

A Twofold Look on Environmental Effects: Satellite Quenching & (Merger-Induced Star Formation) in the ZENS Survey

Anna Cibinel
University of Sussex

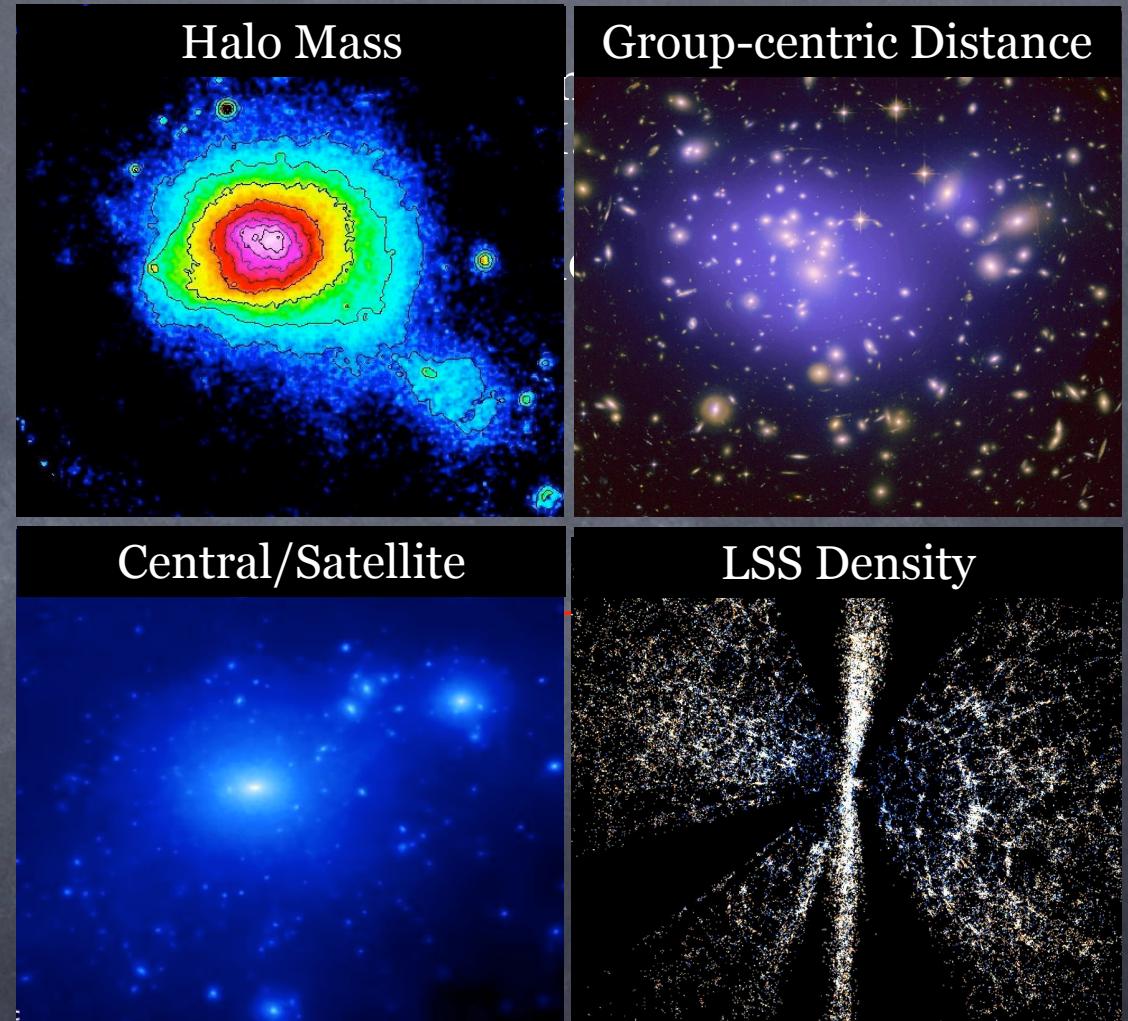
the ZENS team: M. Carollo (P.I.), A. Finoguenov, S. Lilly, F. Miniati,
A. Pipino, M. Sargent, J. Silverman, S. Tacchella, J. van Gorkom

THE ZURICH ENVIRONMENTAL STUDY: ZENS

The Data Set

- ▶ 141 2dFGRS spectroscopic groups ($N \geq 5$)
- ▶ $0.05 < z < 0.0585$, $13 < \log(M) < 14$
- ▶ ~ 1600 galaxies down to $b_j = 19.45$
- ▶ new B,I observations @ ESO Large Pr.
- ▶ All measurements publicly available at
[http://www.astro.ethz.ch/research/
Projects/ZENS](http://www.astro.ethz.ch/research/Projects/ZENS)

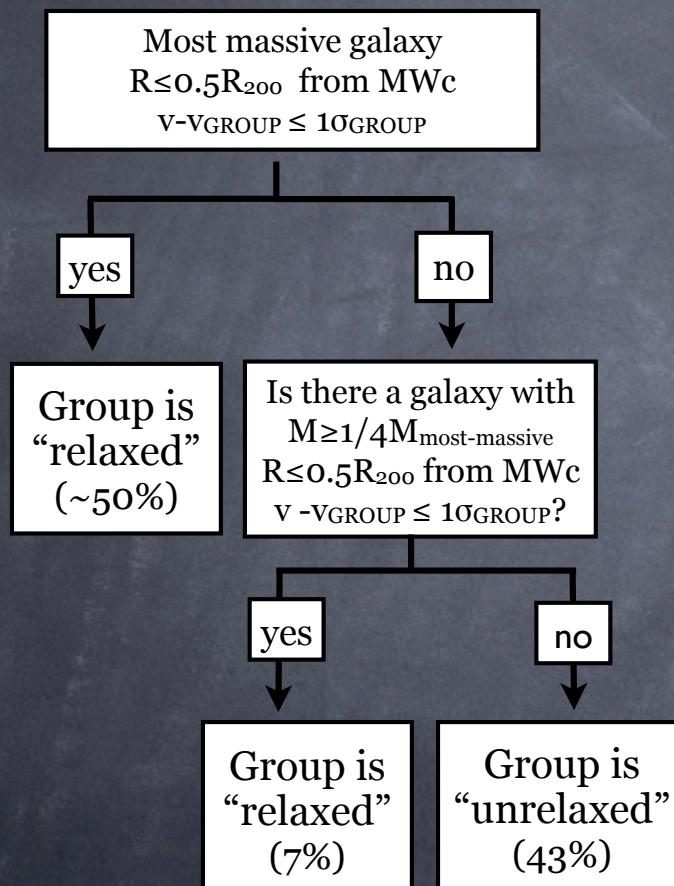
Four Environments



Carollo, Cibinel et al. 2013

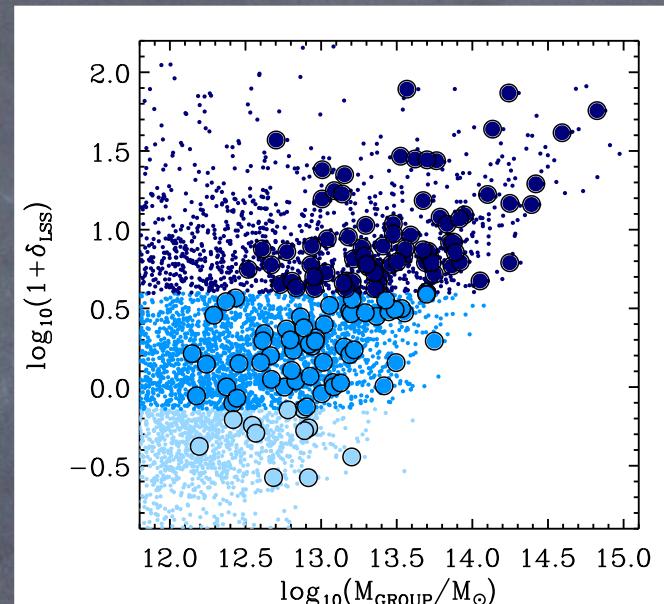
ZENS: IMPROVED ENVIRONMENTAL AND GALAXY DESCRIPTION

Cen/Sat distinction



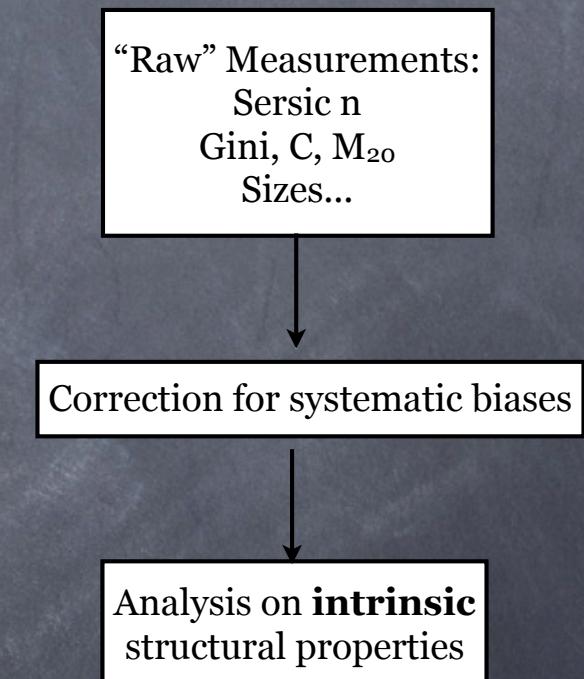
mass (w. errors),
velocity & position
constraints

New LSS definition



5th nearest neighbour
but using
groups as tracers

Calibrated Classification Structural Parameters



Cibinel et al. 2013a,b
Carollo, Cibinel et al. 2013

PART-1: Satellite Quenching

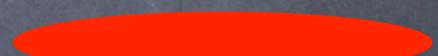
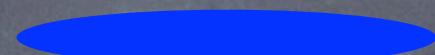
INTRODUCTION

Are morphological transformation and quenching

coeval?



lagged?



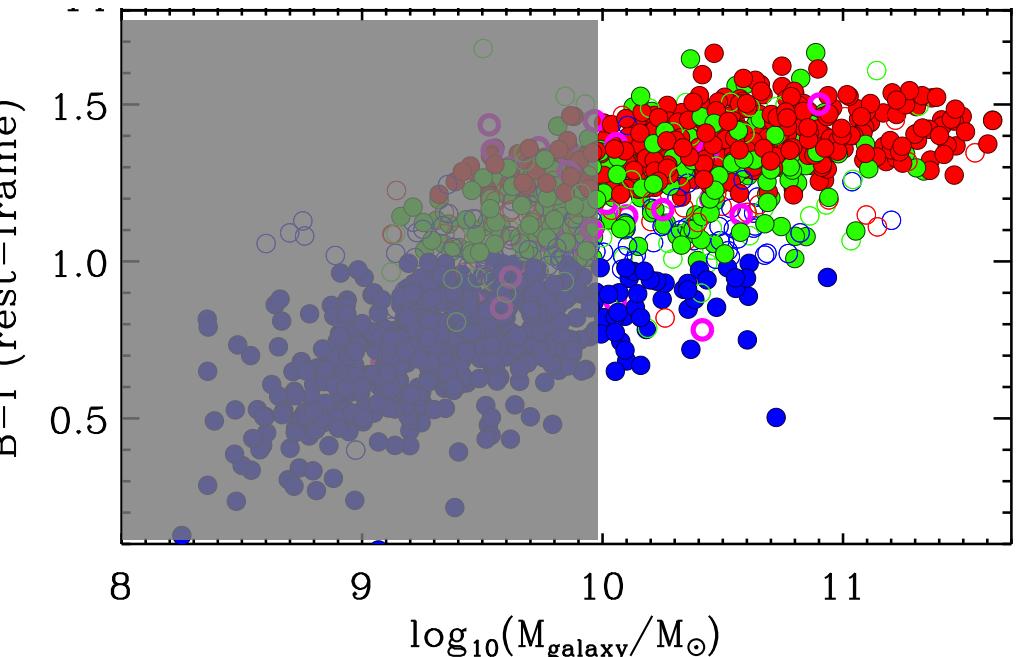
i.e., is quenching causing structural changes?

SAMPLE & DEFINITIONS

Satellite galaxies only

Stellar mass limit of 10^{10} Msun

Early type= I-band B/T>0.5

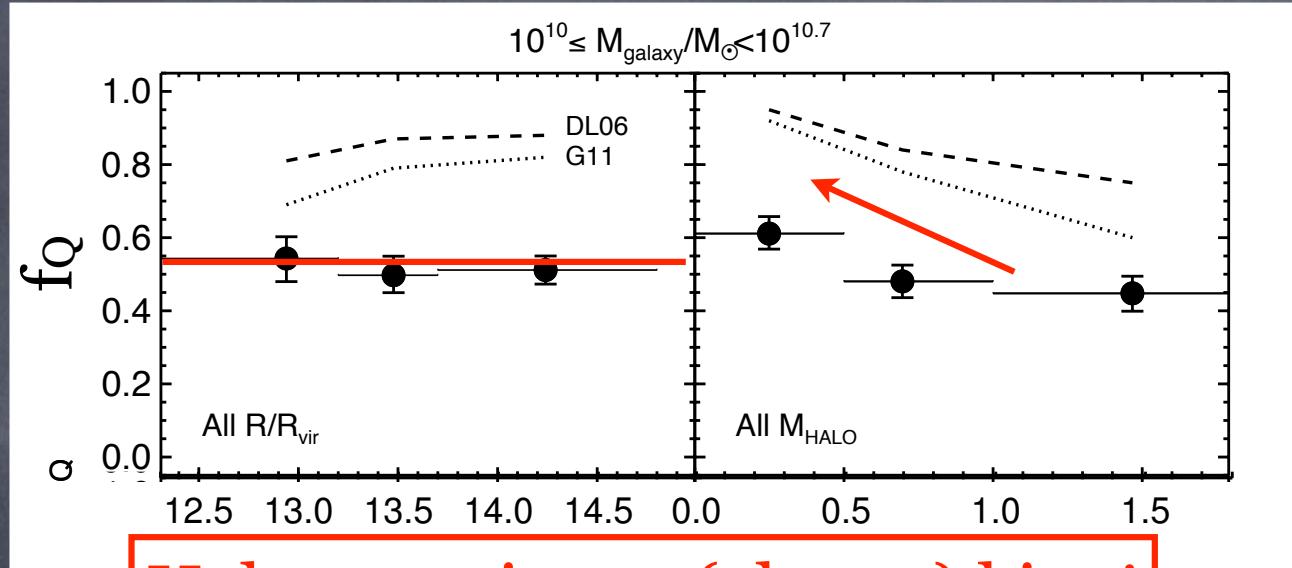


Classification in Quenched/SF based on both
emission lines & NUV+optical color-color selection

SATELLITE QUENCHING: HALO MASS VS. RADIAL POSITION

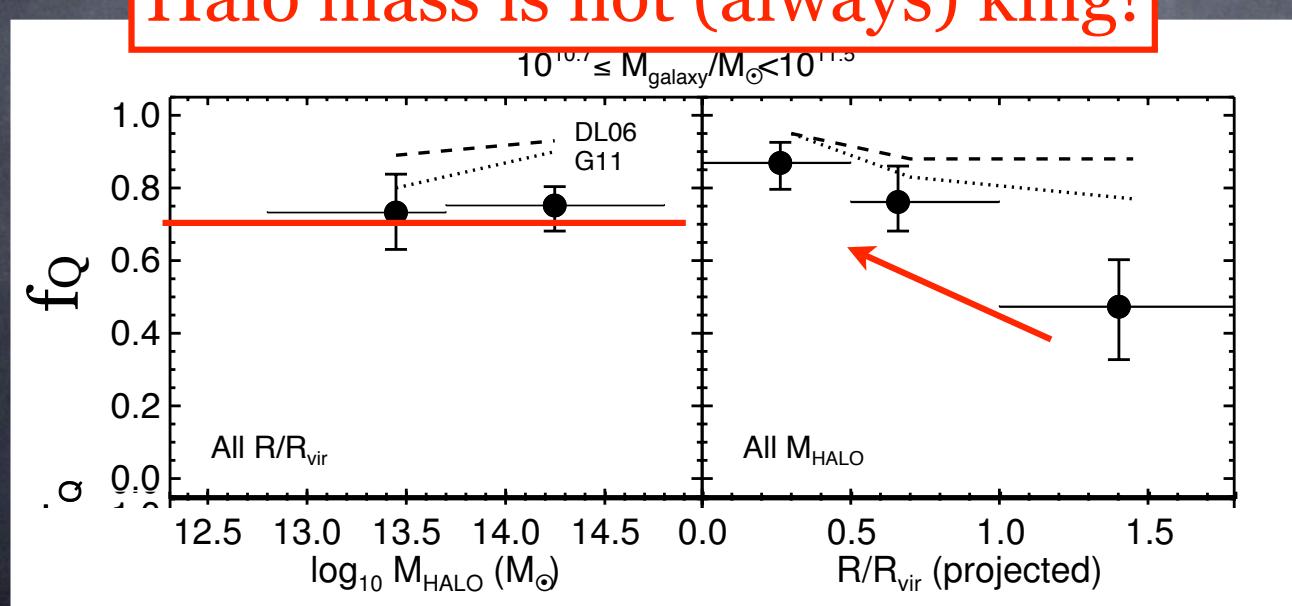
Carollo, Cibinel et al. 2014

Quenched Fraction



Intermediate
mass galaxies

Halo mass is not (always) king!

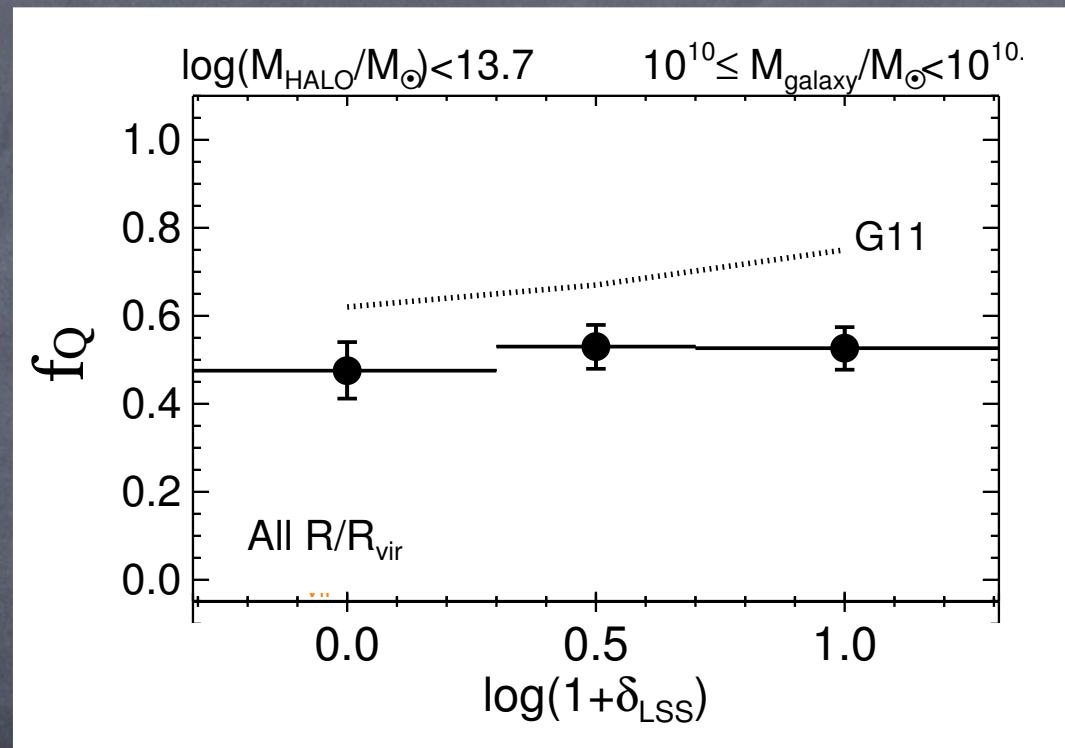


High-mass
galaxies

See also e.g. Peng et al. 2012
but Woo et al. 2013

SATELLITE QUENCHING: QUENCHING FROM OUTSIDE HALOS?

Carollo, Cibinel et al. 2014

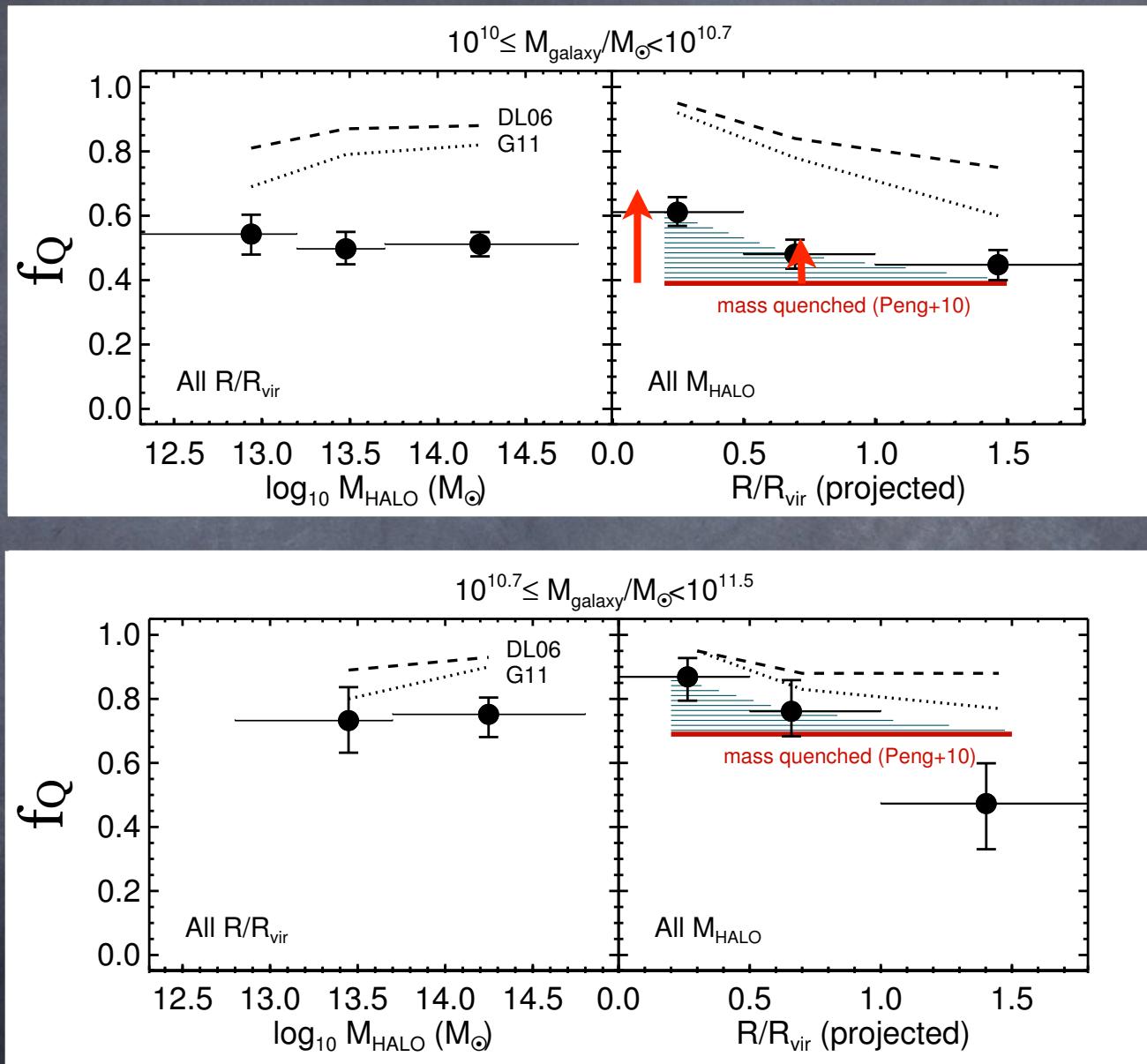


No dependence on large scale environment

(Our new definition of density probes $\sim 2\text{-}3$ Mpc scales)

SATELLITE QUENCHING: HALO MASS VS. RADIAL POSITION

Quenched Fraction

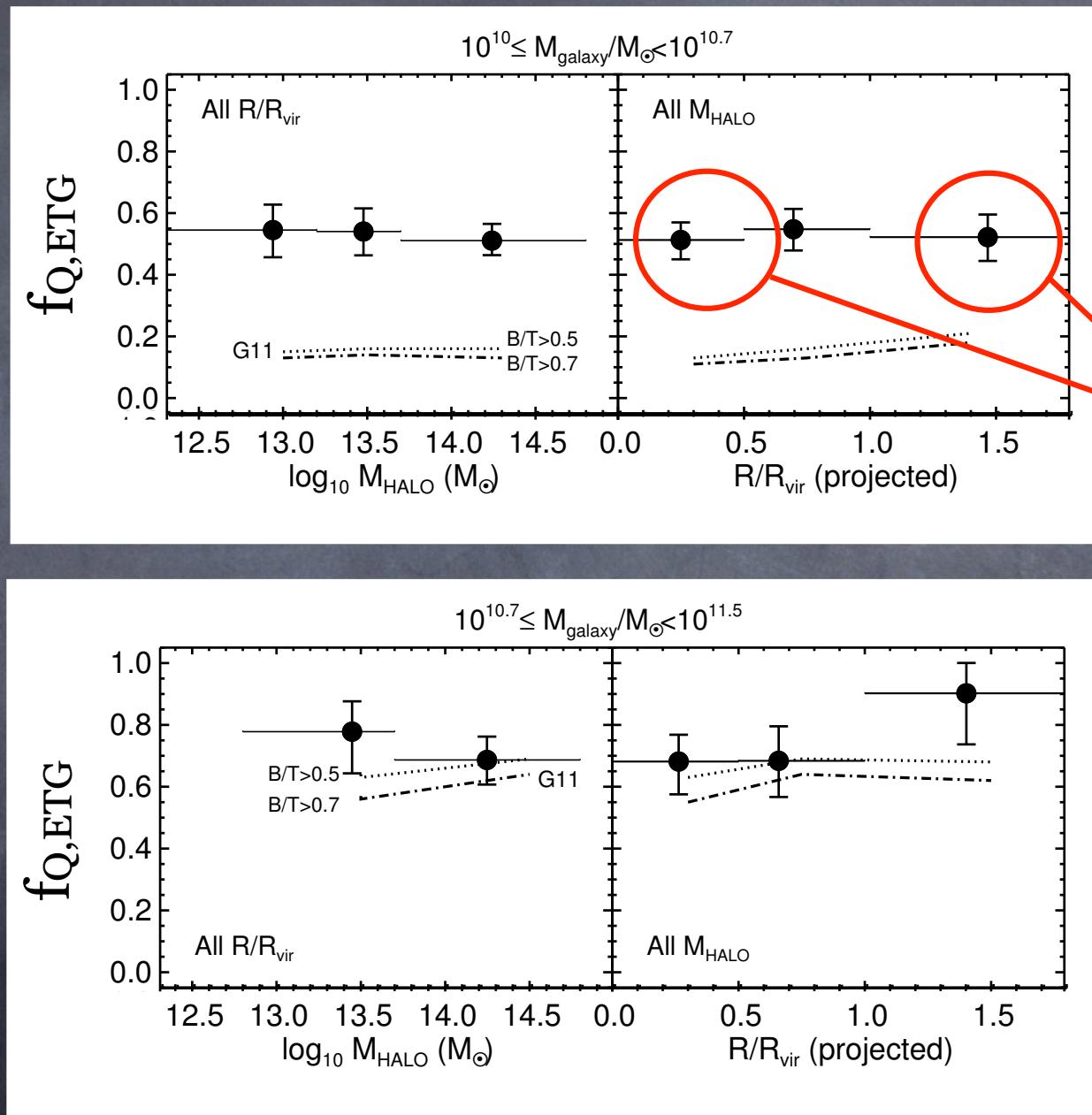


Intermediate
mass galaxies

High-mass
galaxies

SATELLITE QUENCHING: MORPHOLOGY OF QUENCHED GALAXIES

Quenched & Early Fraction
(Early-type:
 $B/T > 0.5$)



Intermediate mass galaxies

Mass- & Environment-Quenching have same morphological output

High-mass galaxies

Carollo, Cibinel et al. 2014

SATELLITE QUENCHING: MORPHOLOGY OF QUENCHED GALAXIES

Possible explanations:

- ▶ Environmental quenching extends much further than R_{vir}
(e.g. backsplash, Noble's, Haines' talks)
- ▶ Mass and environment quenching change morphology in the same way
(similar underlying physical processes?)
- ▶ Neither cause any transformation, structure established before quenching

but...

..we know that morphologies of SF and quenched galaxies are different!

Can we reconcile this?

SATELLITE QUENCHING: BULGE GROWTH OR DISK FADING?

Bulges

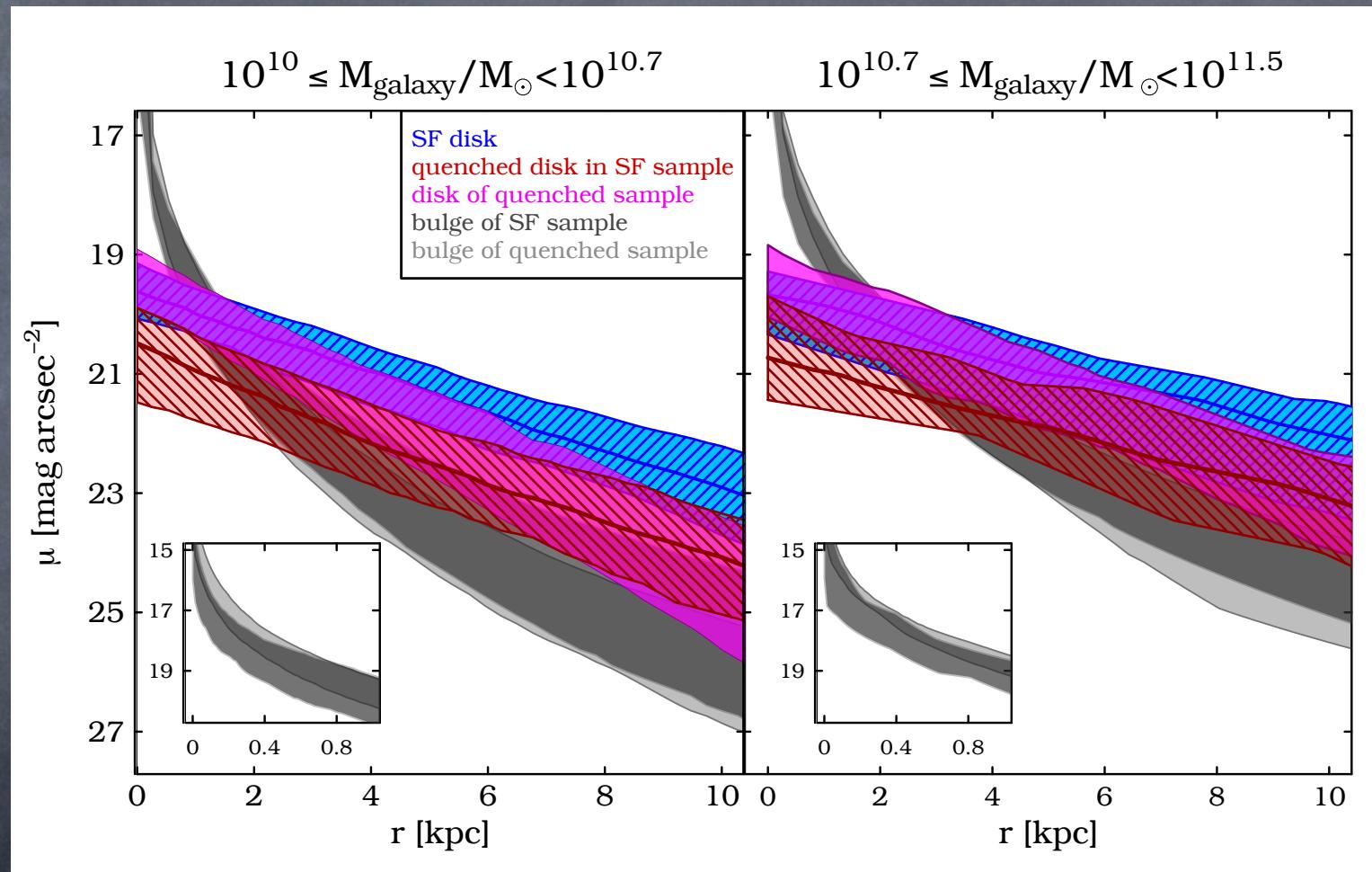
Disk of SF galaxies

Disk of Quenched galaxies

Quenched Disk in SF sample

disk & bulge mass, sizes etc kept constant but disk with luminosity of 1Gyr old passive population

Analytic GIM2D (PSF-deconvolve) bulge/disk decompositions



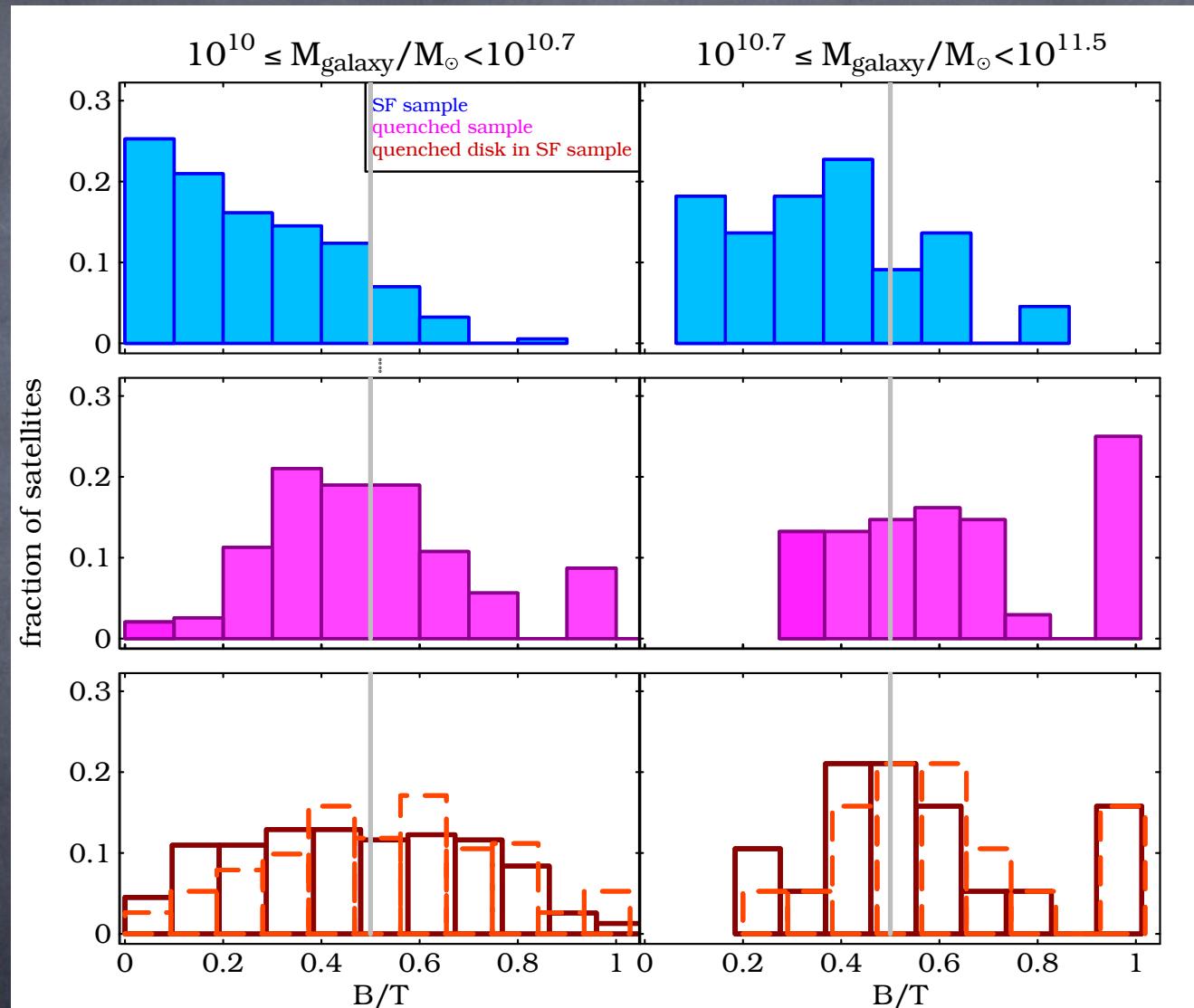
Carollo, Cibinel et al. 2014
Cibinel et al. 2013a

SATELLITE QUENCHING: BULGE GROWTH OR DISK FADING?

SF

Quenched

Quenched
Disk in SF
sample



Carollo, Cibinel et al. 2014

SATELLITE QUENCHING: CHALLENGES

Similar morphological changes for mass and environment quenching are consistent with no changes in the mass-defined B/T.

However, there are still open question

- Bulgeless SF disks but no bulgeless quenched disks
- There is evidence for some increase of the central density in quenched galaxies both in ZENS and other works (e.g. Fang et al 2014)

PART-2: Interactions & Induced Star Formation

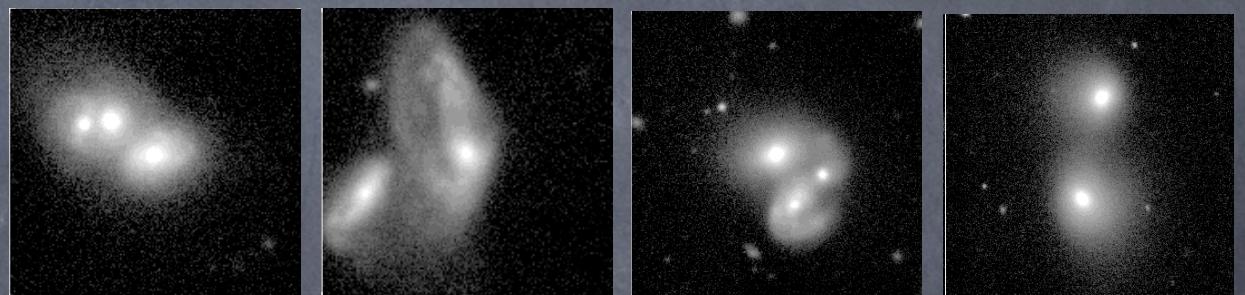
MERGERS: THE DEFINITION

Close Pairs

$d < 50 \text{ kpc}$, $\Delta v < 500 \text{ km/s}$

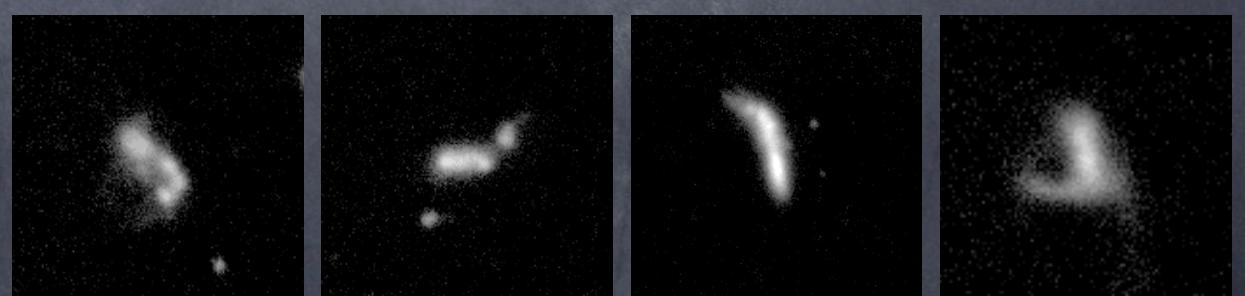
+

Pre-coalescence

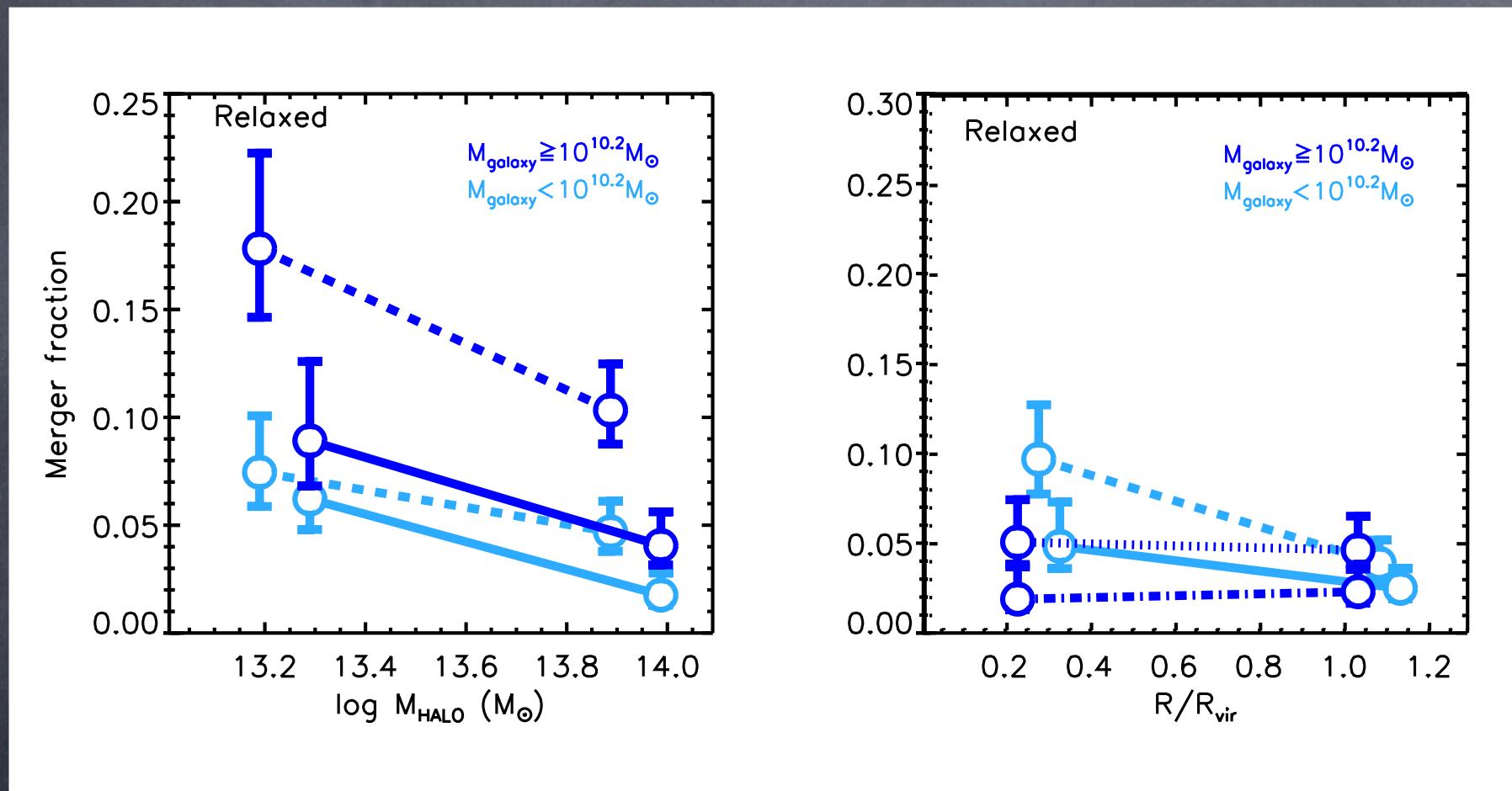


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Irregulars

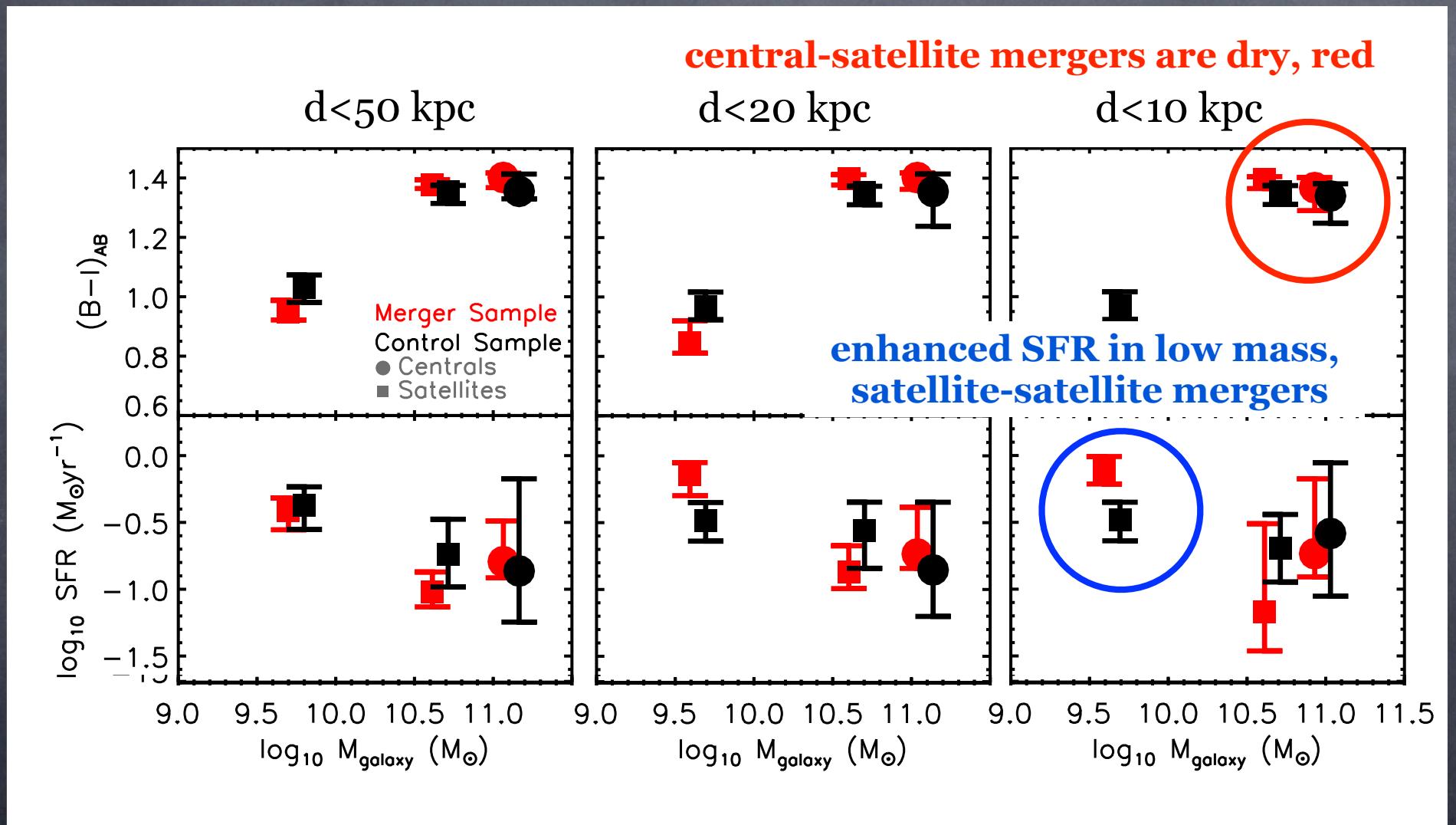


MERGERS: WHICH ENVIRONMENT MATTERS?



Pipino, Cibinel et al. 2014, sub.

MERGERS: PROPERTIES OF MERGING CENS & SATS



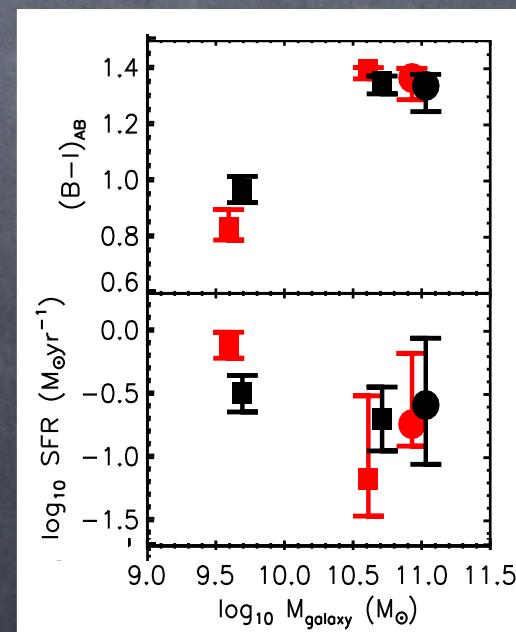
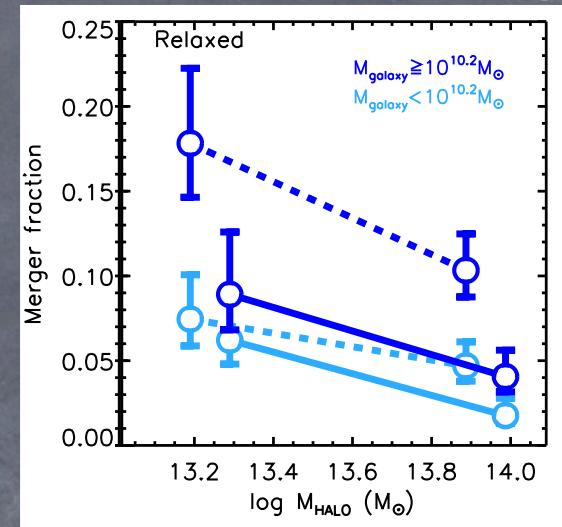
Pipino, Cibinel et al. 2014, sub.

THE TAKE HOME MESSAGES

Similar morphological changes in mass and environment quenching could be explained with simple disk fading with **no** real **structural change/bulge mass growth**



Merger fraction 2x lower in massive groups



central-satellite
mergers are dry&red

enhanced SFR in
low mass, wet
satellite-satellite
mergers