A (biased) view of JWST on galaxy evolution

First results from the GLASS survey

Benedetta Vulcani, June 7, GAEA focus week

GLASS - JWST (PI Treu)

CrossMark

The GLASS-JWST Early Release Science Program. I. Survey Design and Release Plans

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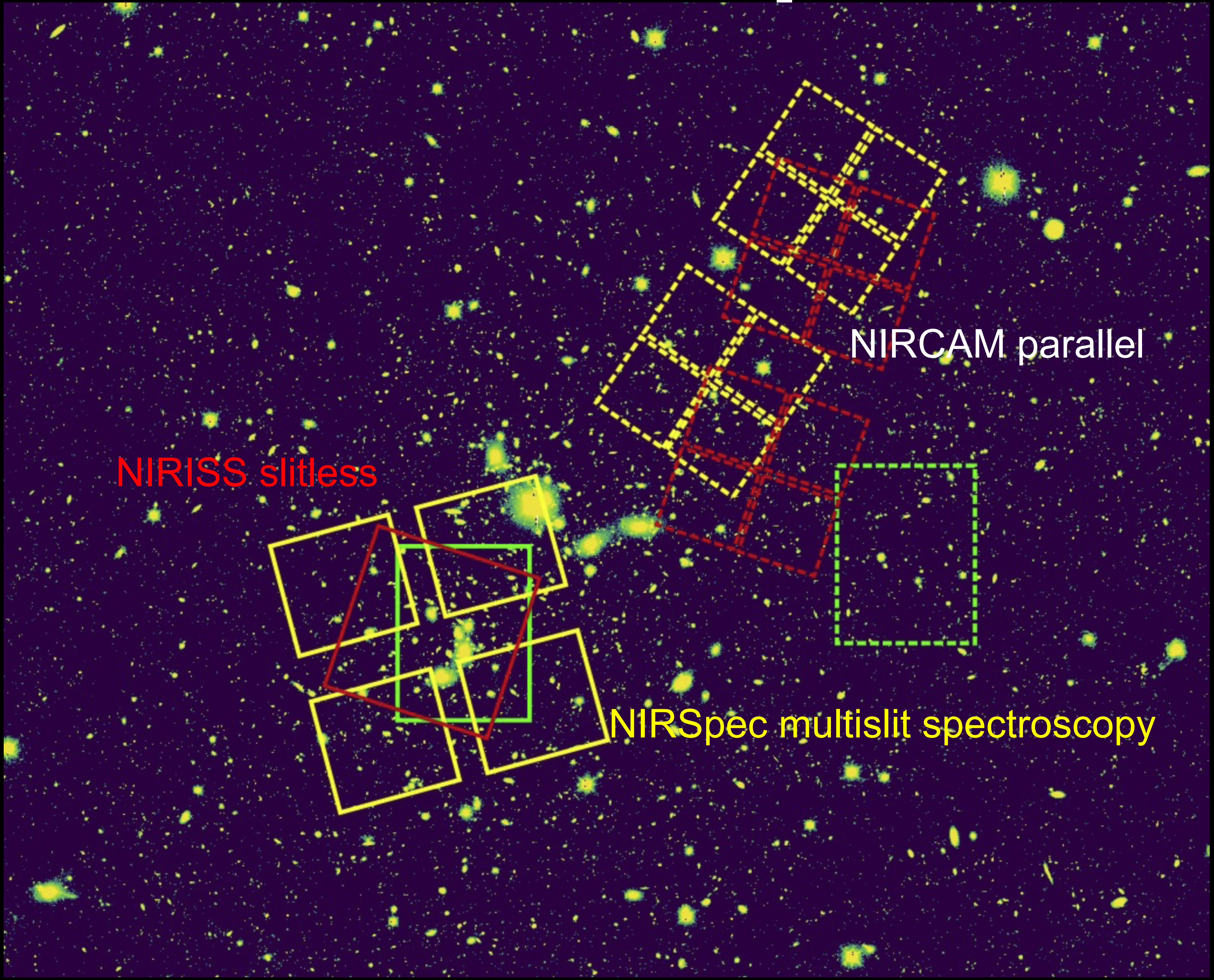
Treu et al. 2022

GLASS - JWST (PI Treu)

- **ERS program**
- **Deepest imaging and spectroscopy (35 hrs) of the ERS programs**
- **The power of strong lensing (foreground cluster A2744 acts as a magnifying GLASS)**

Observation	Visit	Status	Targets	Template	Hours	Start UT	End UT	
6	1	Archived	MPTCAT092722	NIRSpec MultiObject Spectroscopy	19.84	Nov 10, 2022 13:01:48	Nov 11, 2022 05:37:55	
1	1	Failed Archived	ABELL2744	NIRISS Wide Field Slitless Spectroscopy	14.92	Jun 28, 2022 22:47:21	Jun 29, 2022 11:32:51	Rescheduled by WOPR 88501 as observation 7 visit 1 in this program

Experimental Setup



Treu et al. 2022

GLASS - JWST (F090W, F115W, F150W, F200W, F277W, F356W, F444W)

+

UNCOVER (Bezanson et al. 2022, Weaver et al. 2023) (F115W, F150W, F200W, F277W, F356W, F410M, F444W)

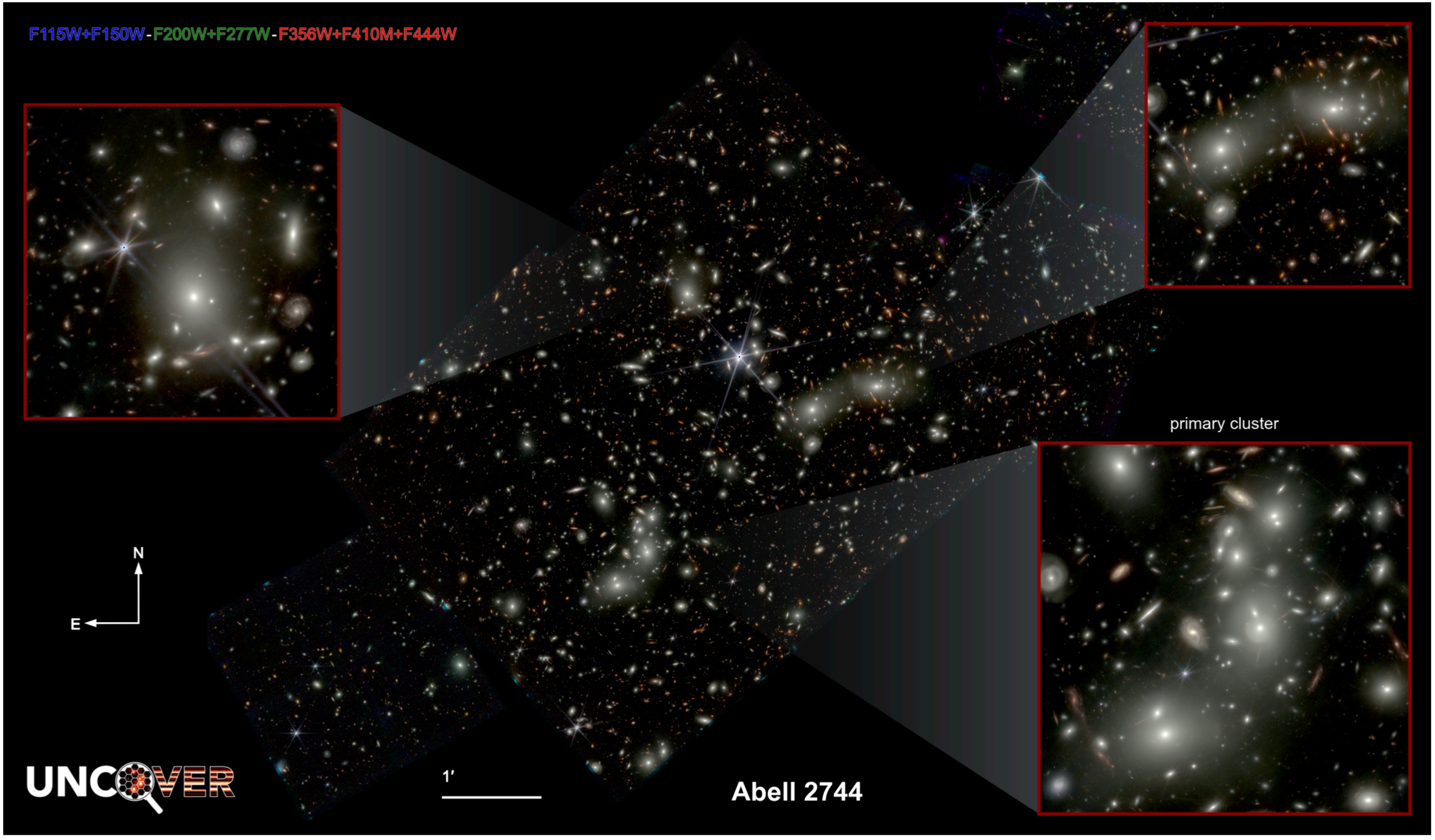
+

Director's Discretionary Time Program 2756, aimed at following up a Supernova discovered in GLASS-JWST NIRISS imaging (PI Chen) (F090W, F115W, F150W, F200W, F277W, F356W, F444W)

→ Abell 2744 is one of the best characterised clusters beyond the local Universe!

Paris et al. 2023

Abell 2744



Bezanson et al. 2022

Result#1: Too many UV bright galaxies at z>10!

Two bright and robust candidates in GLASS at z=10 and 12...

...We were expecting 0.1!

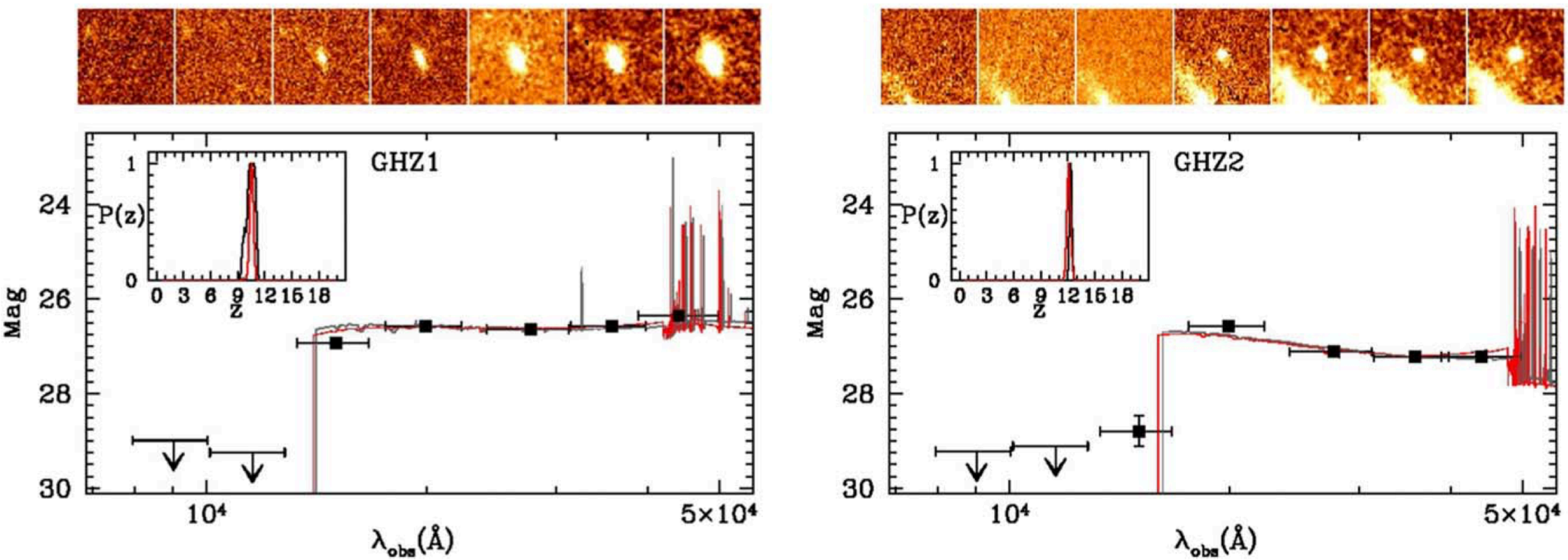
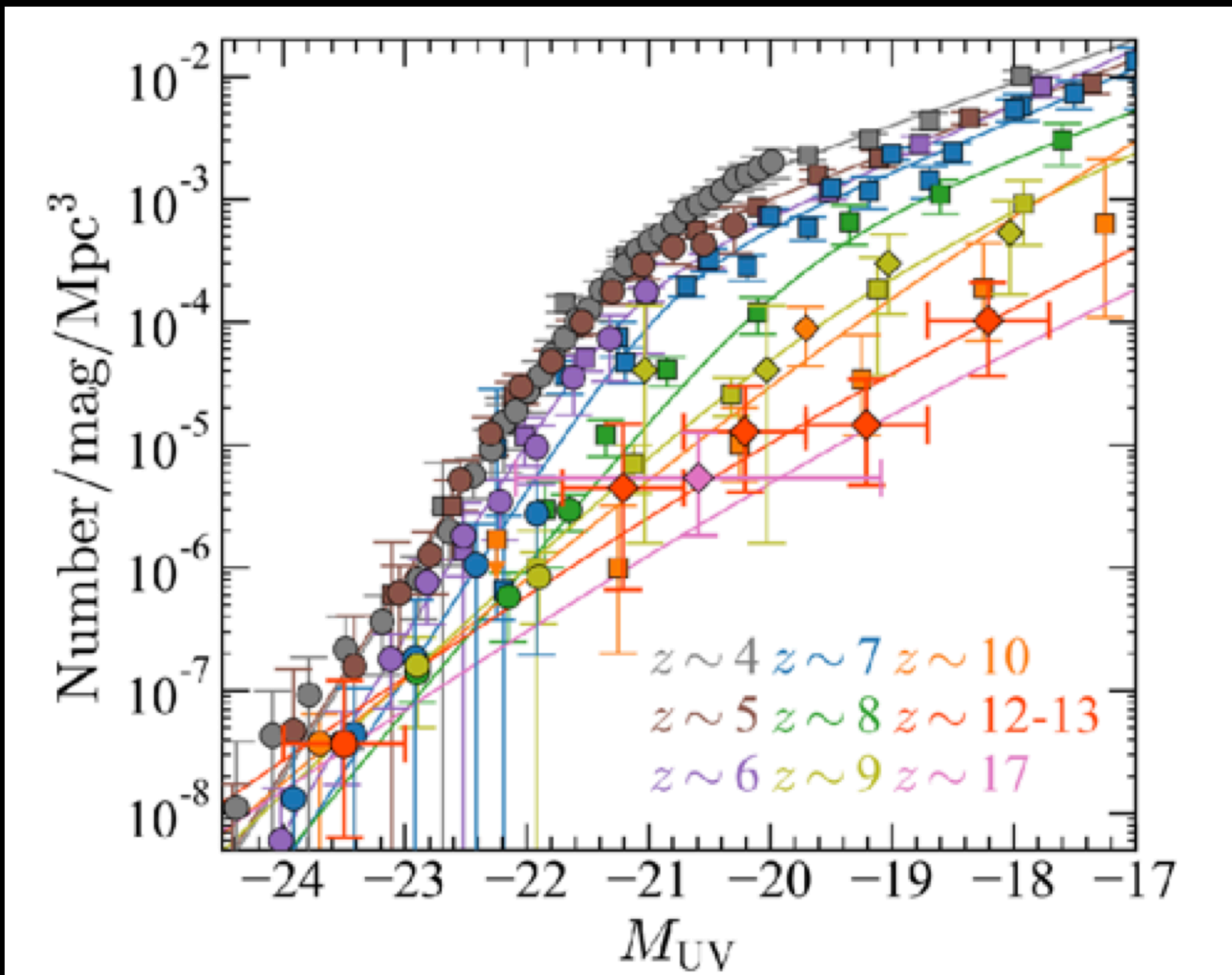


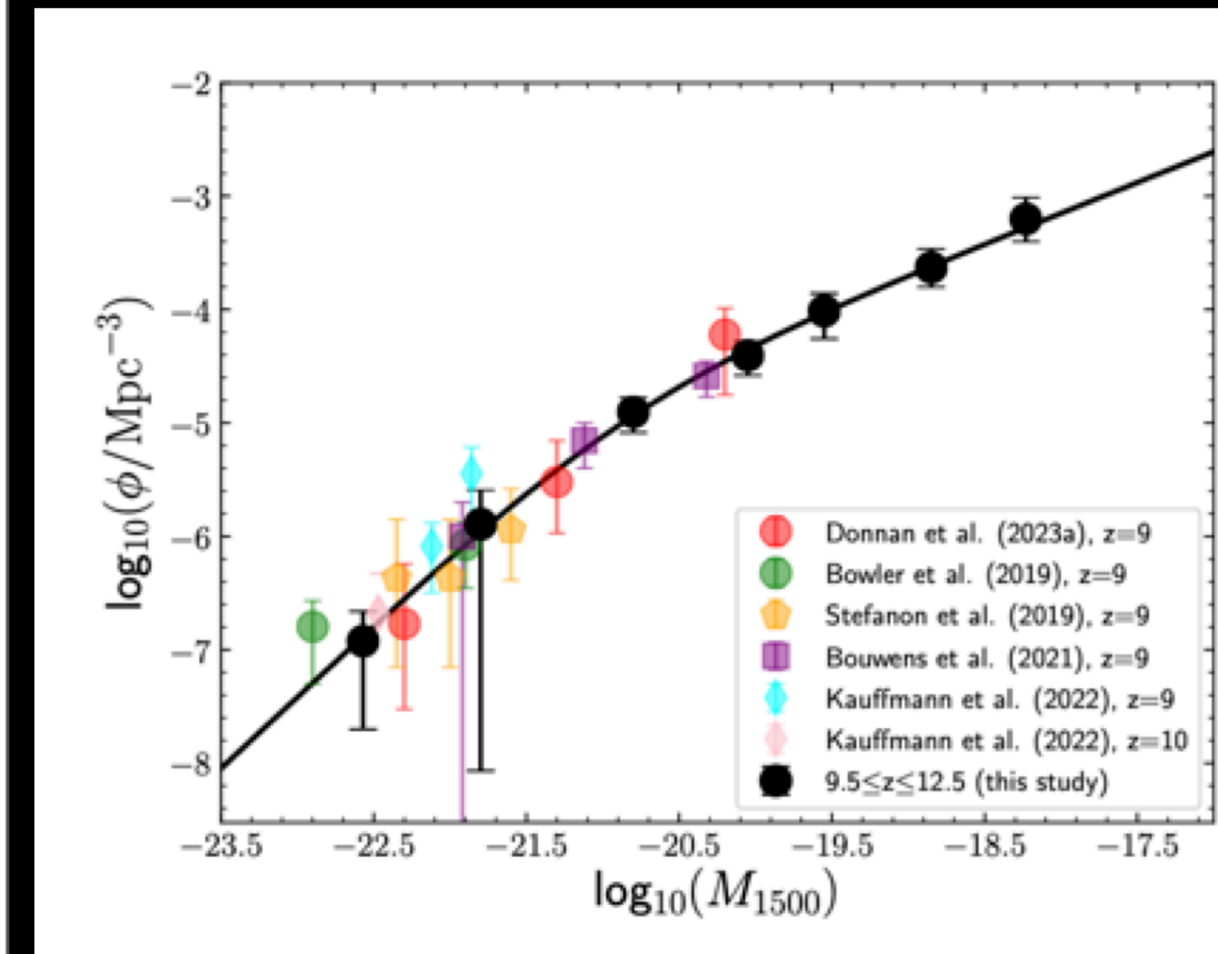
Figure 3. The two high-quality, bright high-redshift candidates from the GLASS-JWST NIRCAM field taken in parallel to NIRISS. Photometry and best-fit SEDs at the best-fit redshift are given in the main quadrant. Redshift probability distributions $P(z)$ from ZPHOT (gray) and EAZY (red) are shown in the inset. Upper limits are reported at the 2σ level, including a conservative estimate of the error budget, especially in the bluest bands (M22). Thumbnails, from left to right, show the objects in the F090W, F115W, F150W, F200W, F277W, F356W, and F444W bands.

Castellano et al. 2022

The observed evolution from z~8 to z~12 is marginal, especially for bright galaxies

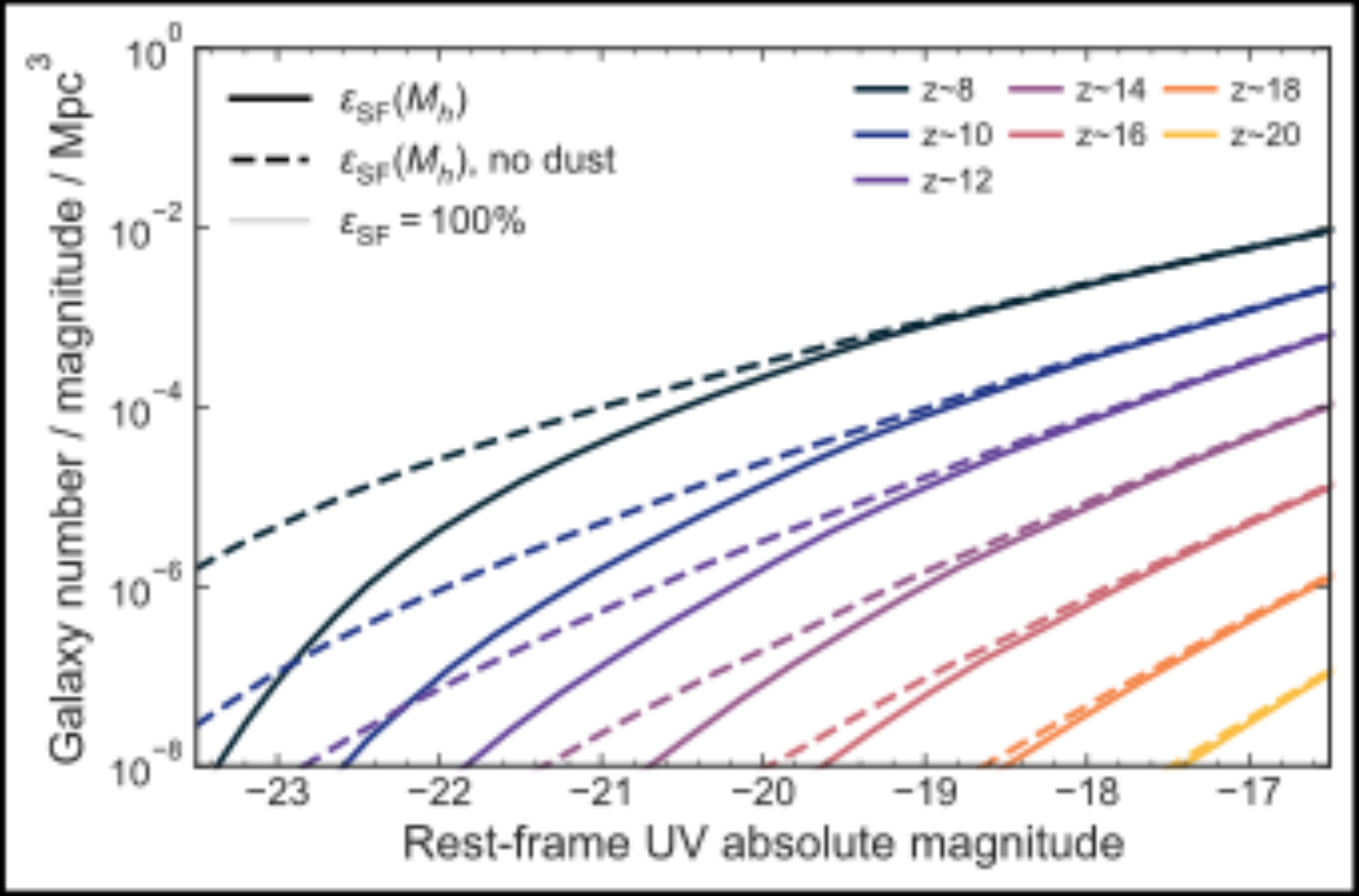


Harikane et al. 2022



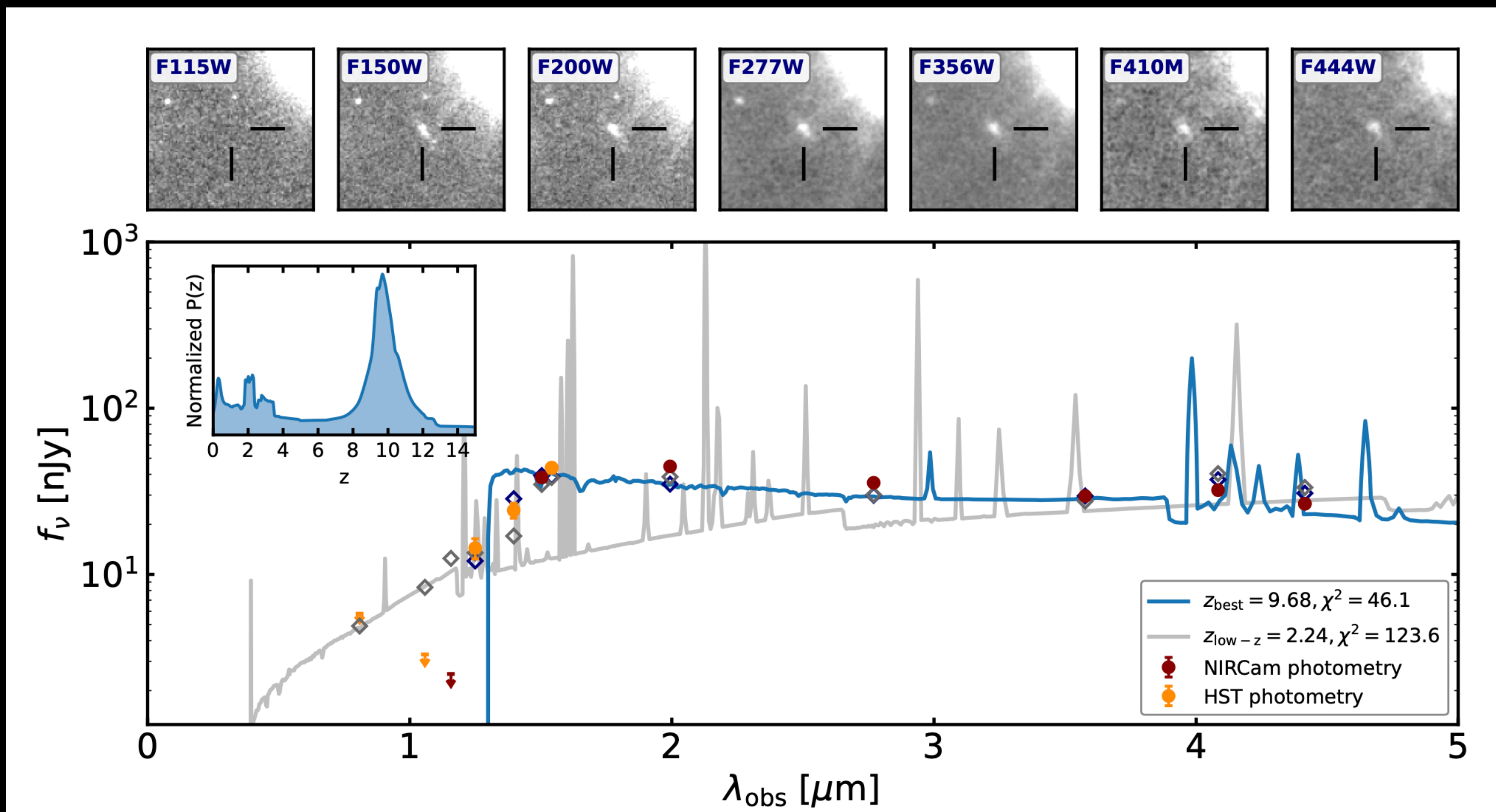
McLeod et al. 2023

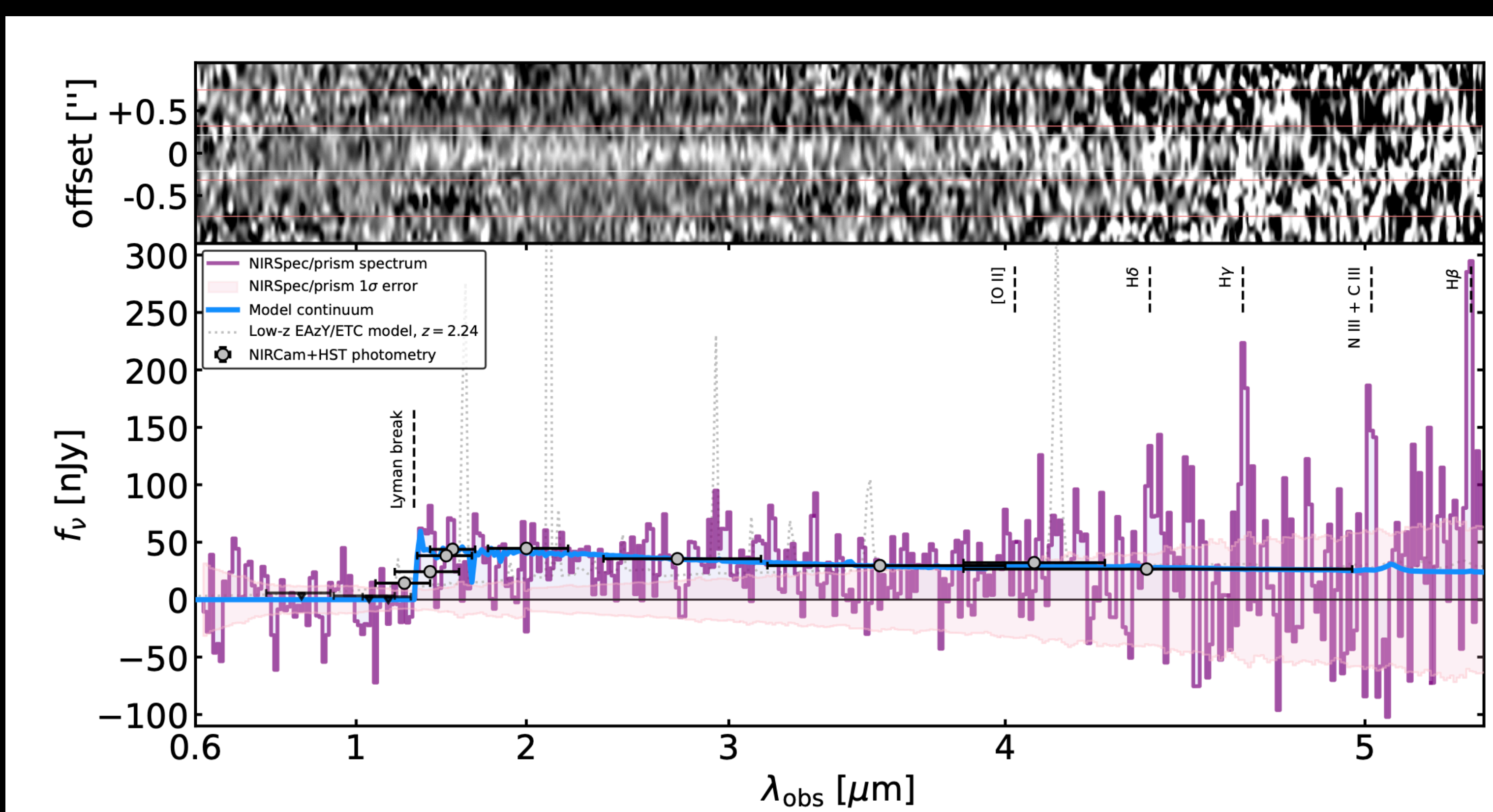
The number of bright galaxies is way larger than predicted by any theoretical model



Mason, Trenti & Treu 2022; see also Ferrara et al. 2022, Finkelstein et al. 2023

Result#2: We can get spectra up to z~13!!





z = 9.79 (480 Myr after the Big Bang)

ultra-faint ($M_{UV} = -17.35$) (luminosity typical of the sources responsible for cosmic reionization)

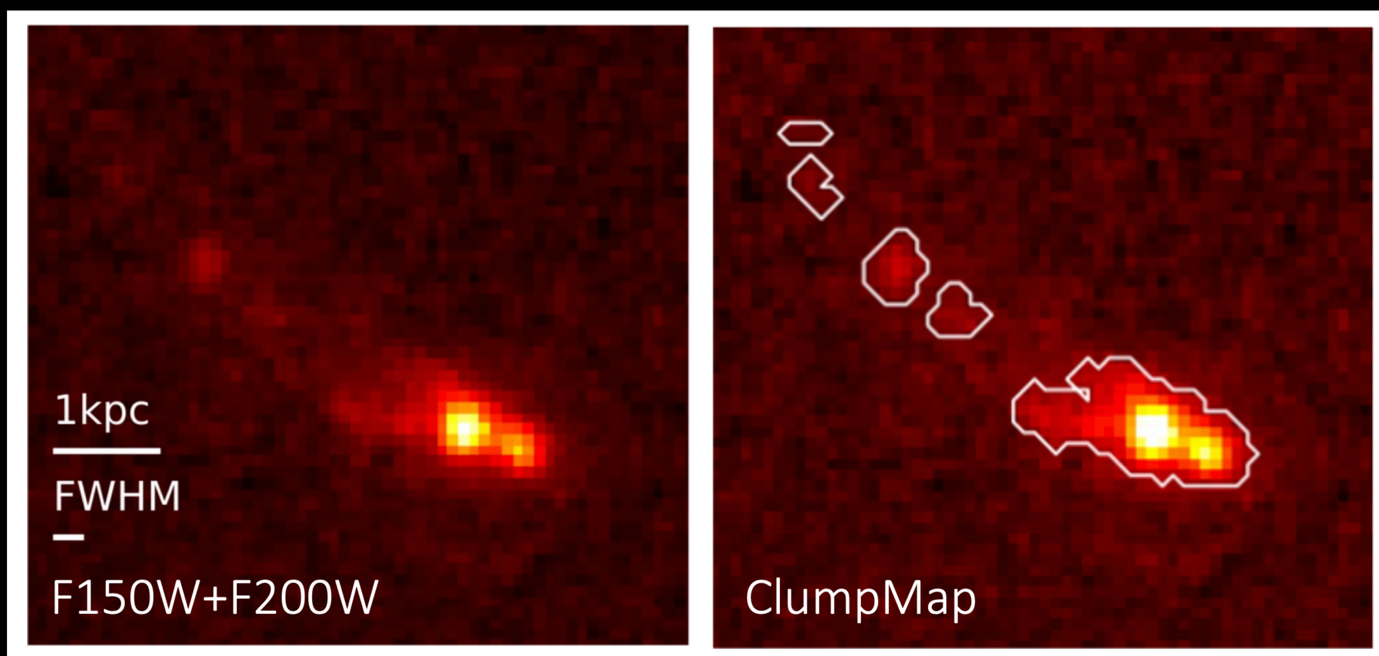
compact (~150 pc) and complex morphology

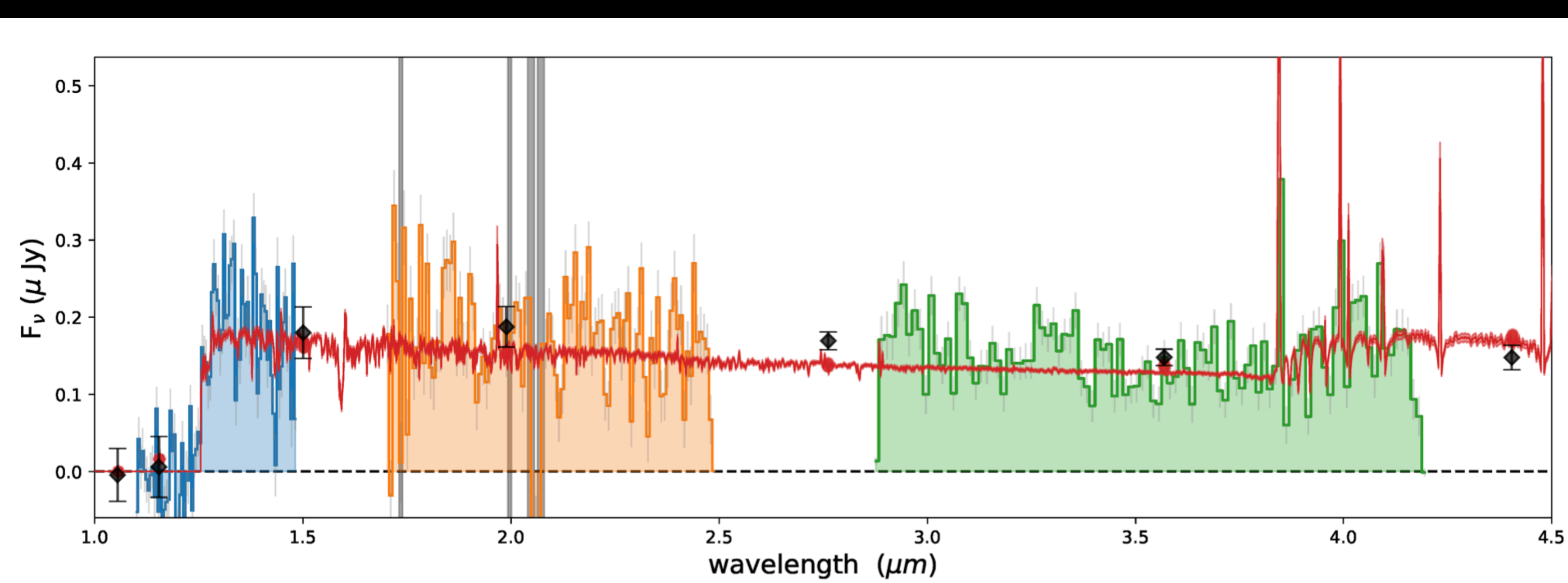
low stellar mass ($10^{7.19}$ $M_\odot$),

subsolar (~0.6 $Z_\odot$) gas-phase metallicity

Roberts Borsani et al. 2023

Result#2: We can get spectra up to z~13!!





z = 9.31 (525 Myr after the Big Bang)

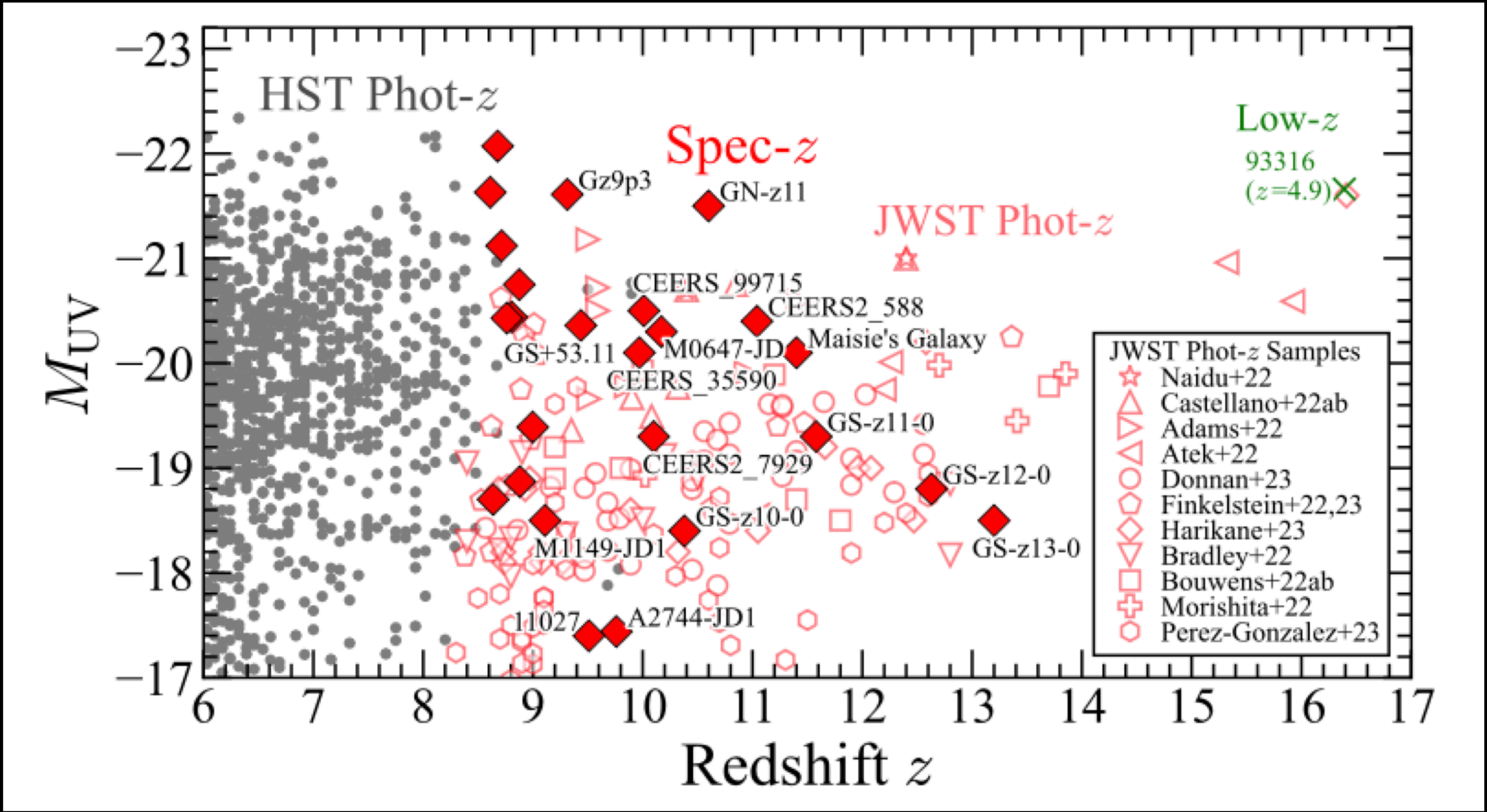
Highly star forming (25 $M_\odot$/yr)

Two interacting galaxies: a two-component main clump of very young stars (age < 10 million yr) surrounded by an extended stellar population (130 million yr)

Large stellar mass ($10^{9.8}$ $M_\odot$),

subsolar (~0.1 $Z_\odot$) gas-phase metallicity

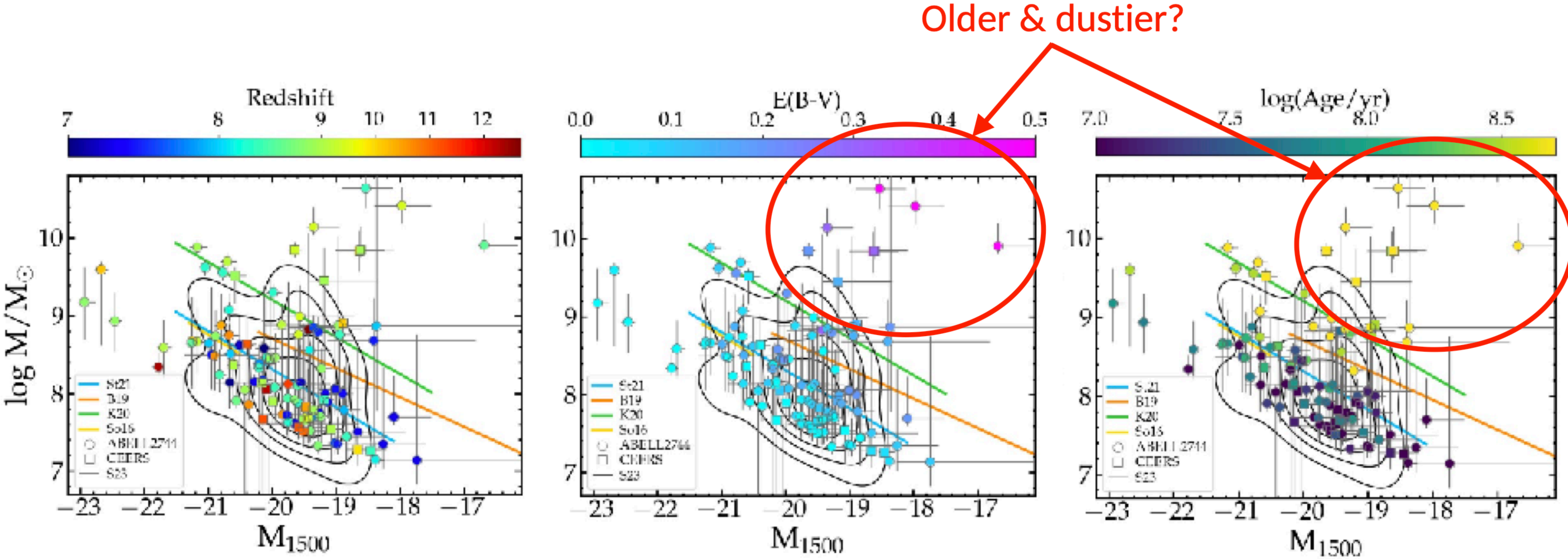
Boyett et al. 2023



Harikane et al. 2023

Result#3: Galaxies at z>8 come in a variety of flavours

Santini et al. 2023

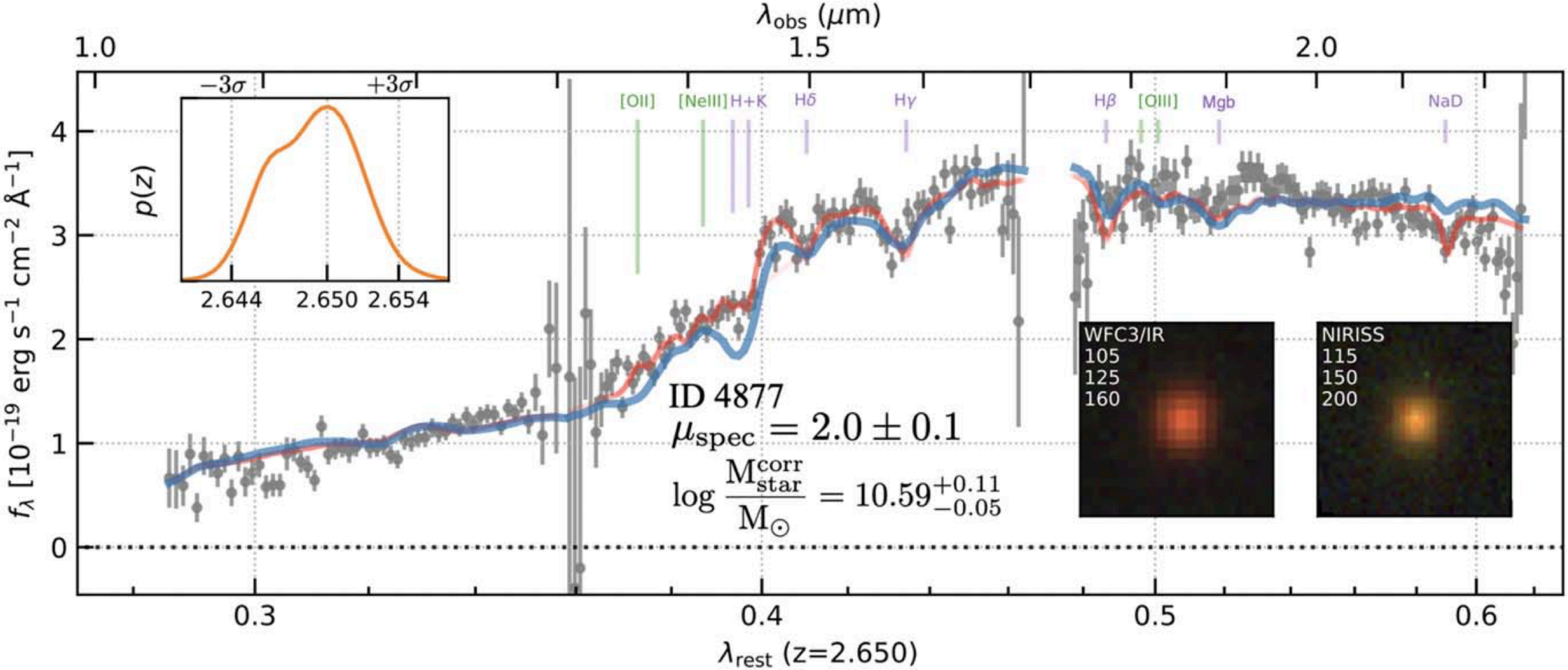


JWST observations reduce the uncertainties on the stellar mass by a factor of at least 5–10, when compared with the highest-quality data sets.

Galaxies exhibit a a two orders of magnitude range of M/LUV values for a given luminosity, indicative of a broad variety of physical conditions and star formation histories

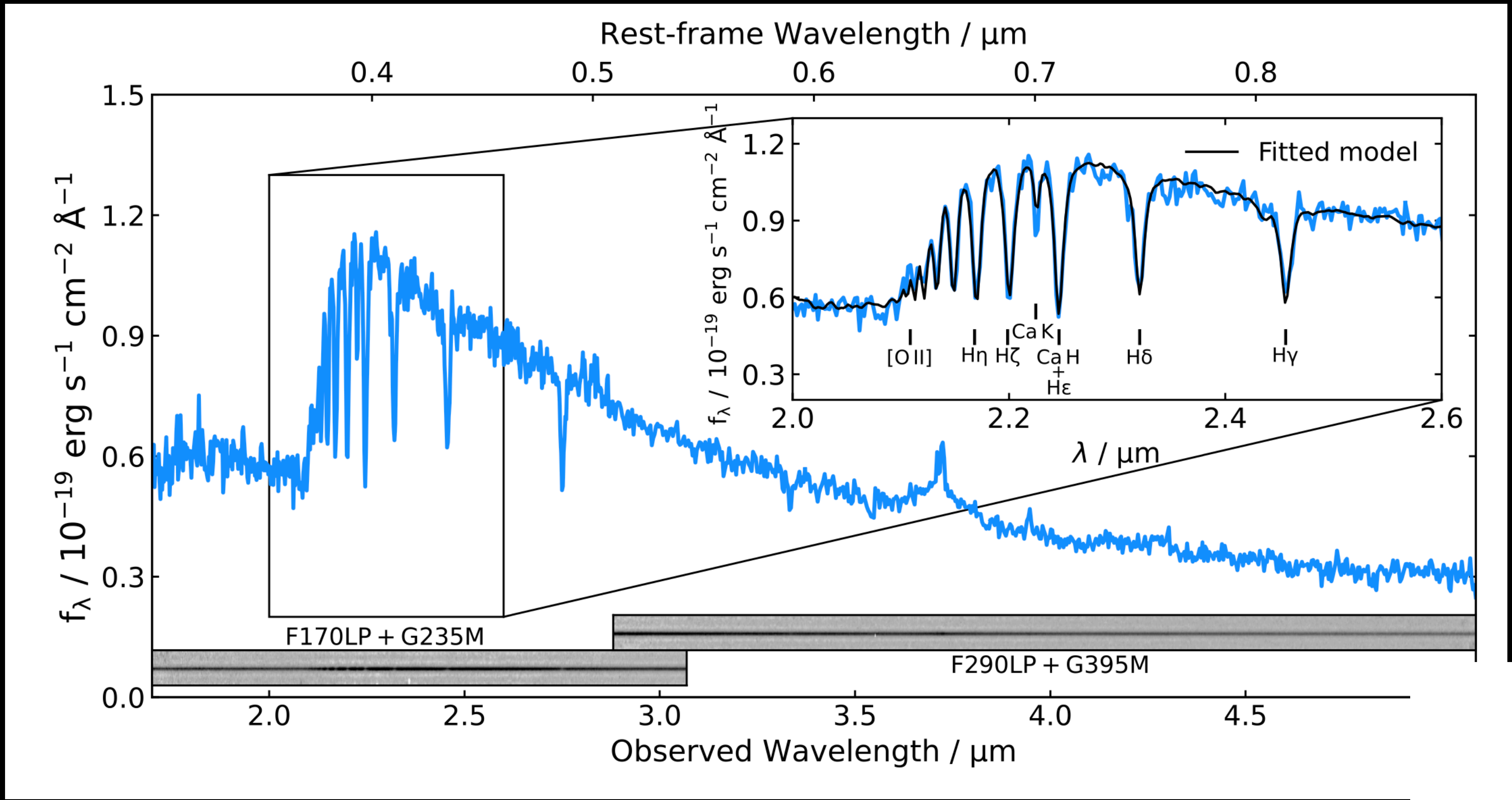
Result#4: Quiescent galaxies exist even in the first Gyr

spectroscopic confirmation of two quiescent galaxies at z>2 with mass $10^{10.59}$ $M_\odot$ and $10^{10.07}$ $M_\odot$

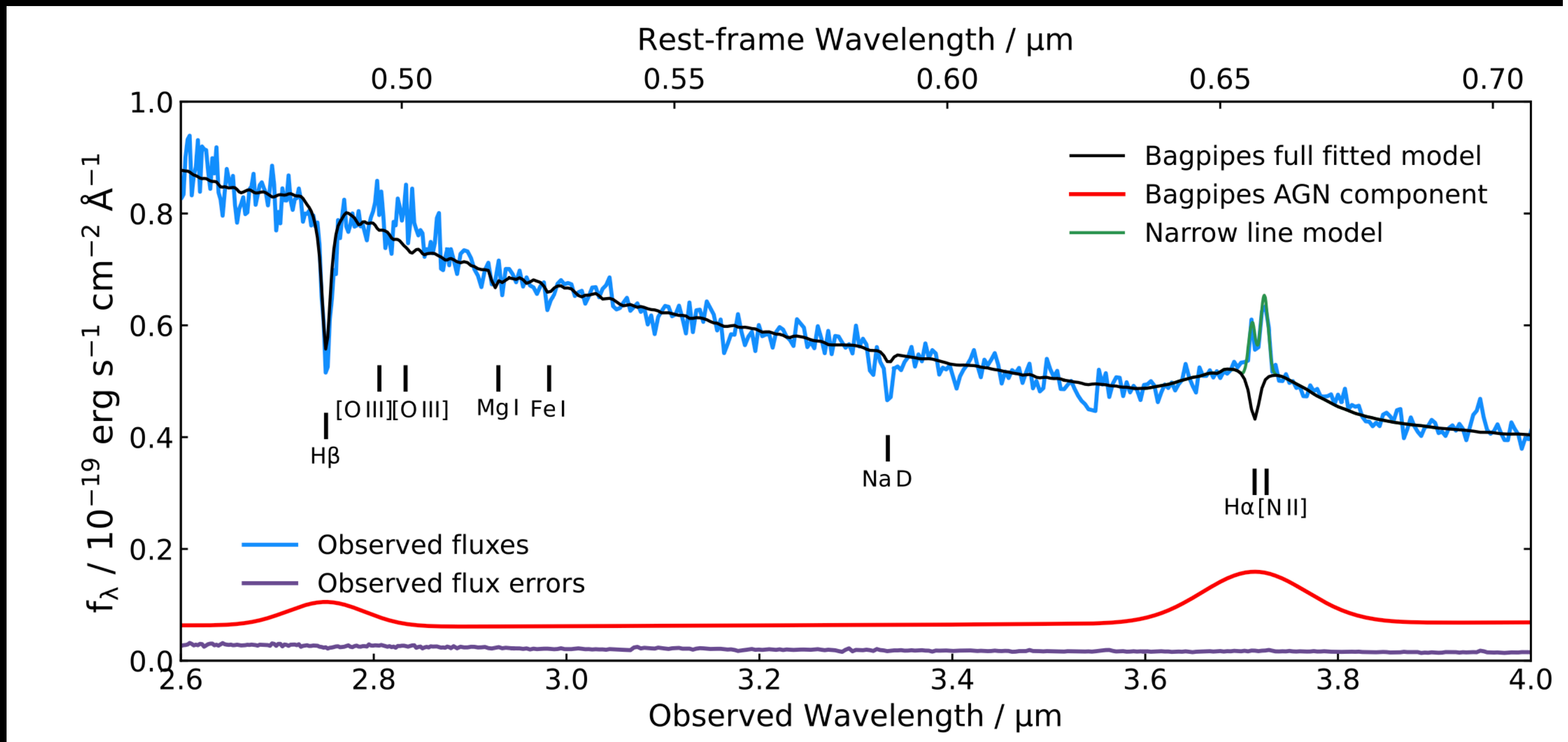


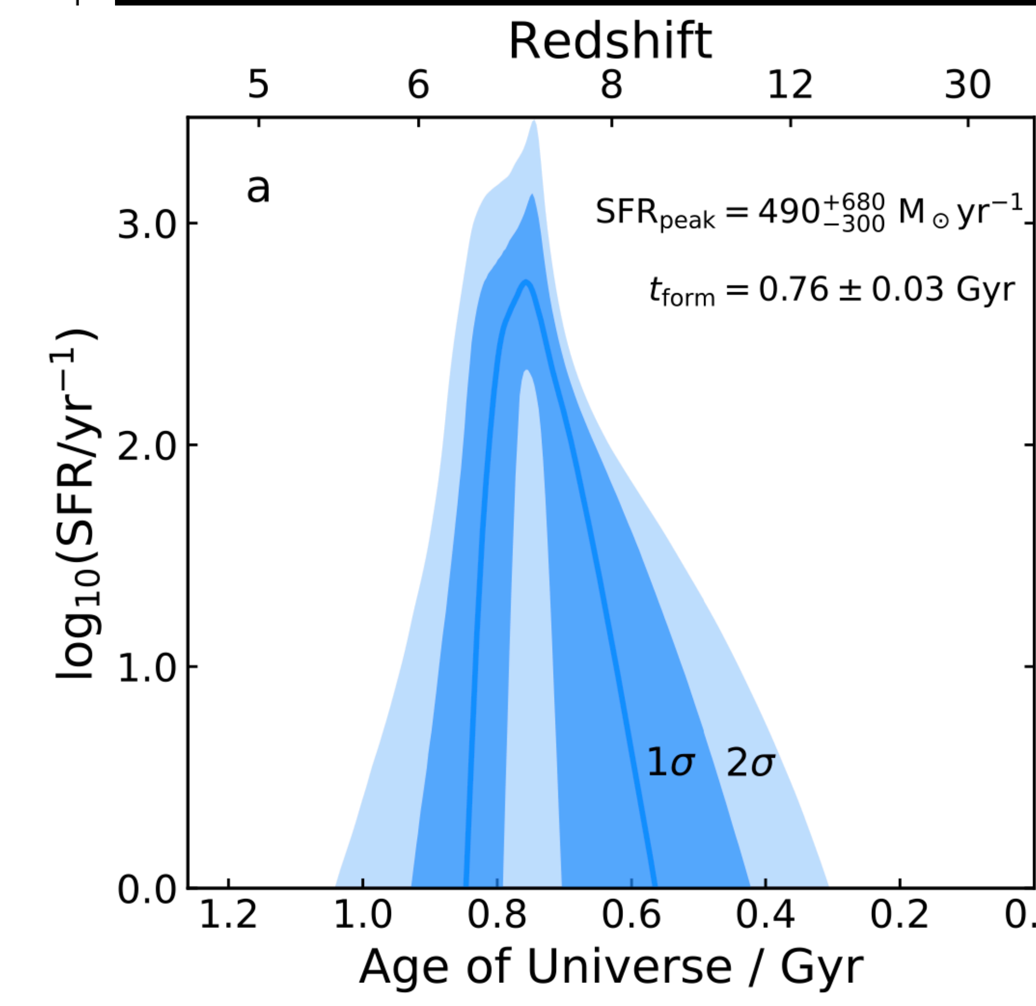
Marchesini et al. 2023

A massive quiescent galaxy, with AGN emission at z=4.7 (age of the universe 1.3 Gyr)



Carnall et al. 2023

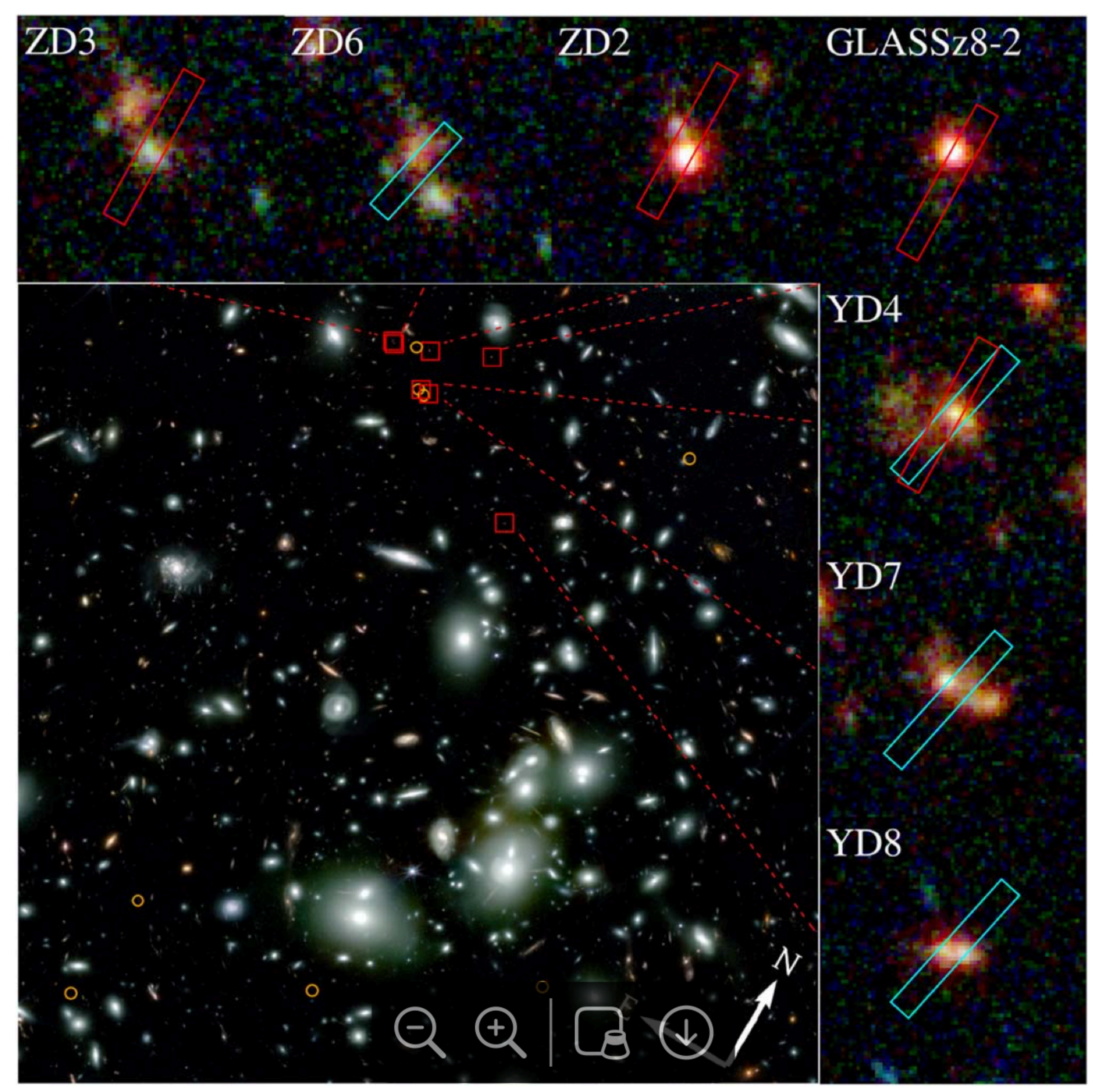


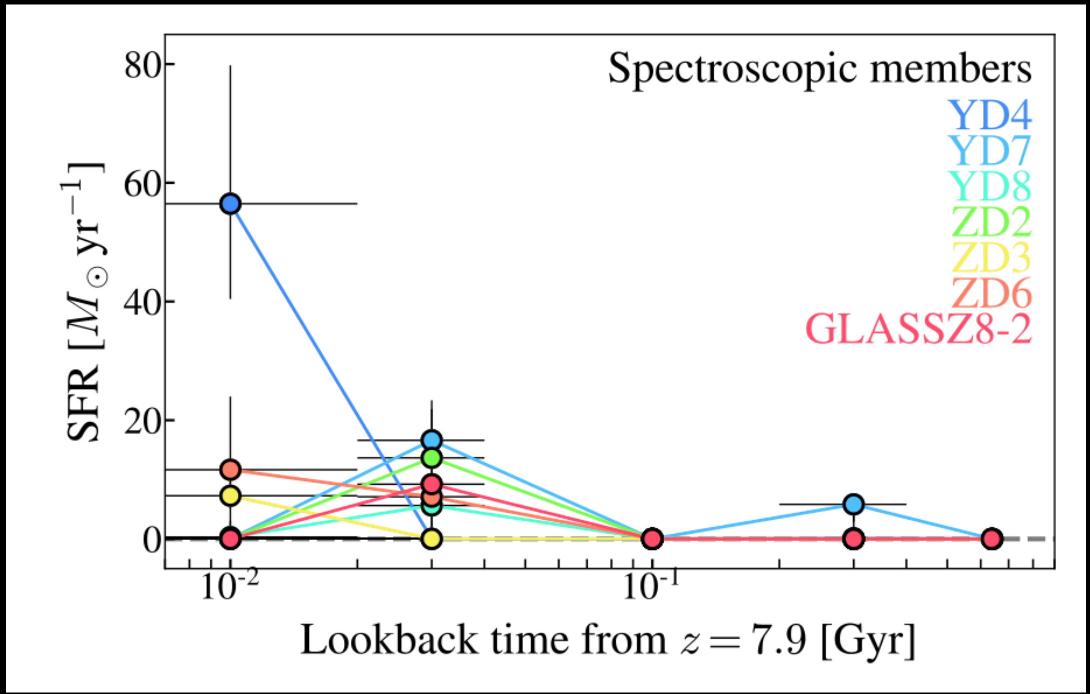


Result#5: Protoclusters at z>7

Morishita et al. 2023

z=7.88





R ~ 60 kpc in the source plane

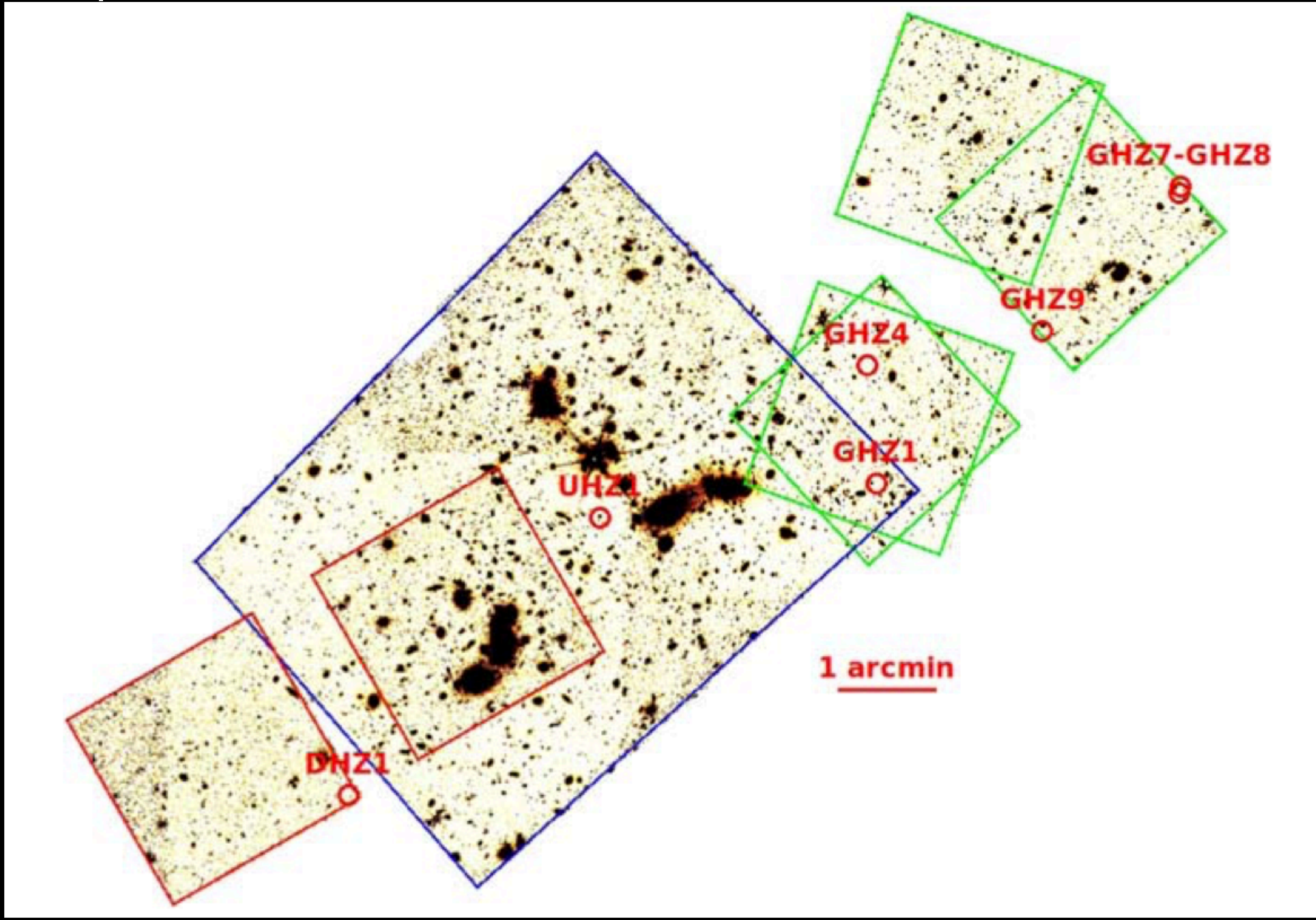
empirical MUV–Mhalo relation for individual galaxies —> M_h > 4 × 10^{11} Msun.

line-of-sight velocity dispersion: 1100±200km/s.

present-day halo mass: 2 × 10^{15} Msun high density of redshift $z \approx 10$ galaxies (about 10× (3×) larger than the average at MUV ≈ −21 (−20) mag reported so far)

galaxies distributed along an apparent filamentary structure of 2 Mpc in projected length

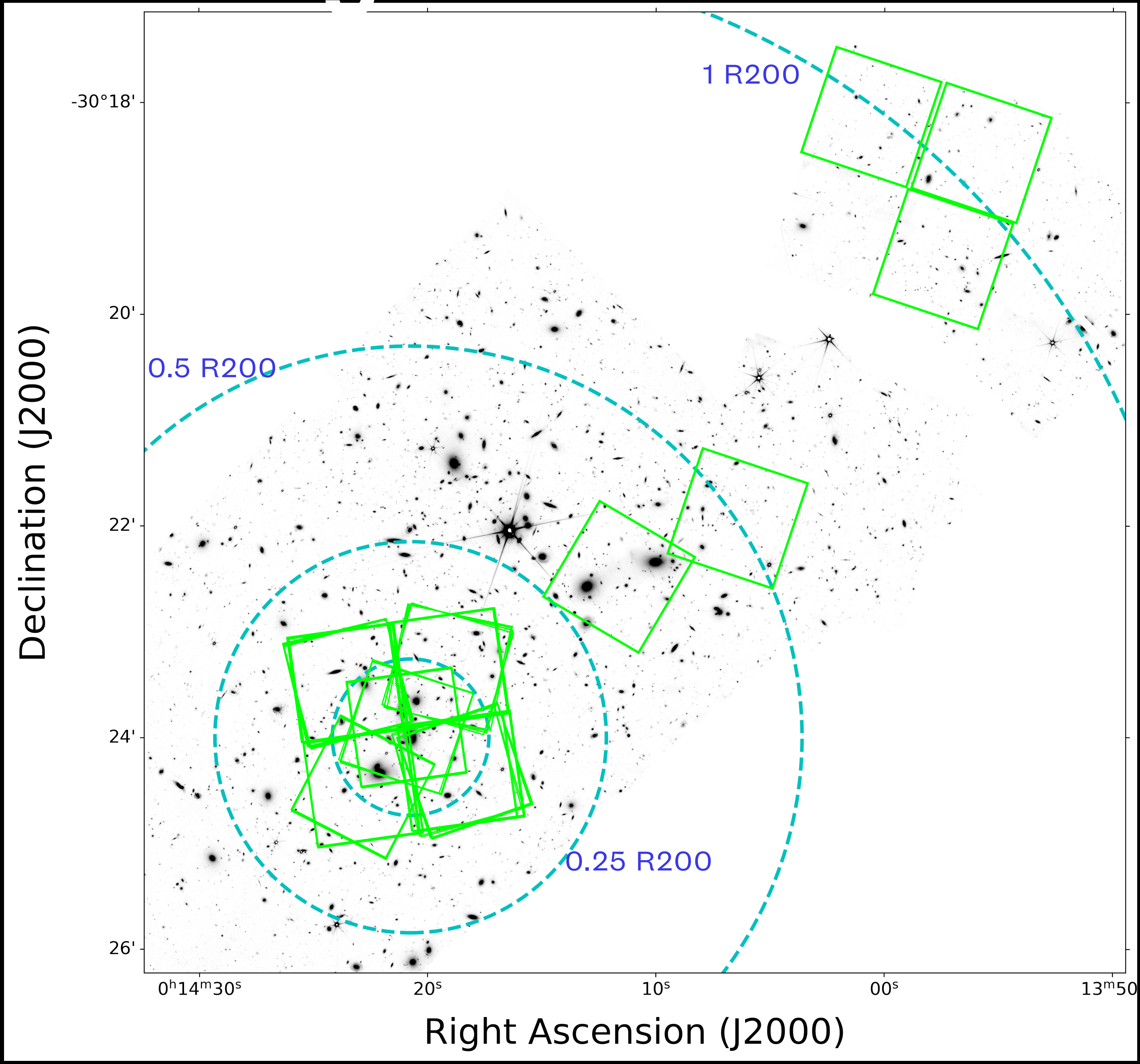
close pair of candidates with MUV<−20 mag having a projected separation of only 16kpc.



presence of a $z \approx 10$ overdensity in the field?

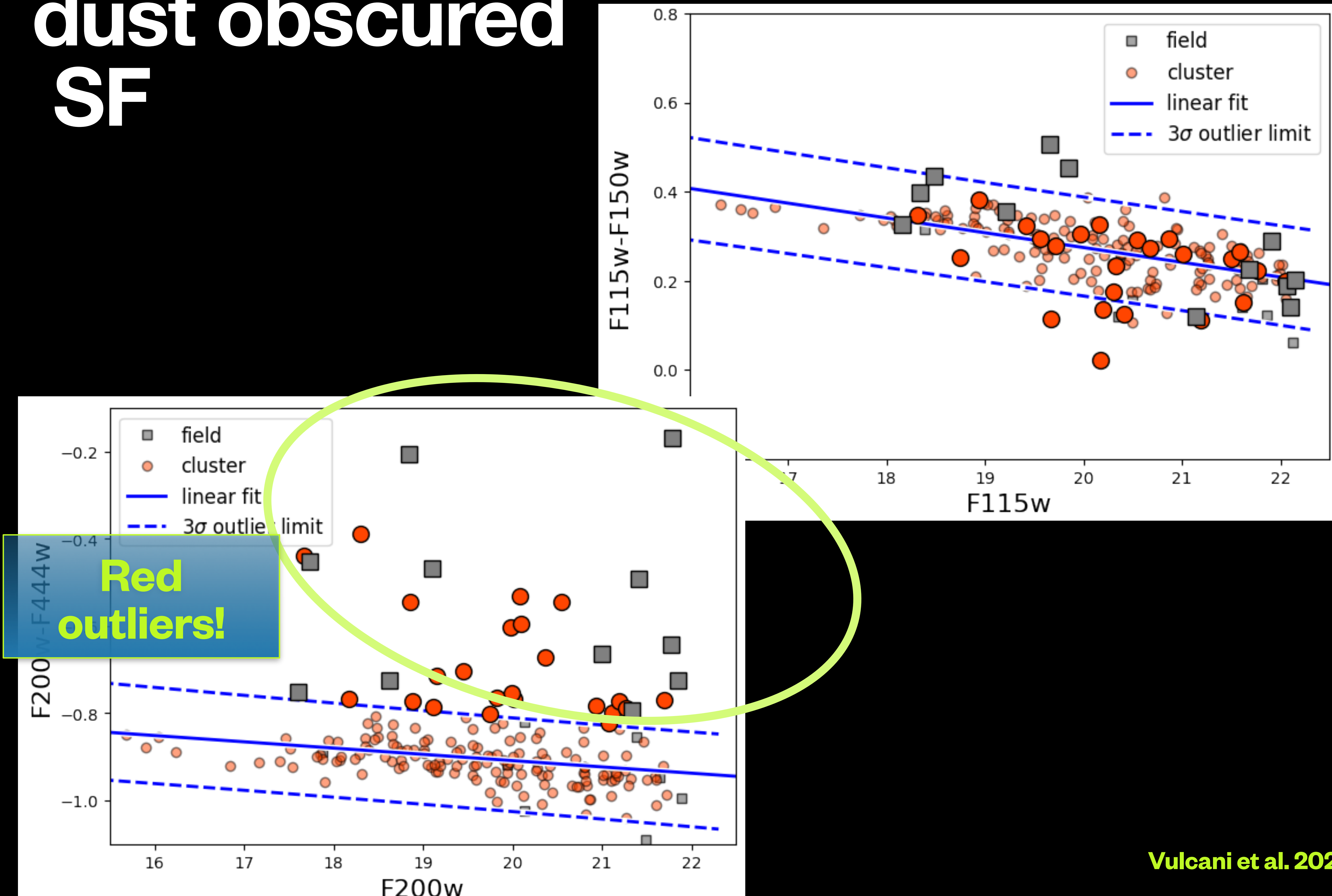
Castellano et al. 2023

Result#6: Cluster galaxies

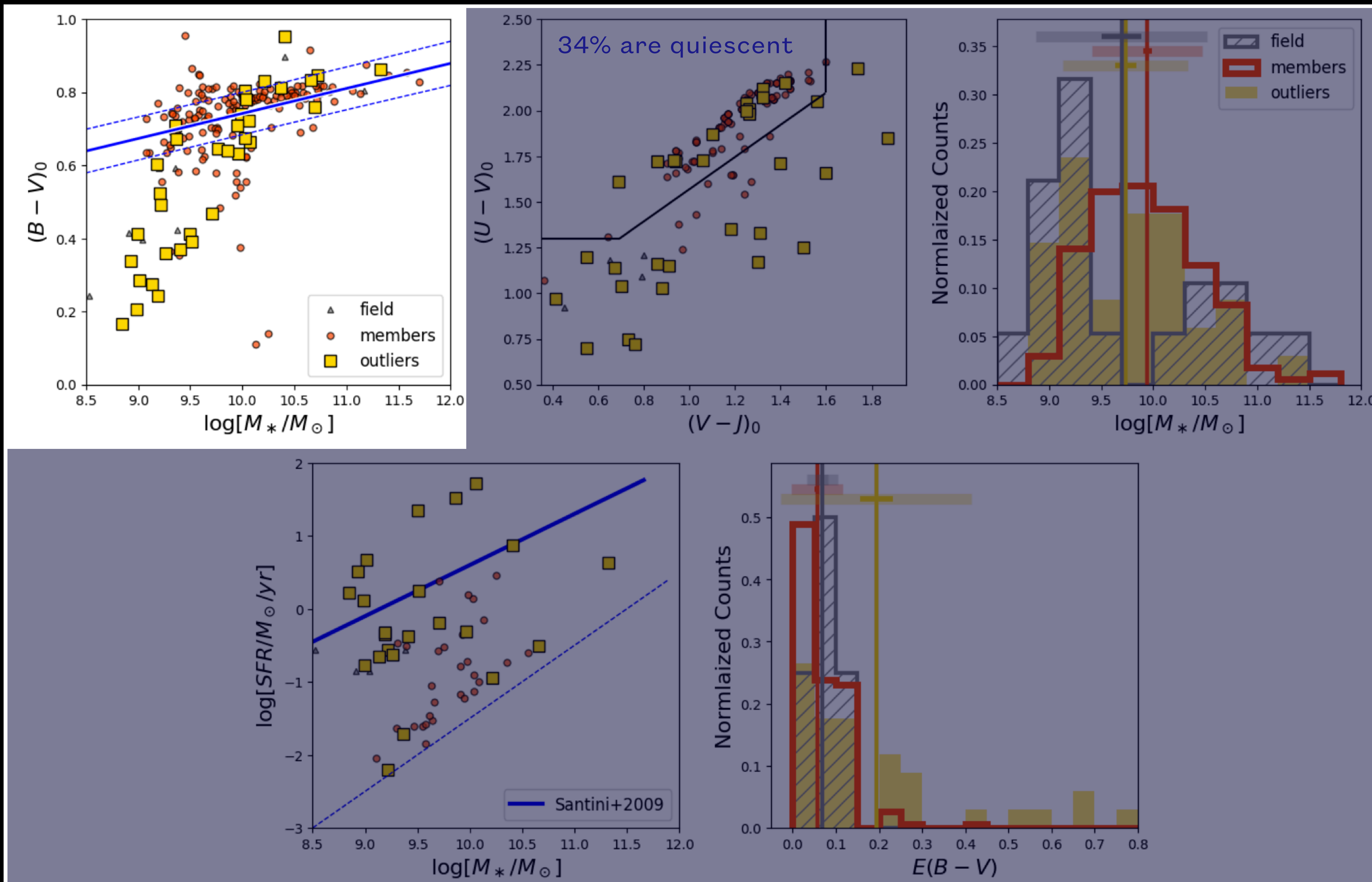


Vulcani et al. 2023

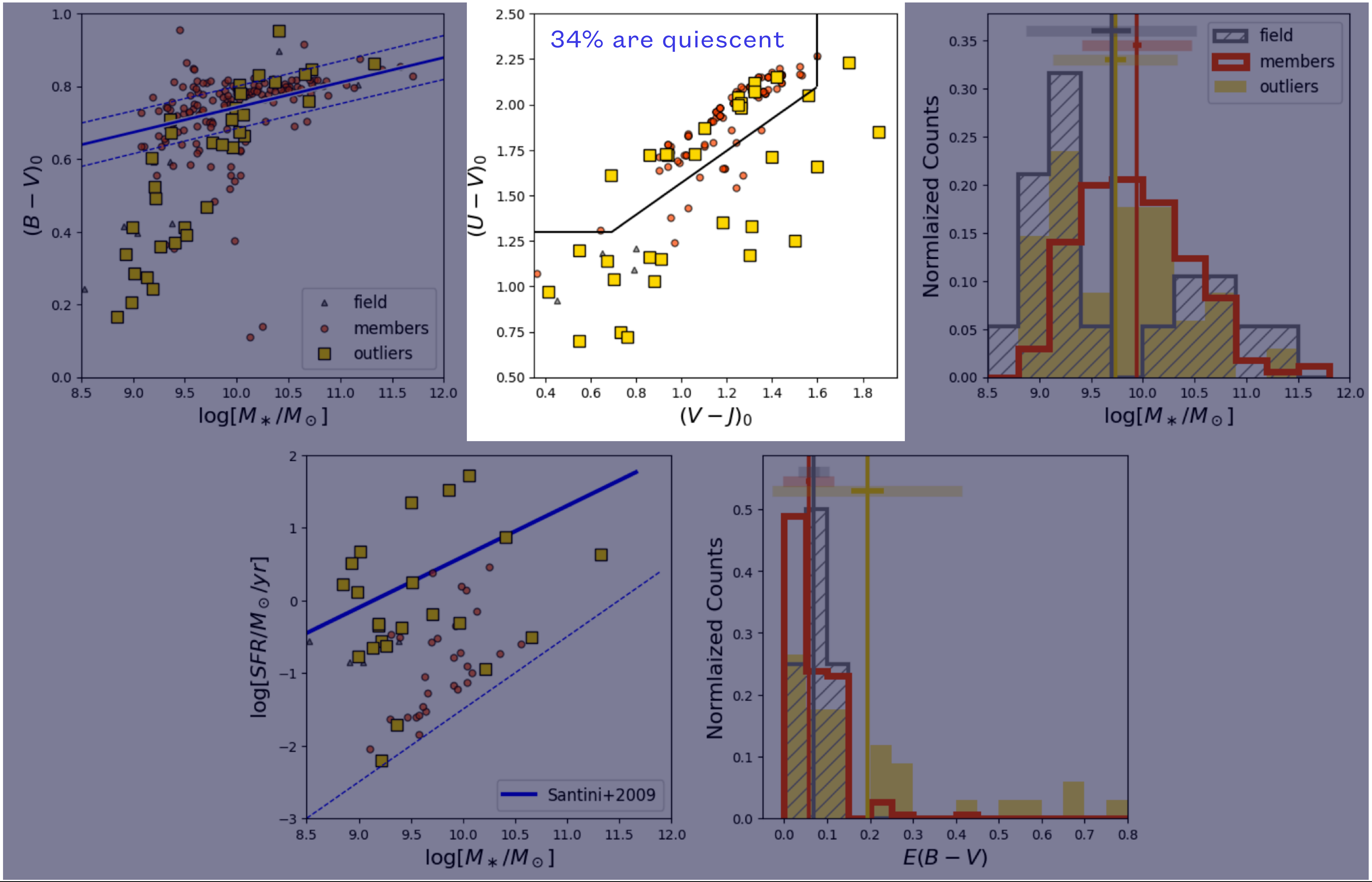
Result#6: Cluster galaxies have dust obscured SF

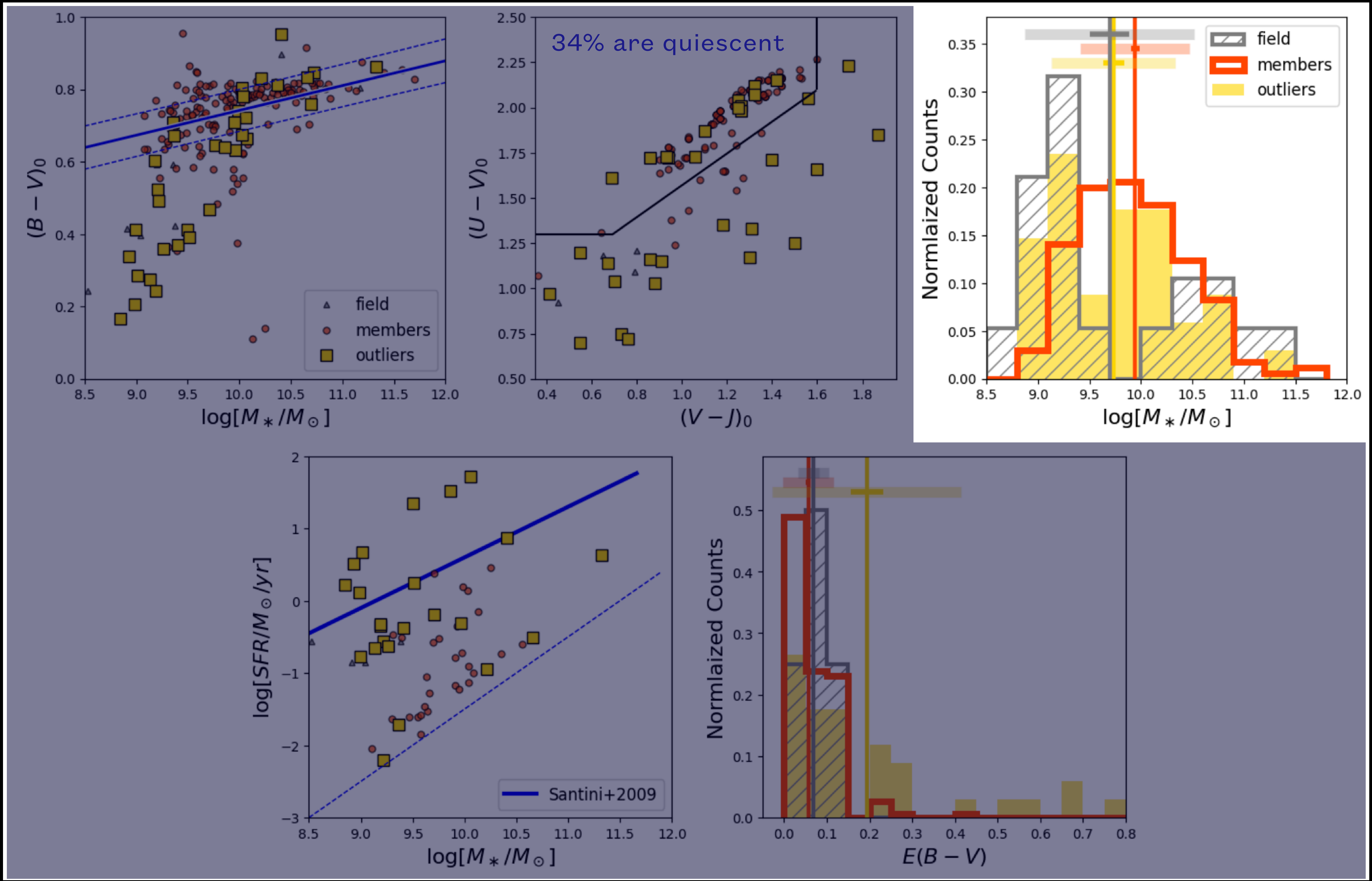


Vulcani et al. 2023



(B − V)0
log[M∗/M⊙]
field
members
outliers
34% are quiescent
(U − V)0
(V − J)0
Normlaized Counts
field
members
outliers
log[M∗/M⊙]
log[SFR/M⊙/yr]
Santini+2009
log[M∗/M⊙]
Normlaized Counts
E(B − V)


34% are quiescent
field
members
outliers
Santini+2009
$(B-V)_0$
$\log[M_*/M_\odot]$
$(U-V)_0$
$(V-J)_0$
Normlaized Counts
$\log[SFR/M_\odot/yr]$
$E(B-V)$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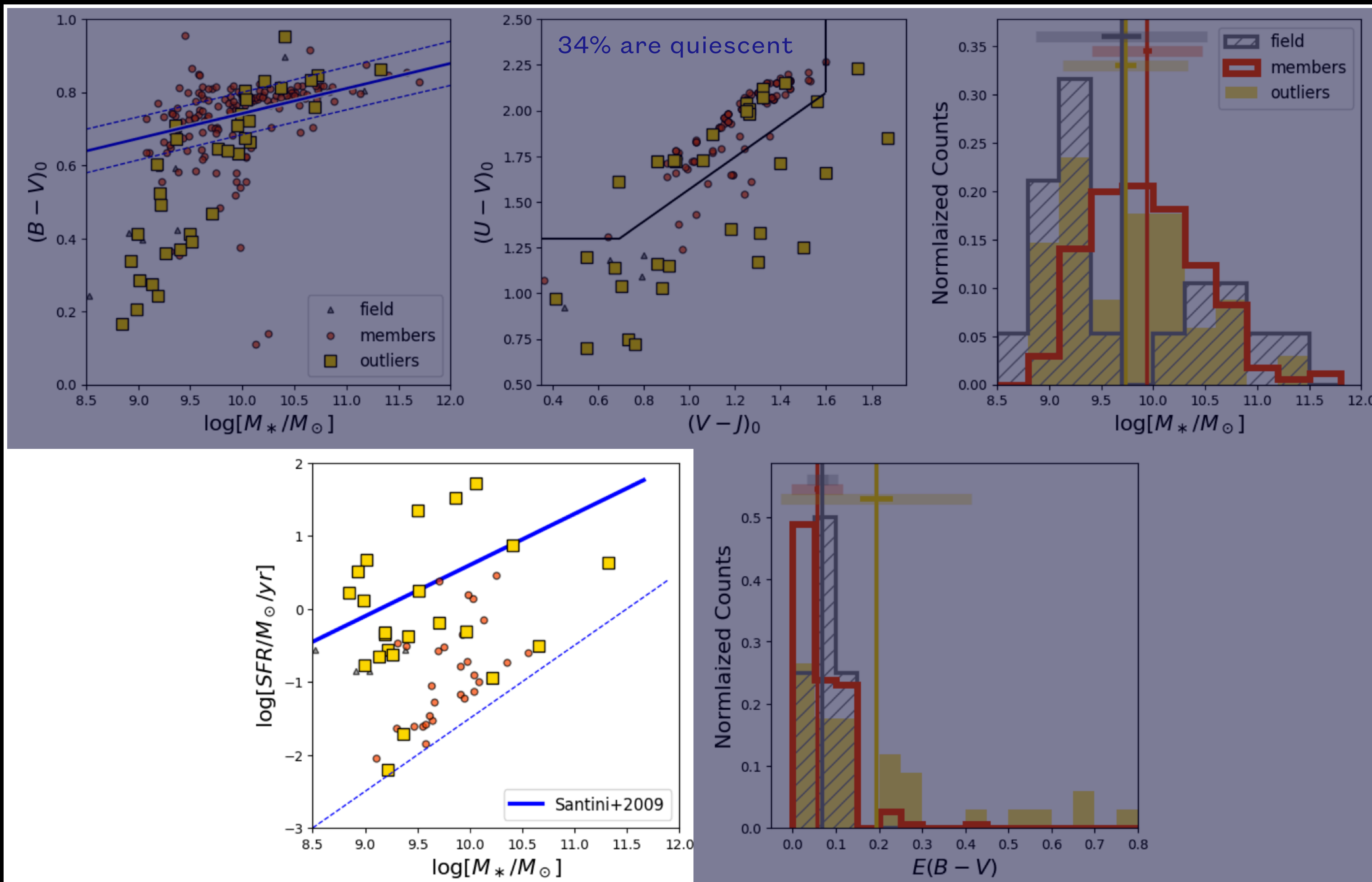

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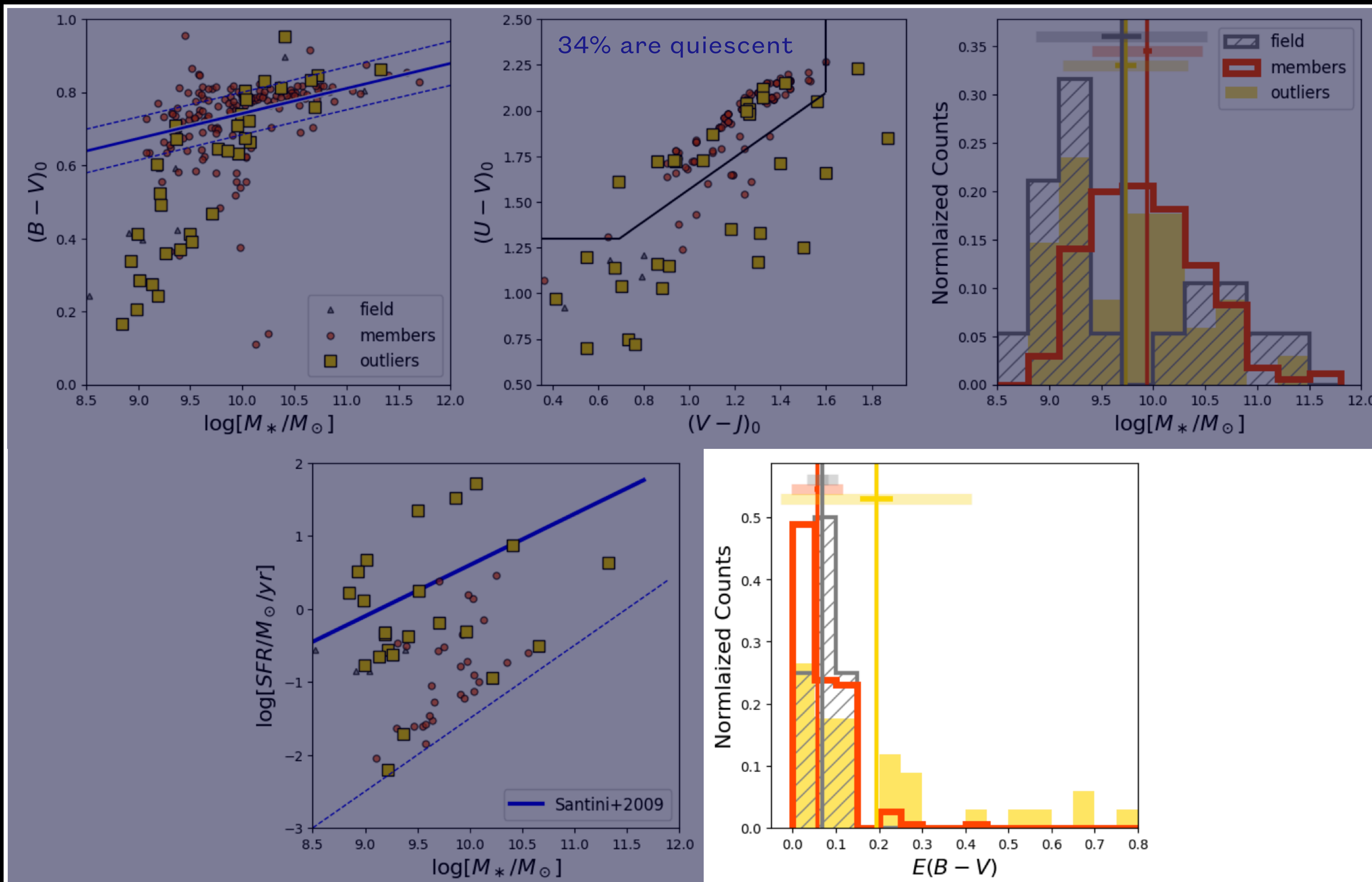
$E(B-V)$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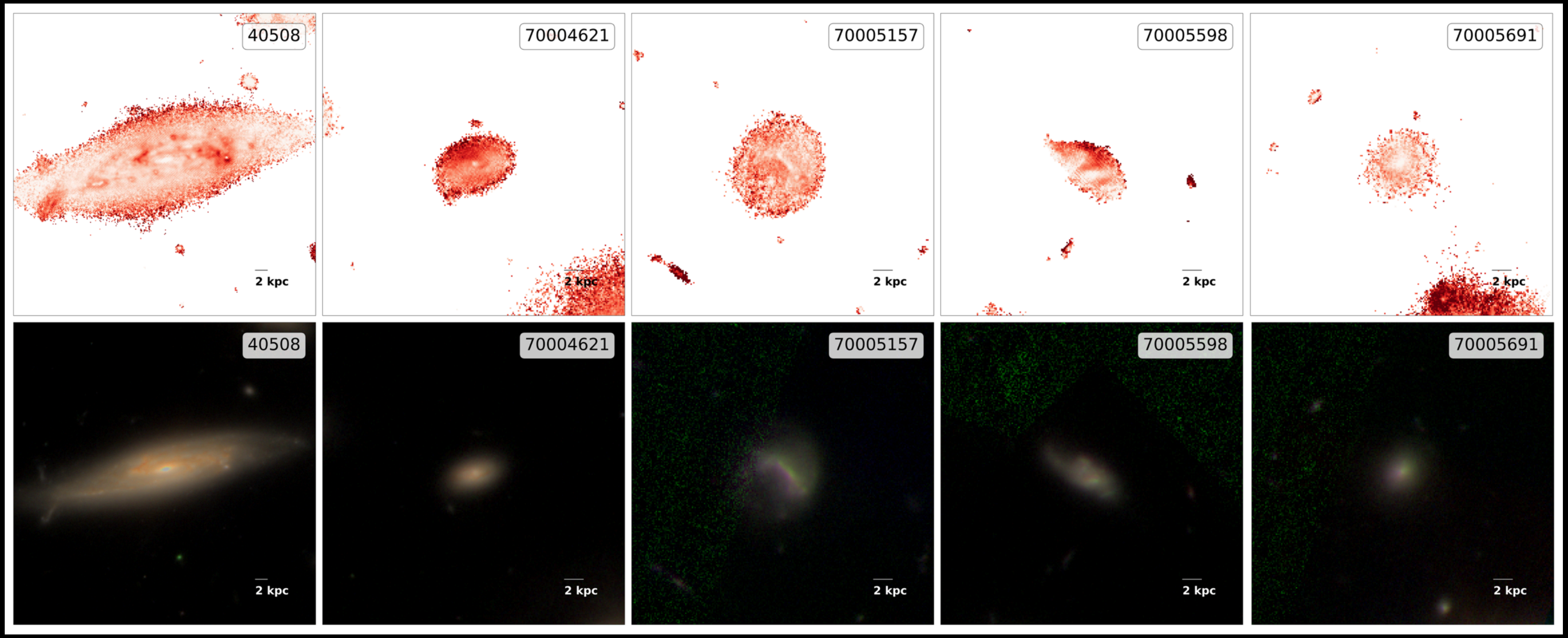
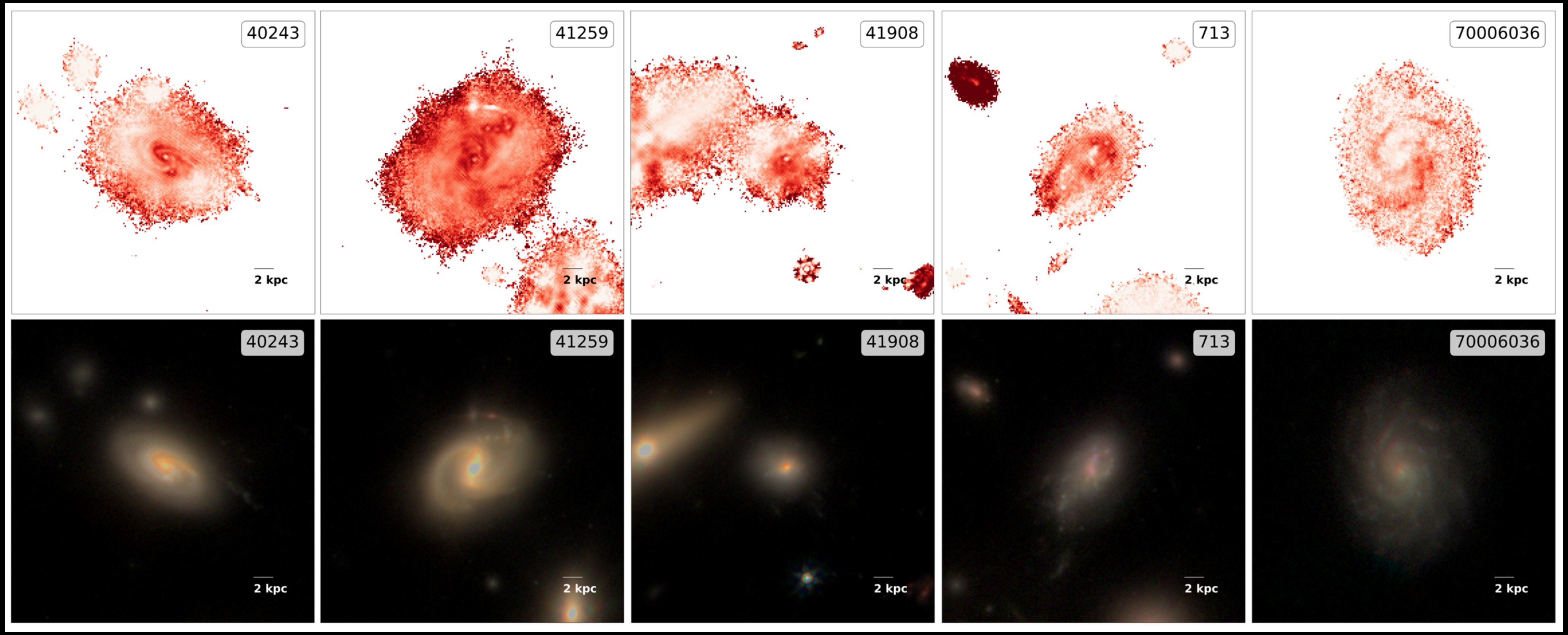
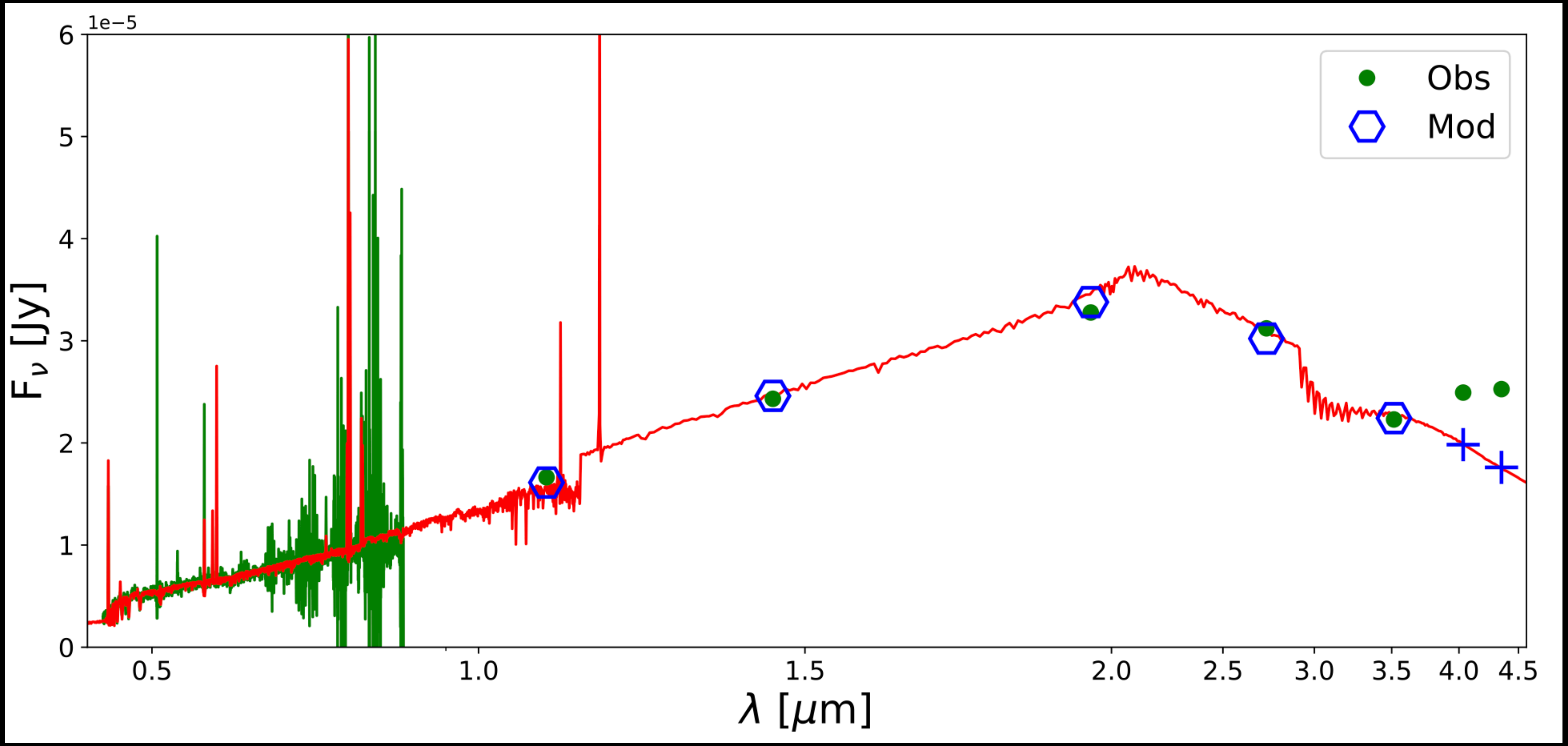
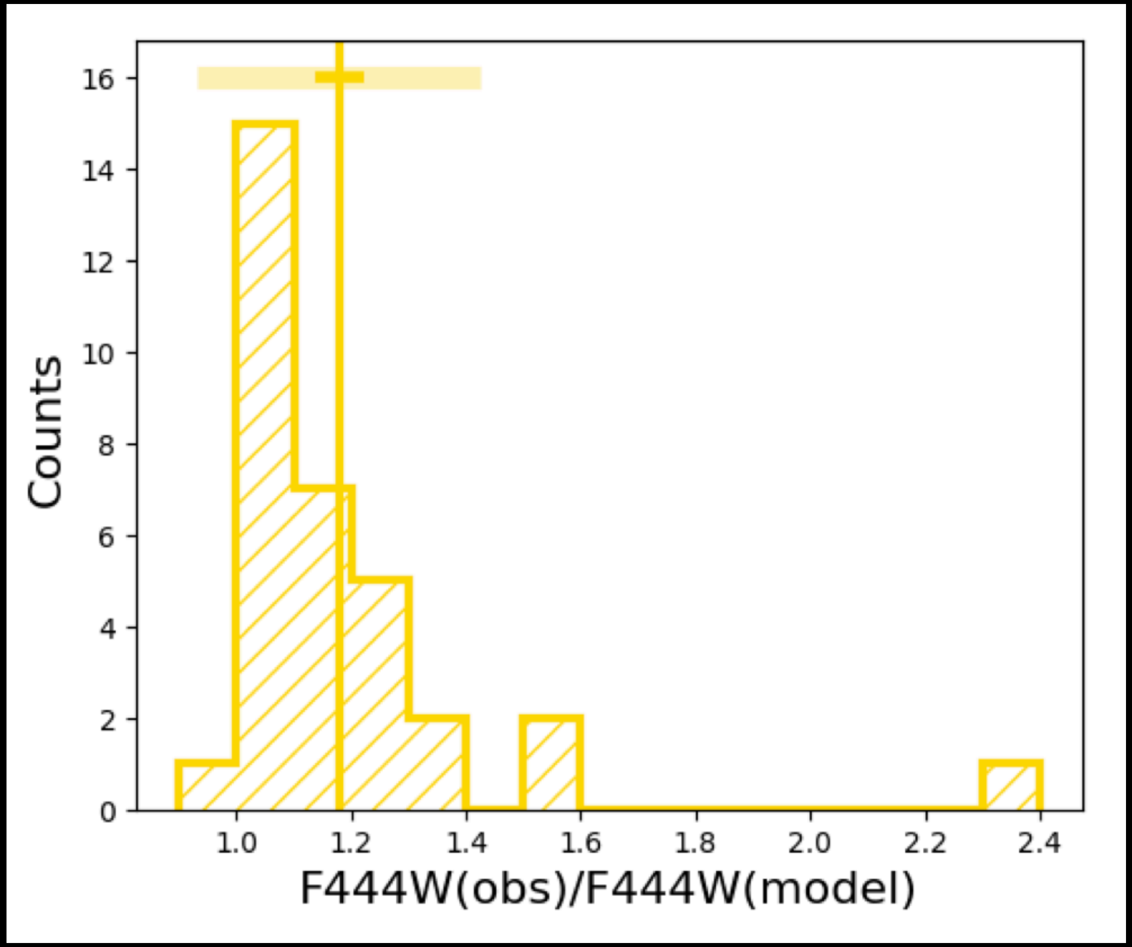




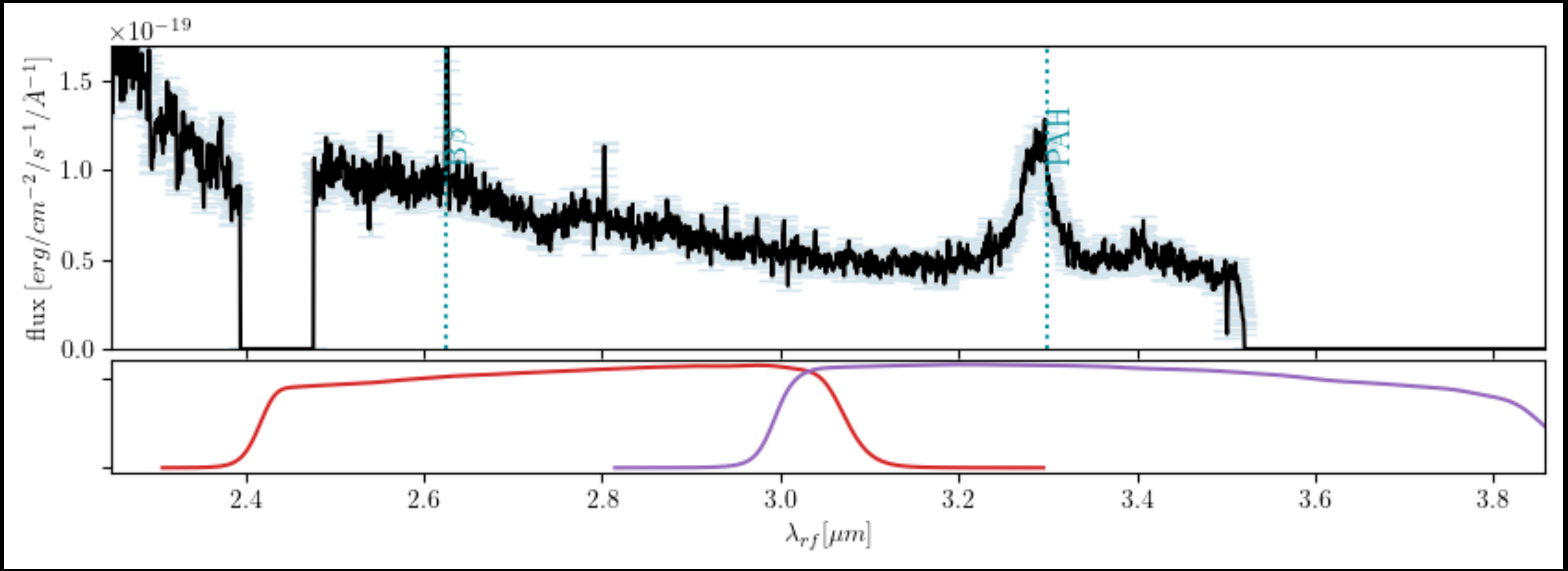
- Ram pressure stripping in the cluster
- Interactions in the field



1e−5
Obs
Mod
F$_\nu$ [Jy]
λ [μm]



Counts
F444W(obs)/F444W(model)



- Is the color excess always due to the PAH emission?
- Is the PAH linked to environmental effects?
- Is it due to dust enshrouded star formation (Magnelli et al. 2008, Rawle et al. 2014)?

Thanks