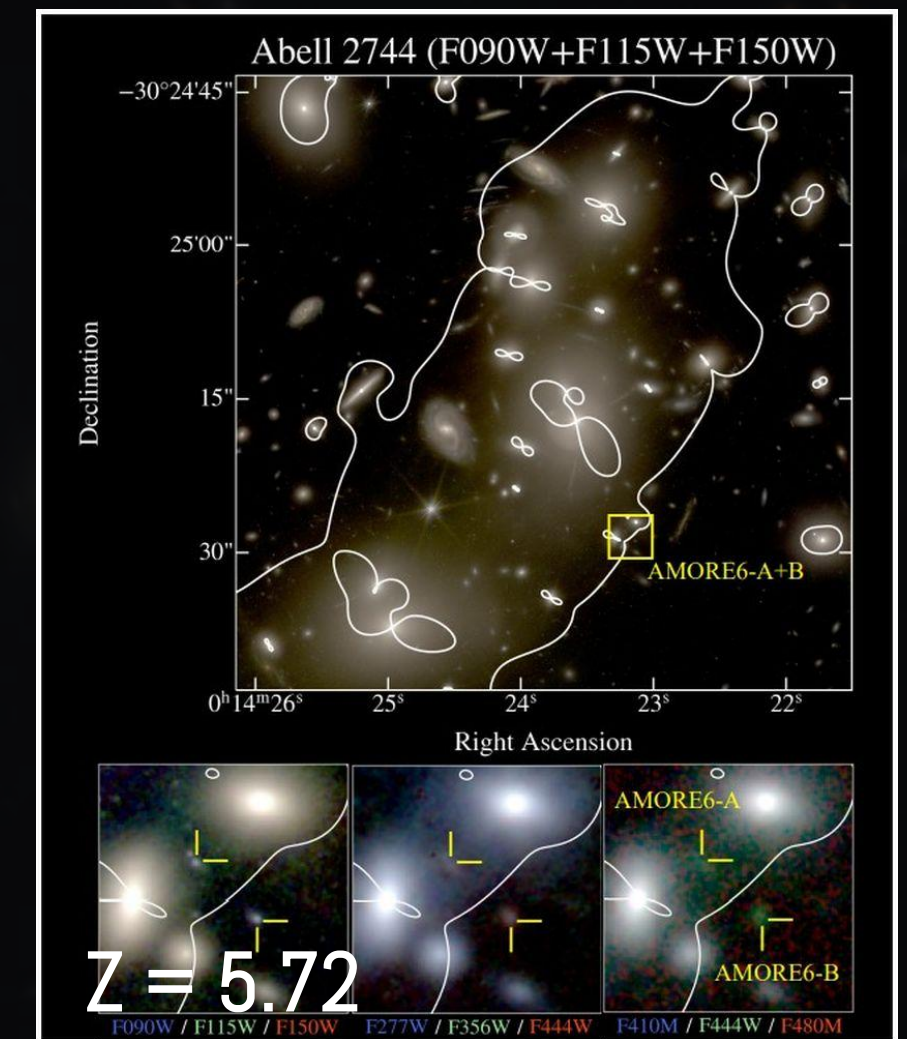
(Morishita et al. 2025; Cai et al. 2025; Maiolino et al. 2026).

PopIII sources are expected to be very faint ($M_{\text{uv}} > -16$)

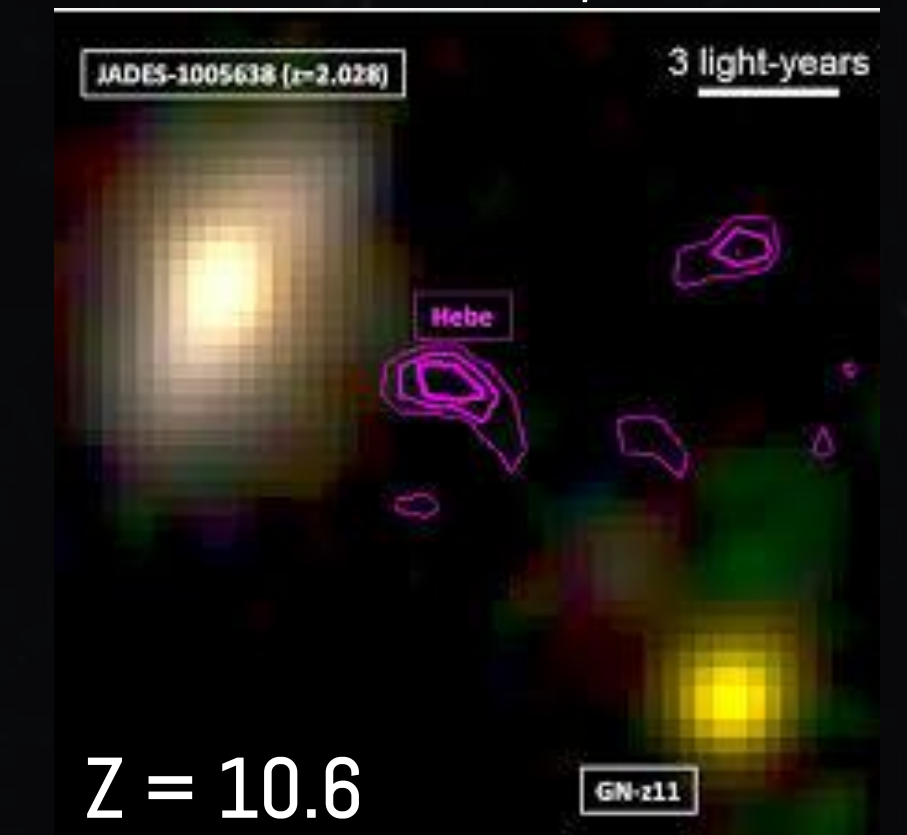
VENUS combines high magnification with 60 lensing clusters, allowing a Systematic PopIII search



Liu et al., 2020



Morishita et al., 2025



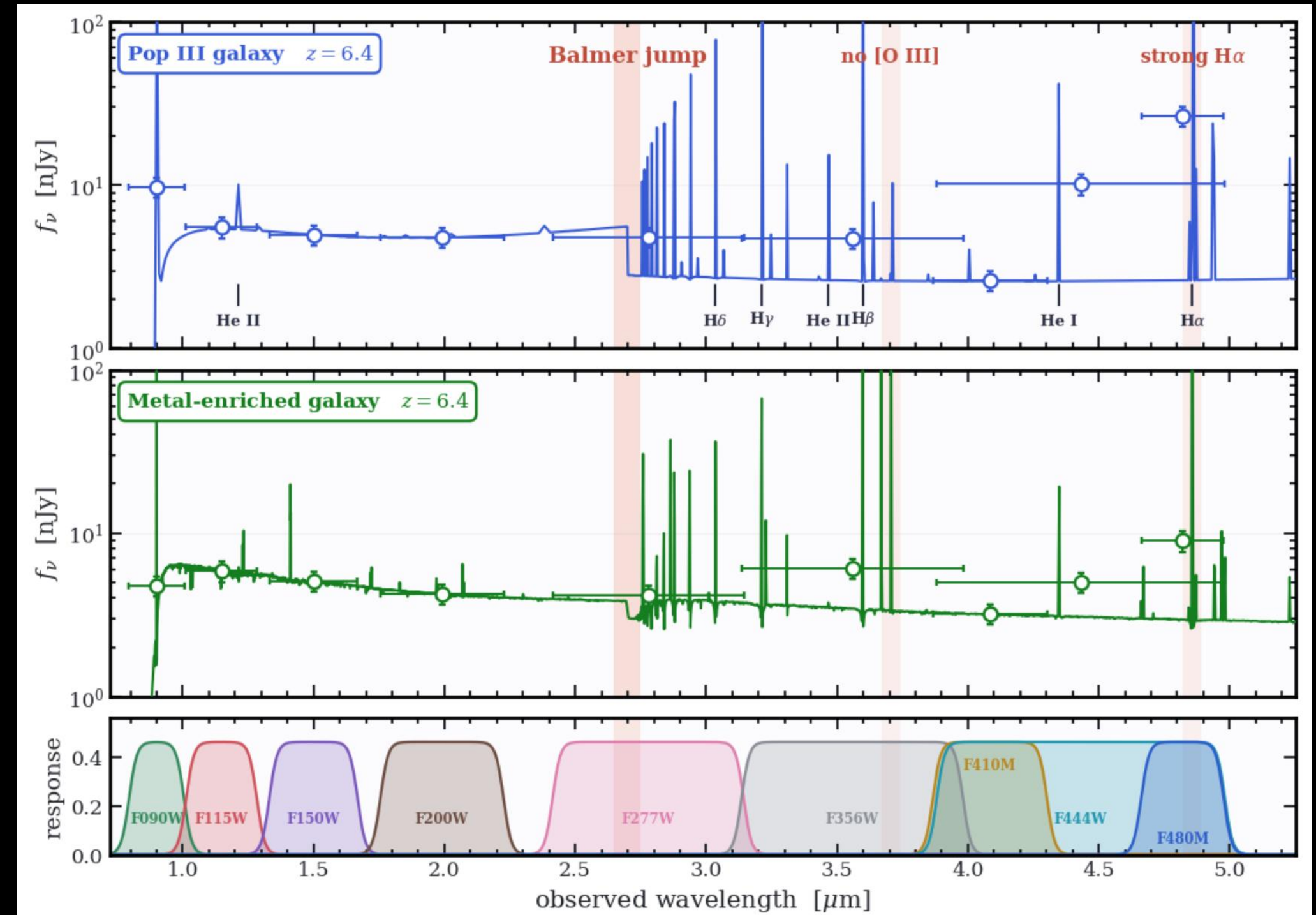
Maiolino et al., 2026

SED signatures of Pop III

Strong H α , absent [O III], and a Balmer-jump are key SED features that could separate Pop III galaxies from metal-enriched ones

AT Z = 5.6-6.6

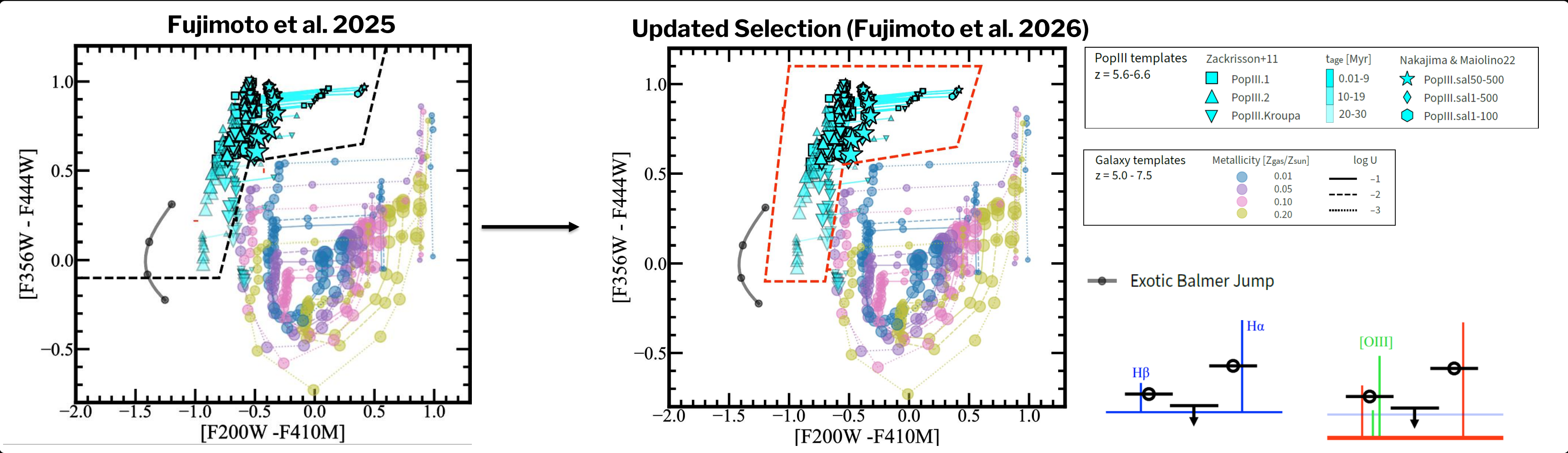
F444W - F410M (H α strength)
F356W - F410M (OIII+H β Strength)
F200W - F410M (Balmer Jump)
etc...



EAZY template at $z = 6.4$. Top: Pop III template, Bottom: Metal-enriched Galaxy Template - see **Fujimoto et al, 2025, Trussler et al, 2023, 2026**

Selection Criteria

Step 1. 3 Color-Color Plots



Step 2. SED Selection w/ EAZY

13 Pop III Templates
13 Metal-enriched Galaxy Templates

$\chi^2(\text{metal-enriched}) - \chi^2(\text{Pop III})$

Criteria adapted from Fujimoto et al. 2025.

DATA

VENUS:
Cy4 Treasury Program
60 Massive Lensing Clusters

300Hrs
2025-2026

10 NIRCam filter set (F090W, F150W, F200W, F210M,
F277W, F300M, F356W, F410M, F444W) + 2 ancillary HST
(F606W, F814W)

MUSE ATLAS ancillary spectroscopy (J. Richards et al.,
2020)

Candidates that Passed Selection

Spectroscopic Redshifts

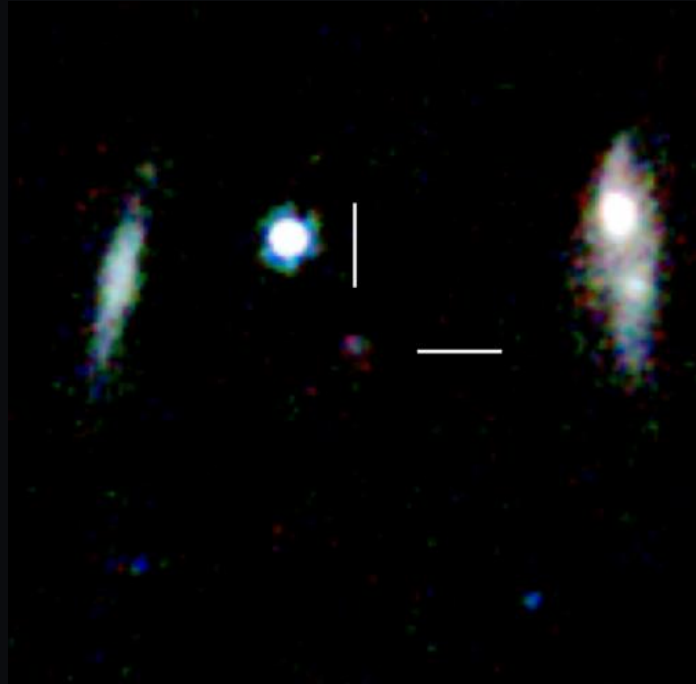
2715 - SJ-2131

$z = 5.72$

$M_{uv} = -15.3$

$F200W = 27.9$

$M_u = 28.3$



Photometric Sources

888 - Bullet Cluster

$z = 6.45$

$M_{uv} = -17.88$

$F200W = 27.9 \text{ mag}$

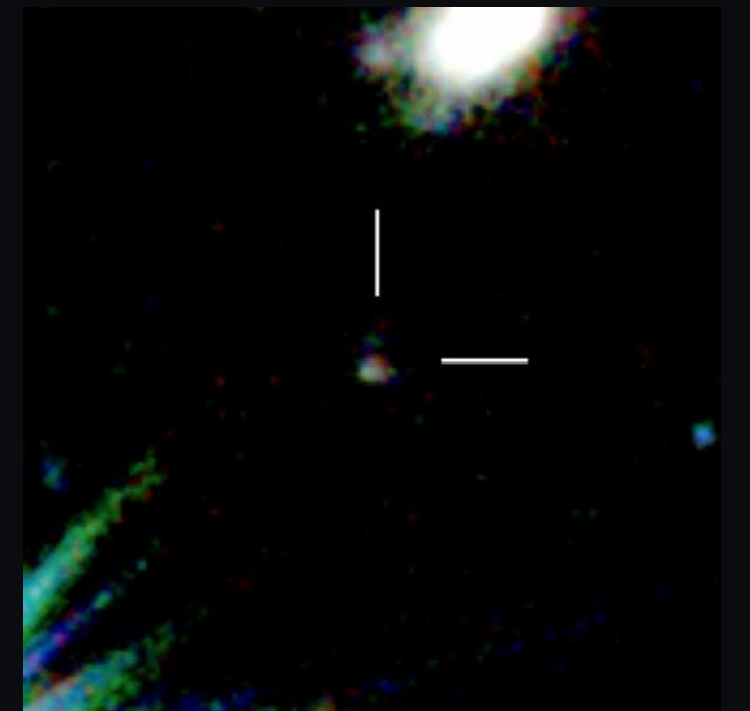


59166 – MACS J0416.1

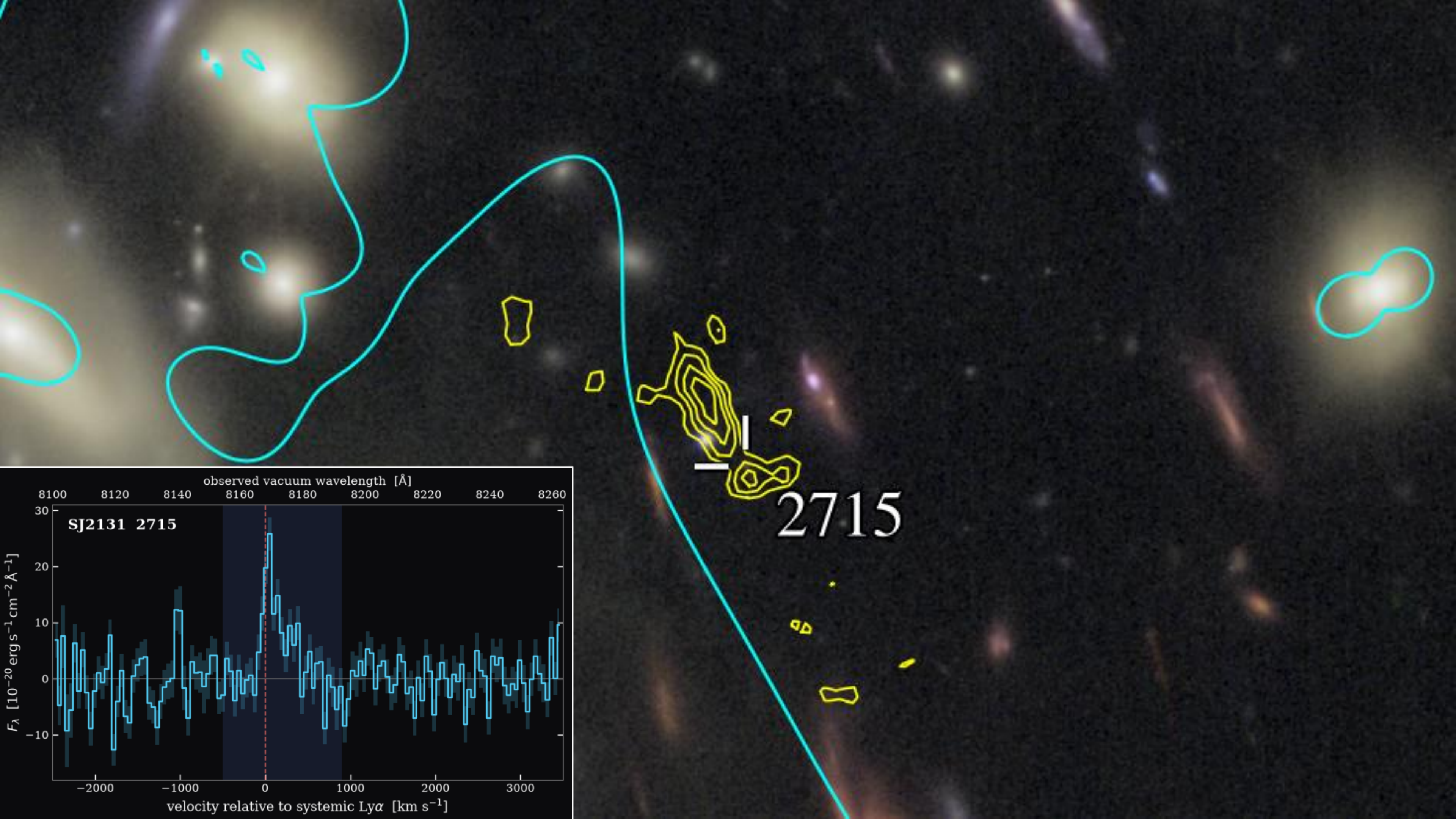
$z = 6.19$

$M_{uv} = -18.07$

$F200W = 28.1$







Spectroscopic Candidate 2715 at $z = 5.72$

Strong Ha EW, Weak O III, Balmer Jump, Blue UV slope, Confirmed spectroscopic redshift and Ly α emission via MUSE

$$\text{EW(H}\alpha) = 2960 \text{ \AA}$$

$$\text{OIII/H}\beta < 0.6$$

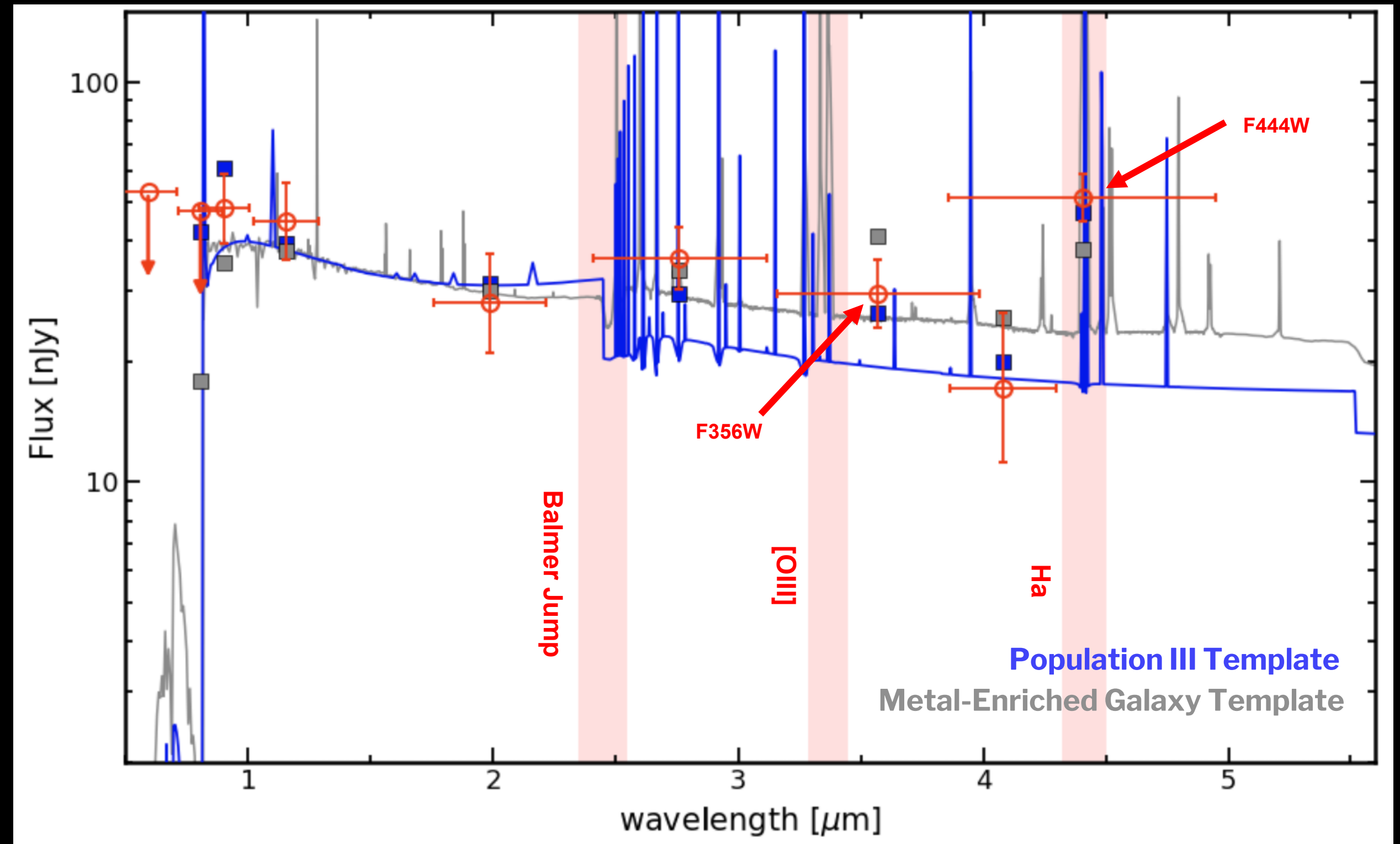
$$\text{F200W} = 27.9$$

$$\beta = -2.7$$

$$\text{M}_{\text{uv}} = -15.3$$

$$\mu = 28.3$$

$$\text{M}_* = 10^5 \text{M}_{\odot}$$

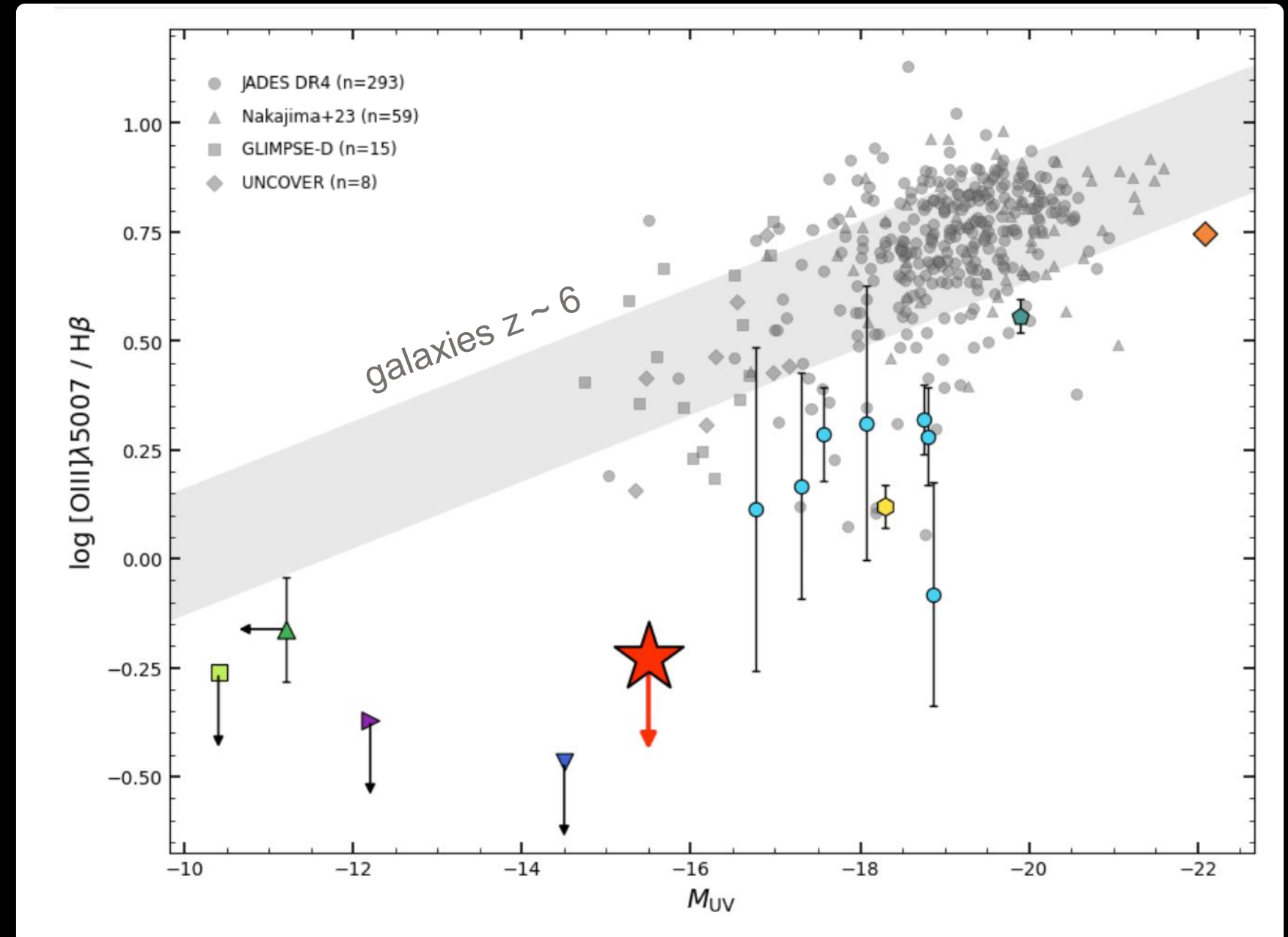
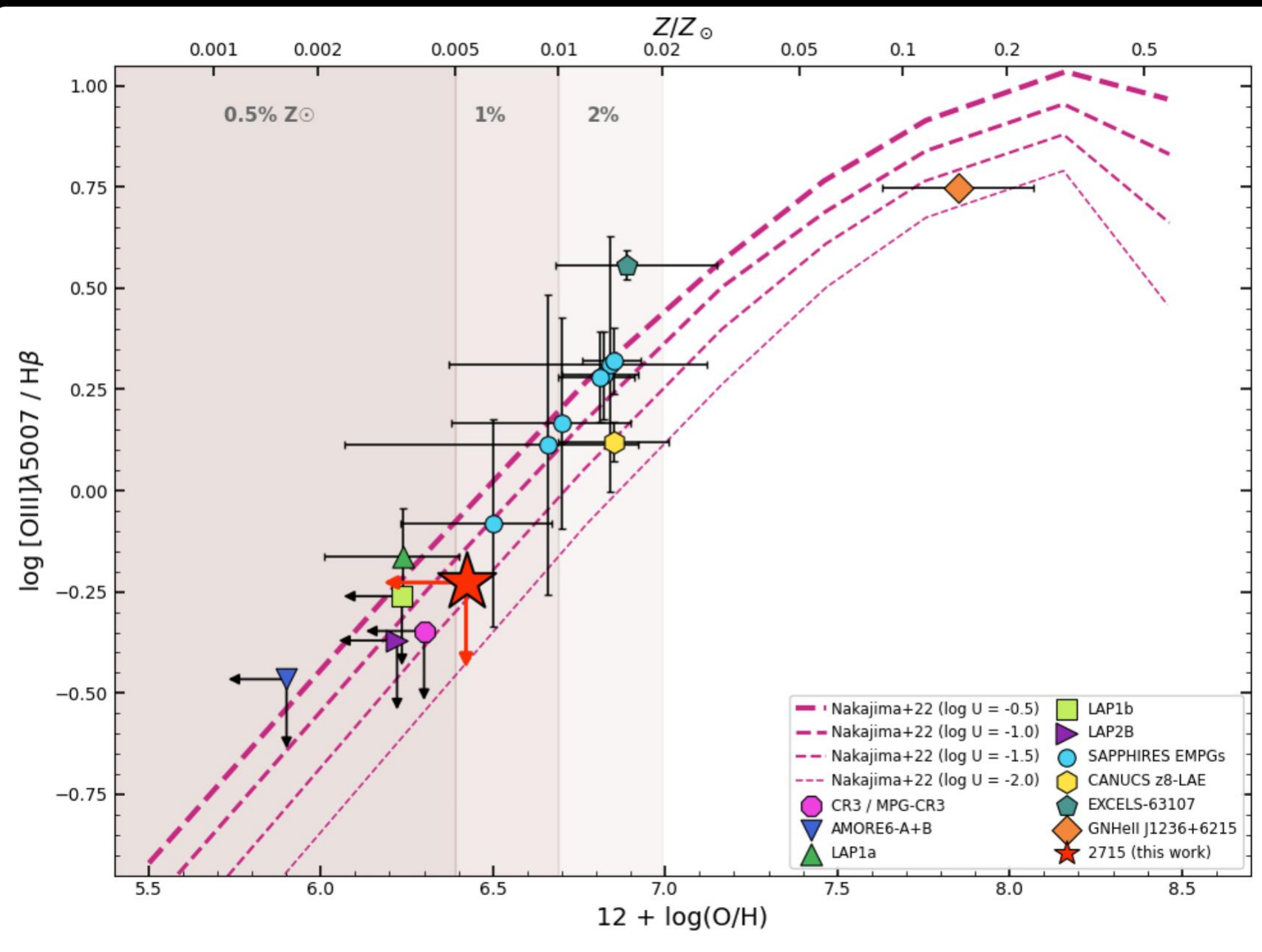


ID 2715 $\cdot \chi^2(\text{Pop III}) = 7.7 \cdot \Delta\chi^2 = 7.1 \cdot z_{\text{spec}} = 5.72.$

Gas Phase Metallicity

$$12 + \log(\text{O}/\text{H}) < 6.4, [\text{OIII}]\lambda 5007/\text{H}\beta < 0.593$$

$\sim 0.5\%$ solar, from the F444W H α excess + Case B recombination.

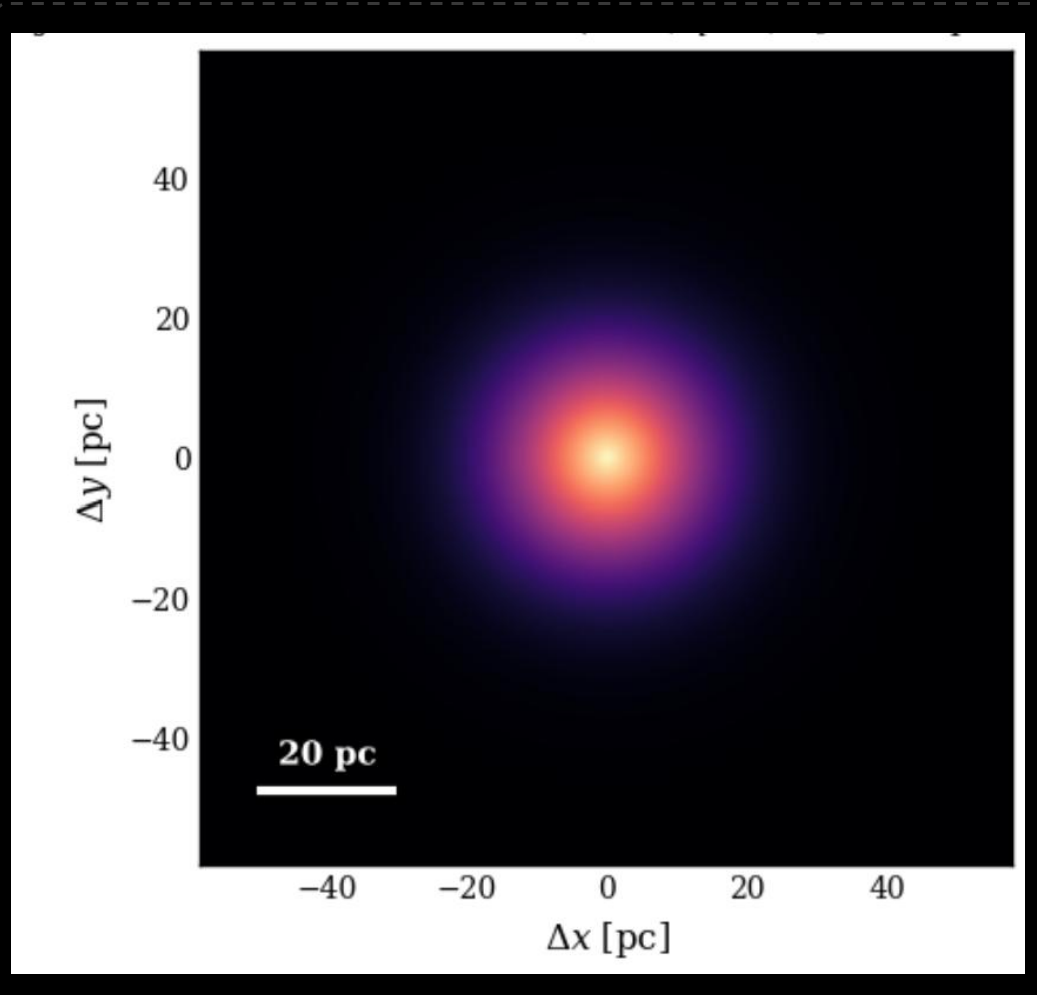


Surface Density and Size Parameters

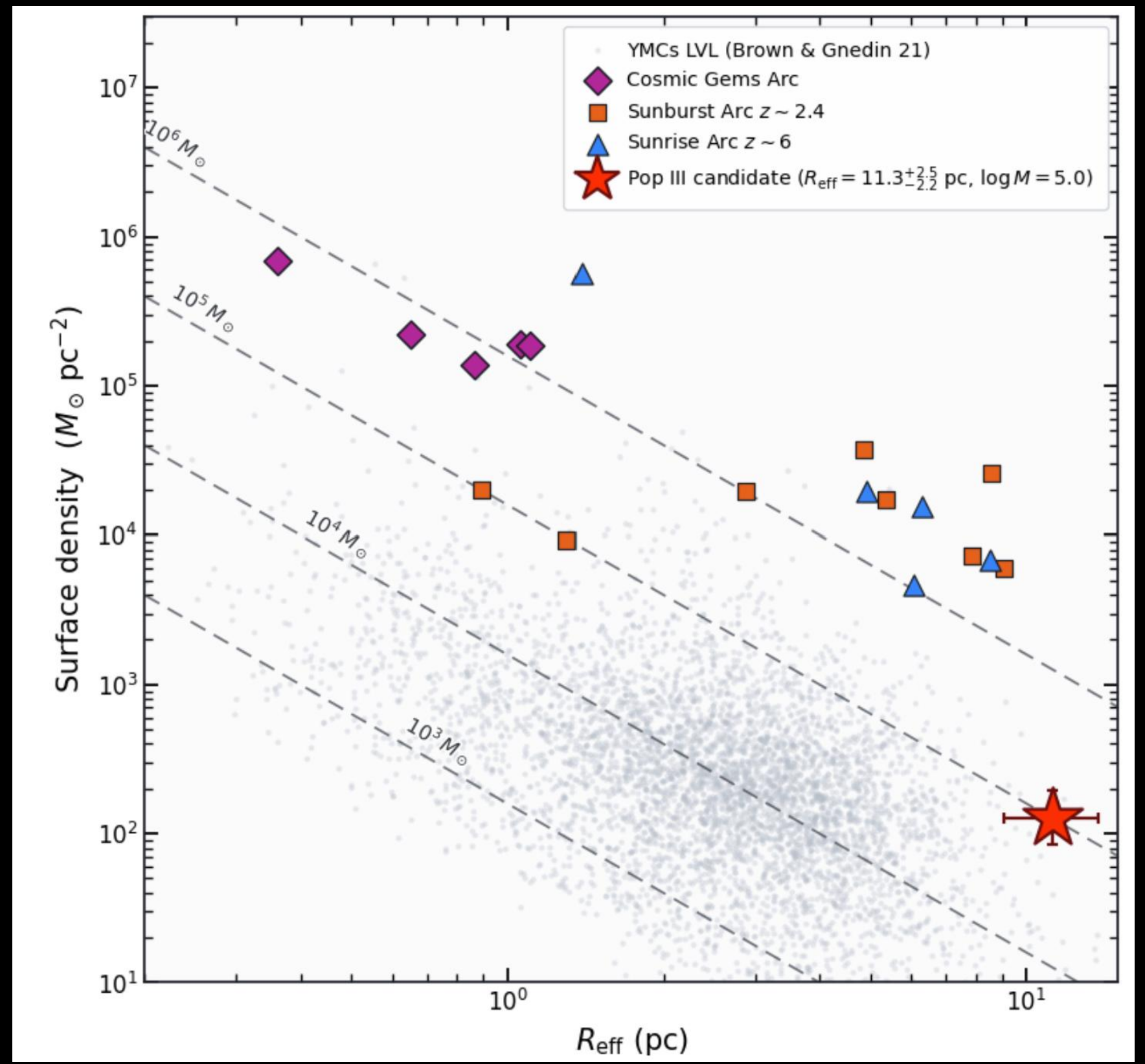
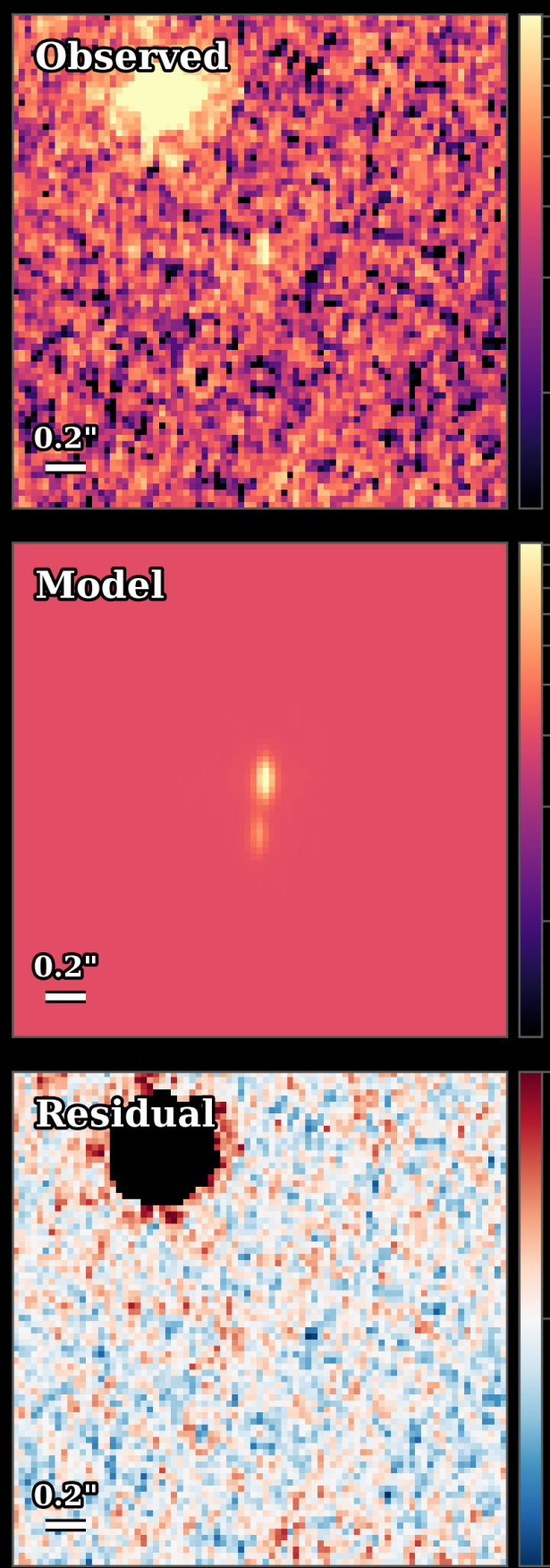
SIZE PARAMETERS

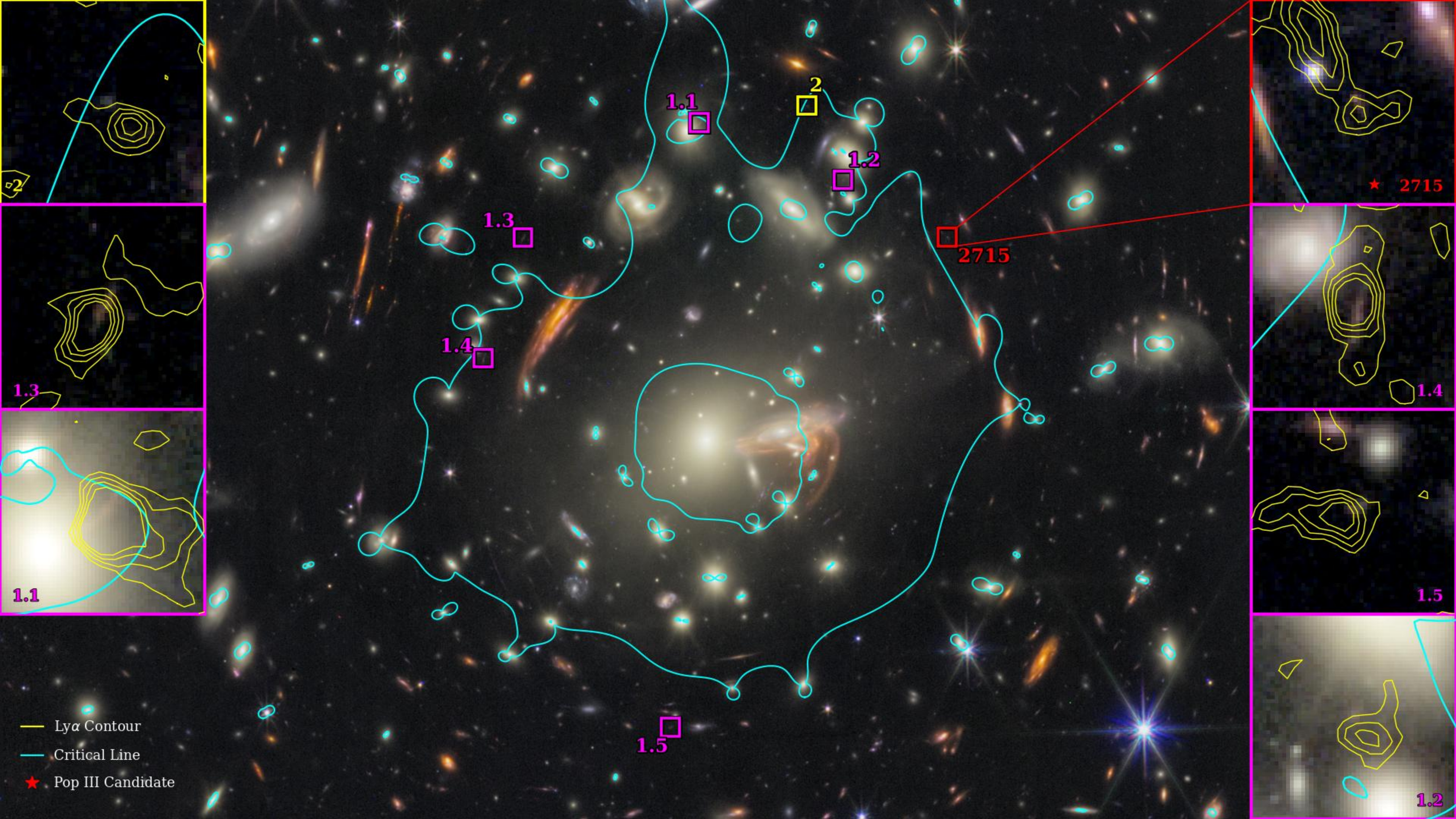
$R_e = 11.3 \text{ pc}$

Surface Density = $118 \text{ } M_{\odot}/\text{pc}^2$



Rest UV Continuum Bands





Complex environment with 2 other sources

SIZE PARAMETERS

$$Re_1 = 196 \text{ pc}$$

$$M_1 = 10^7 M_\odot$$

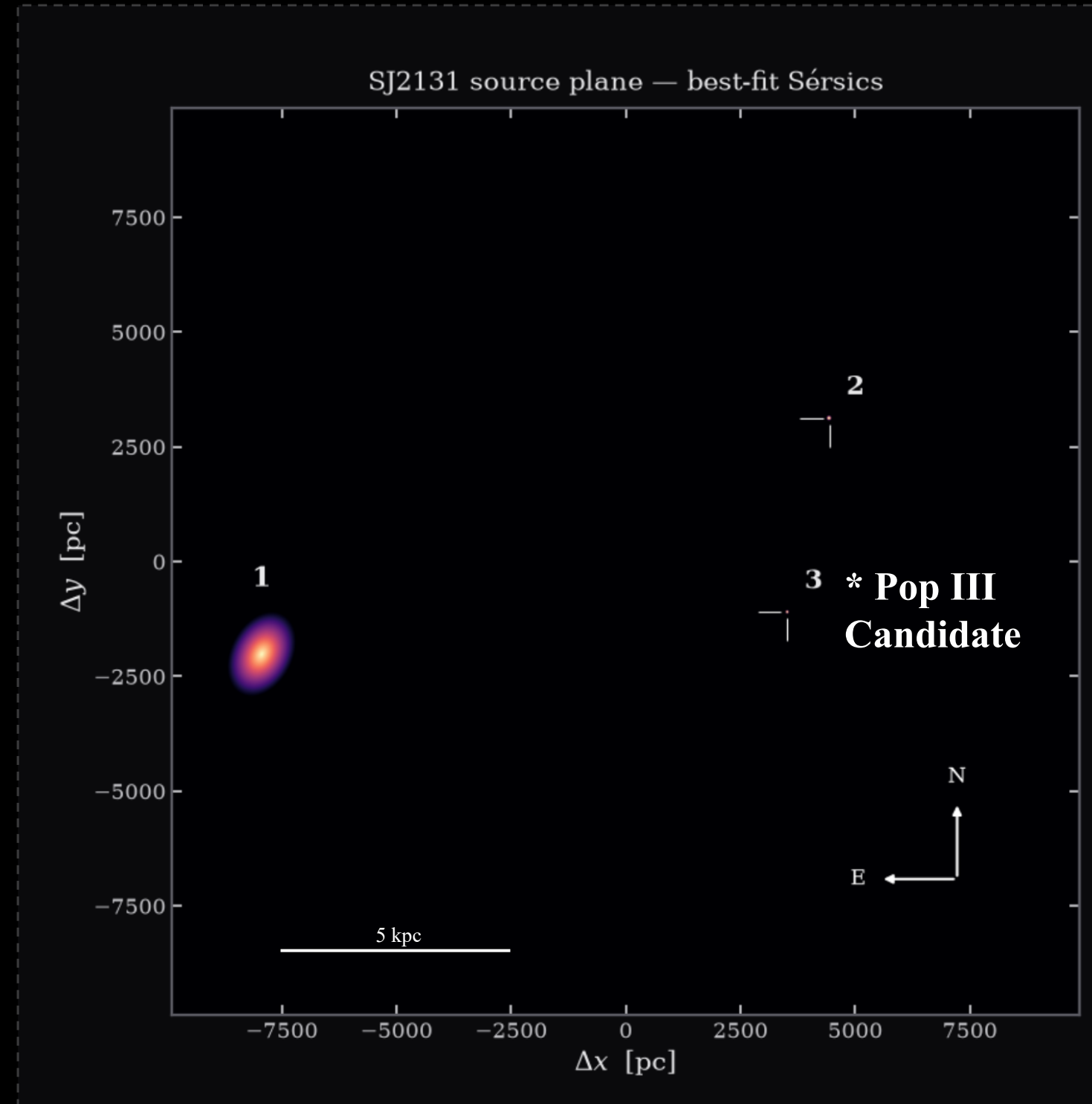
$$Re_2 = 6.5 \text{ pc}$$

$$M_2 = 10^6 M_\odot$$

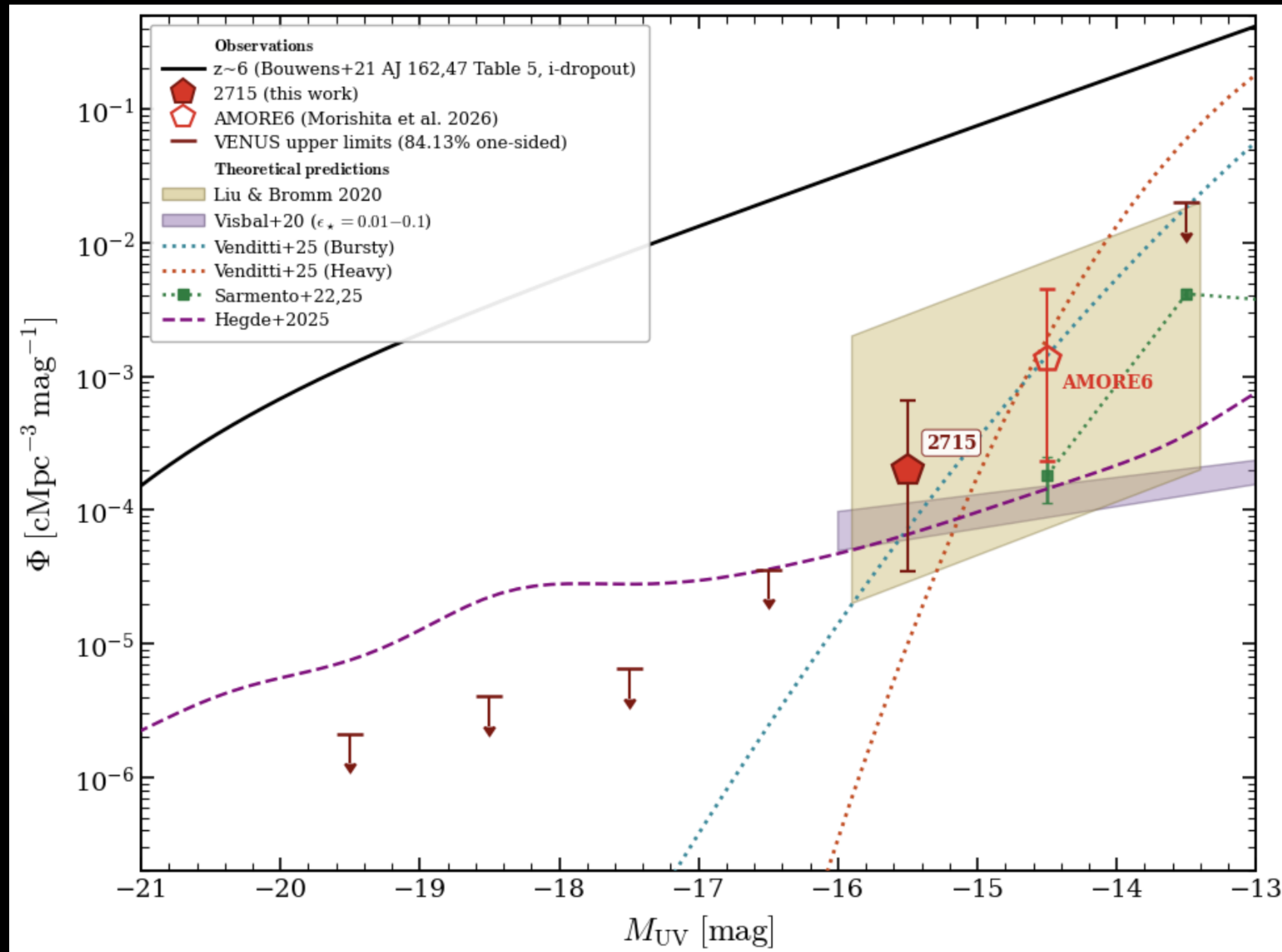
$$Re_3 = 11.3 \text{ pc}$$

$$M_3 = 10^5 M_\odot$$

SOURCE PLANE



UV luminosity function



+ VENUS upper limits vs the $z \approx 6$ LF (Bouwens+21) and Pop III predictions (curves).

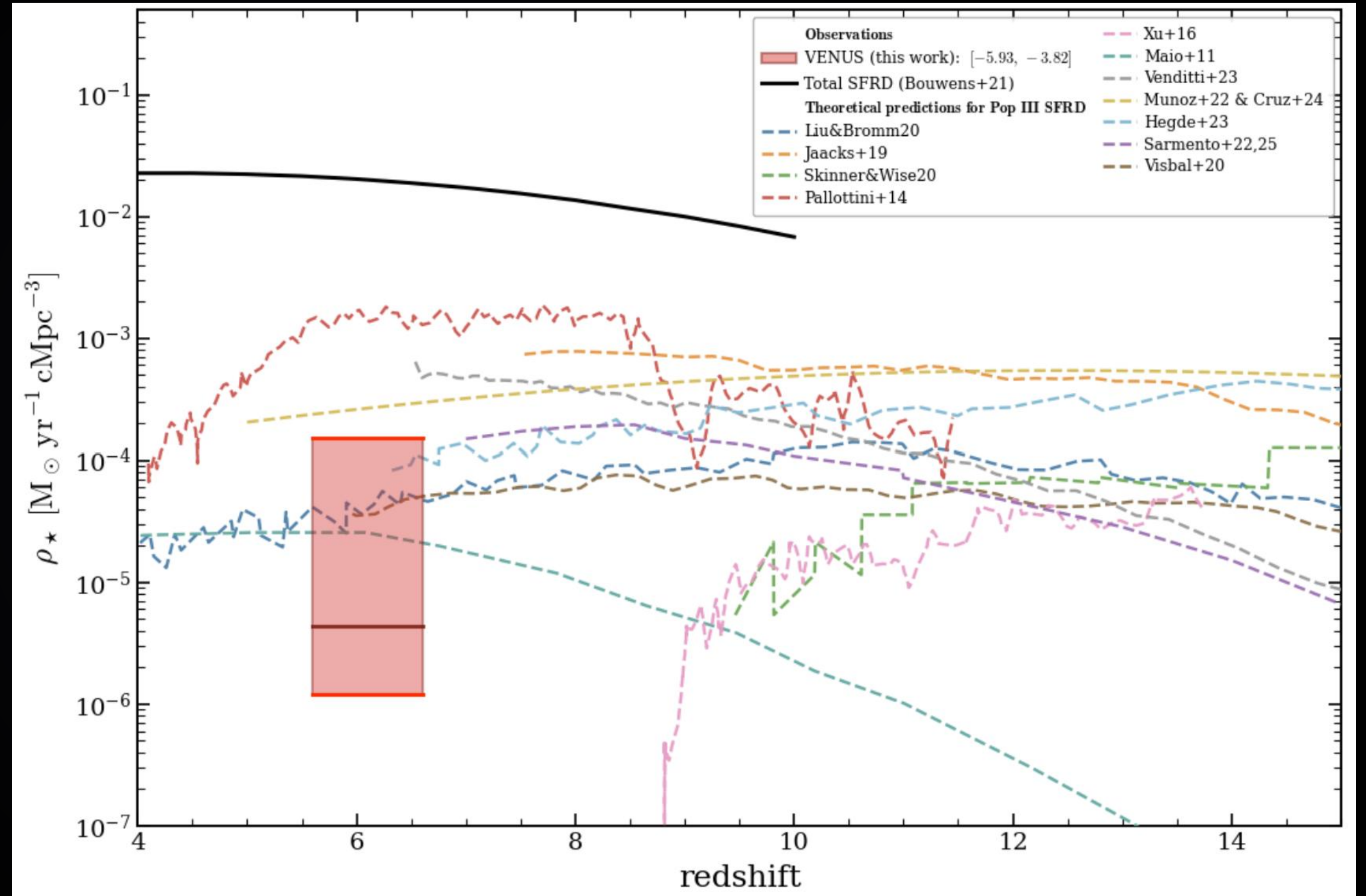
Star-formation-rate density (POP III, $Z \sim 6$)

$$10^{-5.93} - 10^{-3.82} M_{\odot} \text{yr}^{-1} \text{cMpc}^{-3}$$

Lower edge: the single detection.

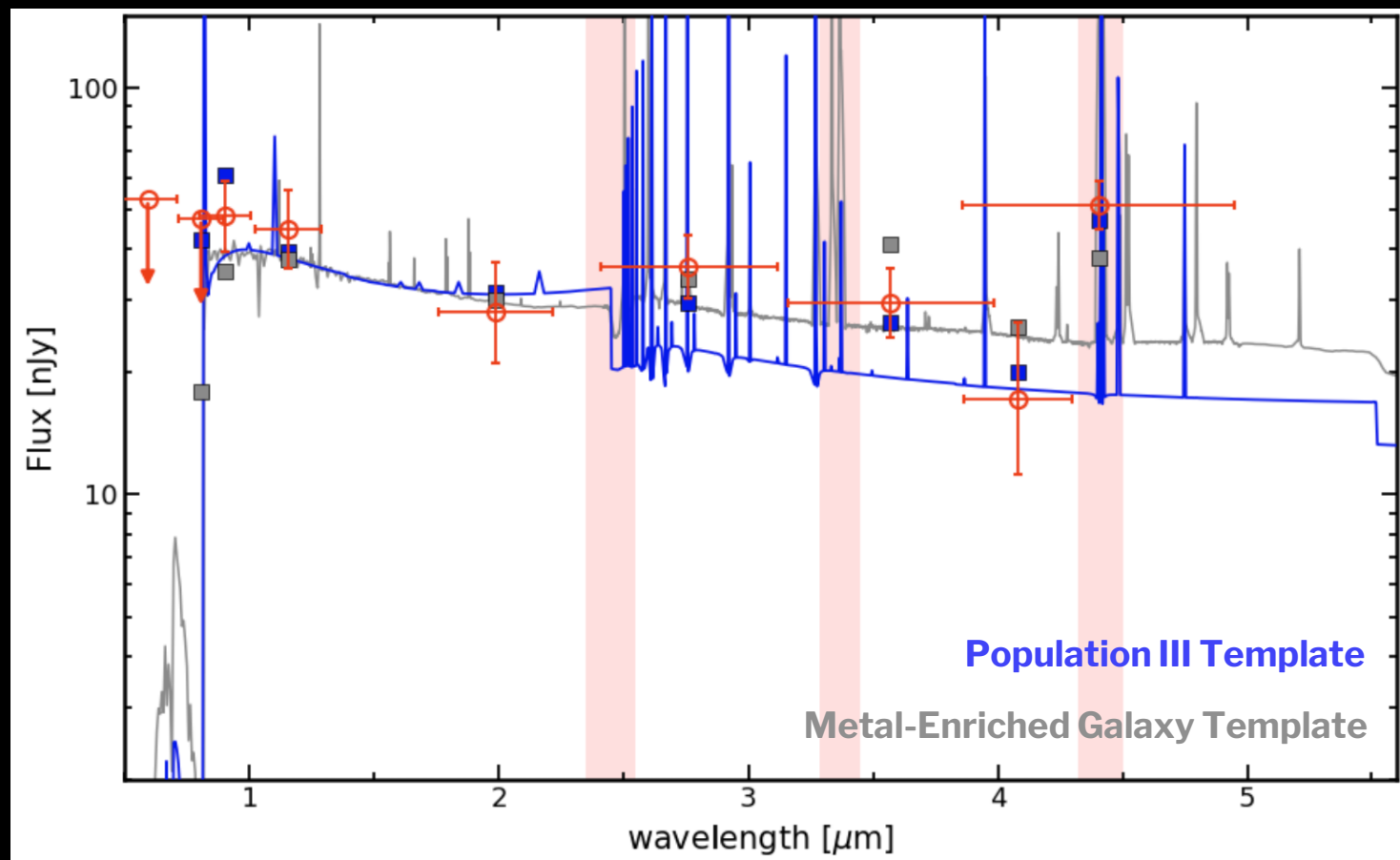
Upper edge: integrating the fitted UVLF to $M_{\text{UV}} = -12$.

$$\text{Middle lower bound} = 10^{-5.36} M_{\odot} \text{yr}^{-1} \text{cMpc}^{-3}$$



Conclusions

- 01** Lensing + colour / SED selection + MUSE identifies Pop III-like candidates at $z \approx 6-7$.
- 02** 2715 at $z = 5.72$, $\mu = 28.3$, $M_{\text{UV}} = -15.3$
- 03** UVLF and SFRD constraints on Pop III-like systems



Next steps

~ MAY 2027

VENUS NIRSPEC MSA follow-up time reserved:
LAEs and Pop III candidate in SJ2131
spectroscopic observations