Environmental quenching and galaxy structural evolution in the first cluster environments

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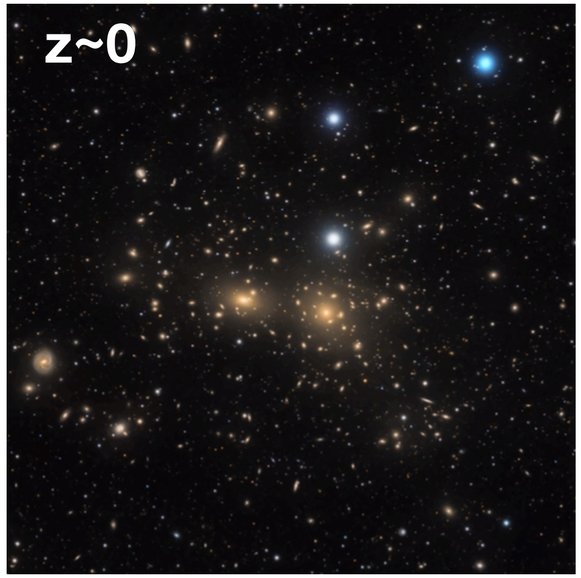
(INAF)

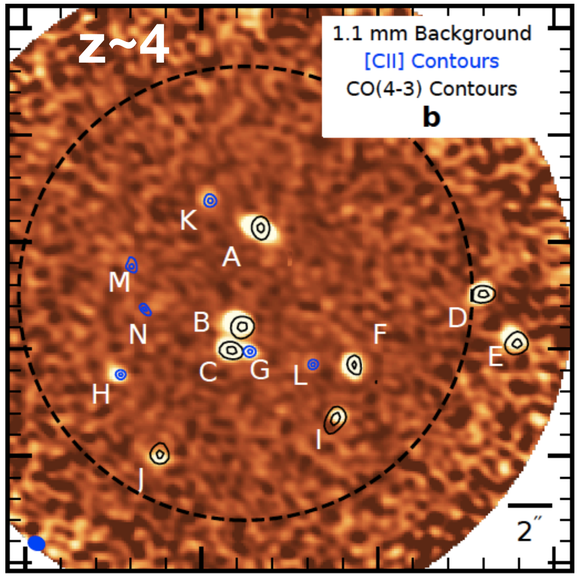
with M. Pannella, J. Mohr, A. Saro, M. Ashby & SPT-clusters WG

GCF II, June 17, 2021

Two main questions in the next 12 minutes on galaxies in z~1.5 clusters:
1. Is star formation suppressed in z~1.5 cluster environments?



… from SPT2349-56 to Coma …



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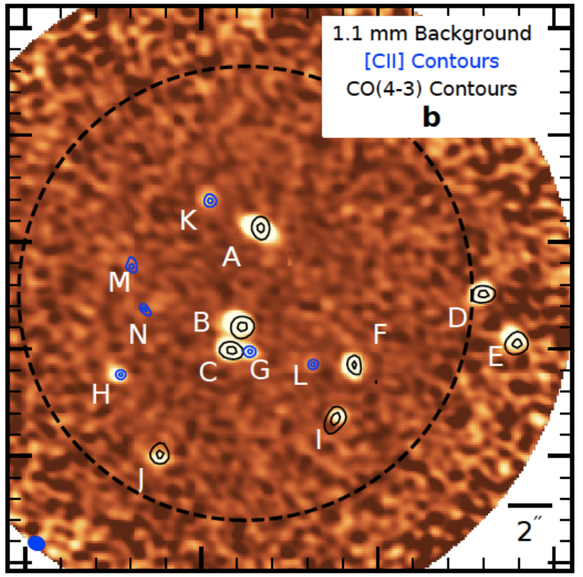

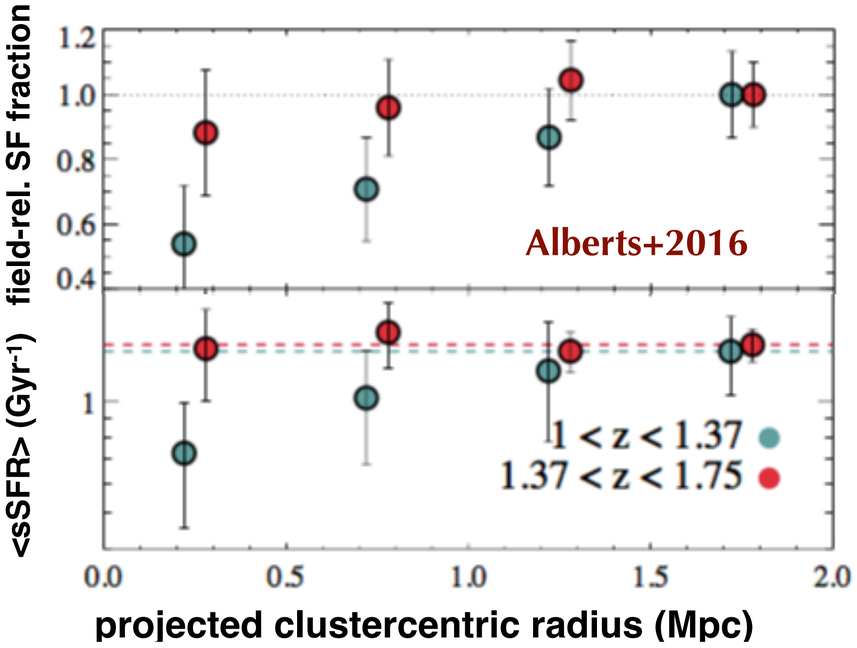

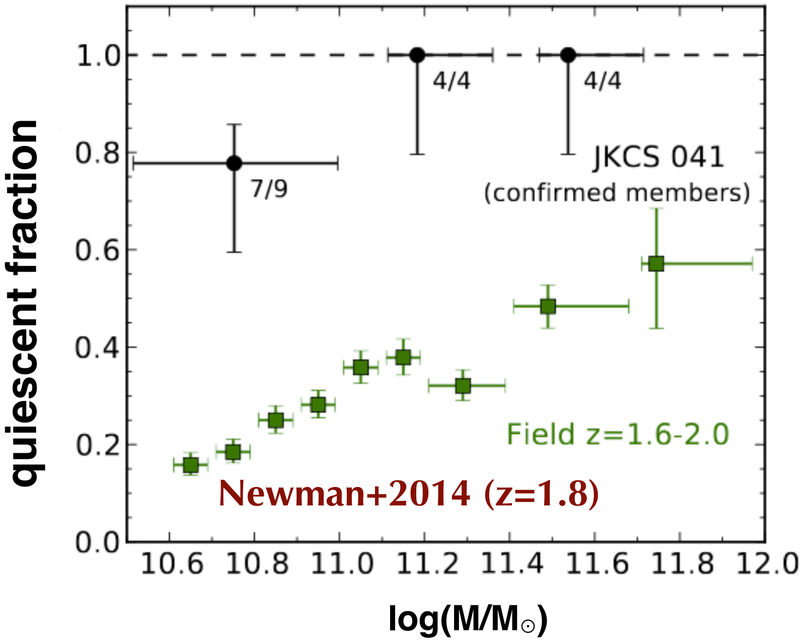

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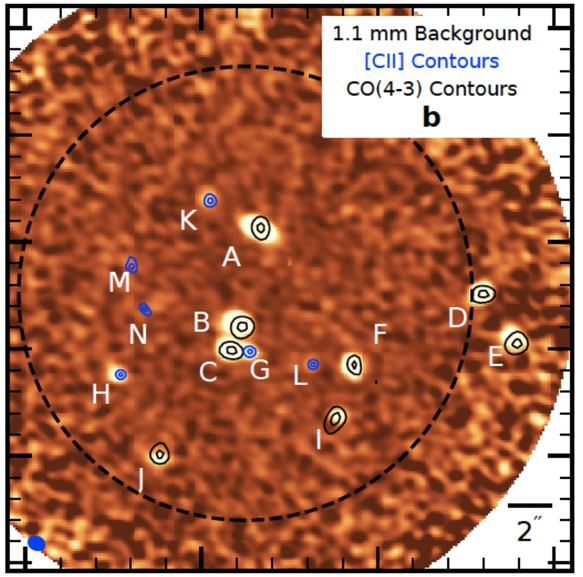
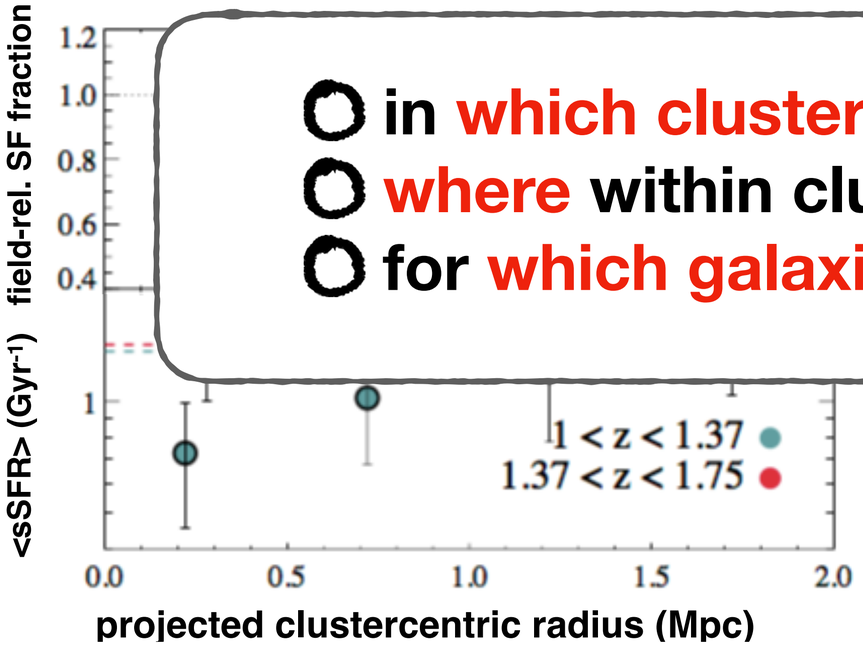
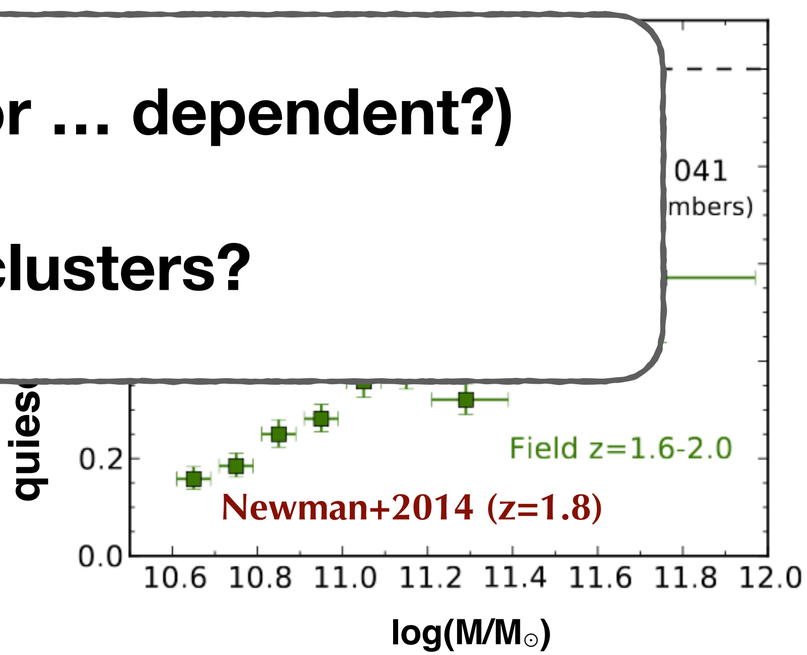


- in **which clusters**? (mass or … dependent?)
- **where** within clusters ?
- for **which galaxies** within clusters?





Two main questions in the next 12 minutes on galaxies in z~1.5 clusters:
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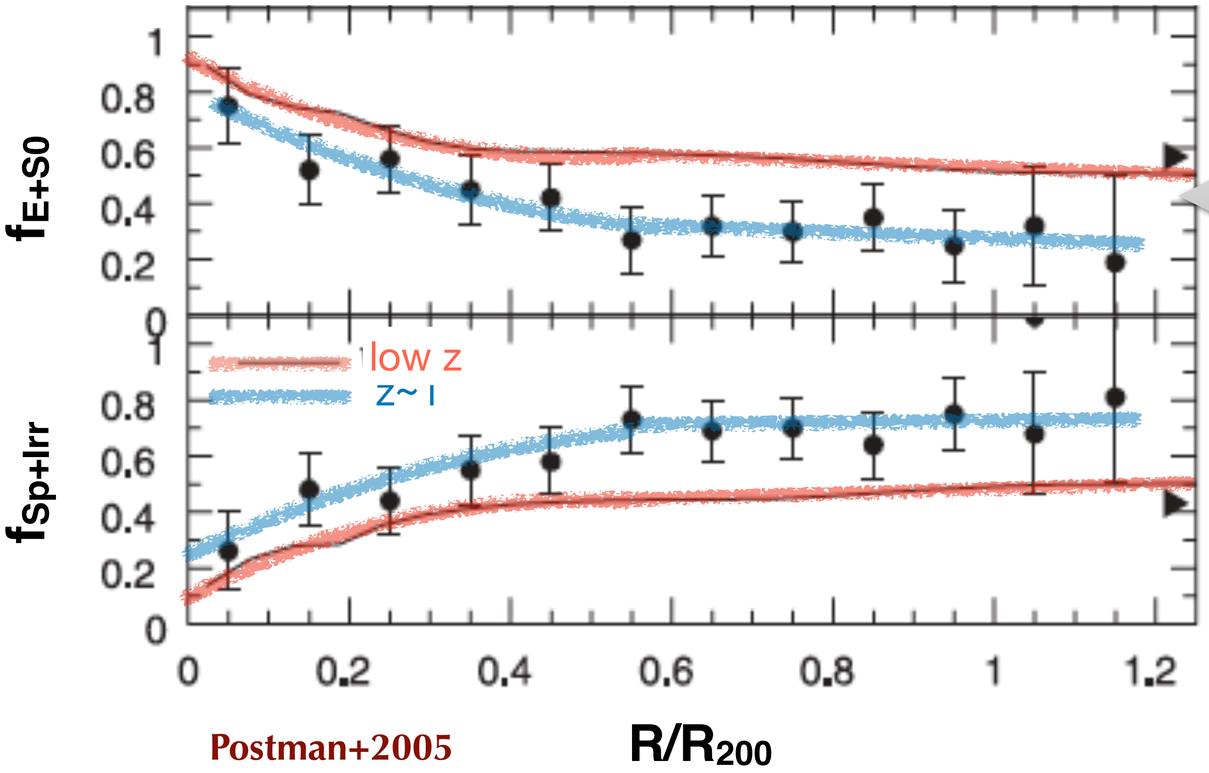

Postman+2005

a morphology-density relation is in place by at least z~1 (some more mixed results going to higher-z, e.g. Sazonova+20)

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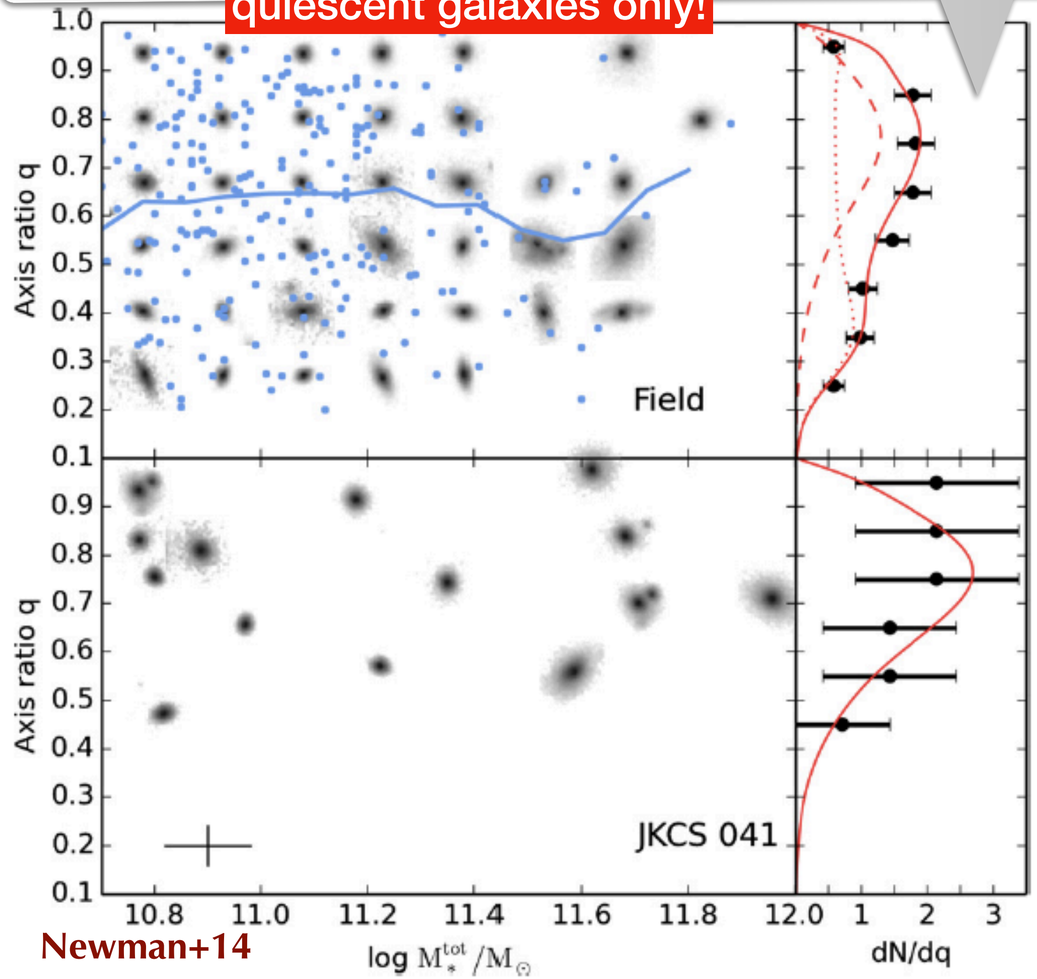
possibly lower (wrt field) disk-dominated fraction in cluster core?

quiescent galaxies only!

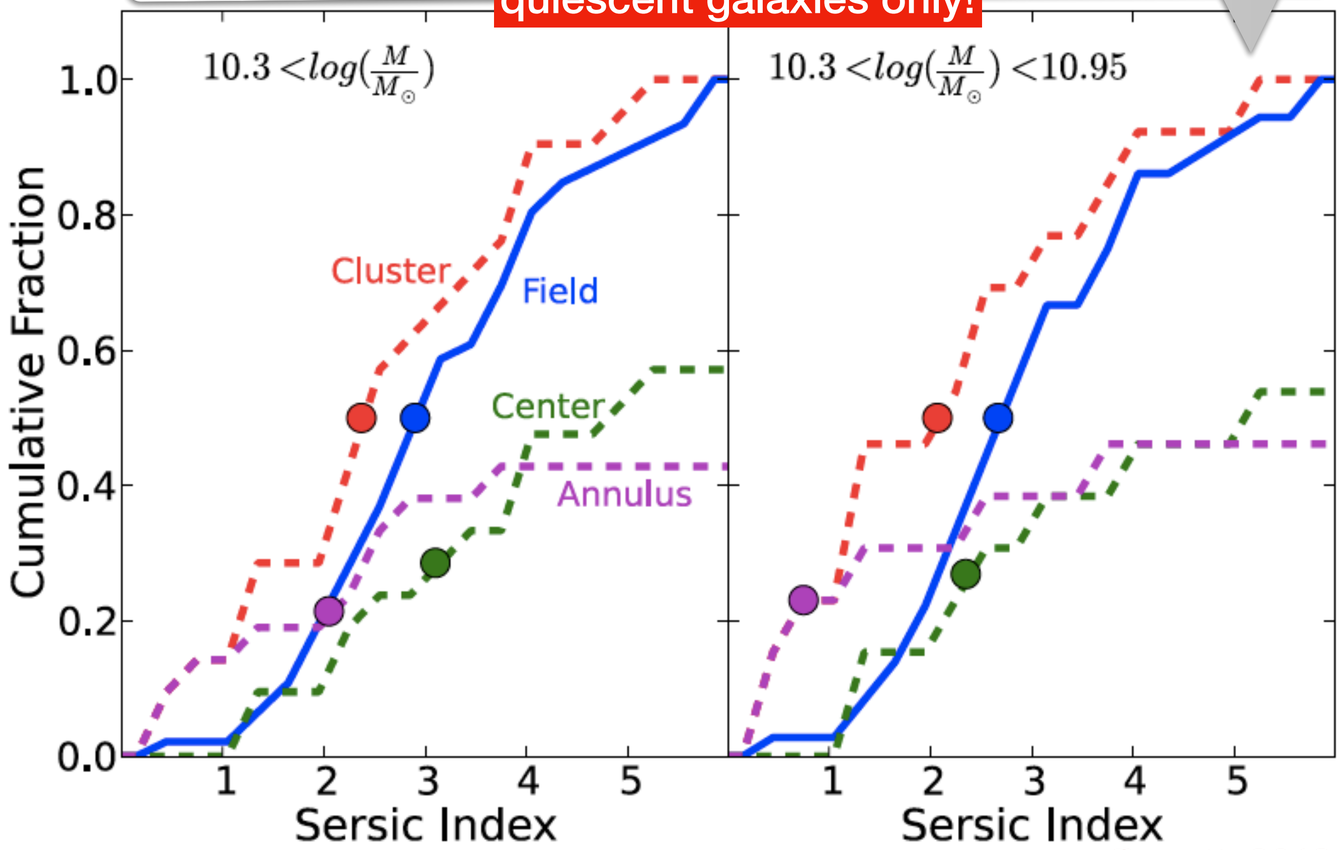


Newman+14

… harder to identify more specific "signatures" on matched populations

possibly higher (wrt field) disk-dominated fraction in cluster outskirts? (mass-dependent?)

quiescent galaxies only!



Bassett+2013

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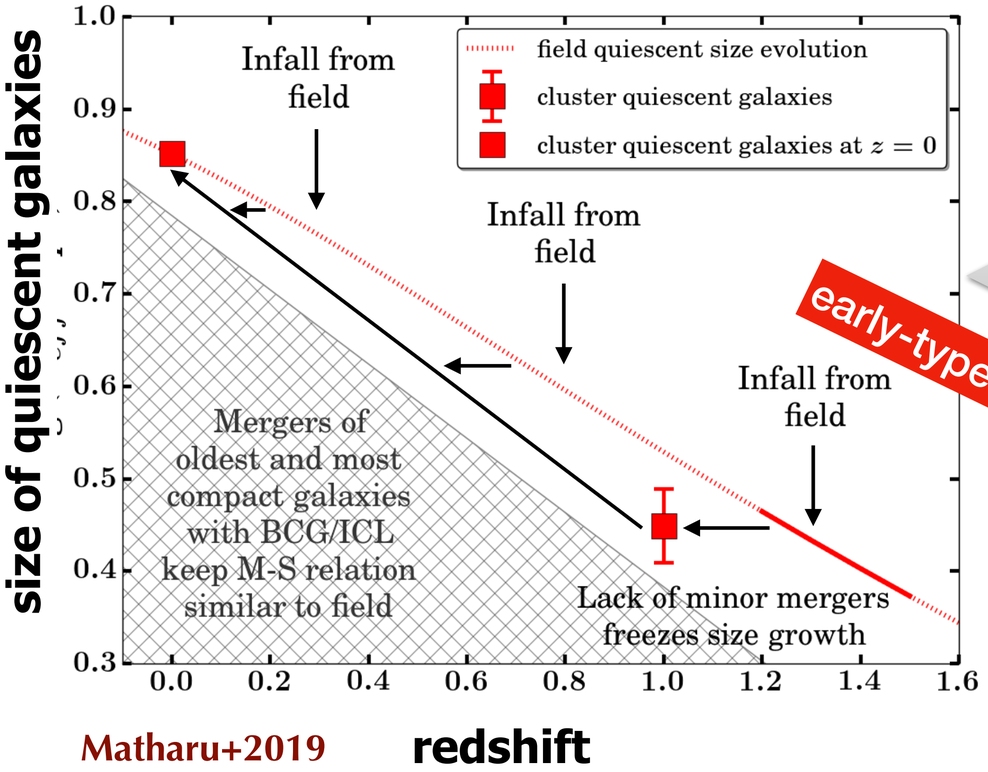
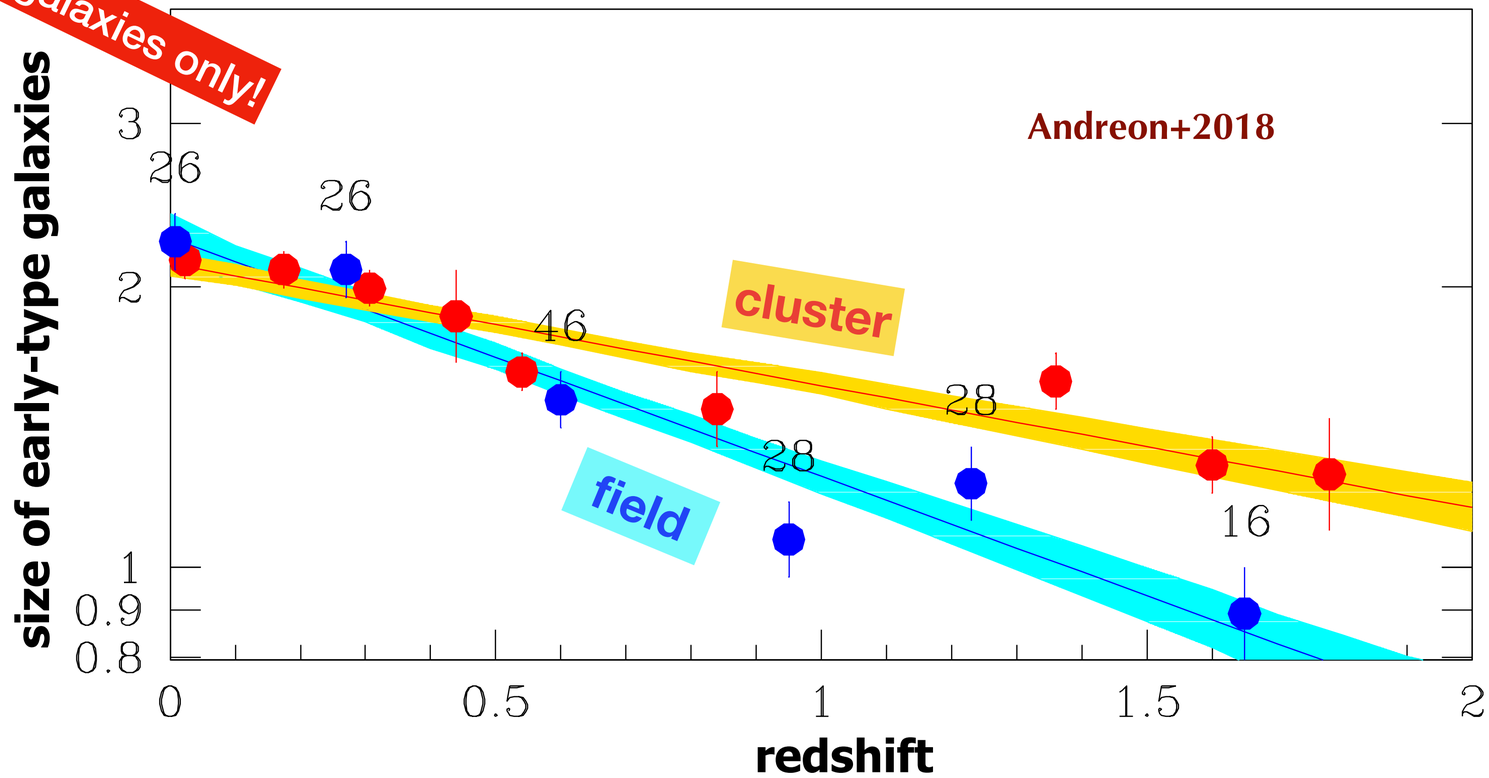


Matharu+2019

mass-size relation in z~1 **clusters lower than in the field** because of lack of growth through minor mergers

early-type (…) galaxies only!

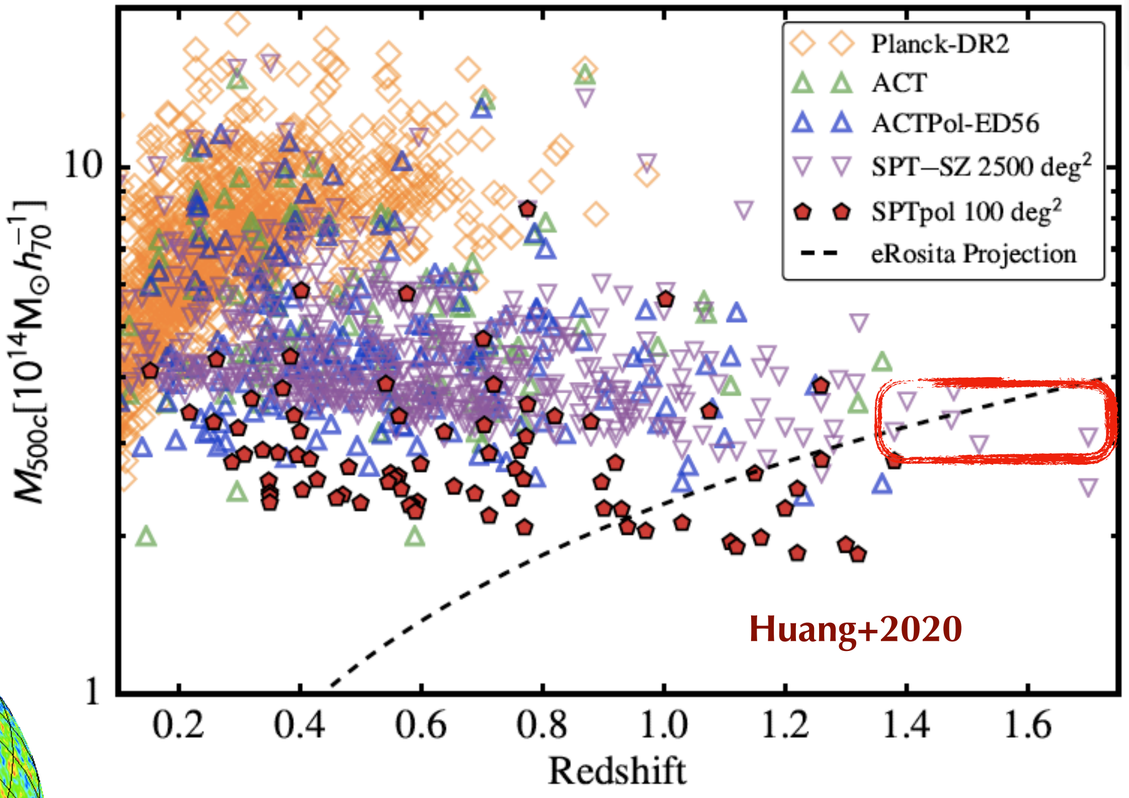


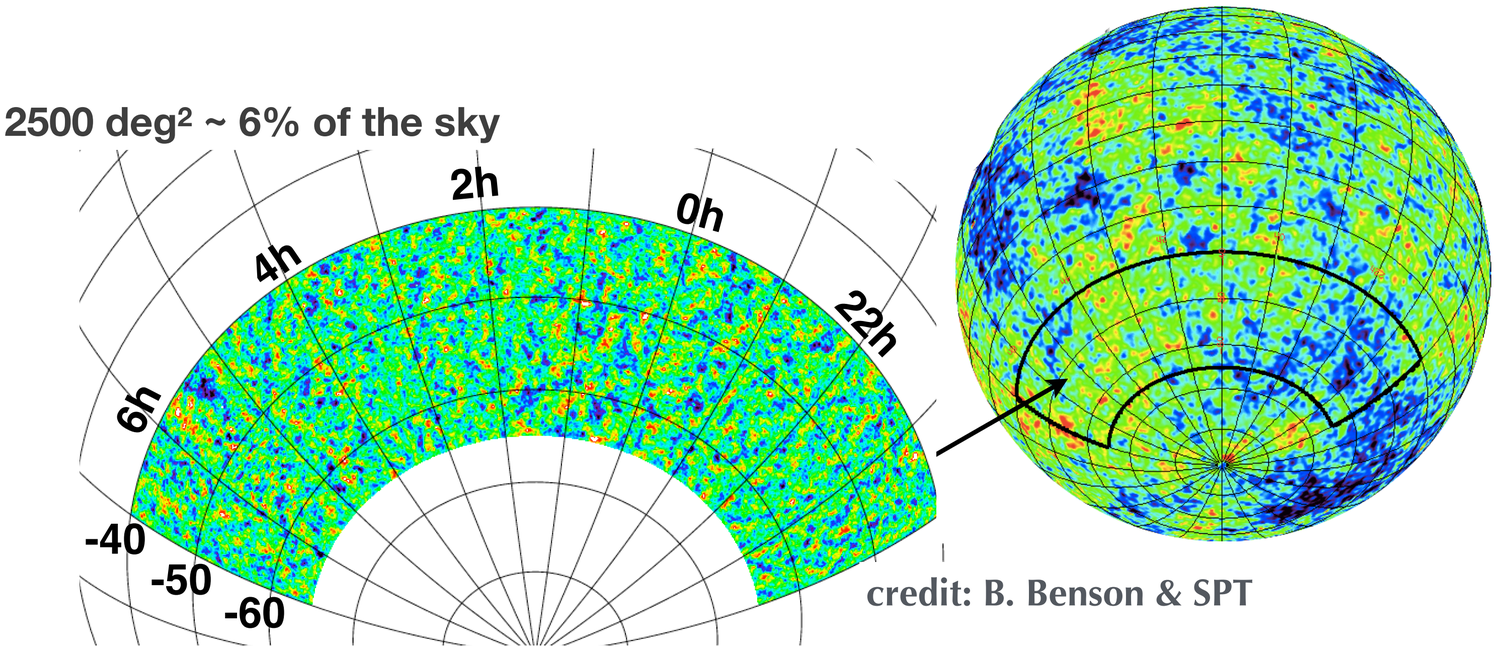
mass-size relation in z≳0.6 **clusters higher than in the field** because of accelerated evolution at early times

Which clusters

SZ-selected in wide-area SPT-SZ survey:

1. the rarest, most massive clusters at this redshift
2. selection independent of cluster galaxies





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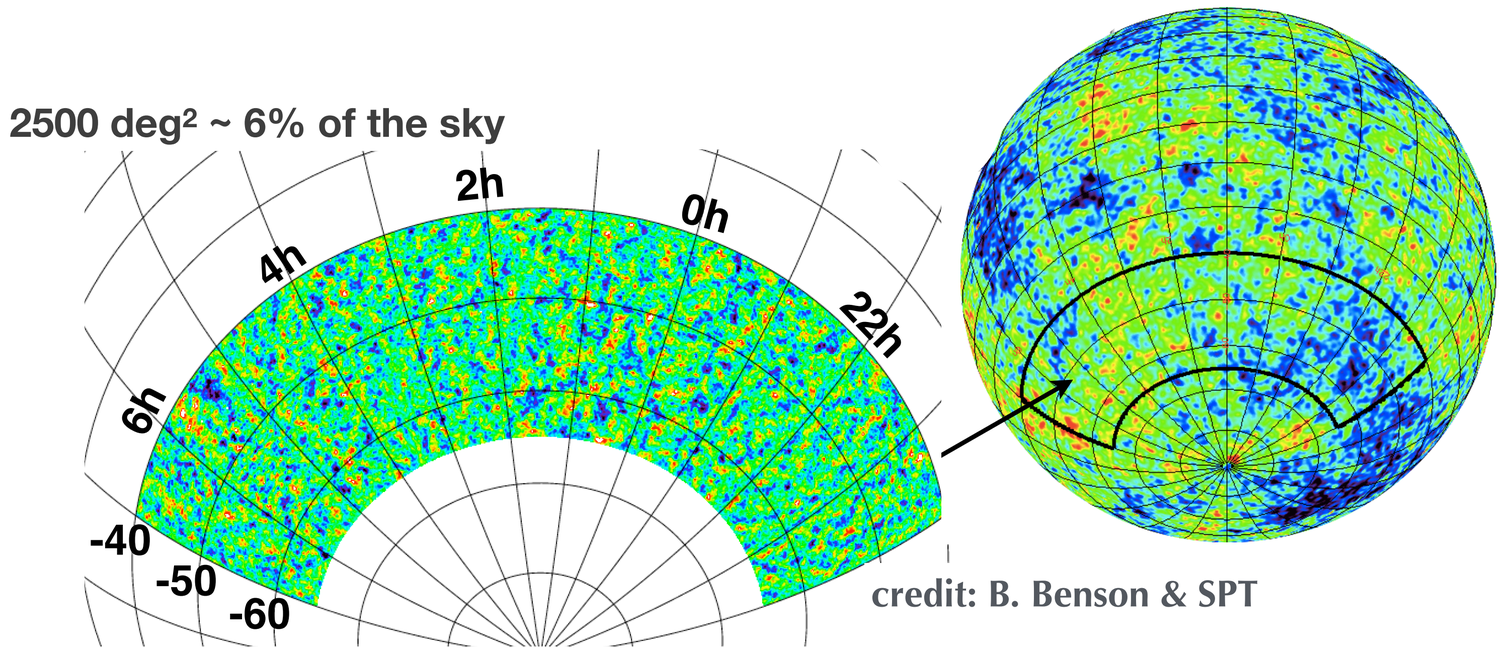
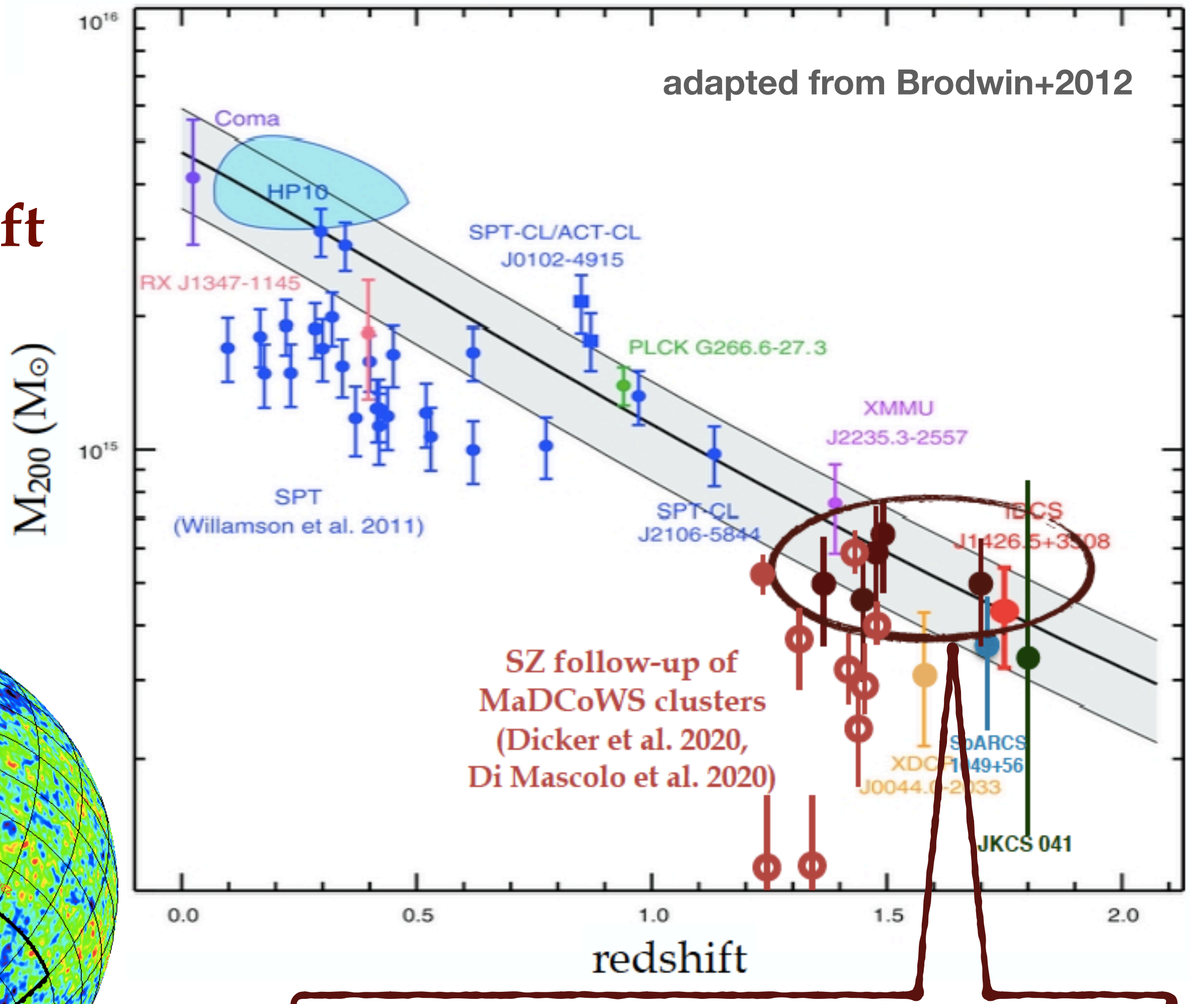
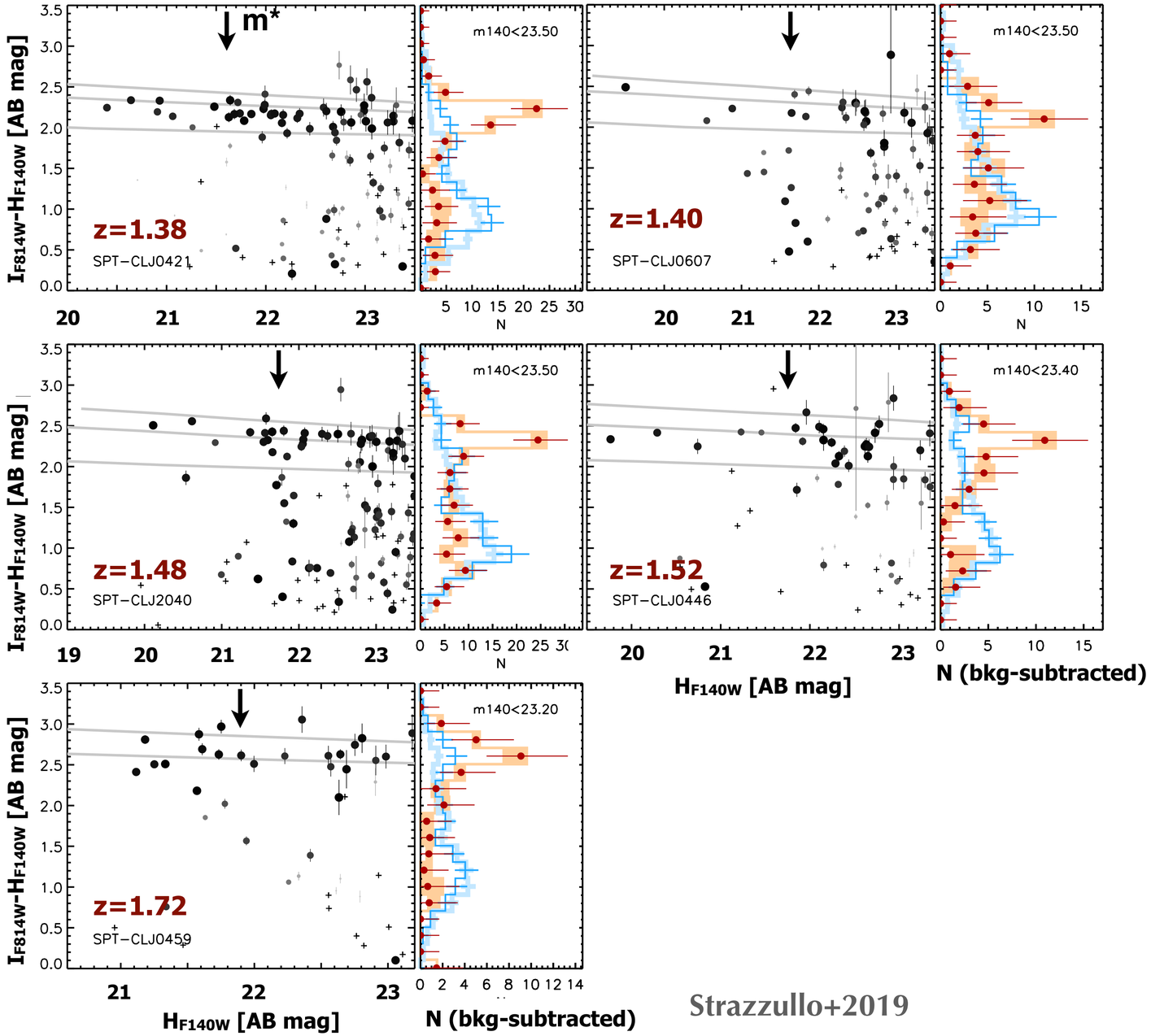


credit: B. Benson & SPT



This sample: 5 SPT-SZ clusters at $1.4 \lesssim z \lesssim 1.7$ with $M_{200} \sim M_\odot$

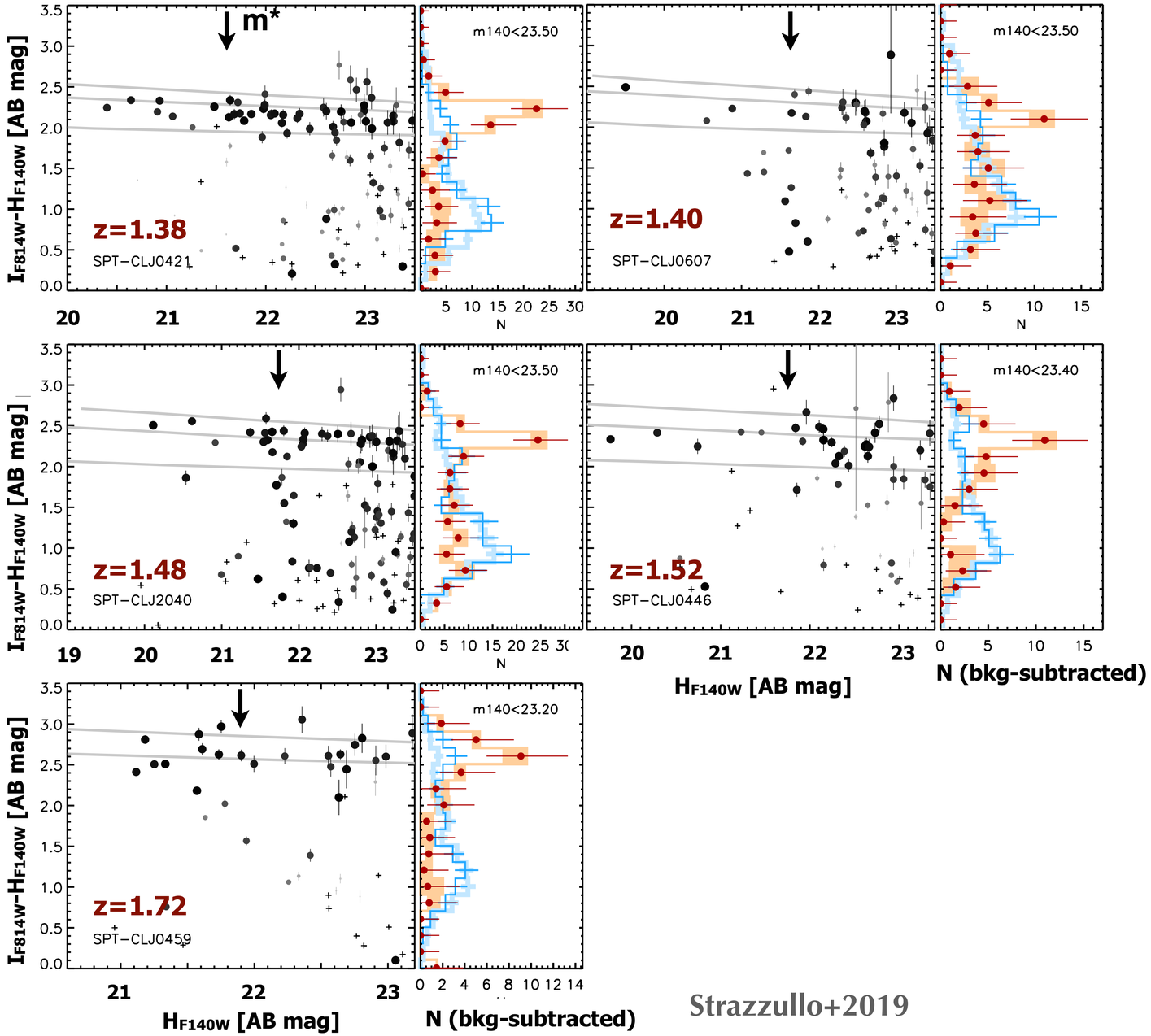
Galaxy populations in cluster central regions ($r<0.7\ r_{500}$)



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

Strazzullo+2019

Galaxy populations in cluster central regions (r<0.7 r_{500})



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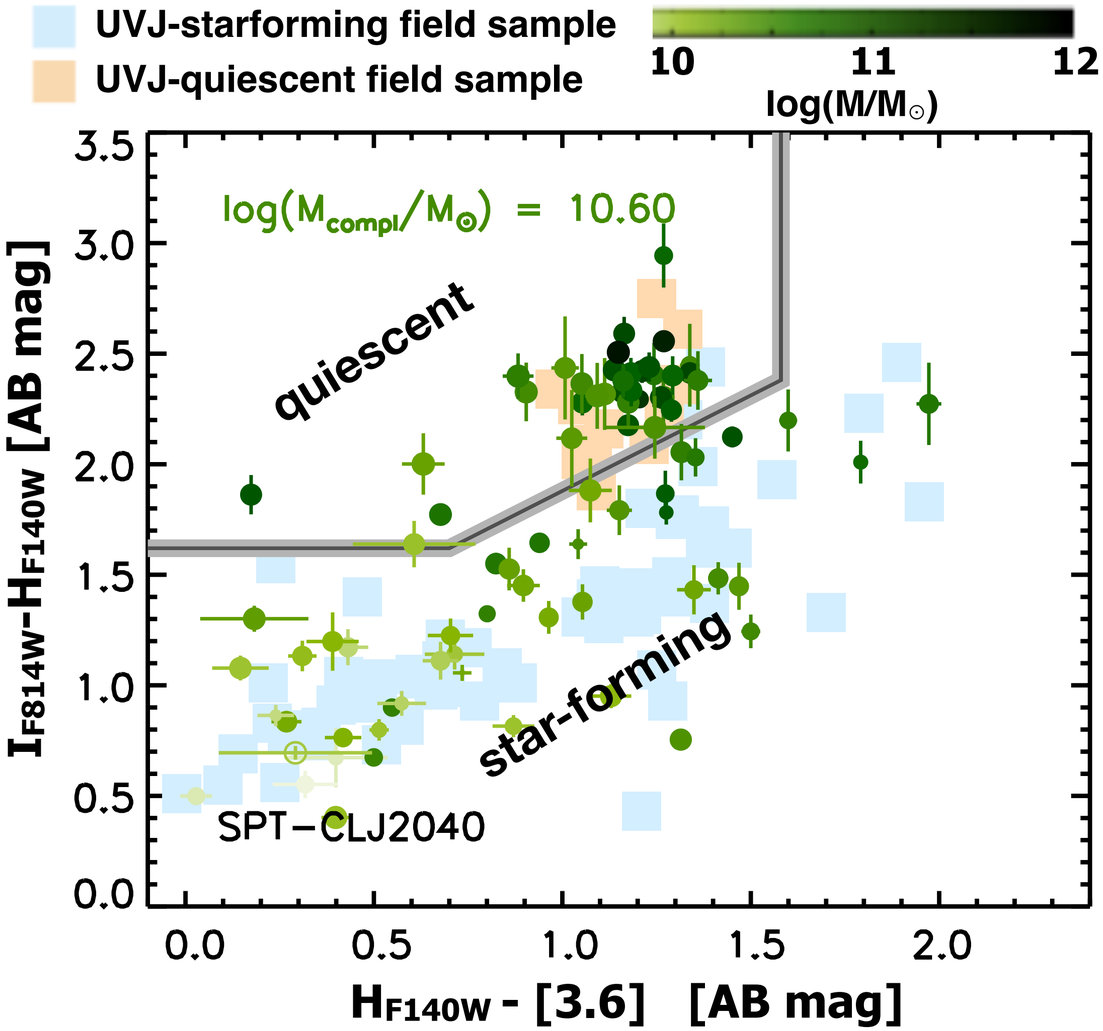
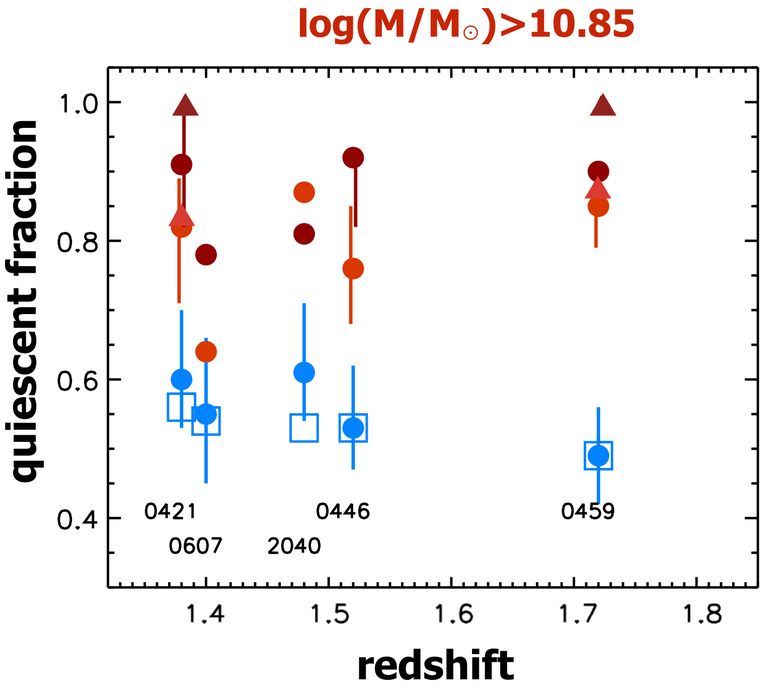


Environmental quenching in cluster central regions ($r<0.7\ r_{500}$)

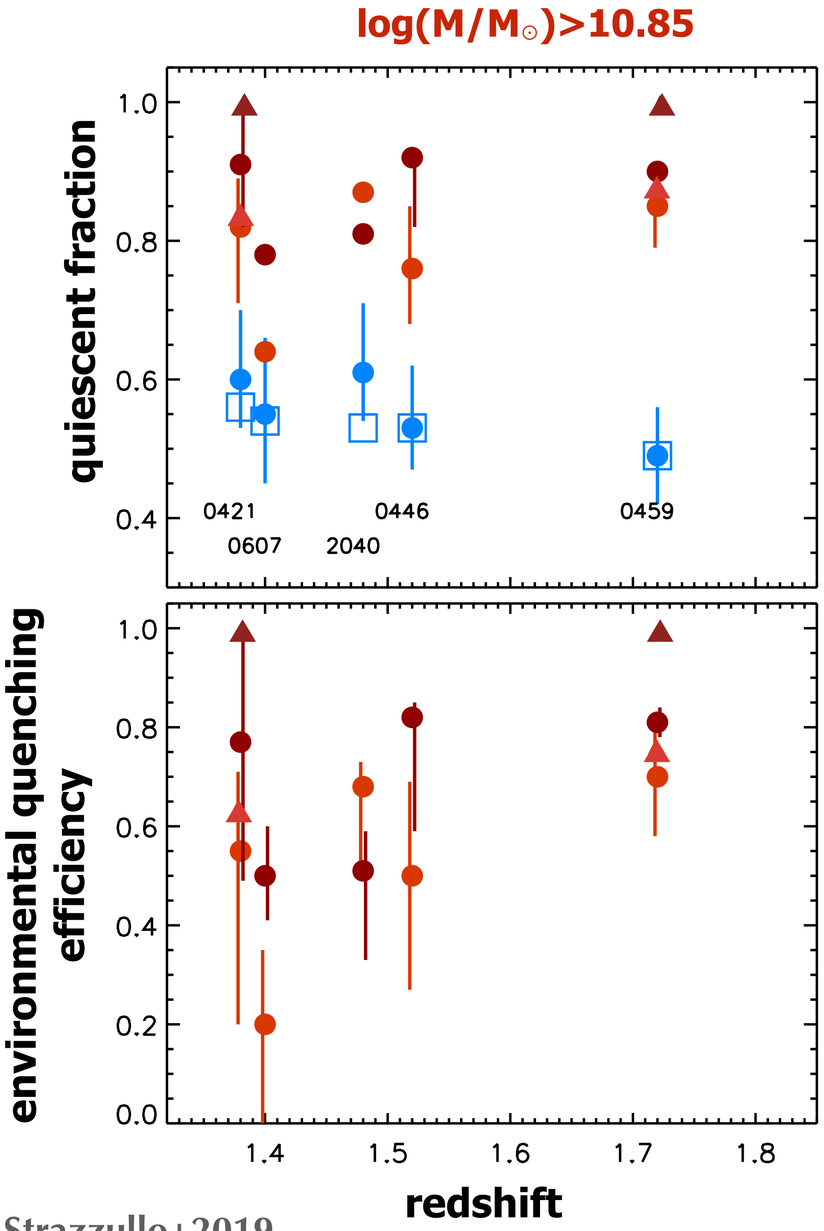


cluster ($r<0.45\ r_{500}$)

cluster ($r<0.7\ r_{500}$)

field (at the cluster redshift)

Environmental quenching in cluster central regions ($r<0.7\ r_{500}$)



cluster ($r<0.45\ r_{500}$)

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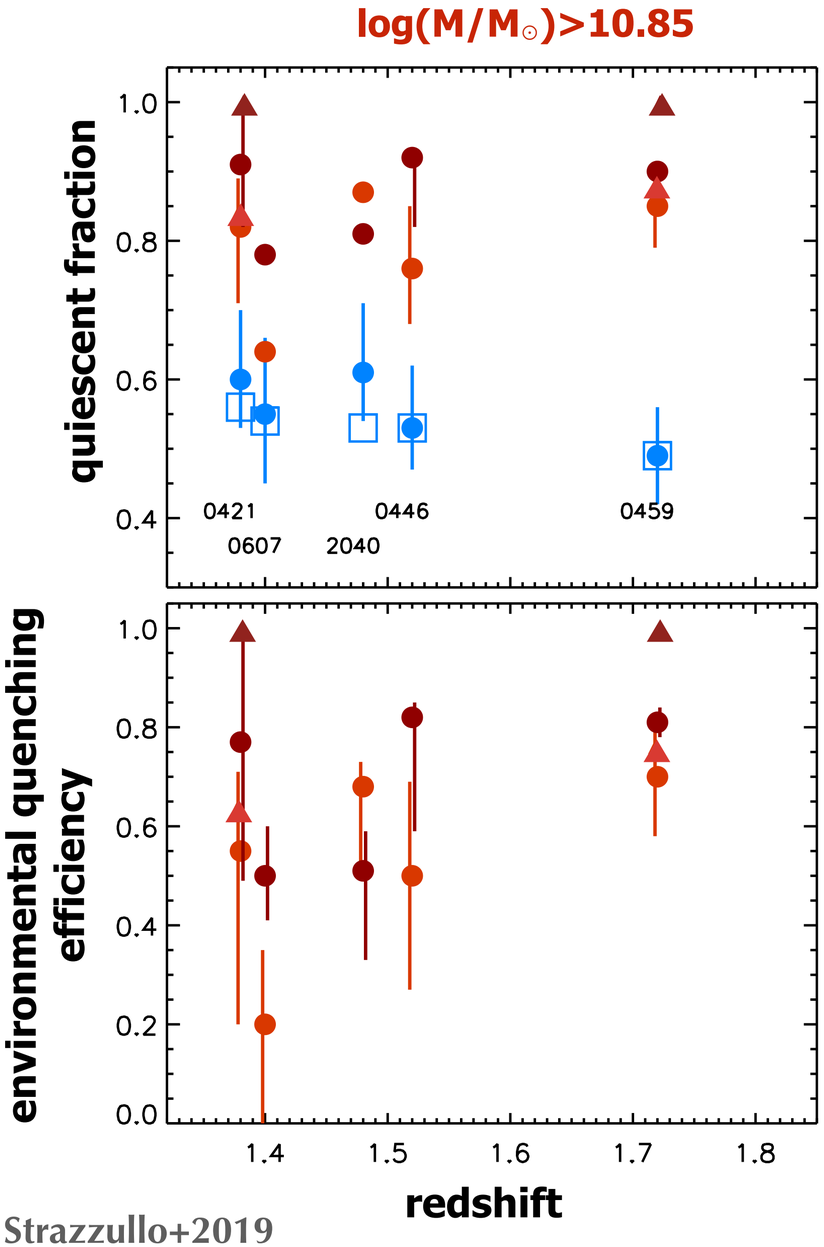
The environmental quenching efficiency at high stellar masses, in the central regions of these massive clusters, is typically ≳50%

Strazzullo+2019

Environmental quenching in cluster central regions ($r<0.7\ r_{500}$)



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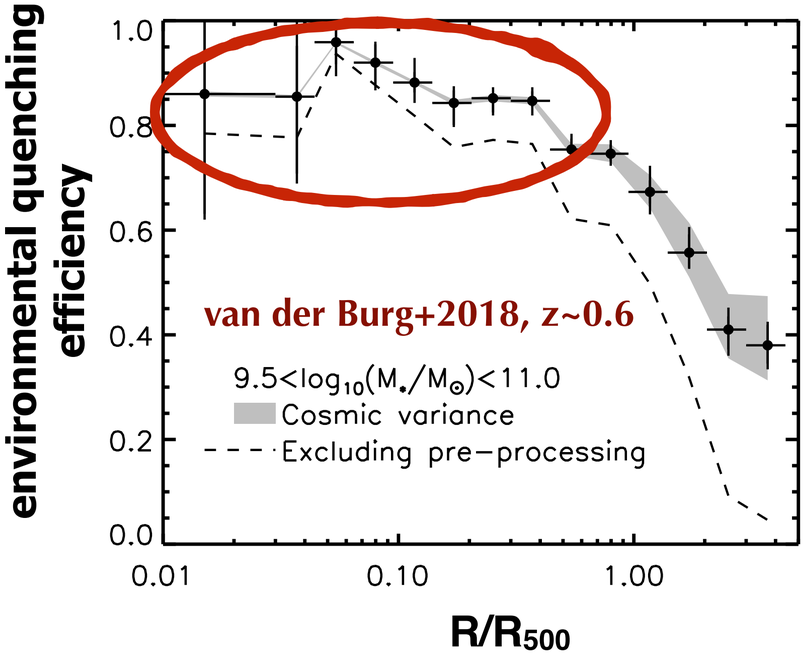
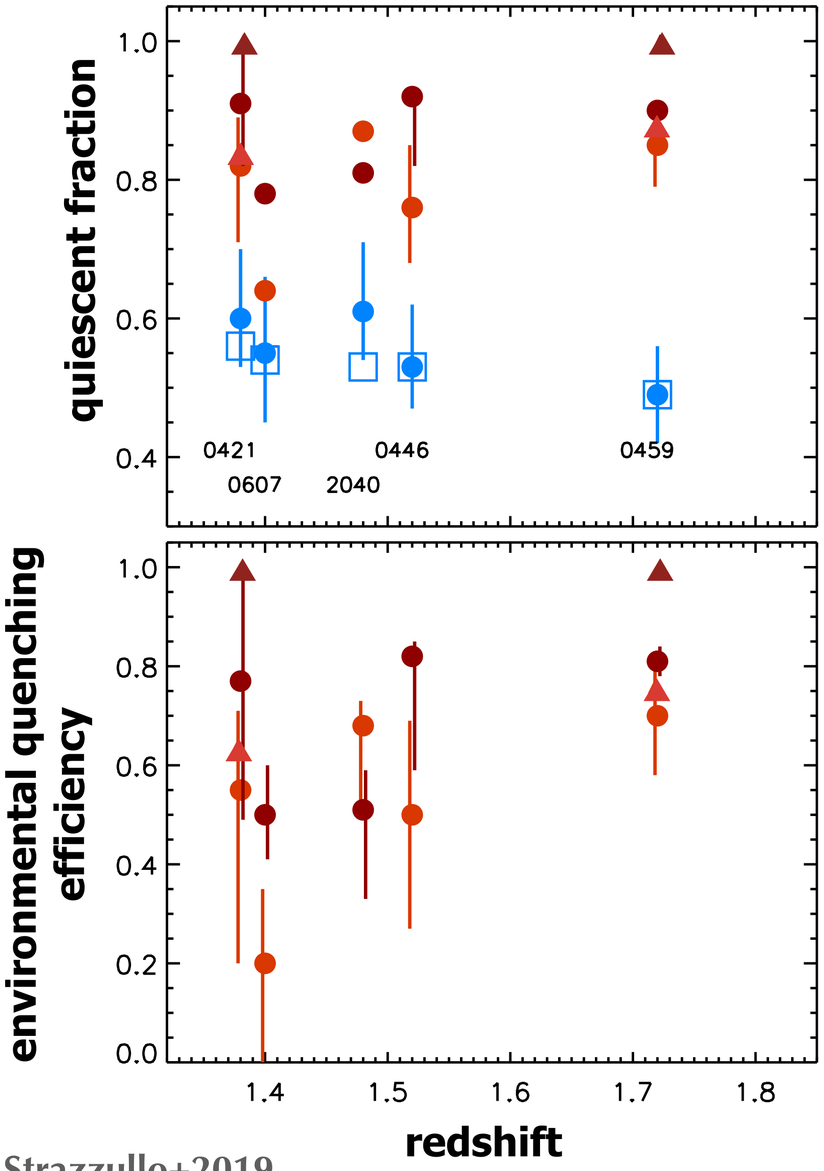


Strazzullo+2019

Environmental quenching in cluster central regions (r<0.7 r_{500})

log(M/M$_\odot$)>10.85



Strazzullo+2019

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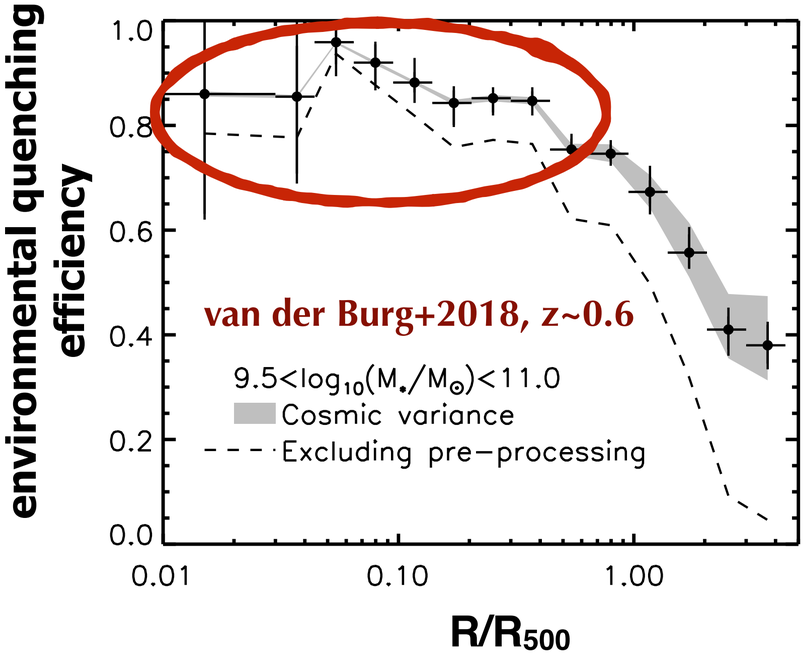
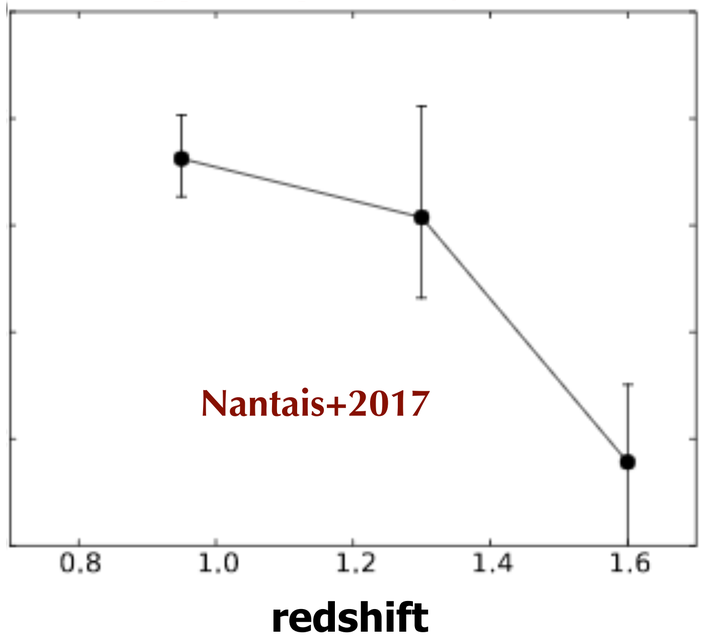


log(M/M$_\odot$)>10.56, r<r_{200}



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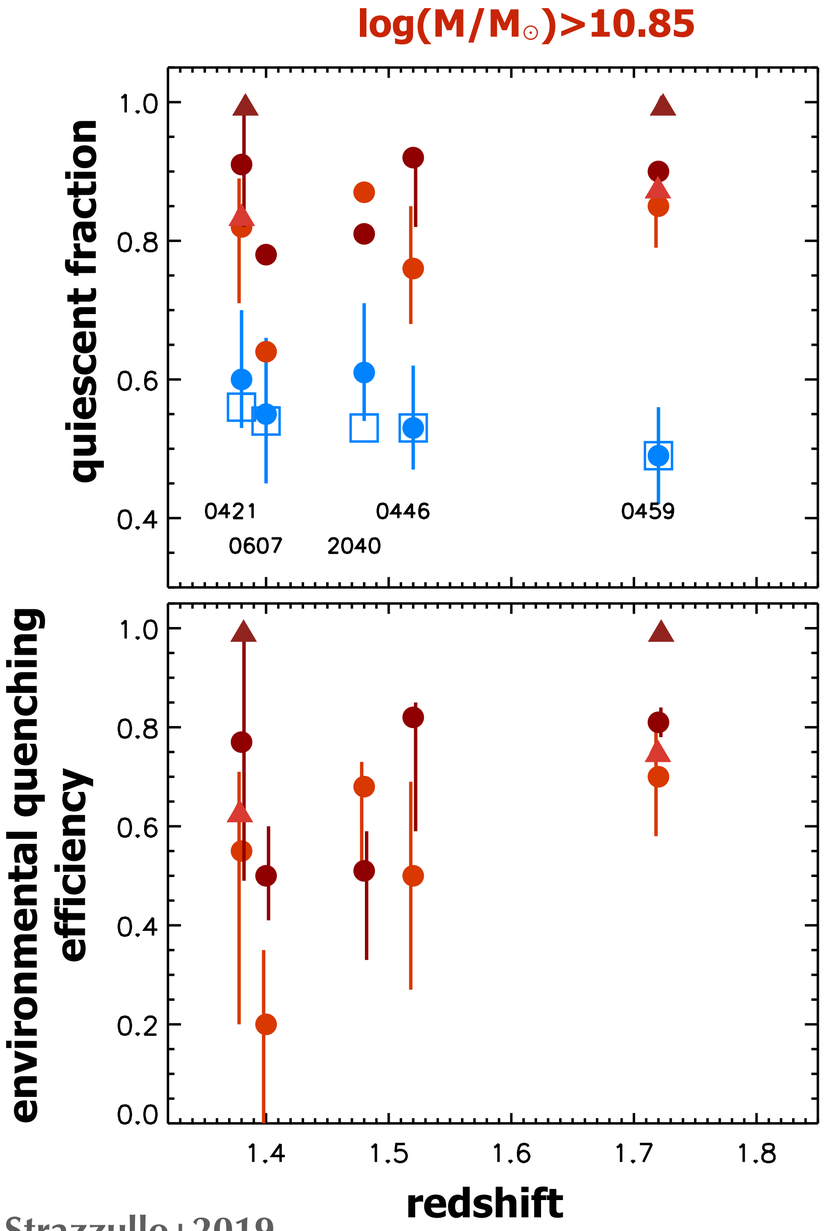
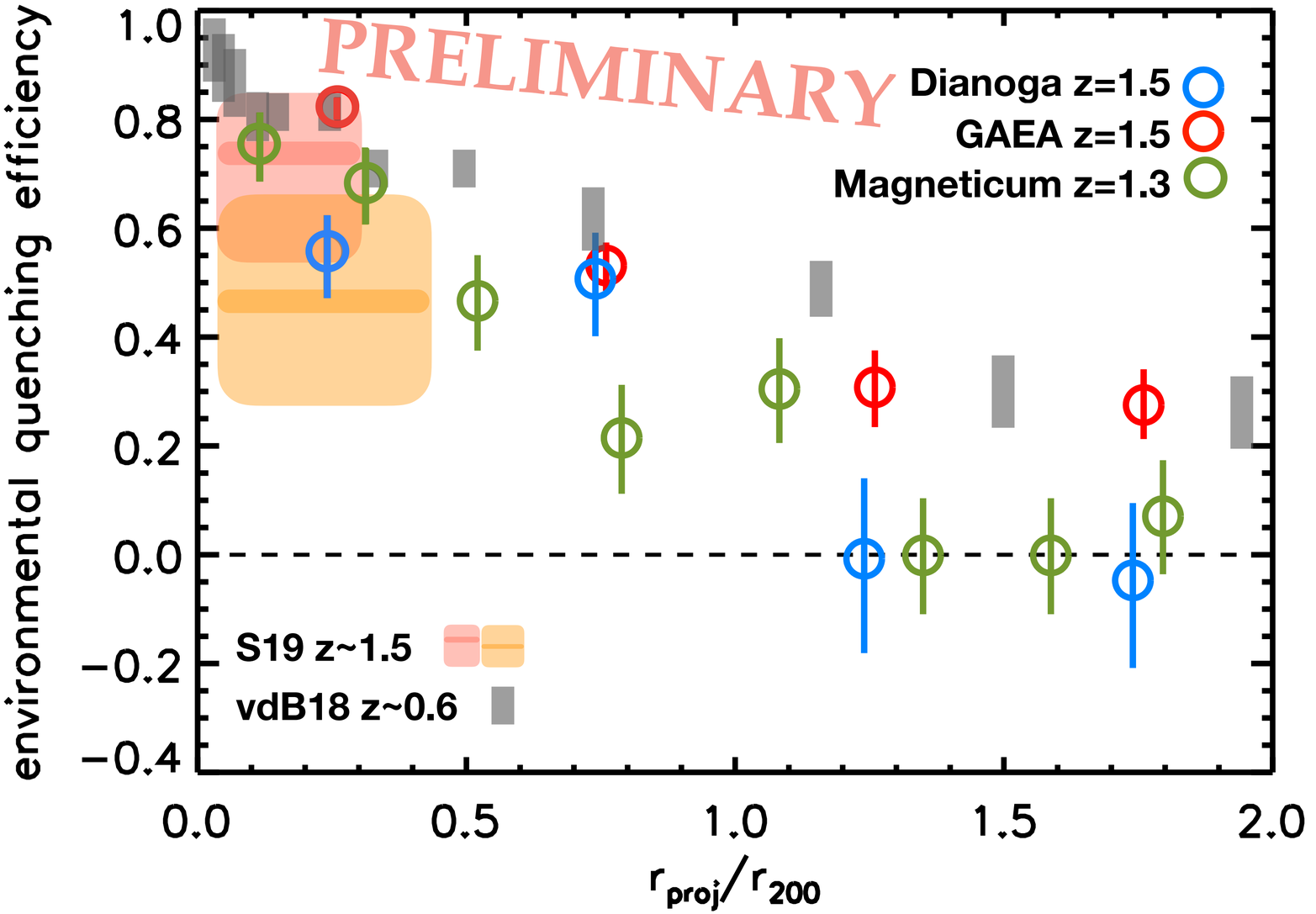


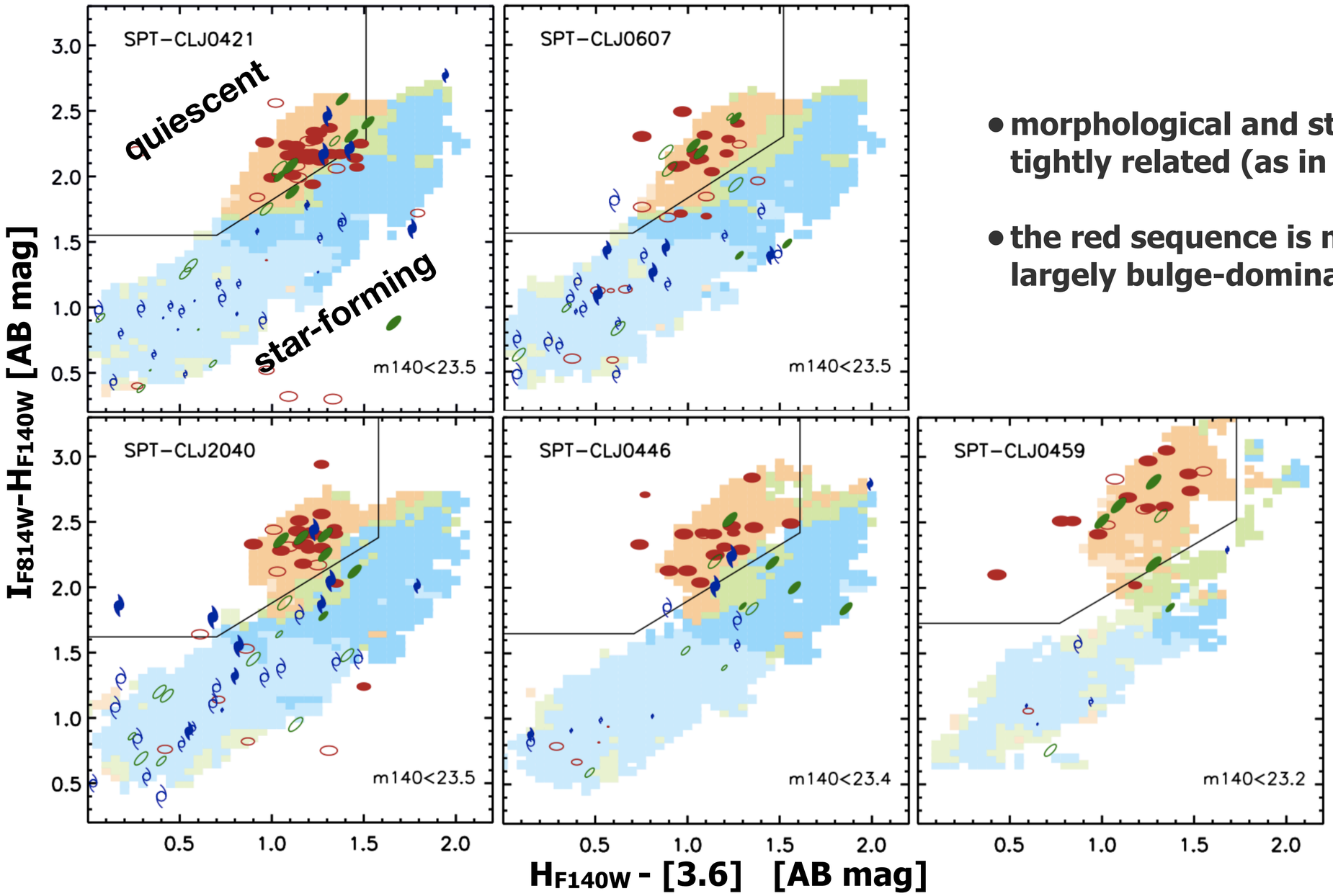
Strazzullo+2019

with P. Lustig, I. Marini, G. De Lucia, R.-S. Remus, K. Dolag



Strazzullo+in prep.

Structural properties of cluster galaxies



- morphological and stellar population properties tightly related (as in the field)
- the red sequence is mostly made of quiescent, largely bulge-dominated sources

field average cluster

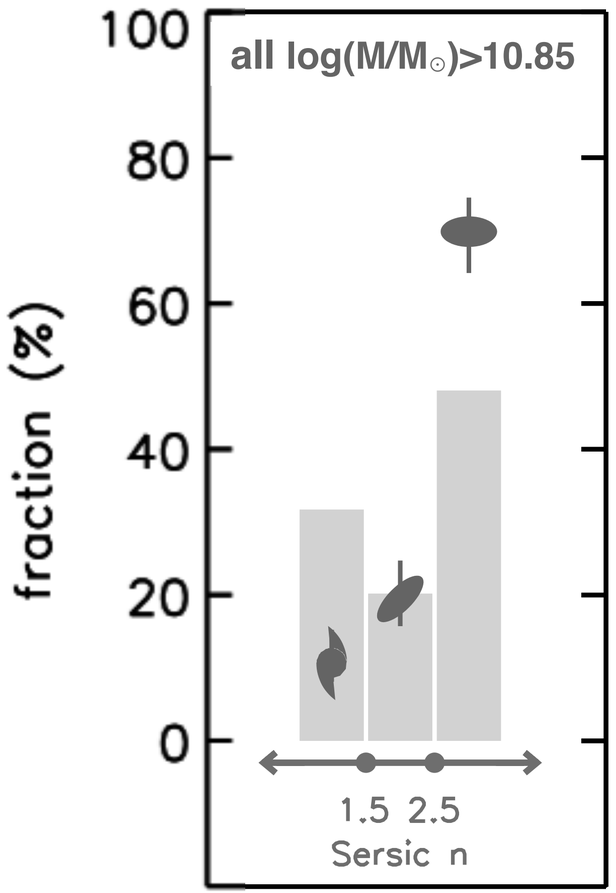
n_{Sersic}<1.5

1.5<n_{Sersic}<2.5

n_{Sersic}>2..5

Strazzullo+in prep.

Structural properties of cluster galaxies



field

cluster

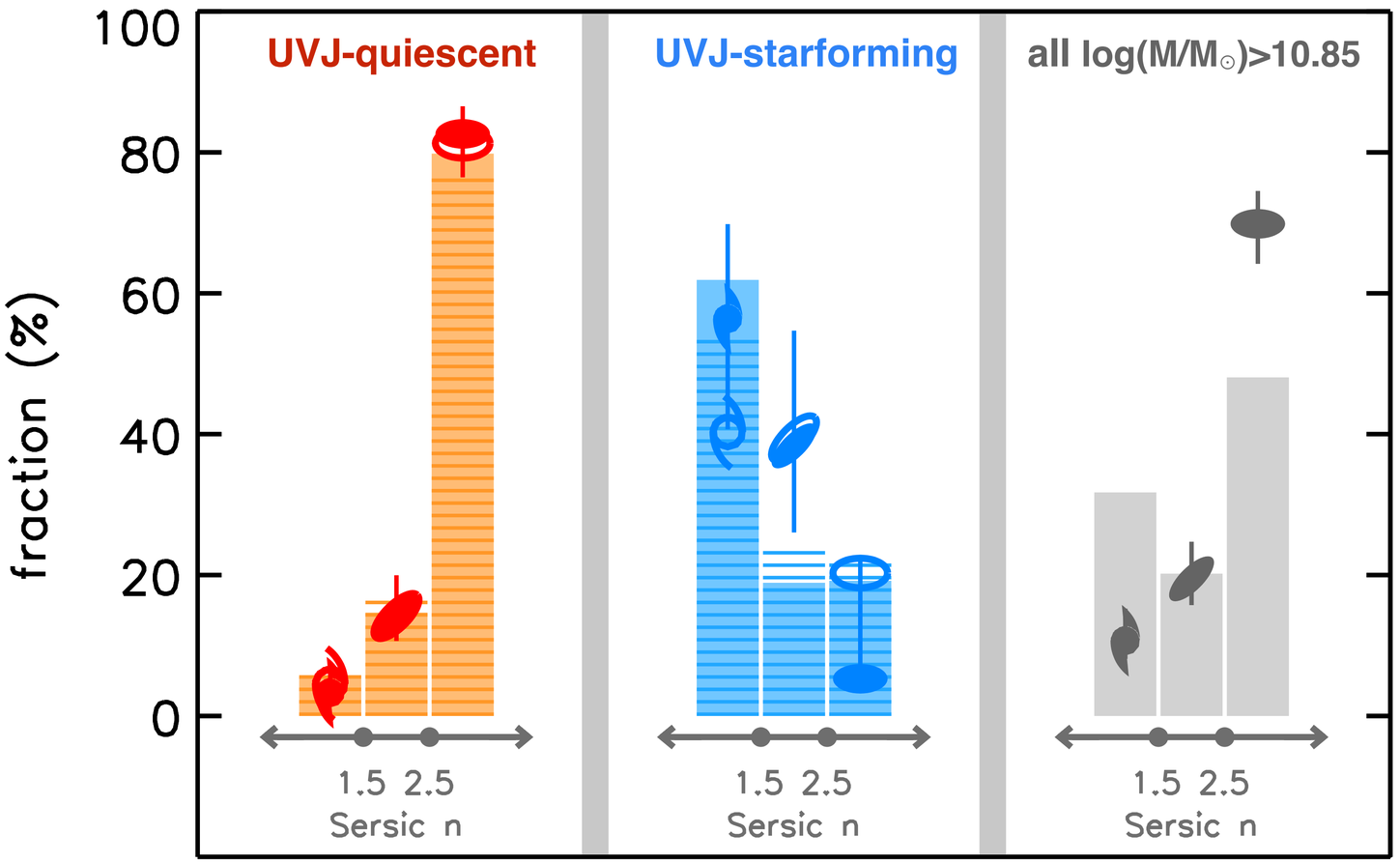
r<0.7 r_{500}
log(M/M⊙)>10.85

UVJ-border excised
bkg-corrected

morphology-density relation

Strazzullo+in prep.

Structural properties of cluster galaxies



field

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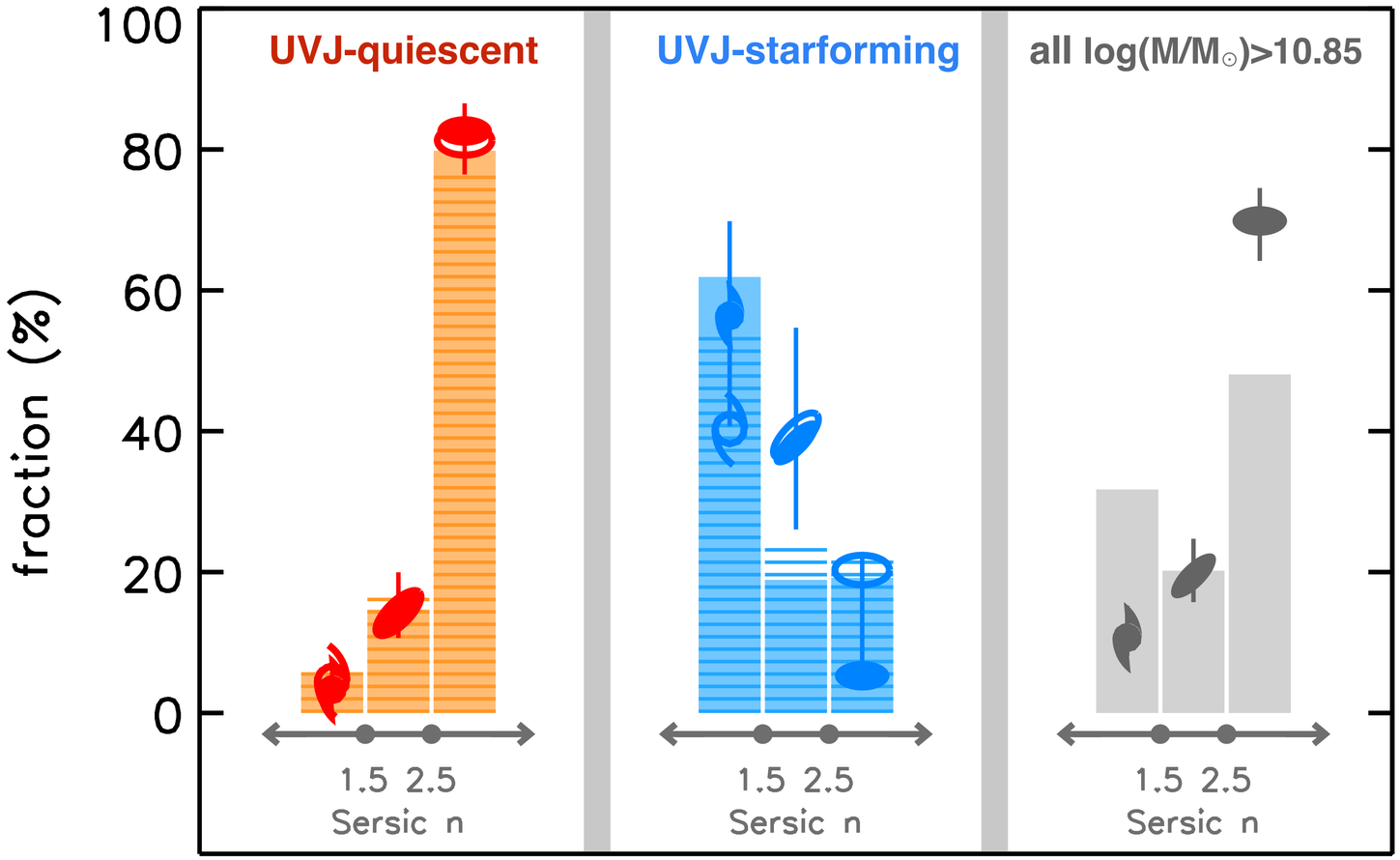
bkg-corrected

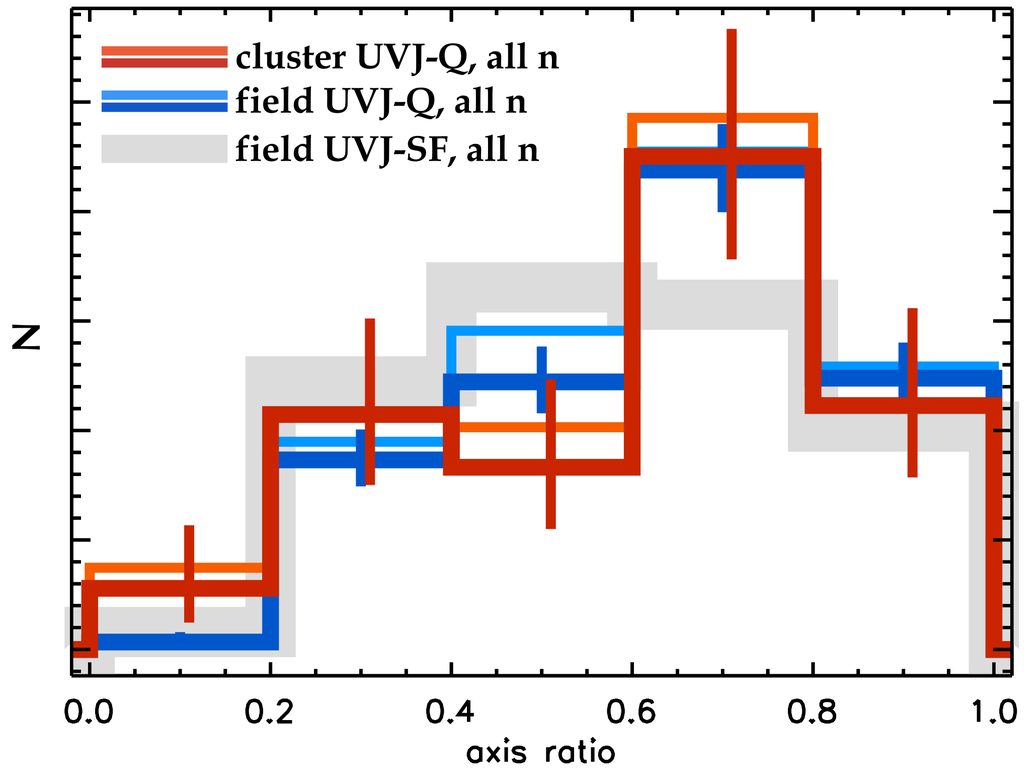
largely driven by
high quiescent fraction

morphology-density
relation

Strazzullo+in prep.

Structural properties of cluster galaxies



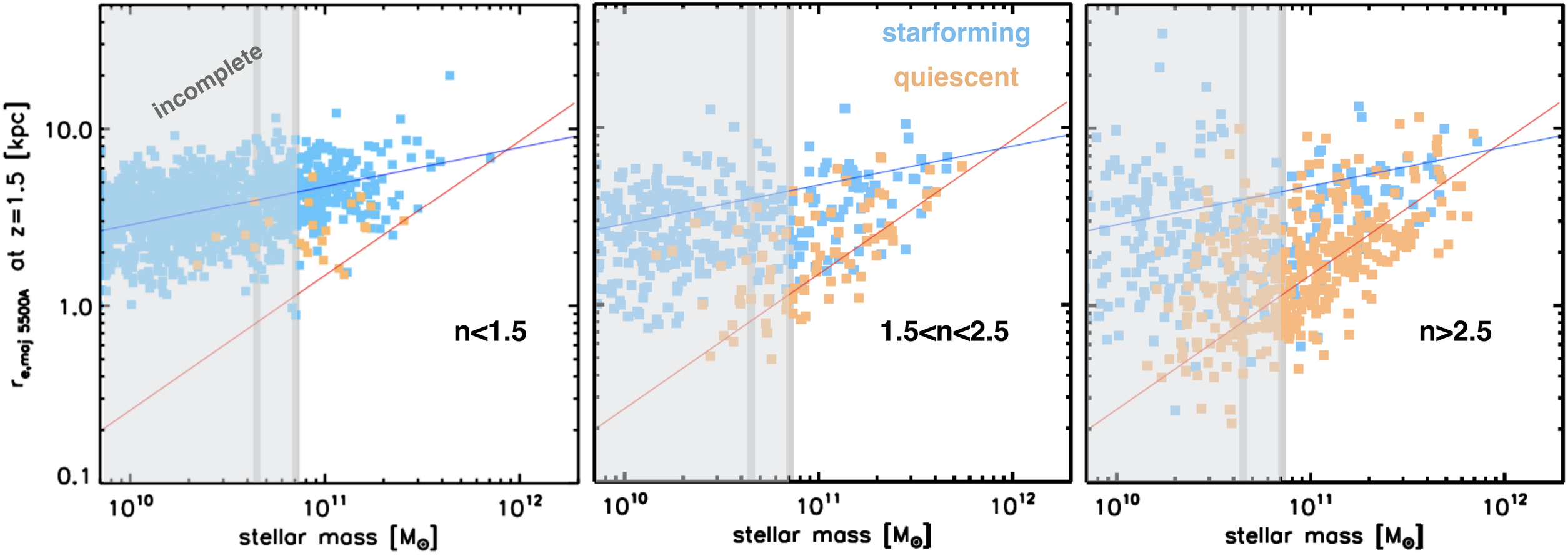


largely driven by high quiescent fraction

morphology-density relation

Strazzullo+in prep.

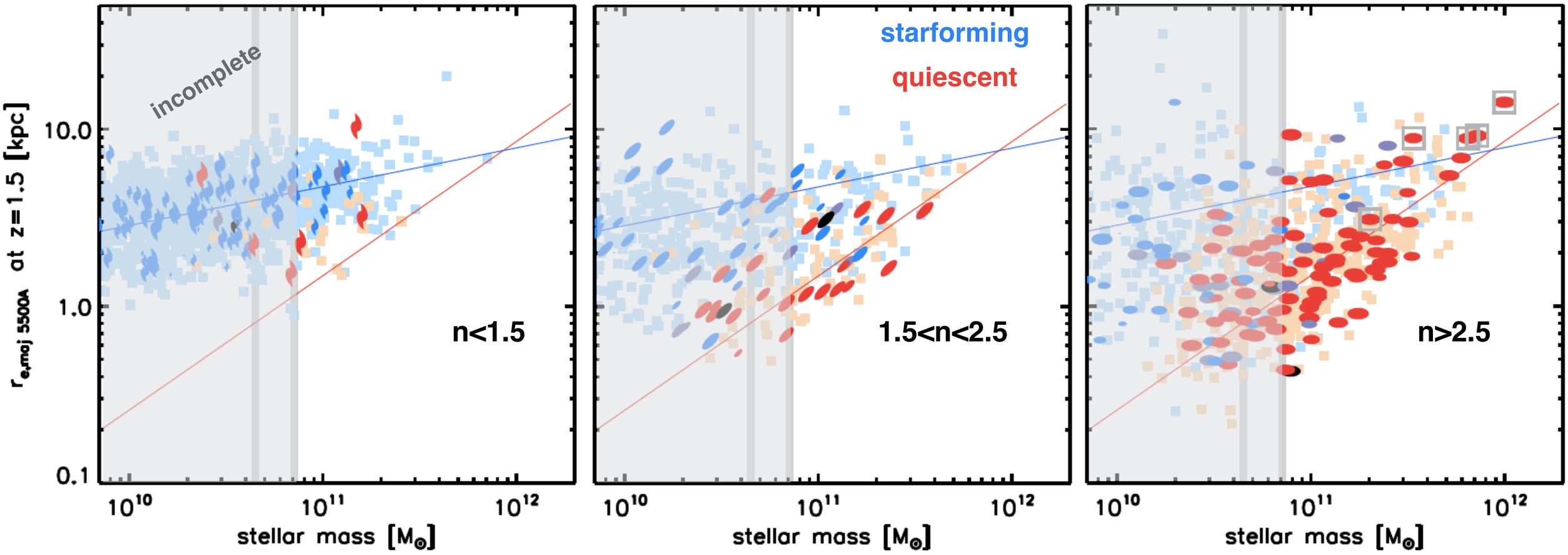
Mass-size relation of cluster galaxies



field
(van der Wel+14)

Strazzullo+in prep.

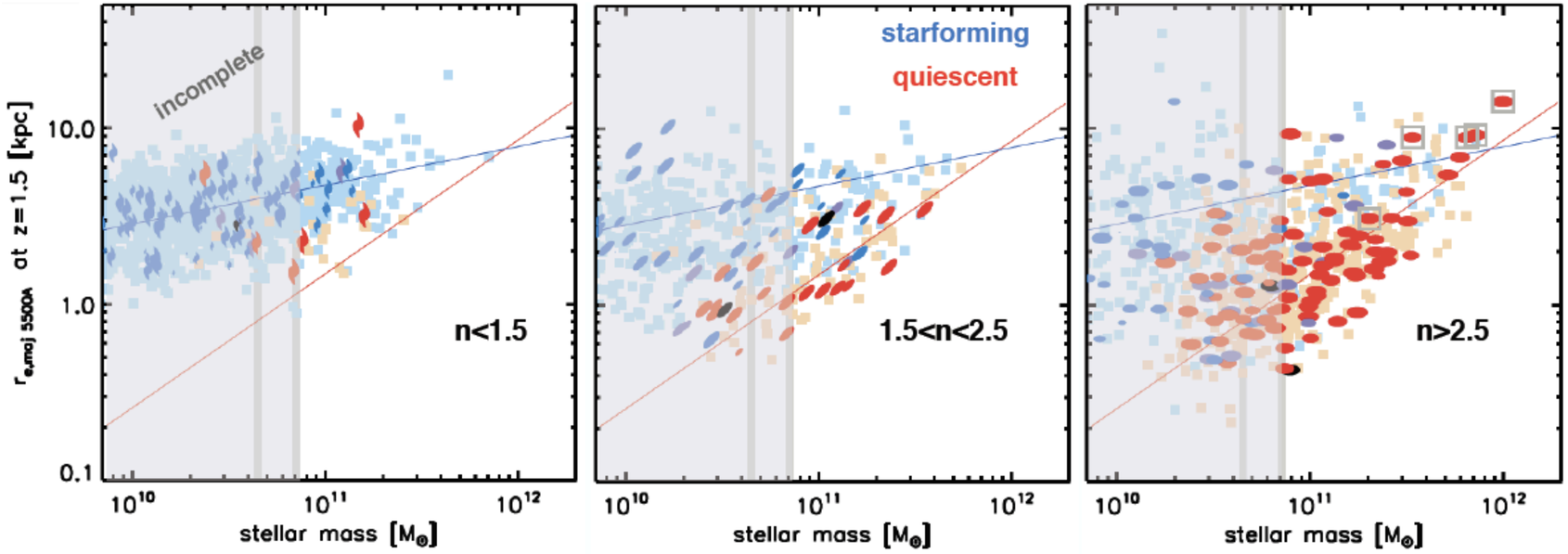
Mass-size relation of cluster galaxies

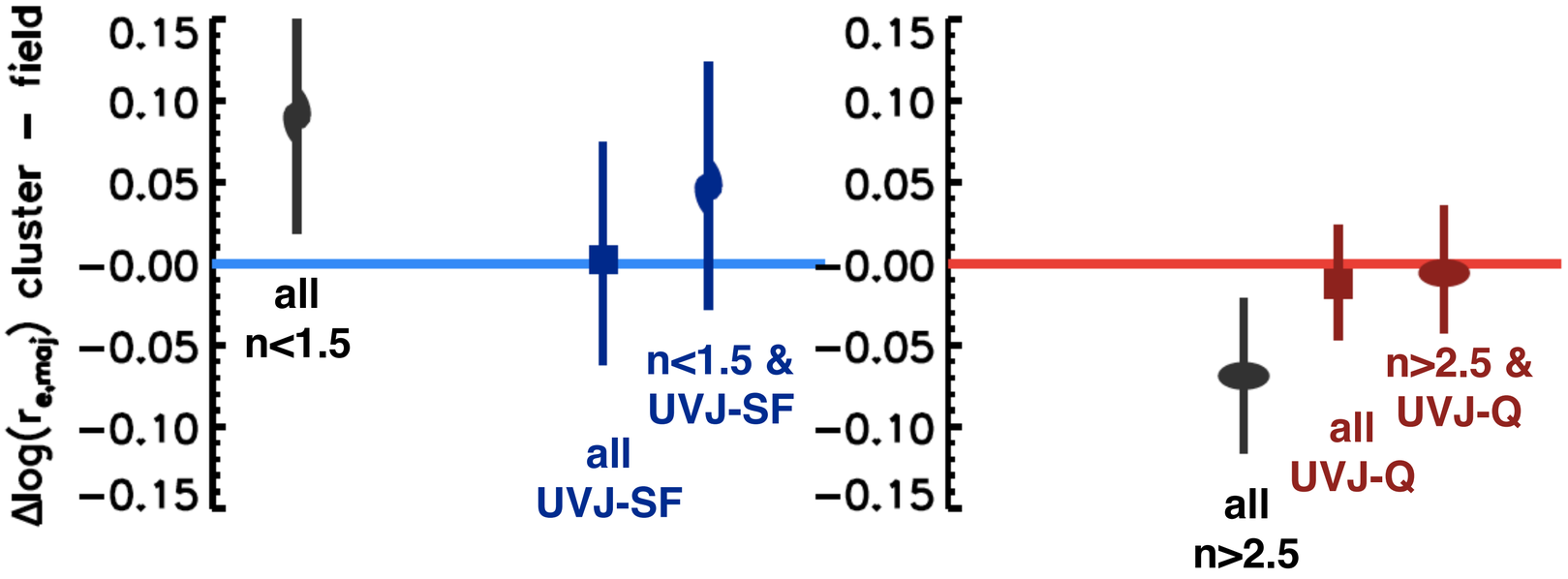


all clusters
(scaled to z=1.5)

Strazzullo+in prep.

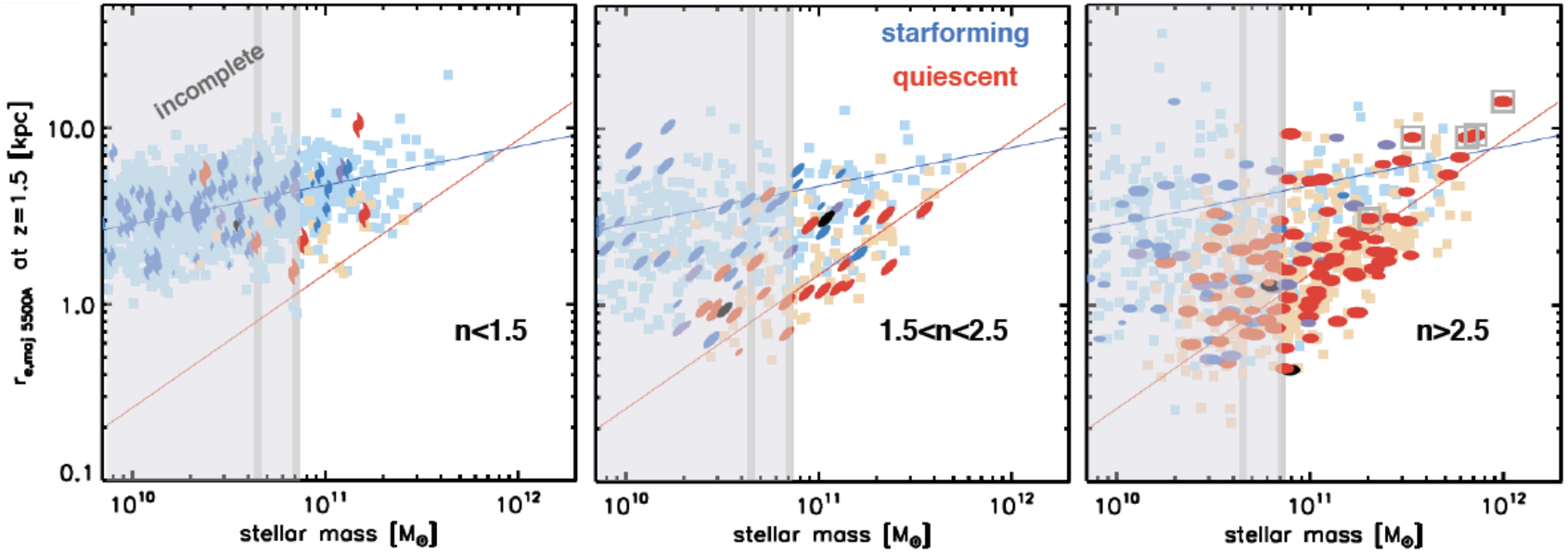
Mass-size relation of cluster galaxies

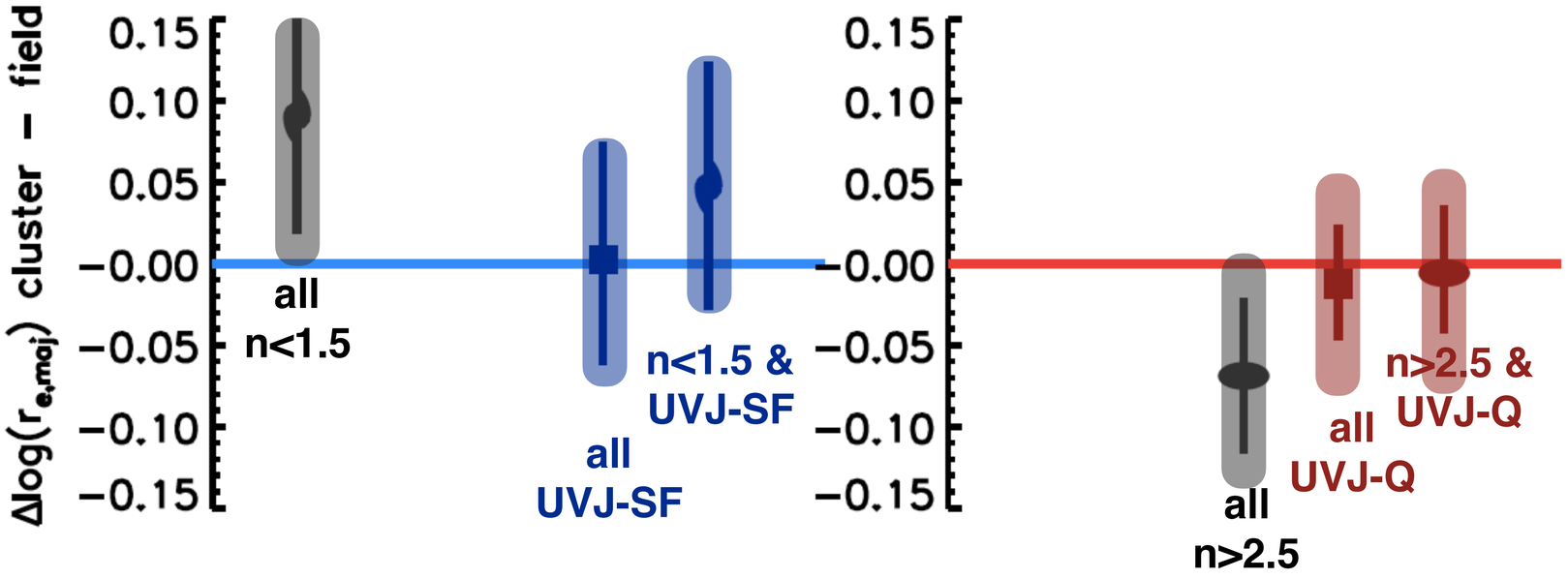




log(M/M$_\odot$)>10.85

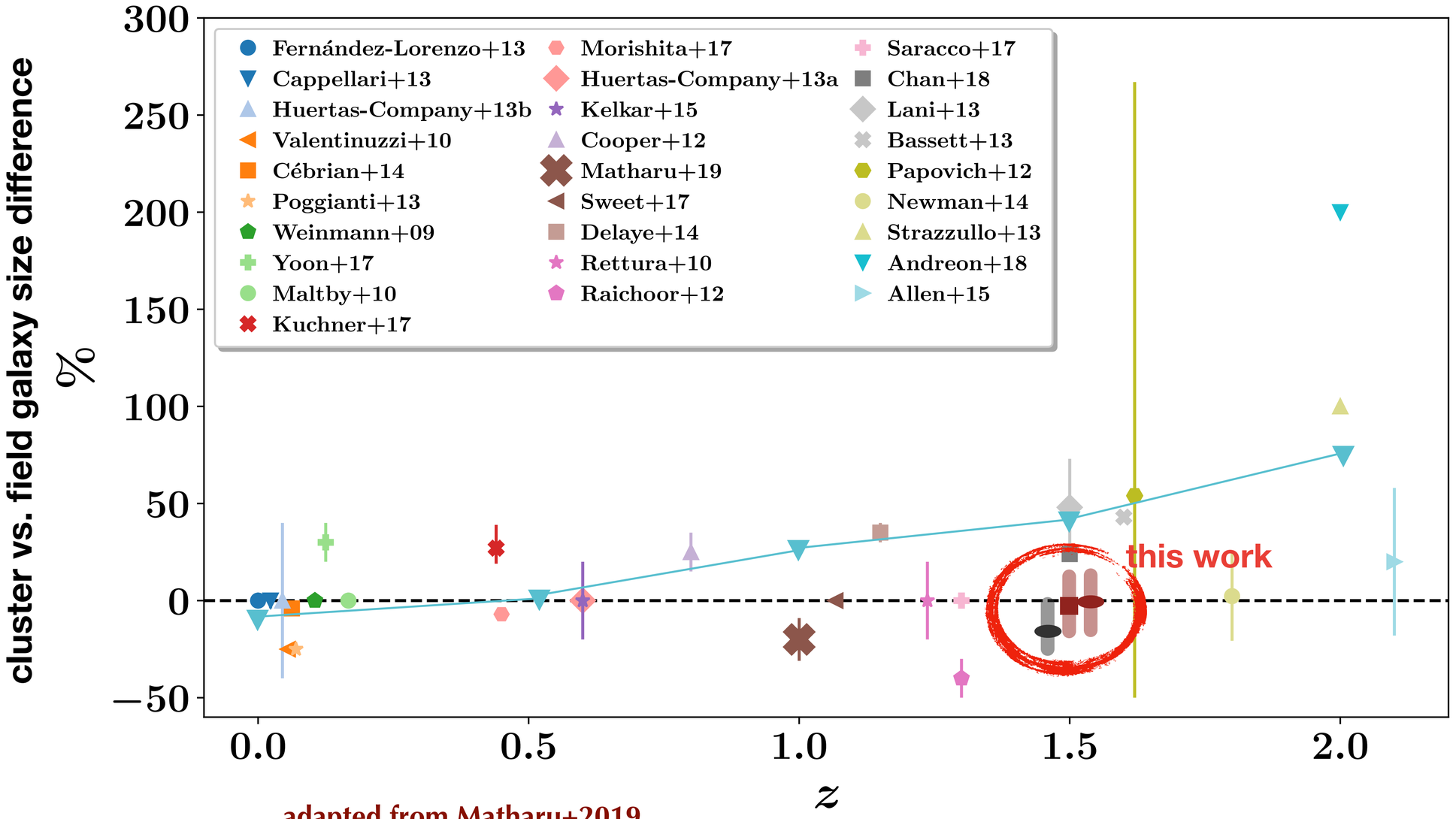
Mass-size relation of cluster galaxies





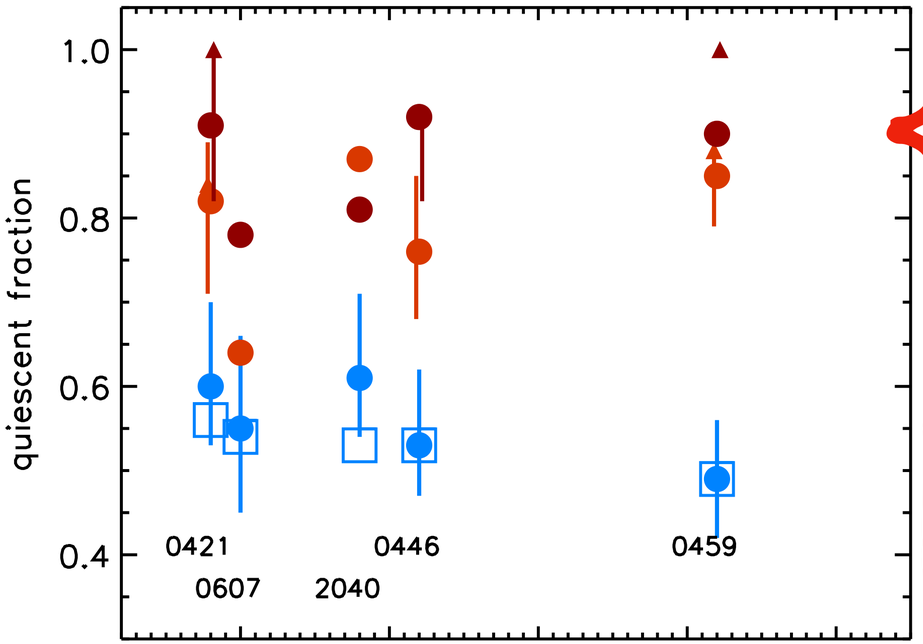
log(M/M$_\odot$)>10.85

Mass-size relation of early-type cluster galaxies



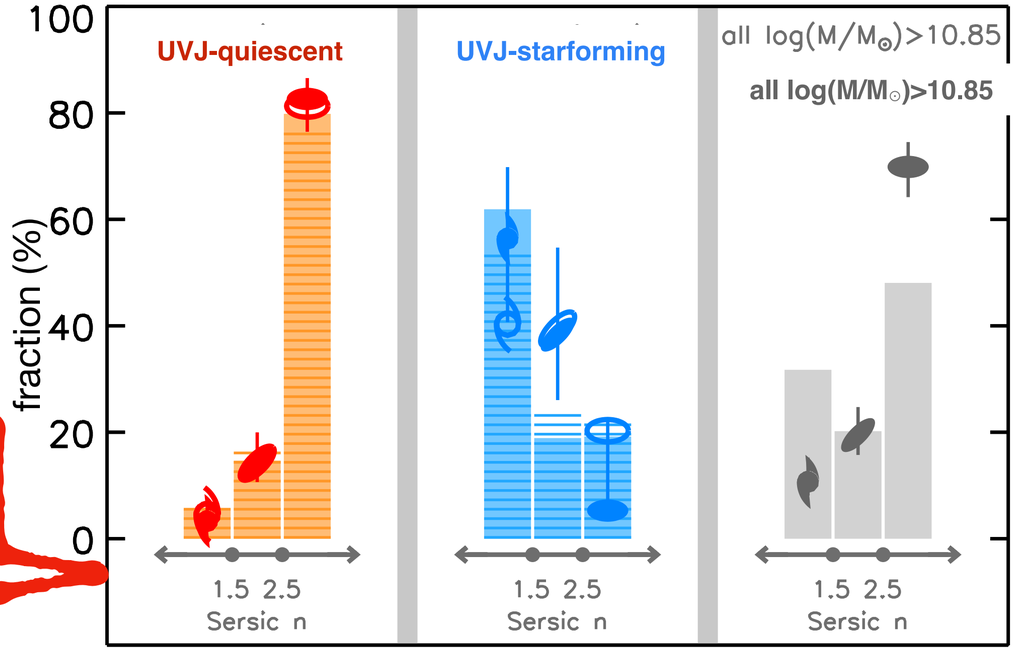
adapted from Matharu+2019

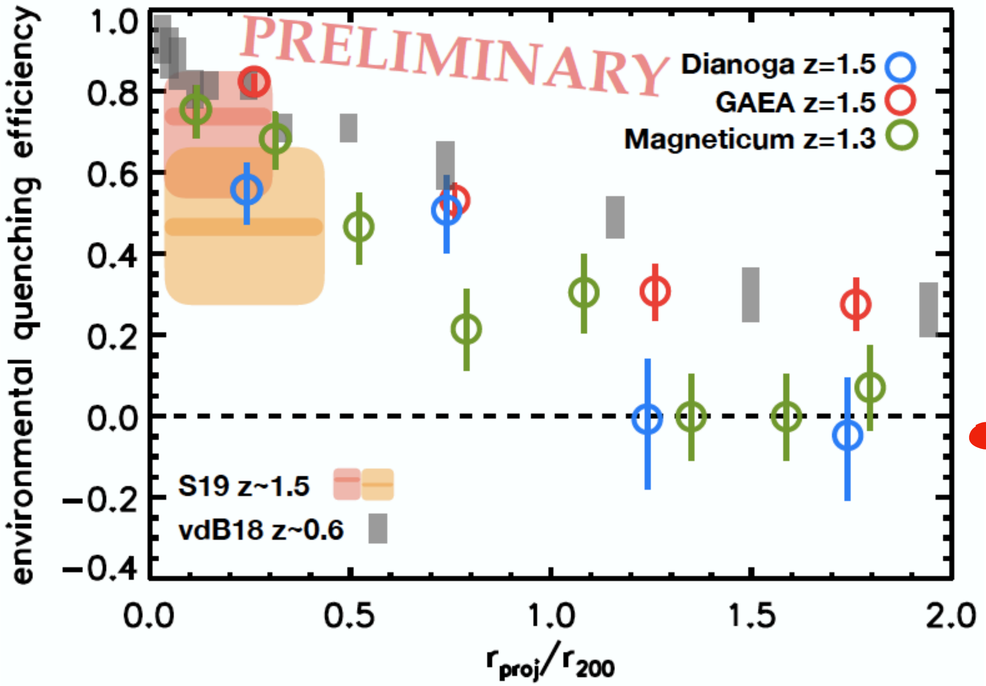
In short...



Environmental quenching is active (cluster central region)

Morphological evolution follows along.





No significant evidence for size difference wrt field... ?

Exploit synergies with cosmological simulations