FROM PROTOCLUSTERS TO CLUSTERS: GALAXY EVOLUTION IN HIGH REDSHIFT STRUCTURES

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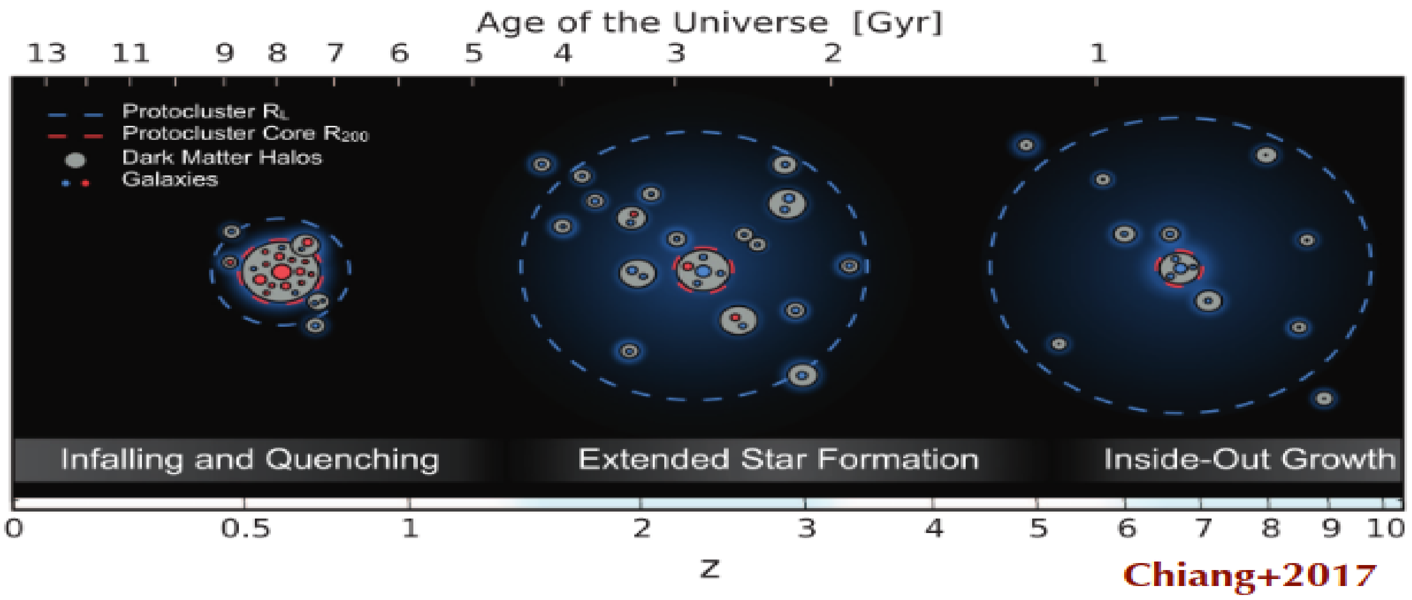
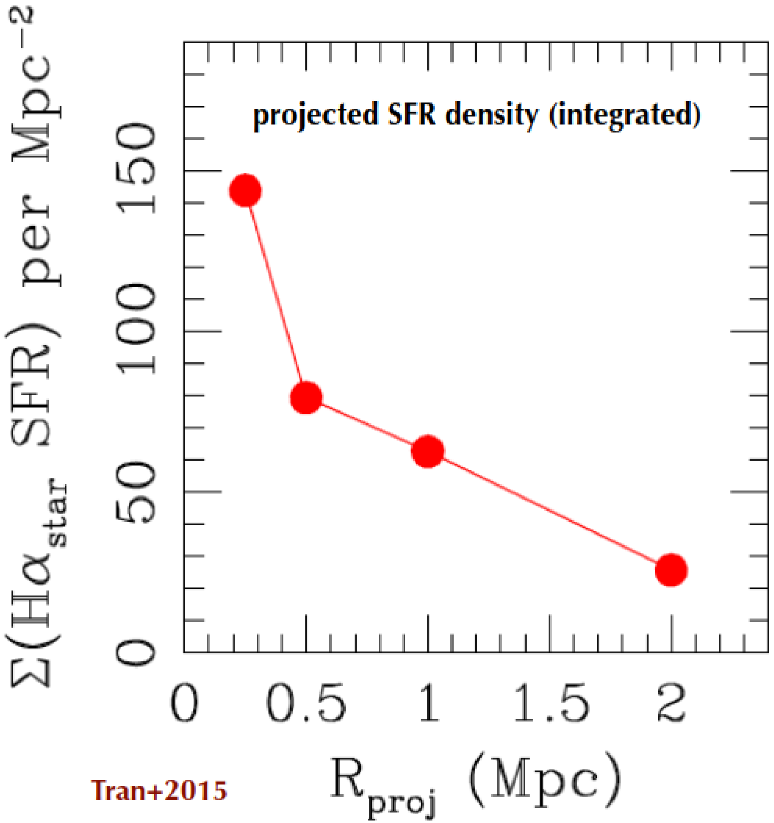
INAF ISTITUTO NAZIONALE DI ASTROFISICA

The first massive clusters emerging from the proto-cluster to cluster transition



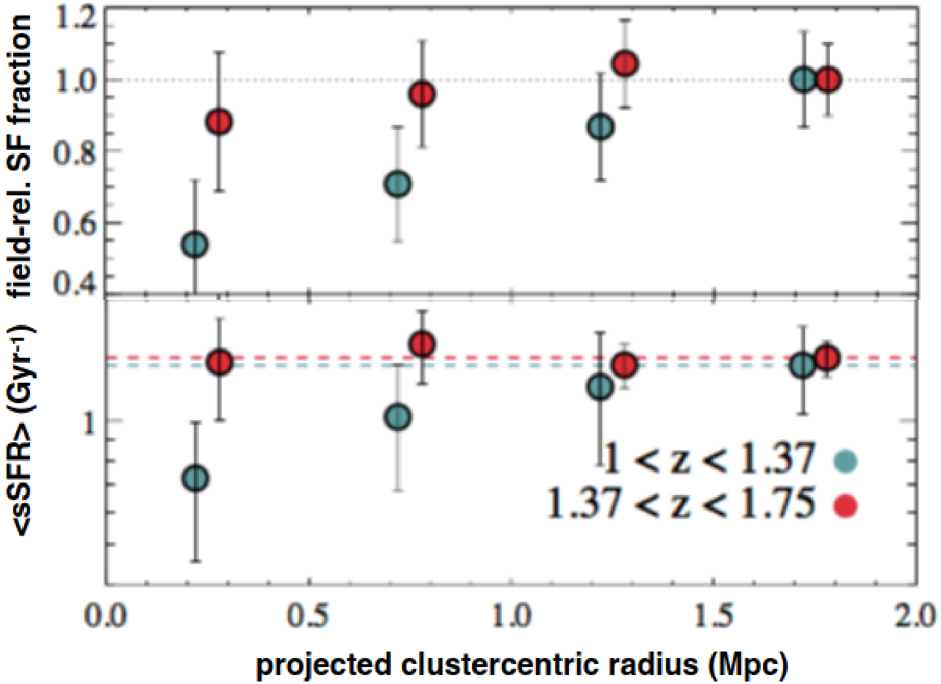
0 < z < 1.4	1.4 < z < 3	z > 4
Infalling satellites	**massive galaxies formation**	**BCGs assembly**

Main science driver – Star formation and quenching in the first massive clusters



Tran+2015

Alberts+2016



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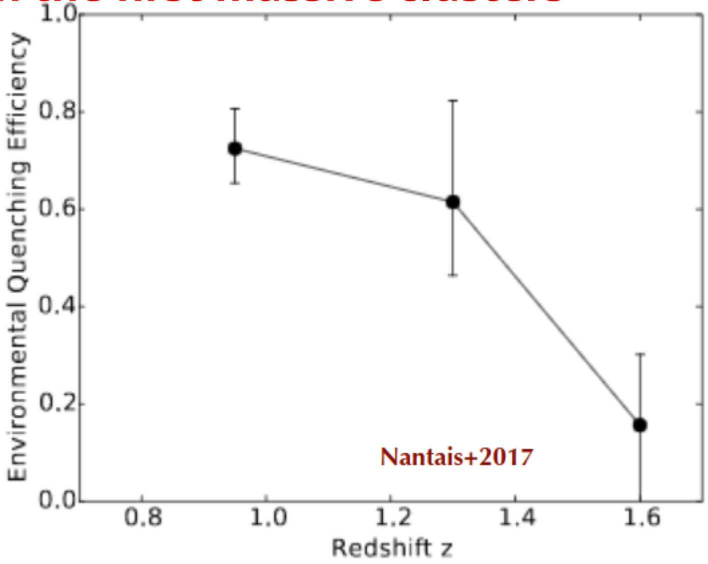
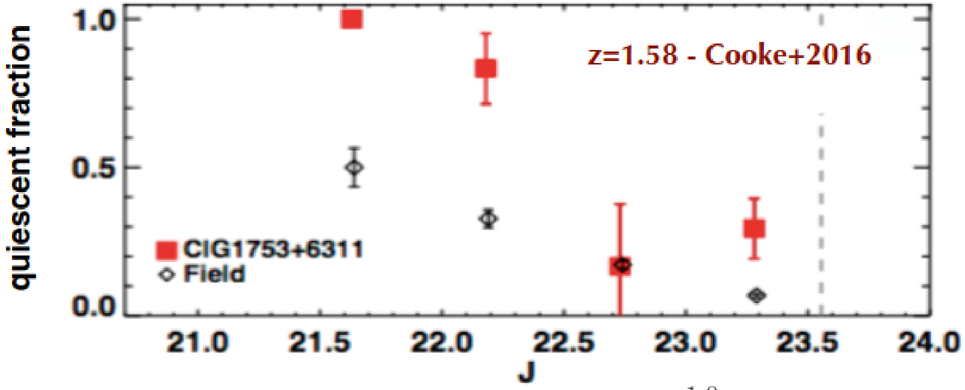
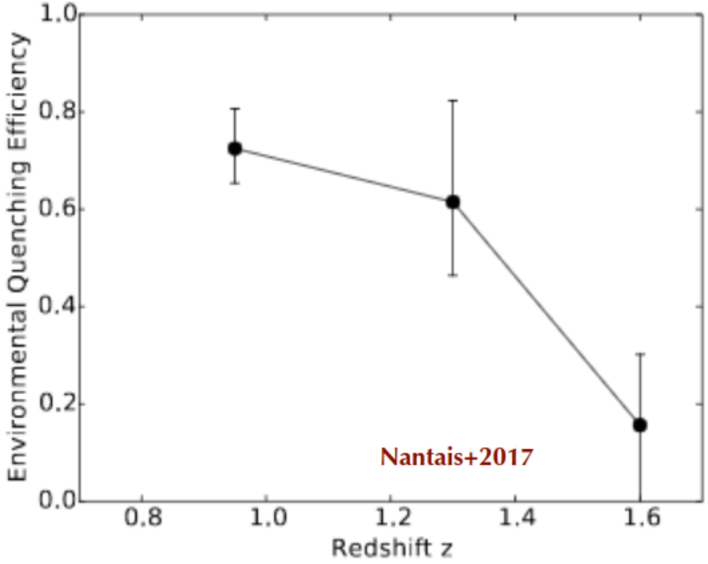
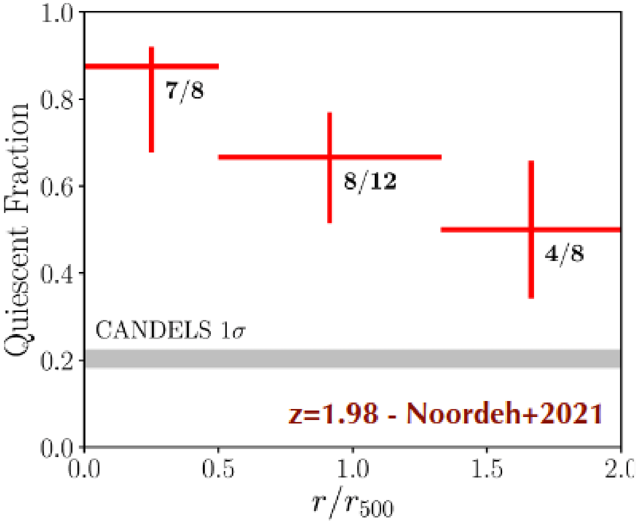


$(f_{q,cl} - f_{q,fld})/(1 - f_{q,fld})$, which is the fraction of galaxies that would be star-forming in the field and that instead have had their star formation suppressed by the cluster environment







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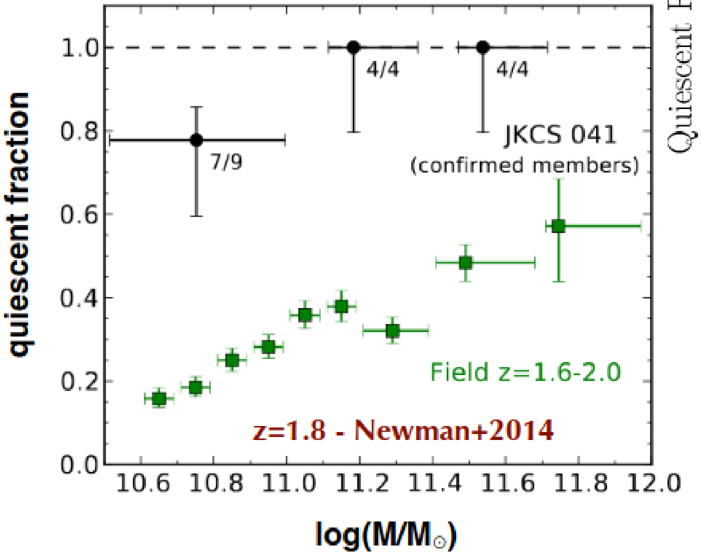
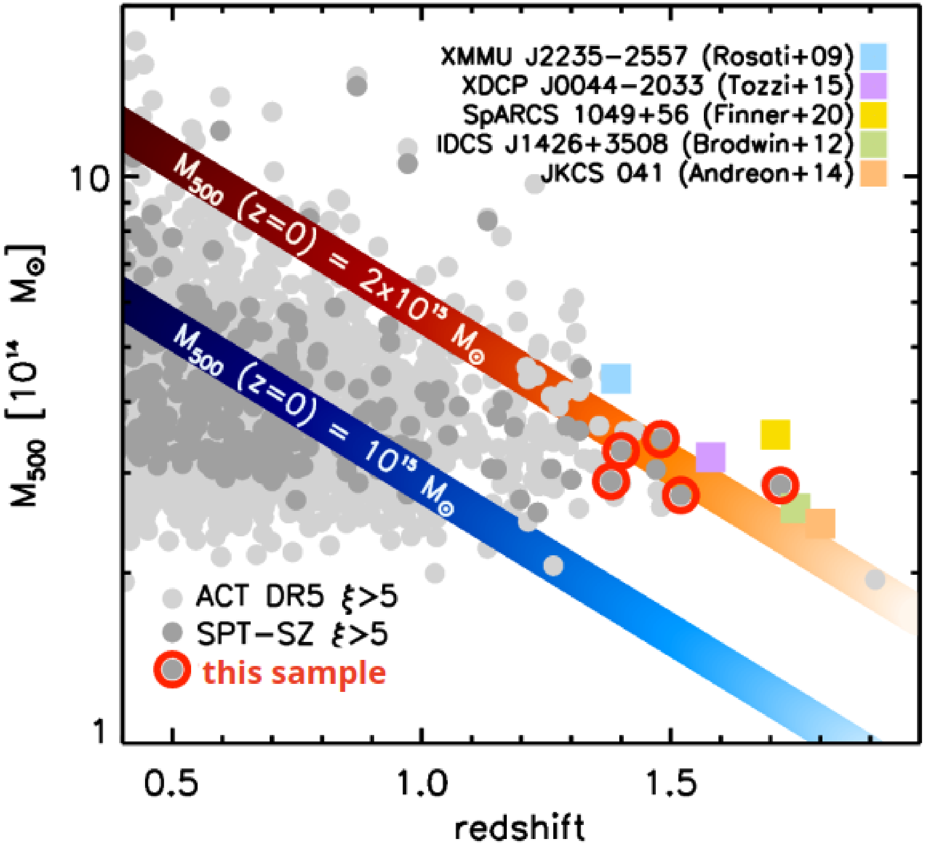


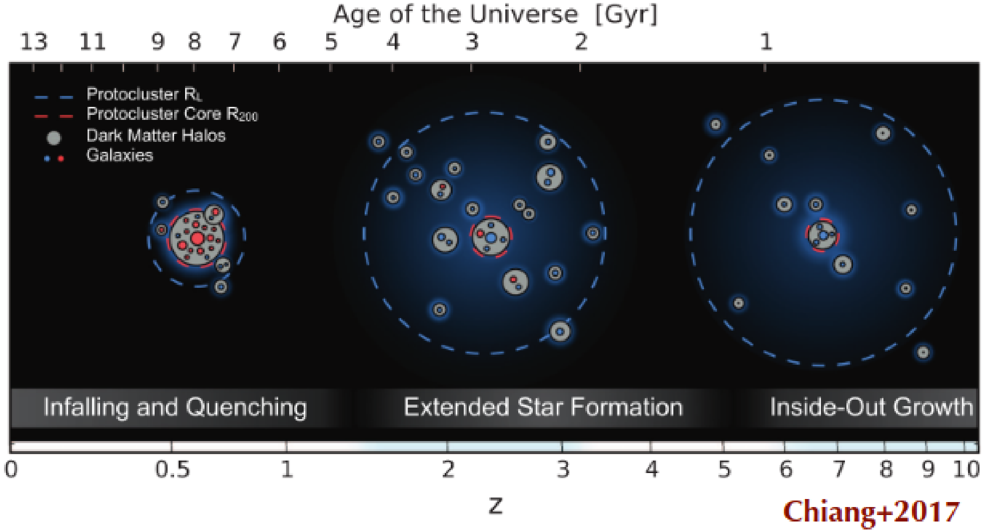
how significant is environmental quenching

in high-redshift clusters ?

(in which clusters, where within cluster, at what stellar mass, … ?)

The first massive clusters emerging from the proto-cluster to cluster transition





Chiang+2017

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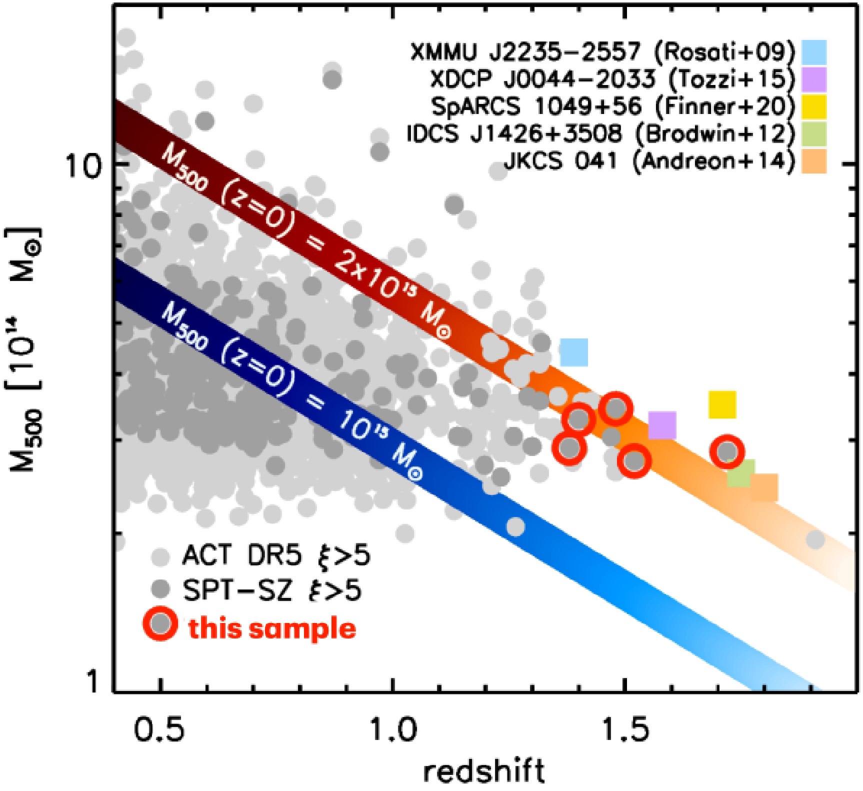
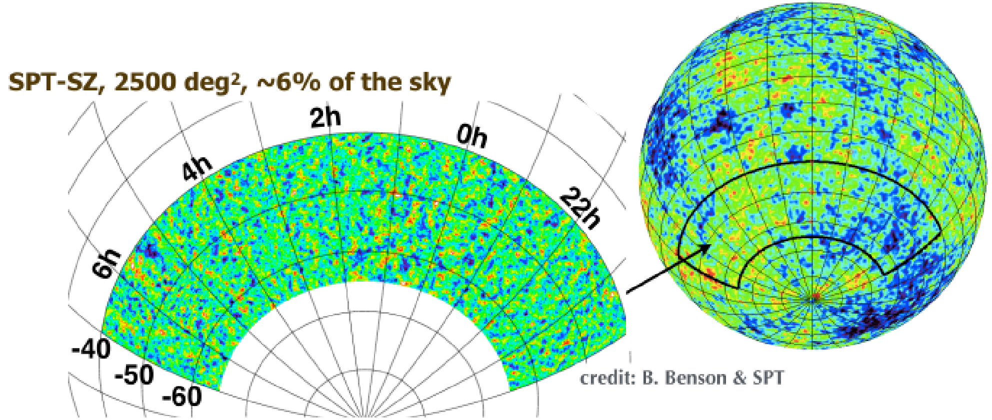


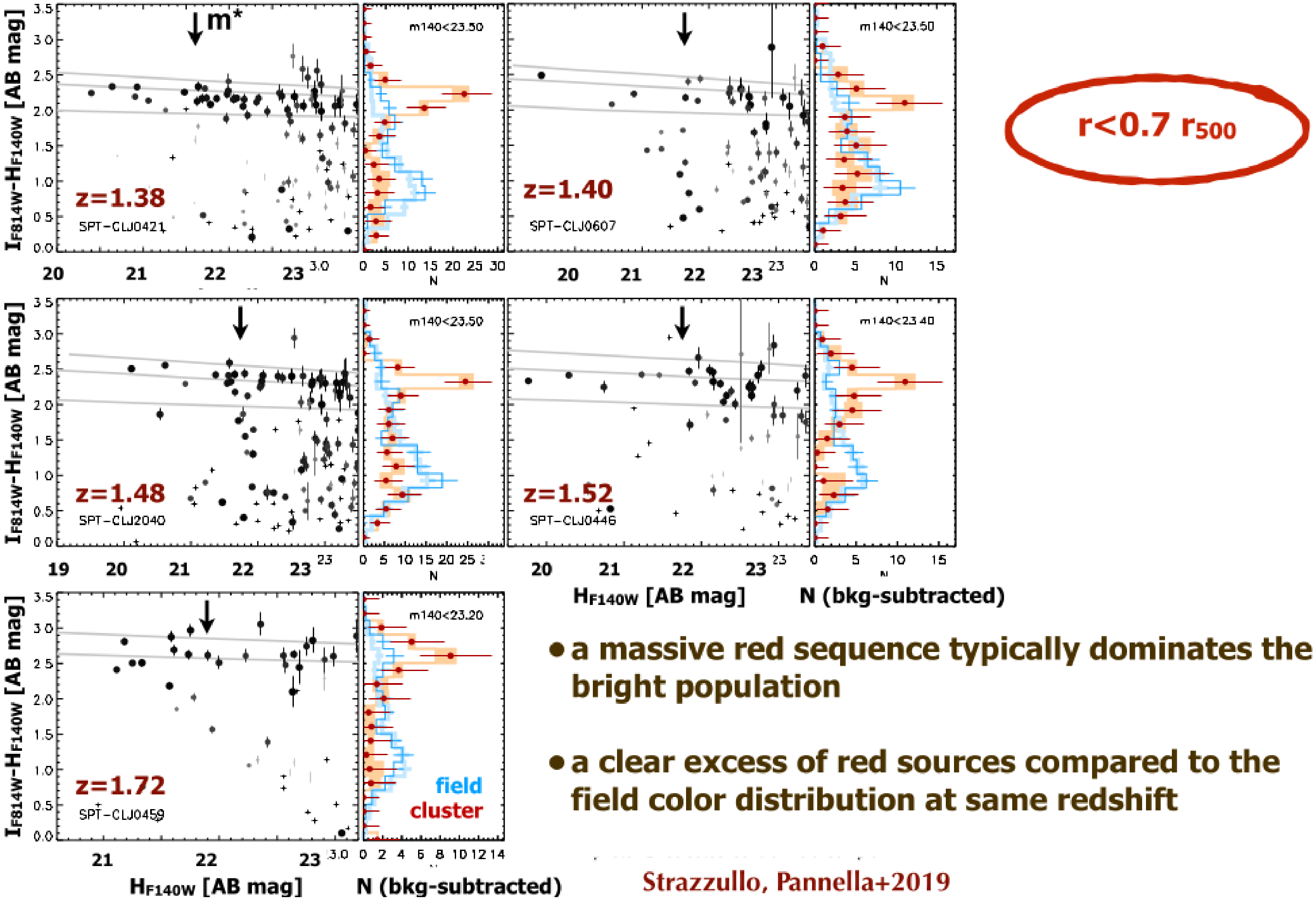
▸ 5 massive clusters at z~1.4-1.7 from SPT-SZ



- >500 clusters, ~40 clusters at z>1, 5 ξ>5 clusters at z>1.4 (as of Bleem+15)
- clean sample with roughly redshift independent mass threshold $M_{500} \gtrsim 3 \cdot 10^{14}\ M_\odot$

- selection probing the first very massive clusters
- SZE-based cluster mass determinations
- among the rarest, most massive clusters known at these redshifts
- (after some effort...) homogeneous dedicated follow-up for galaxy evolution studies

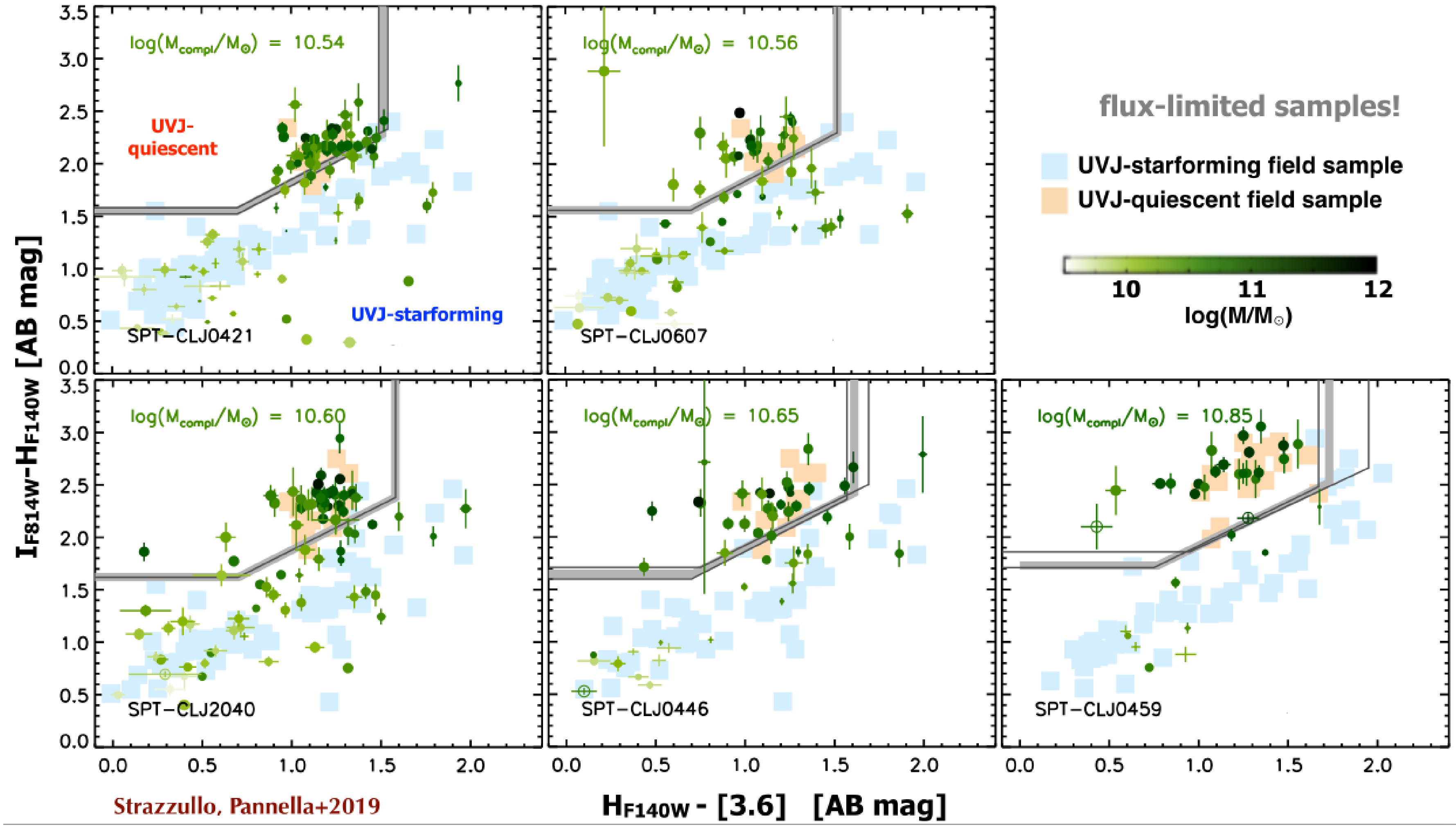
Galaxy populations in the first massive clusters



- a massive red sequence typically dominates the bright population
- a clear excess of red sources compared to the field color distribution at same redshift

Strazzullo, Pannella+2019

The environmental quenching efficiency



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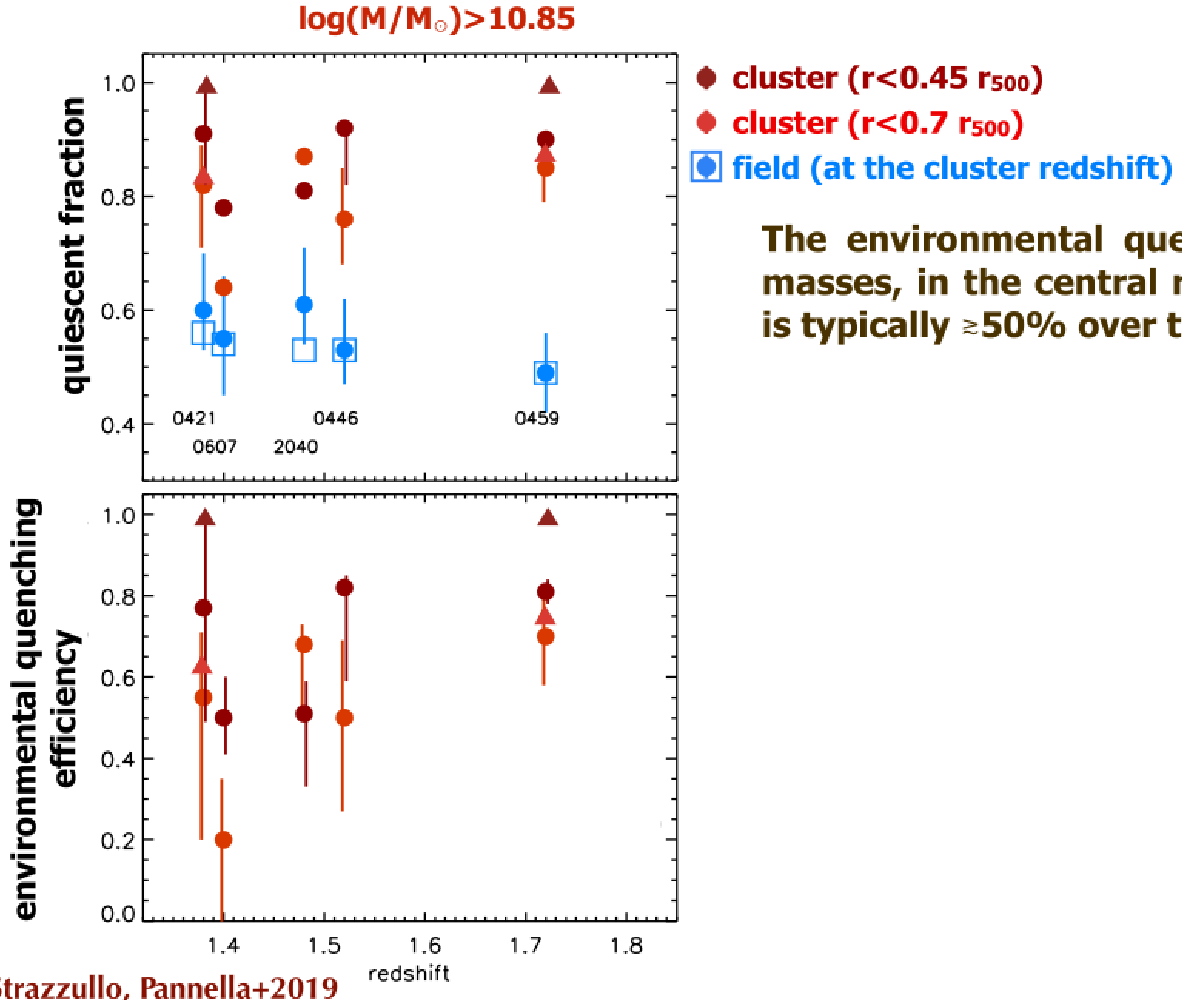

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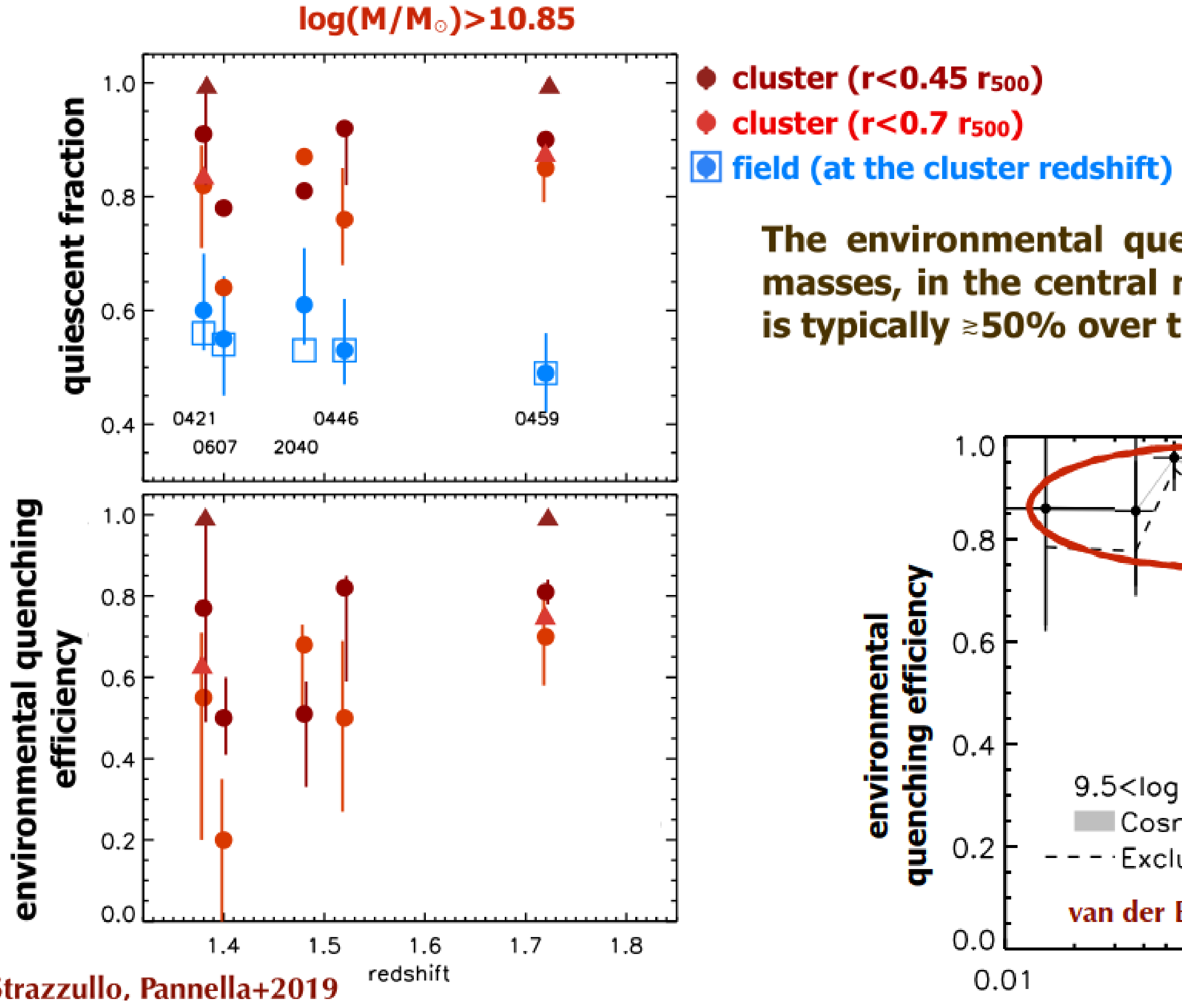
The environmental quenching efficiency at high stellar masses, in the central regions of these massive clusters, is typically ≳50% over the probed redshift range.

The environmental quenching efficiency



Strazzullo, Pannella+2019

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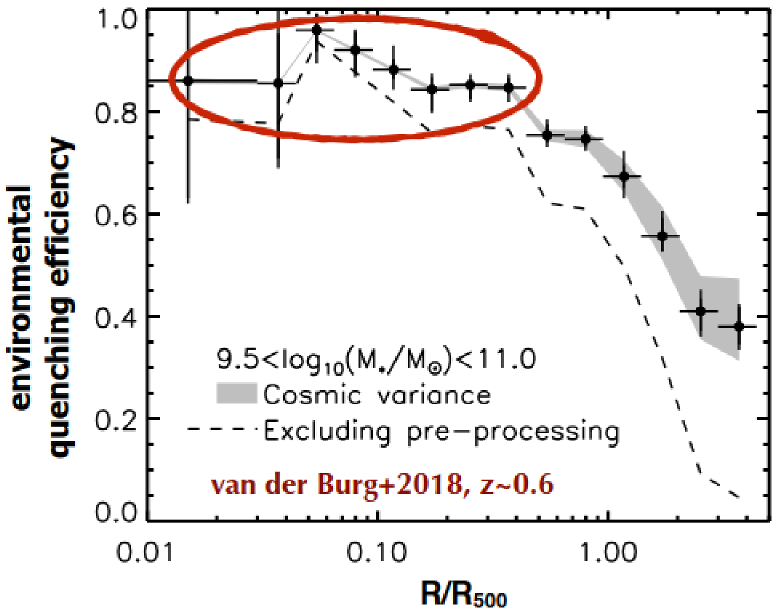
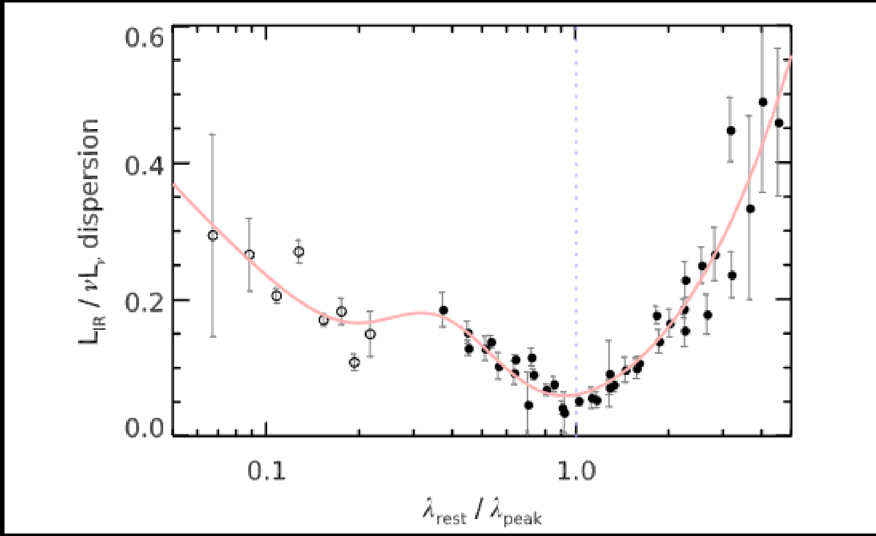


van der Burg+2018, z~0.6

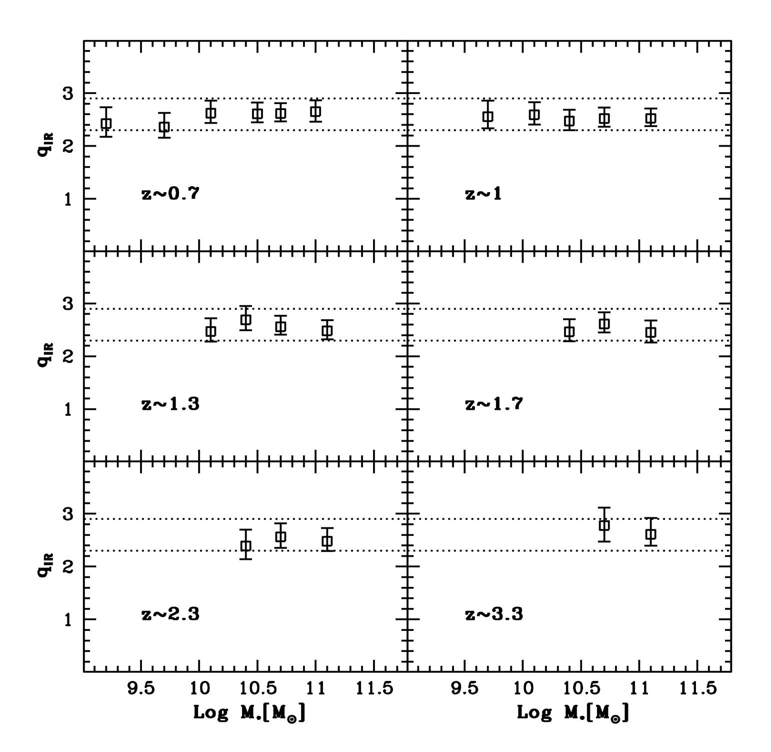
HOW GOOD ARE OUR STAR FORMATION ESTIMATES?

IN SHORT, NOT SO GOOD



(Schreiber, MP et al., 2015)

RADIO-FIR CORRELATION



(MP et al. 2015)

The radio-FIR correlation

Long story short ...

— the correlation holds up to high z

— stays (fairly) constant with redshift…

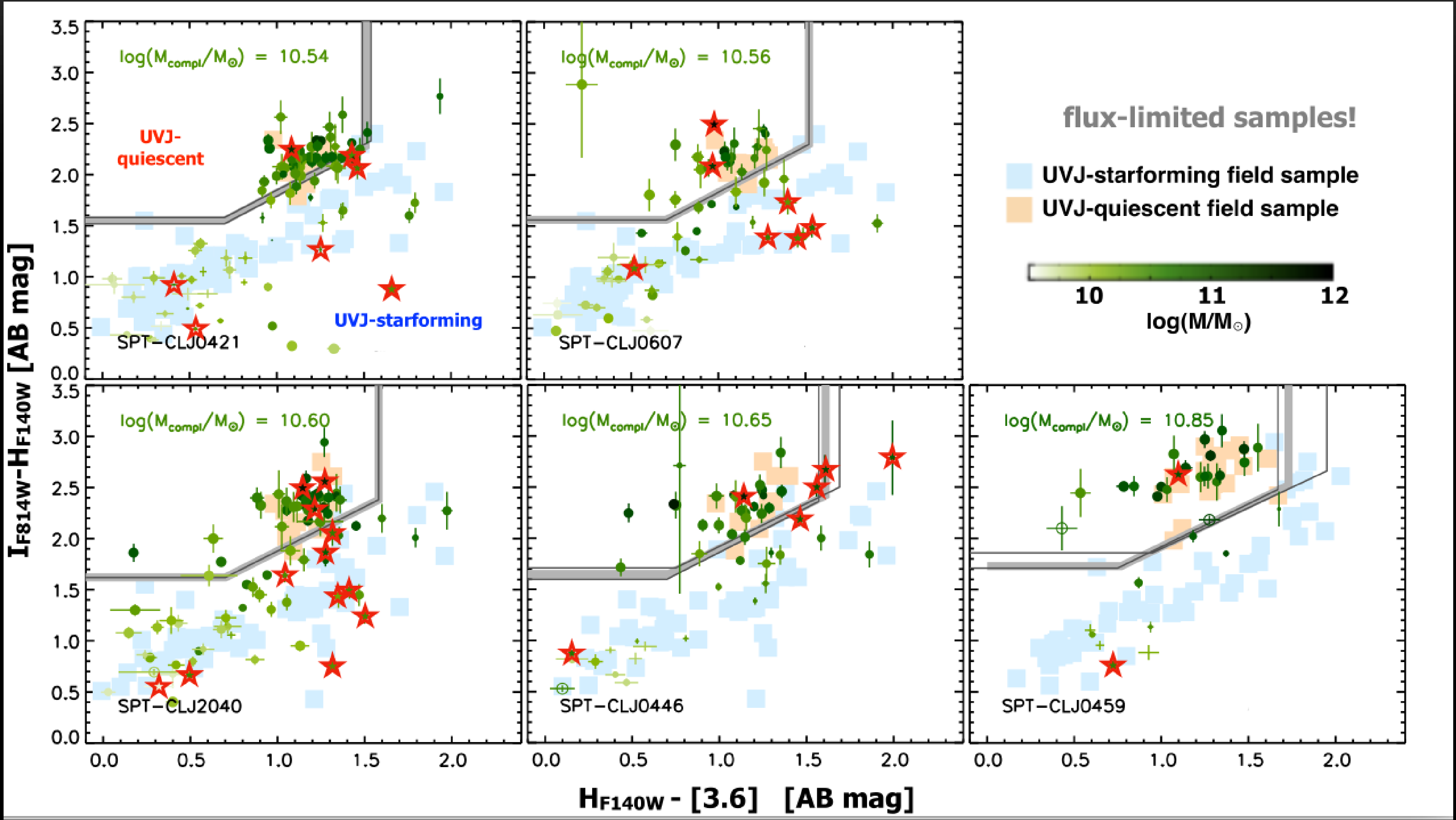
HOW GOOD ARE OUR STAR FORMATION ESTIMATES?

MeerKAT – the SKA-mid precursor

L band 1.28 GHz
FWHP ~ 55 arcmin
5.7" angular resolution

~4uJy/beam in 5.5 hours
SFR ~60 Mo/yr (5σ)

DUST UNBIASED STAR FORMATION FROM RADIO CONTINUUM



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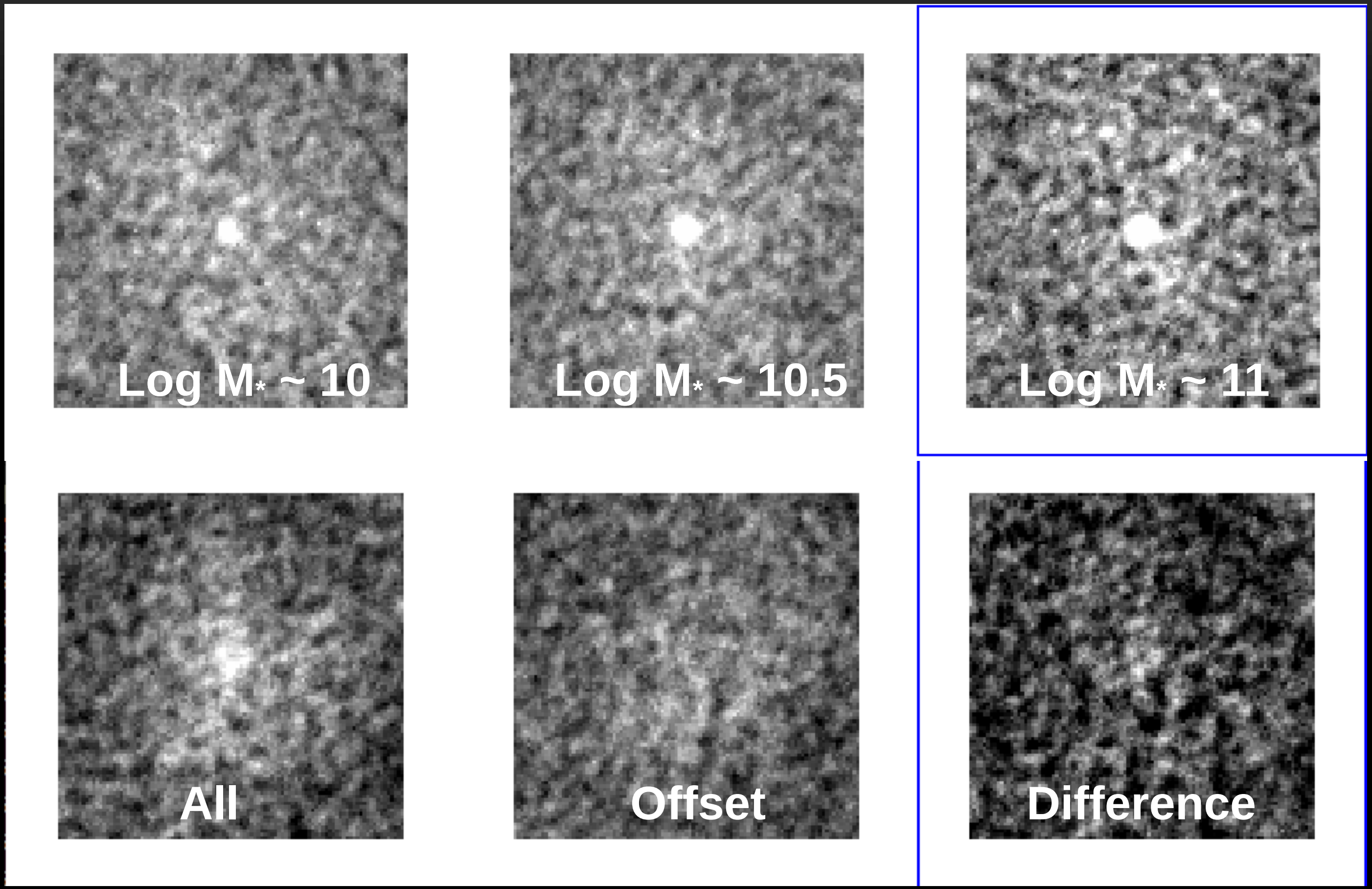
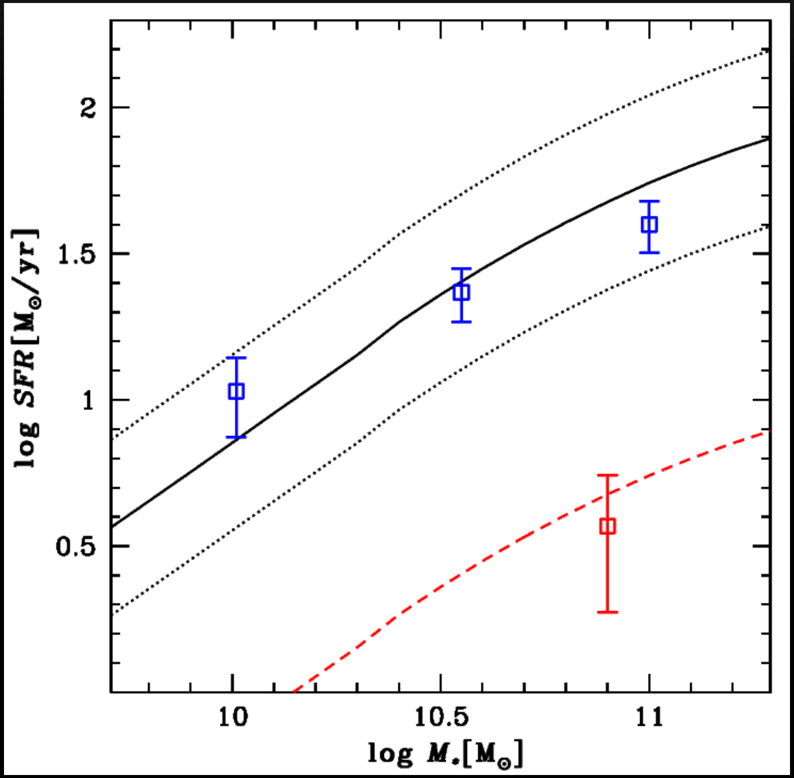


UVJ star-forming

UVJ passive

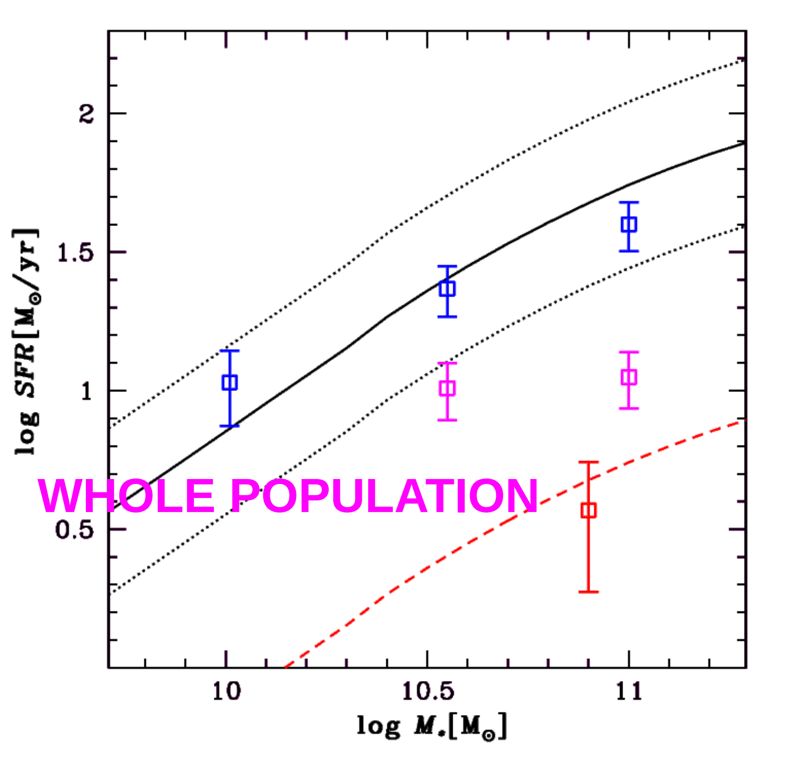
STATISTICAL PROPERTIES OF GALAXIES FROM RADIO STACKING



- Star-forming galaxies in MS
- Passive galaxies with zero signal

No substantial hidden star formation

STATISTICAL PROPERTIES OF GALAXIES FROM RADIO STACKING



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CAN WE LEARN SOMETHING MORE?

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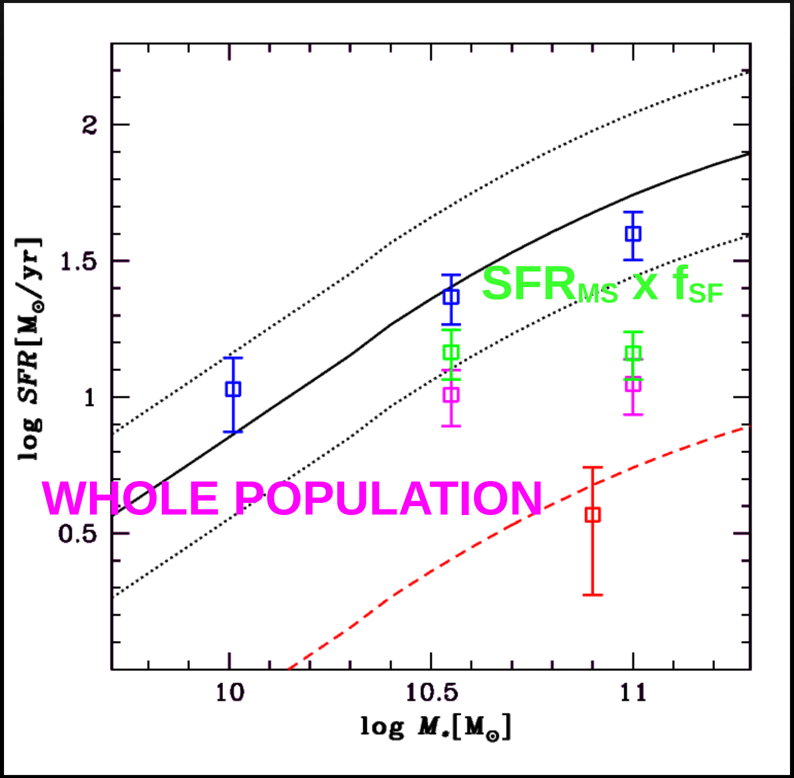

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CAN WE LEARN SOMETHING MORE?

MAYBE YES!

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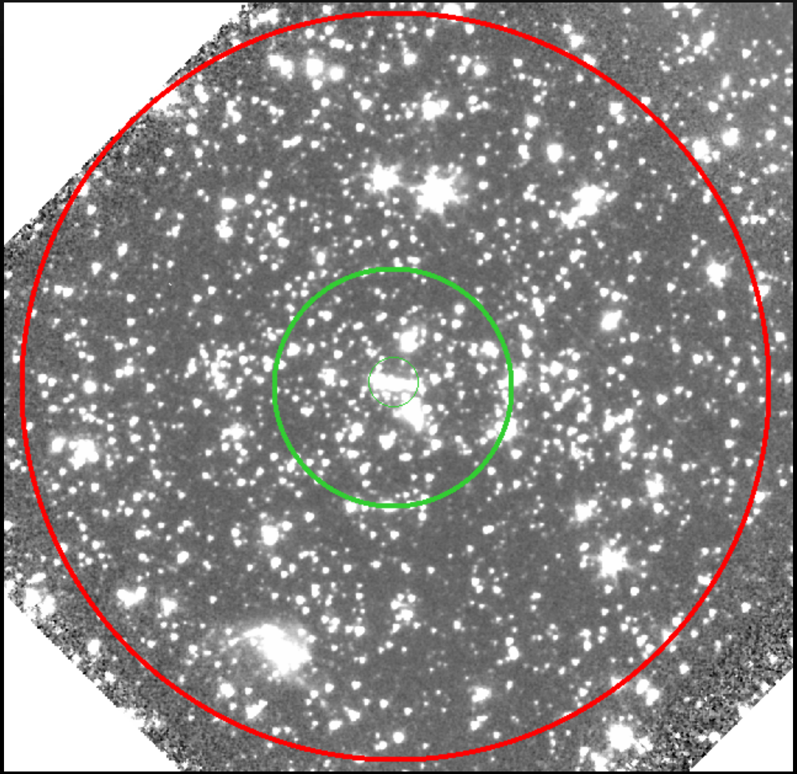


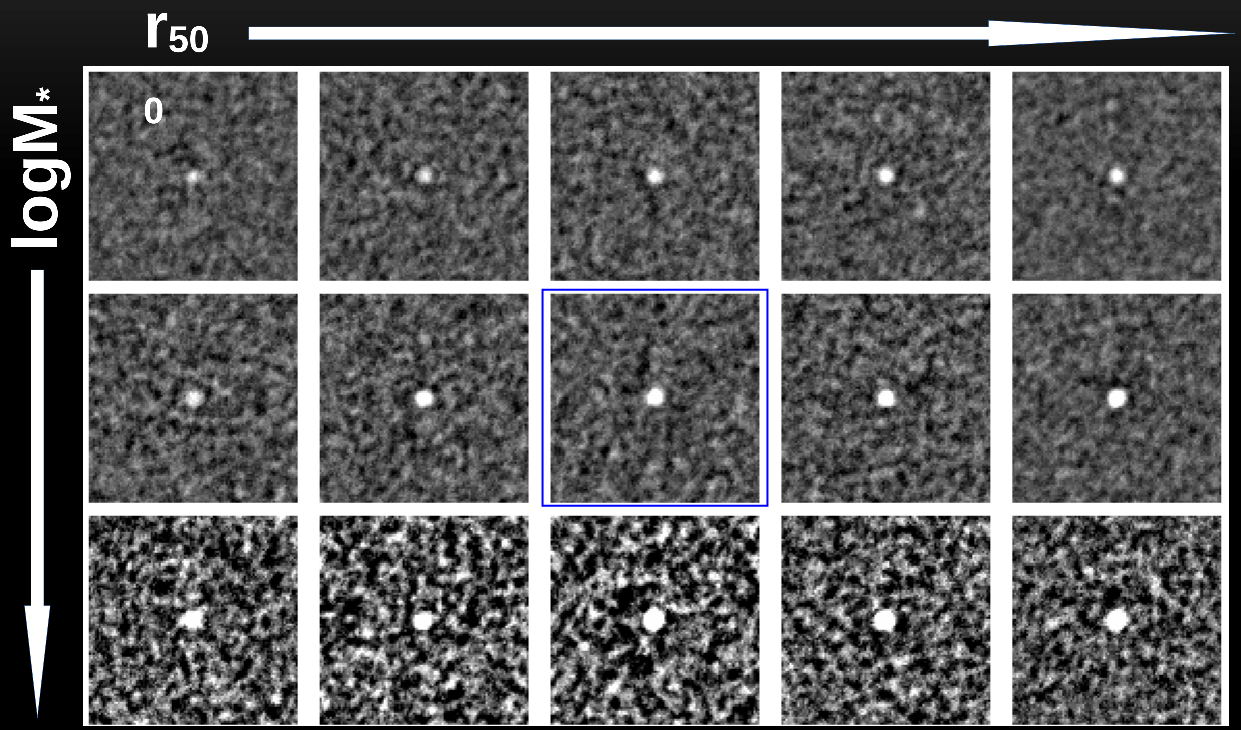
IRAC catalog extending out to 3.5 r_{500}

-0.2 < Ch1 – Ch2 < 0.3 to select candidate members

COSMOS-SEDS to estimate field contamination

COSMOS-MIGHTEE data to correct radio stacking

STATISTICAL PROPERTIES OF GALAXIES FROM RADIO STACKING



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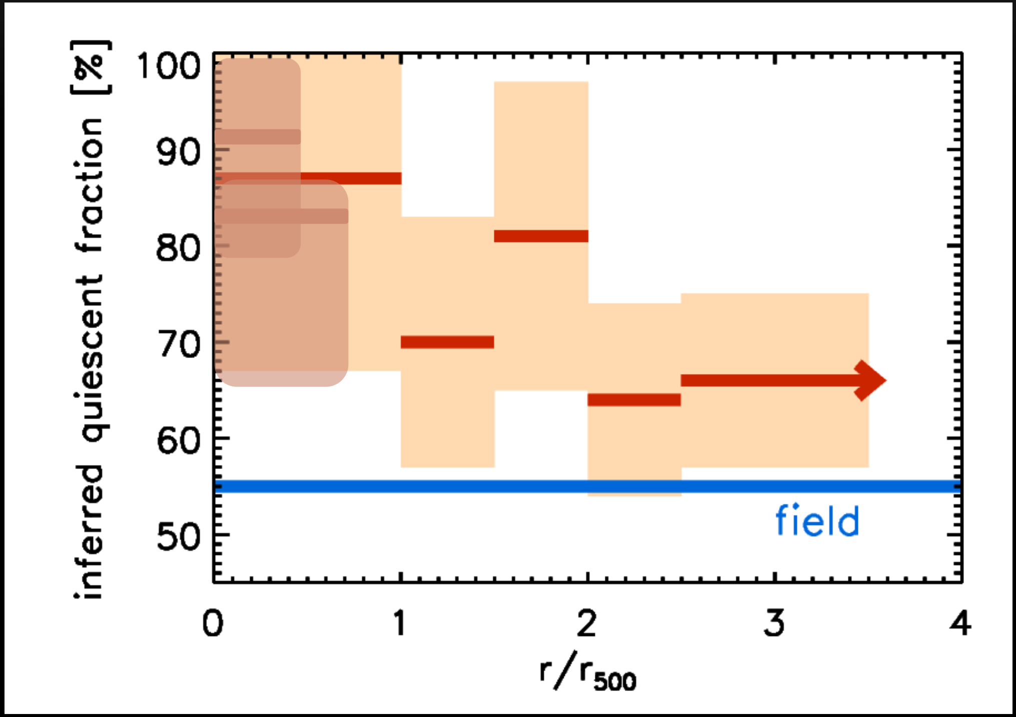

Consistent with the optical/NIR analysis in cluster core regions

Environmental signature on quiescent fractions across the virial volume?

SUMMARY & OUTLOOK

– Deep radio continuum imaging to estimate robust star formation rates

– First results confirm a high quencing efficiency in these massive cluster cores

– MUSE observations on 3 clusters have secured representative spectroscopic SF cluster member samples, and will allow us to probe potential MS offset

– MeerKAT+ imaging will simplify crosscorrelation to opt-NIR counterparts

– Comparison with theoretical expectations from simulations to constrain physical processes across the protocluster to cluster transition.