

THE ROLE OF ENVIRONMENT: MY QUESTIONS & ANSWERS

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Zwicky Symposium

THE DATA

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Most of the talk is based on results from the ZENS study

Provided detailed structural and star-formation properties for centrals and satellites in ~ 150 local ($z \sim 0.05$) groups.

ZENS-I

Carollo, Cibinel et al. 2013

ZENS-II

Cibinel, Carollo et al. 2013

ZENS-III

Cibinel, Carollo et al. 2013

ZENS-IV

Carollo, Cibinel et al. 2014

ZENS-V

Pipino, Cibinel et al. 2015

ADVISORY NOTE

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Mostly focusing on local, relatively massive ($>10^{10} M_{\text{sun}}$), satellite galaxies

The picture at high-redshift, for centrals/singletons and lower mass satellites could be different

THE QUESTIONS

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- How well can we measure environment?
- Can we reliably identify Cens & Sats?
- Are large scale (supra-halo) effects relevant?
- Is (environment) quenching decoupled from morphology?
- What is the role of mergers?

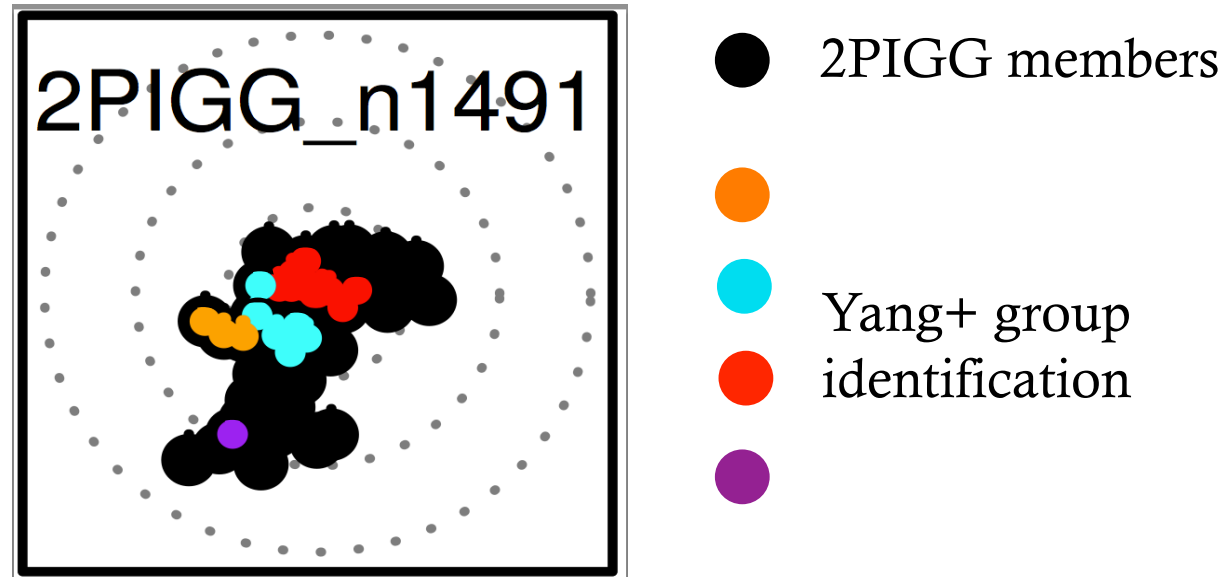
HOW WELL CAN WE MEASURE ENVIRONMENT?

HOW WELL CAN WE MEASURE ENVIRONMENT?

5

Carollo, A.C. et al. 2013

One (large) group or 3 groups + individual galaxy?



Due to survey completeness, different grouping algorithms, parent samples, etc..

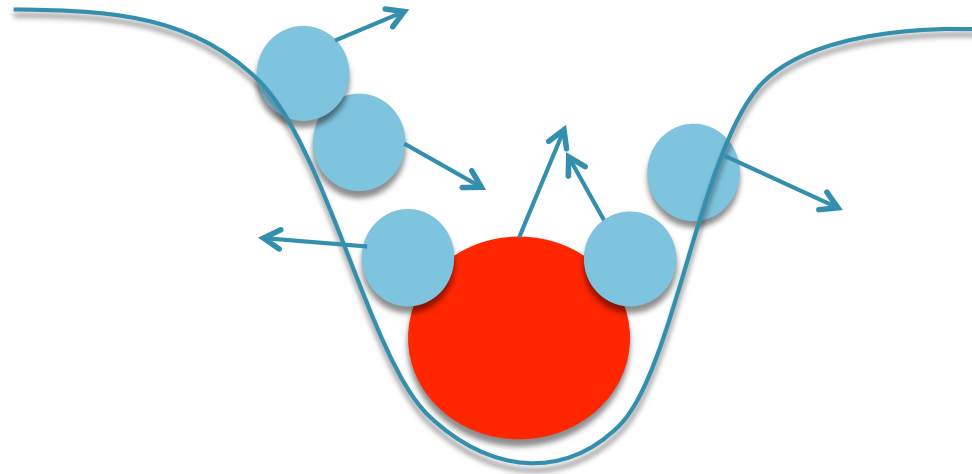
Note this is $z=0.05$, how much worse does it get at high- z ?

CAN WE RELIABLY IDENTIFY CEN'S & SAT'S?

CENTRALS, WHAT YOU EXPECT

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Carollo, A.C. et al. 2013

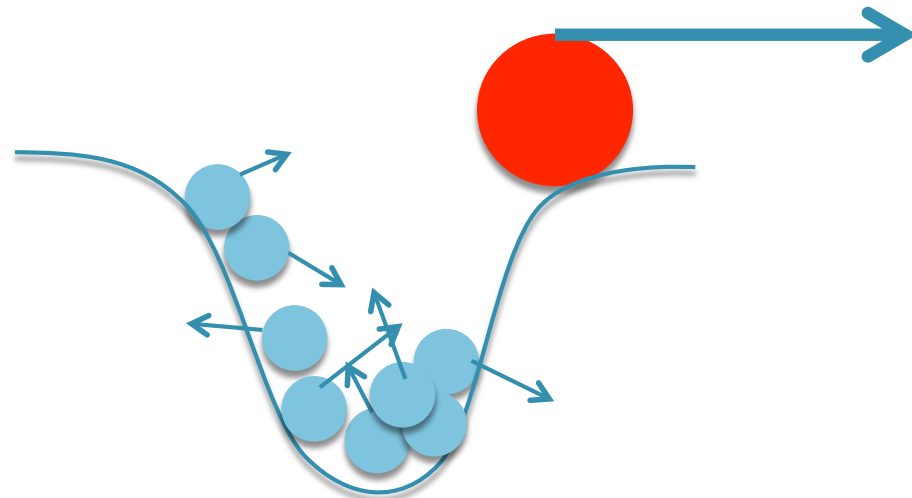


for a galaxy to be a good central in a group halo, it must be its most massive inhabitant *and* must be compatible with the inferred spatial *and* velocity centroids of this halo.

CENTRALS, WHAT YOU GET

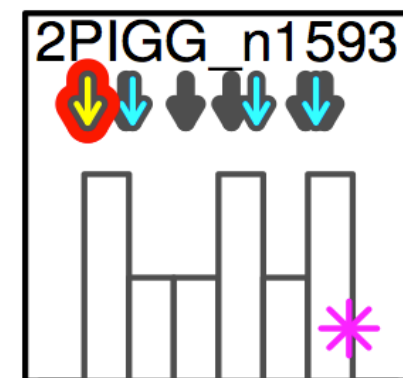
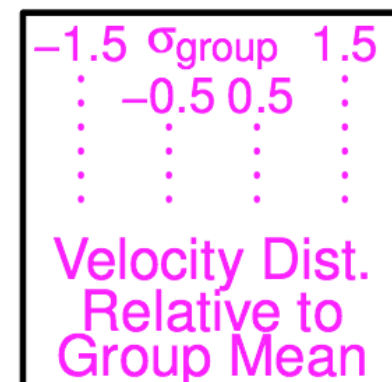
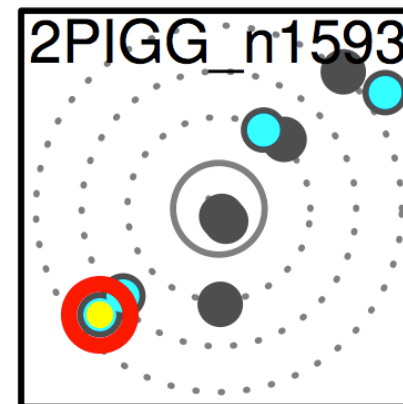
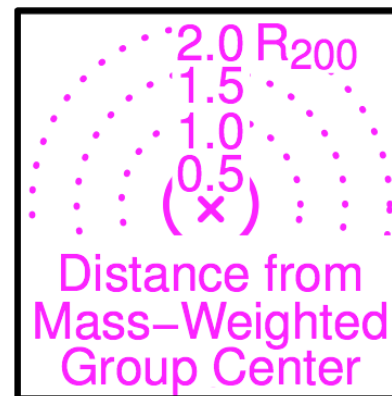
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Carollo, A.C. et al. 2013



Unrelaxed groups or measurement errors?

Most Massive Galaxy
Factor 2 from most massive



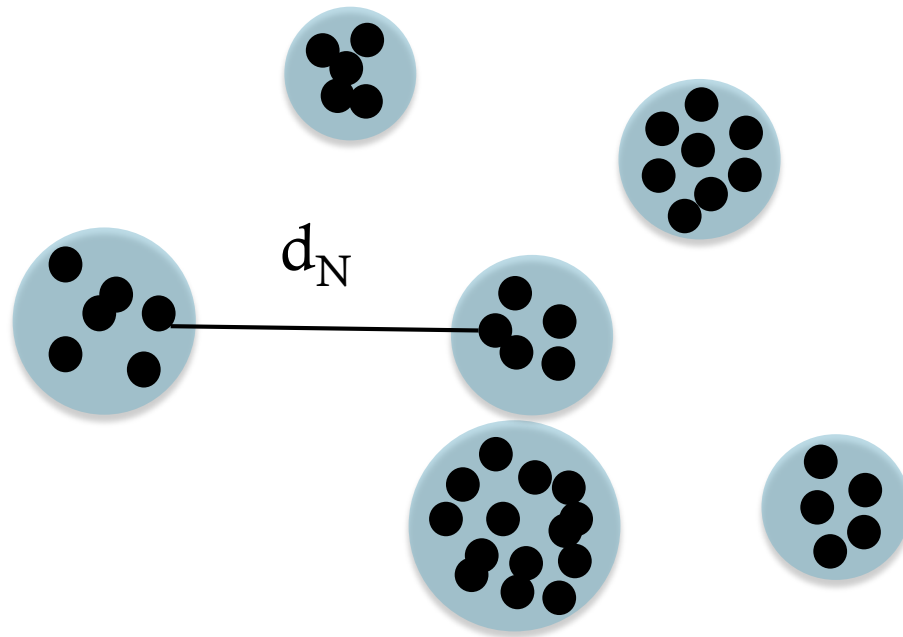
ARE LARGE SCALE (SUPRA-HALO) EFFECTS RELEVANT?

OUR DEFINITION OF LSS

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Carollo, A.C. et al. 2013

5th nearest neighbour density using **groups** as tracers



$$\delta_{LSS} = \frac{\rho(\theta, z) - \rho_m}{\rho_m}$$
$$\rho(\theta, z) = \sum_i^N w_i / (\pi d_N^2)$$

w_i = group mass

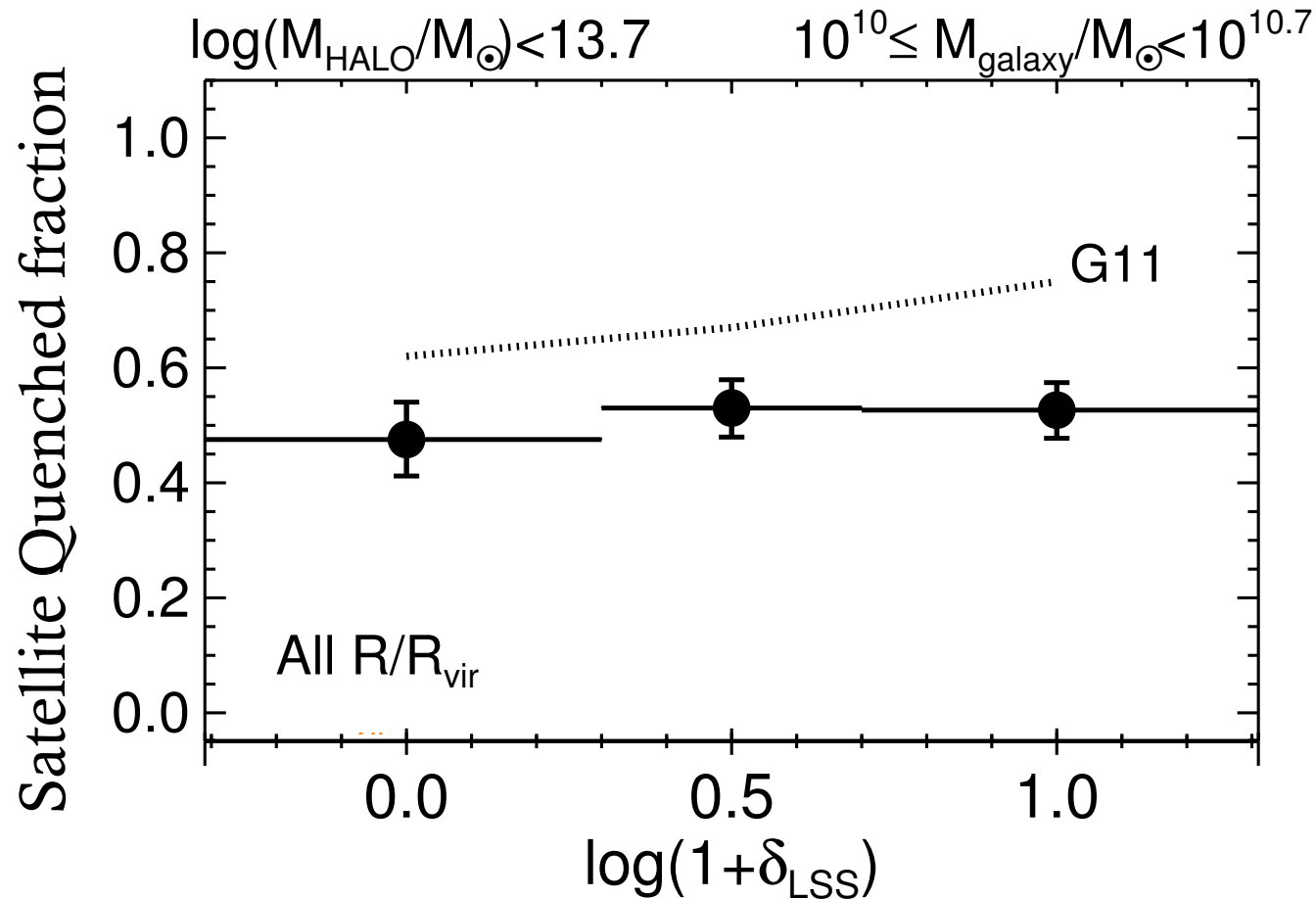
d_N = distance to 5th nearest **group**

δ_{LSS} probes global density, not densities within halo/local enhancements
Our new definition of density probes ~ 3 Mpc scales

SATELLITE QUENCHING FROM OUTSIDE HALOS

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Carollo, A.C. et al. 2013

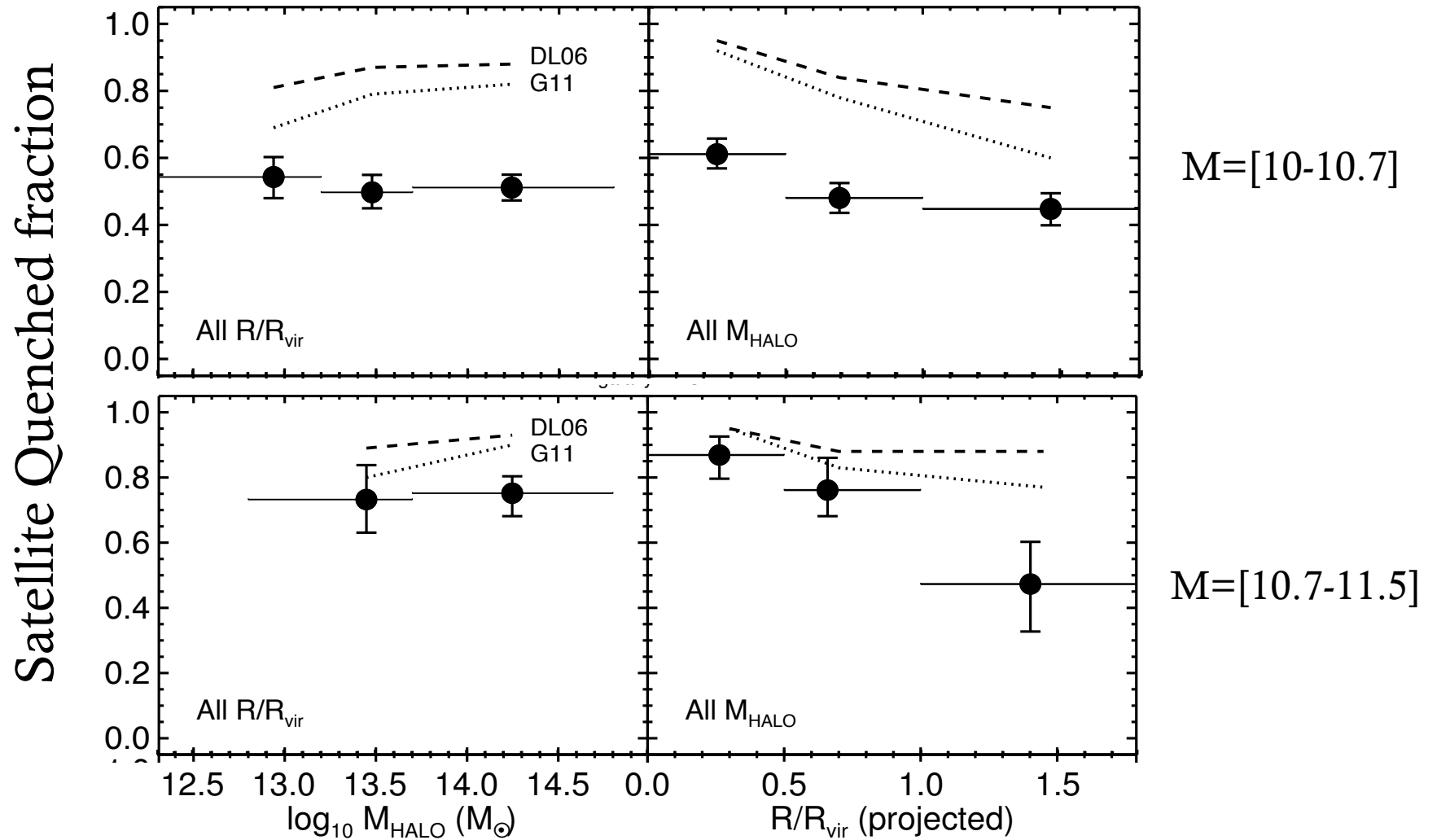


No dependence on large scale environment

SATELLITE QUENCHING FROM OUTSIDE HALOS

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Carollo, A.C. et al. 2013



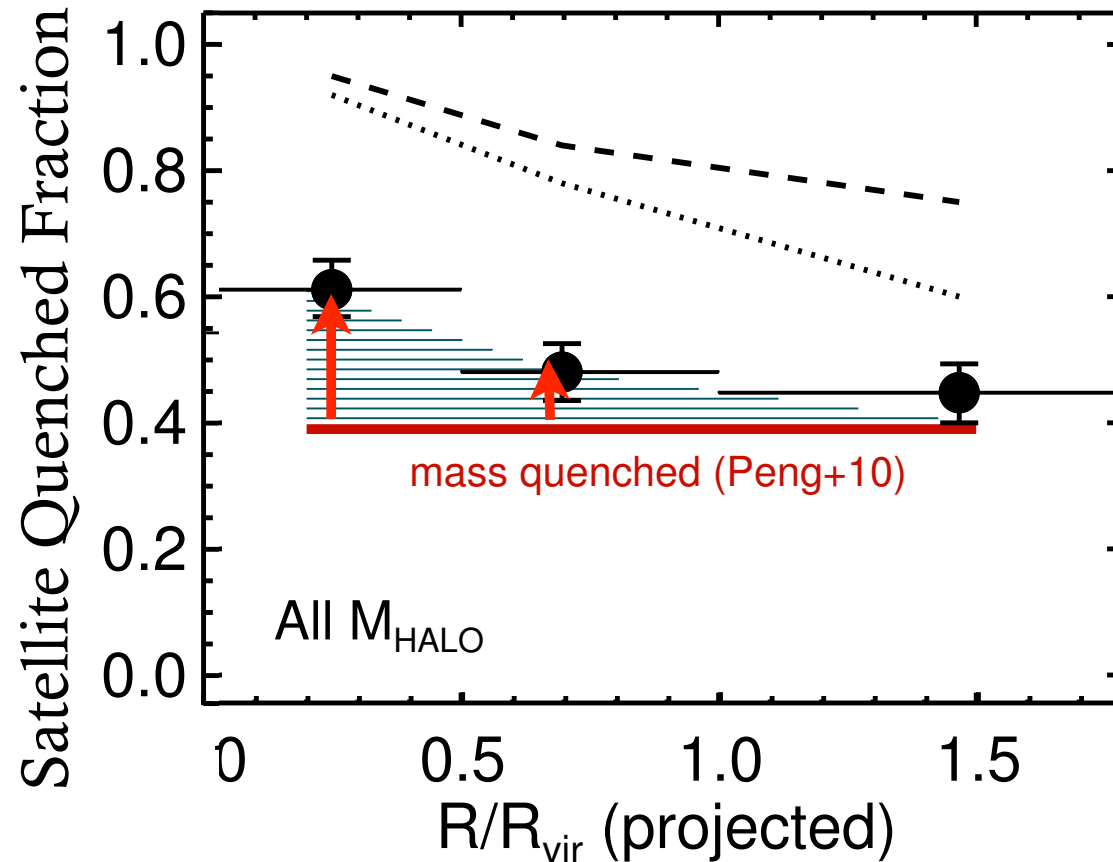
Dependence on local density

IS (ENVIRONMENT) QUENCHING DECOUPLED FROM MORPHOLOGY?

MORPHOLOGY OF QUENCHED GALAXIES

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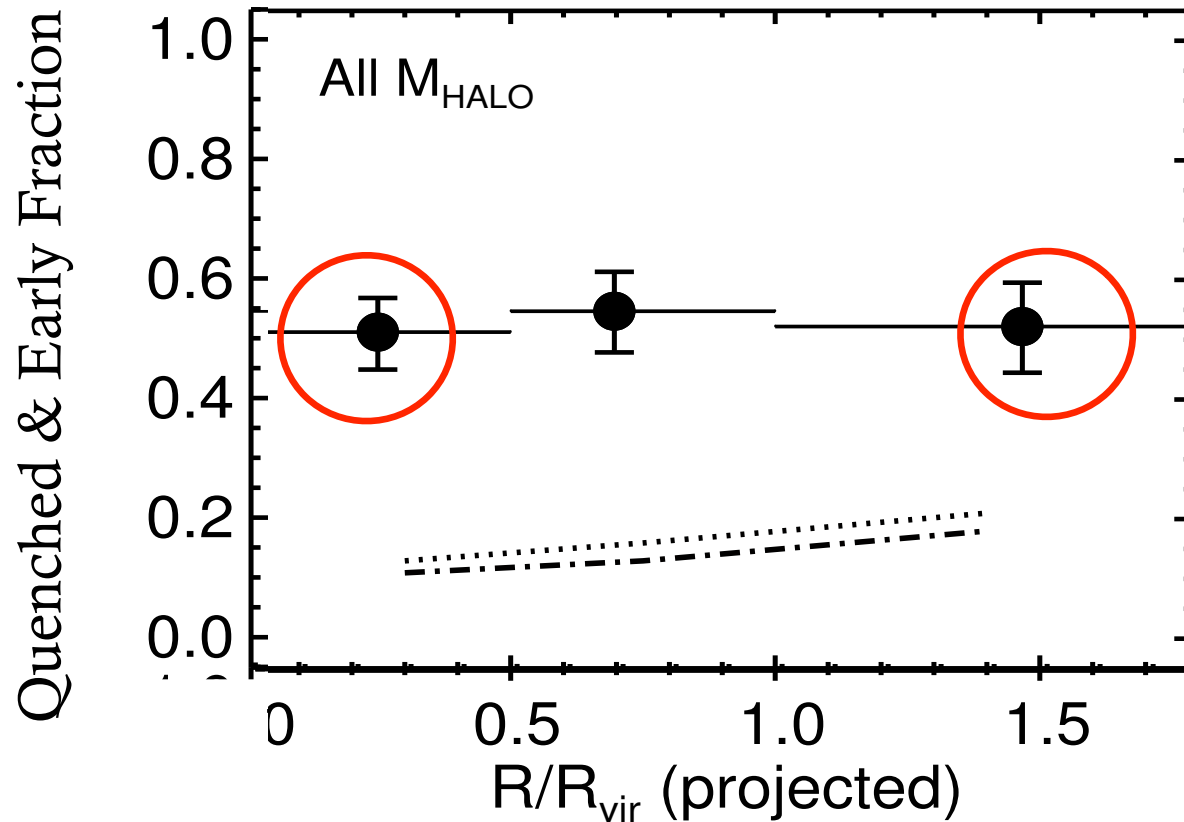
Carollo, A.C. et al. 2014



MORPHOLOGY OF QUENCHED GALAXIES

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Carollo, A.C. et al. 2014



Mass- & Environment-Quenching have same morphological output

MORPHOLOGY OF QUENCHED GALAXIES

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Carollo, A.C. et al. 2014

Mass and environment quenching affect galaxies in the same way

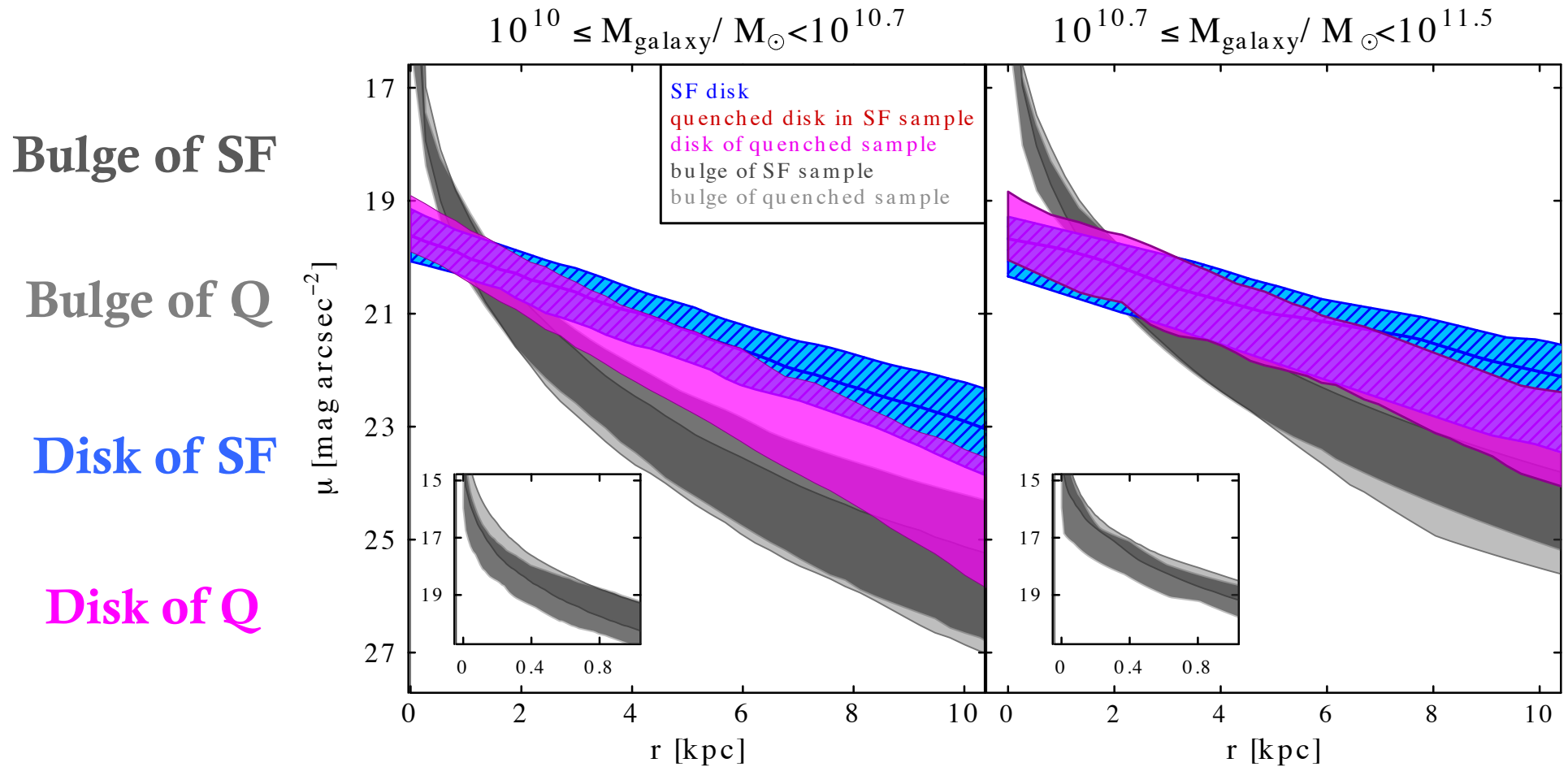
- Same underlying physical processes
(e.g., Gabor&Dave' 2015, Knobel+2015, Kormendy 2015)
- Neither induce real changes, structure is established prior to quenching

But we know that morphologies of SF and quenched galaxies are different, can this be reconciled?

QUENCHING: BULGE GROWTH VS. DISK FADING

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Average surface brightness profile for disks and bulges
of SF and quenched galaxies



Carollo, A.C. et al. 2014

QUENCHING: BULGE GROWTH VS. DISK FADING

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Carollo, A.C. et al. 2014

Start with sample of
SF disk galaxies



Replace Disk Component with
1Gyr old passively evolving SSP
keeping **mass in the bulge and disk
constant**, as well as all structural
parameters

→ **keep structure constant**



Recompute observed
I-band structural
parameters

$B/T_{\text{quenched disk}}$



**New light-weighted
morphology**

QUENCHING: BULGE GROWTH VS. DISK FADING

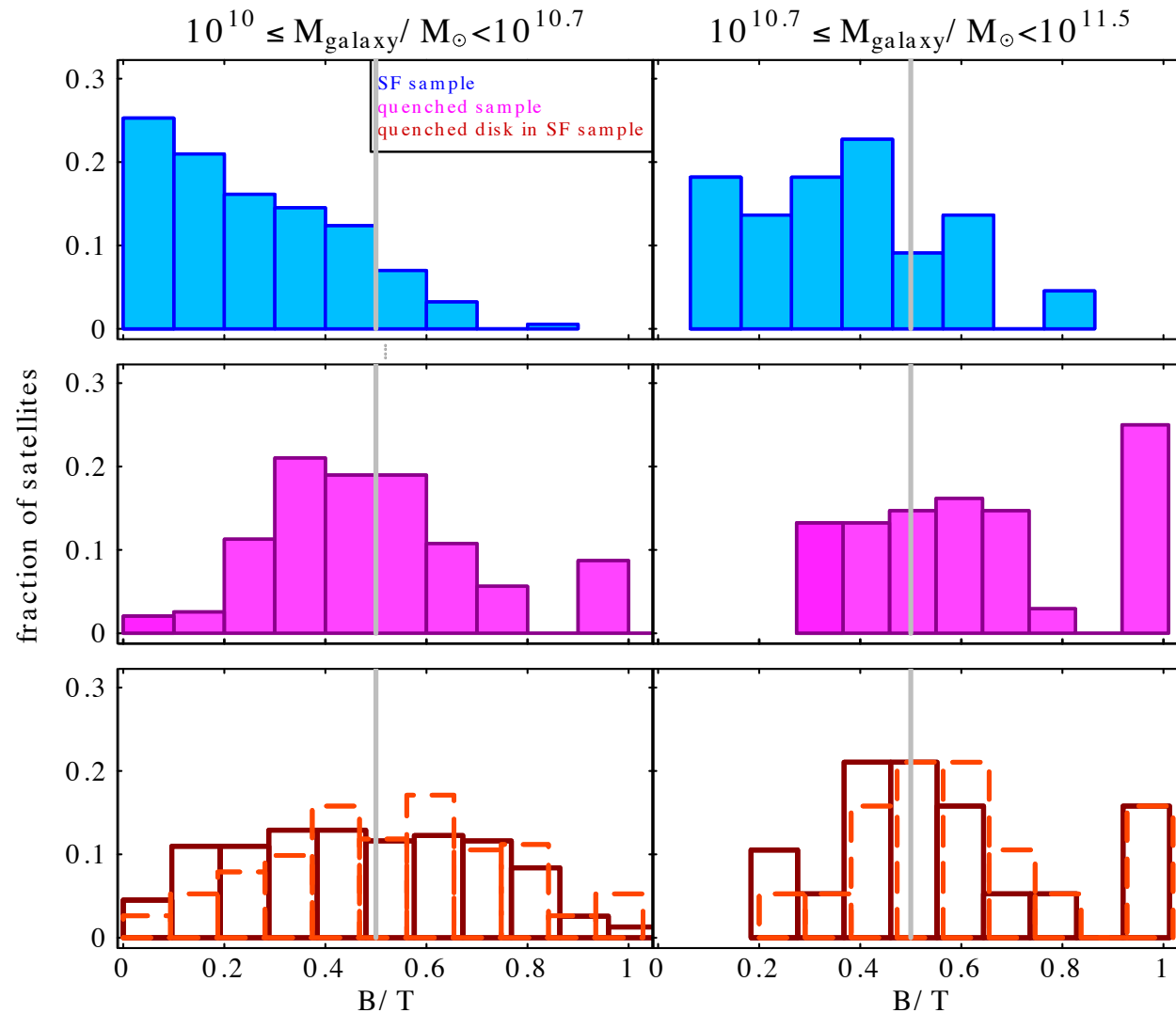
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Carollo, A.C. et al. 2014

SF

Quenched

Quenched
disk in SF
sample

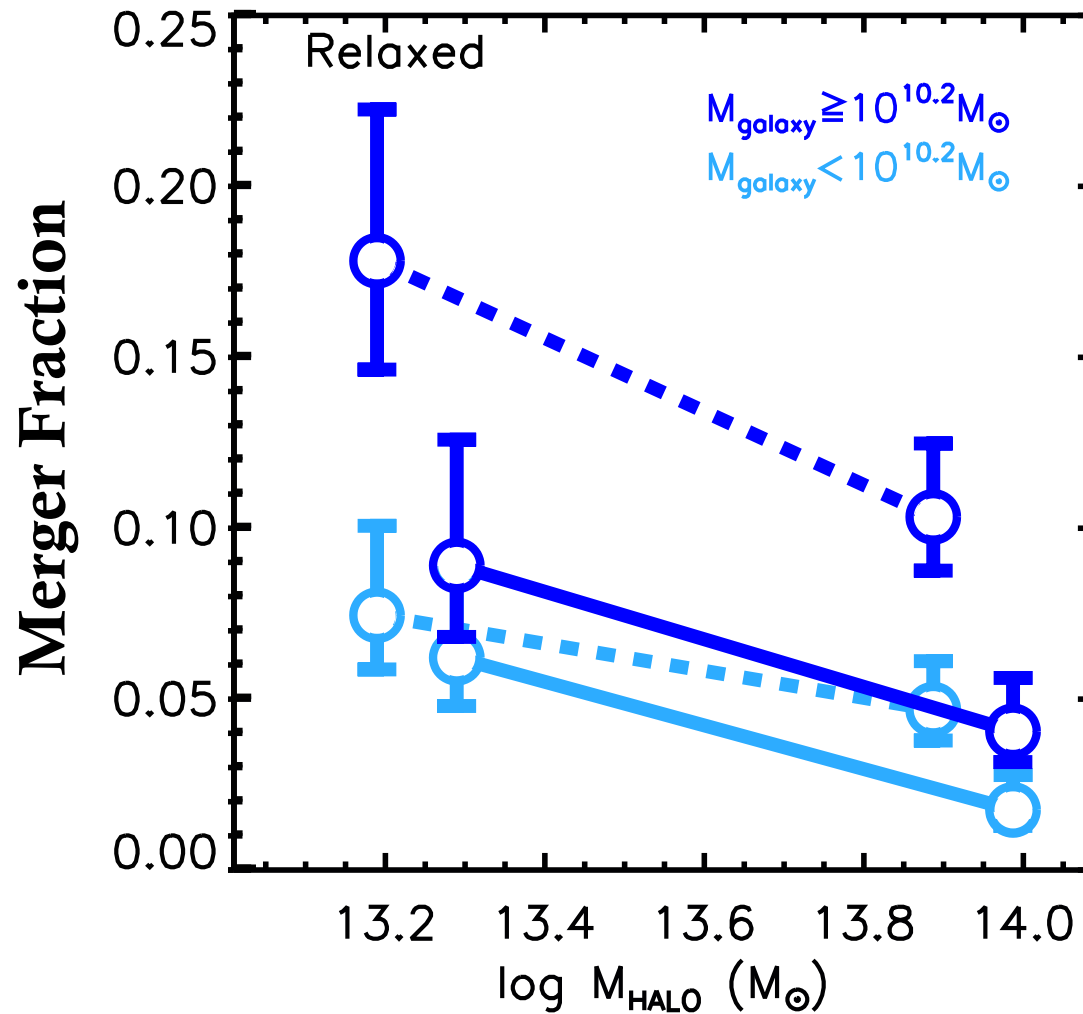


WHAT IS THE ROLE OF MERGERS?

MERGERS: WHERE DO THEY HAPPEN?

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Pipino, A.C. et al. 2015

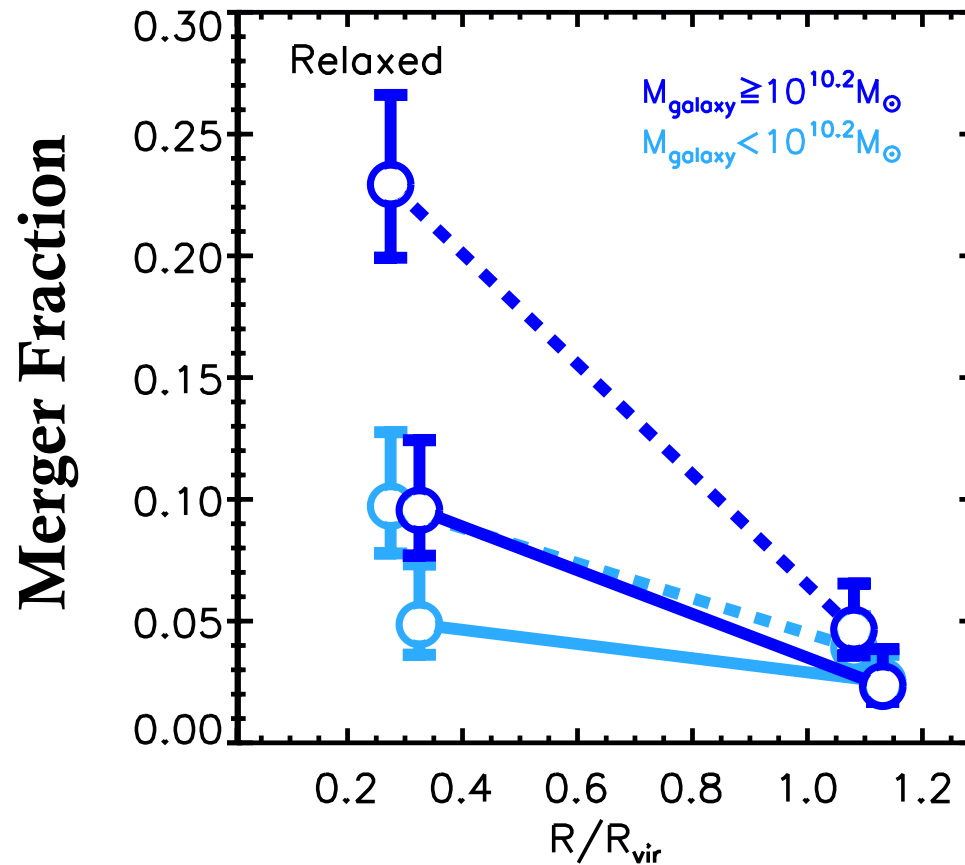


MERGERS: WHERE DO THEY HAPPEN?

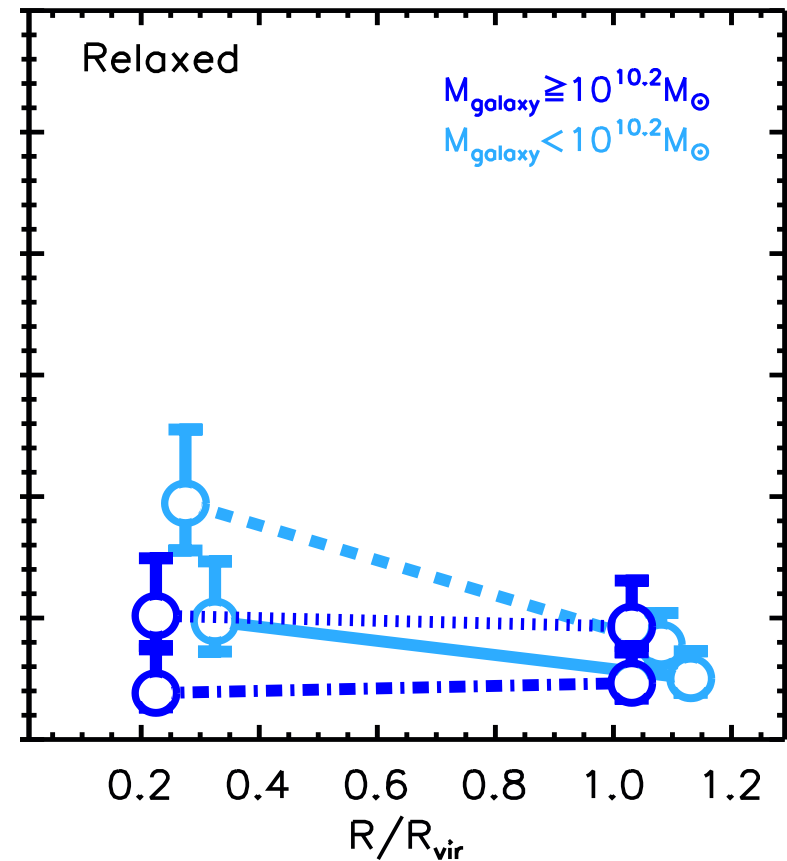
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Pipino, A.C. et al. 2015

Including central-satellite mergers



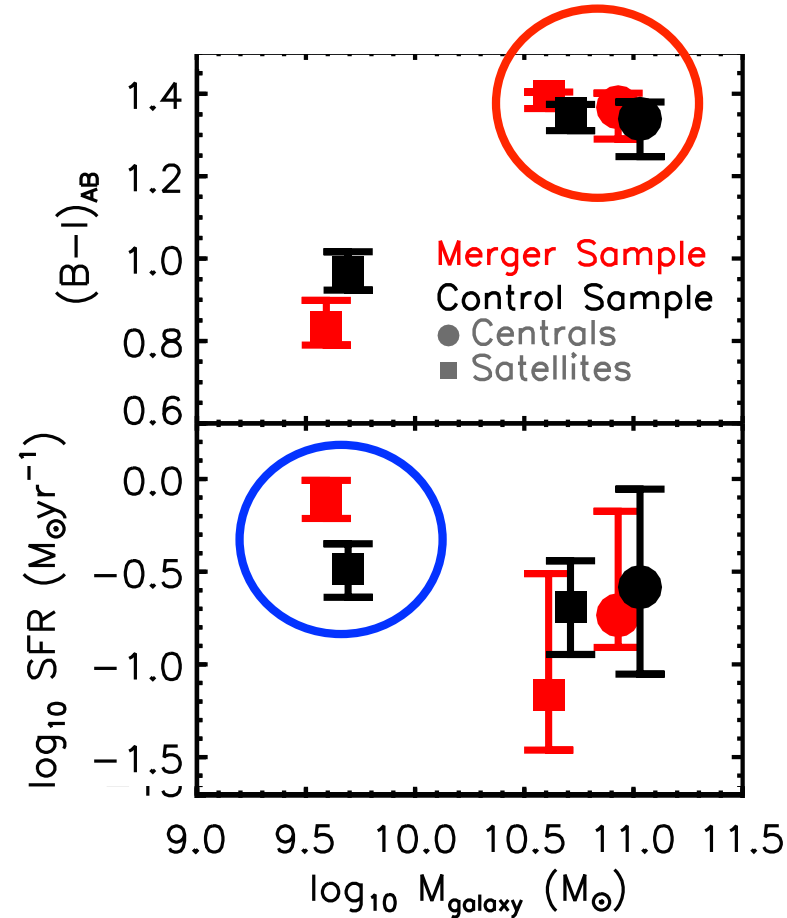
Excluding central-satellite mergers



THE EFFECT OF MERGERS

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central-satellite mergers are dry, red



enhanced SFR in low mass,
satellite-satellite mergers

Pipino, A.C. et al. 2015

SUMMARY

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- How well can we measure environment?
Not as well as we'd like (but probably good enough).
- Can we reliably identify Cens & Sats?
Not always, need to be careful.
- Are large scale (supra-halo) effects relevant?
Probably not for quenching
(May be relevant for other processes?)
- Is (environment) quenching decoupled from morphology?
Likely.
- What is the role of mergers?
Dry growth of massive central galaxies in group-sized halo.

YOUR ANSWERS?