Evidence for a correlation between the sizes of quiescent galaxies and local environment to z≈2

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The University of Nottingham

UKIDSS UDS

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- Motivation
- The data
- Method
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- Conclusions

GALAXY SIZE EVOLUTION

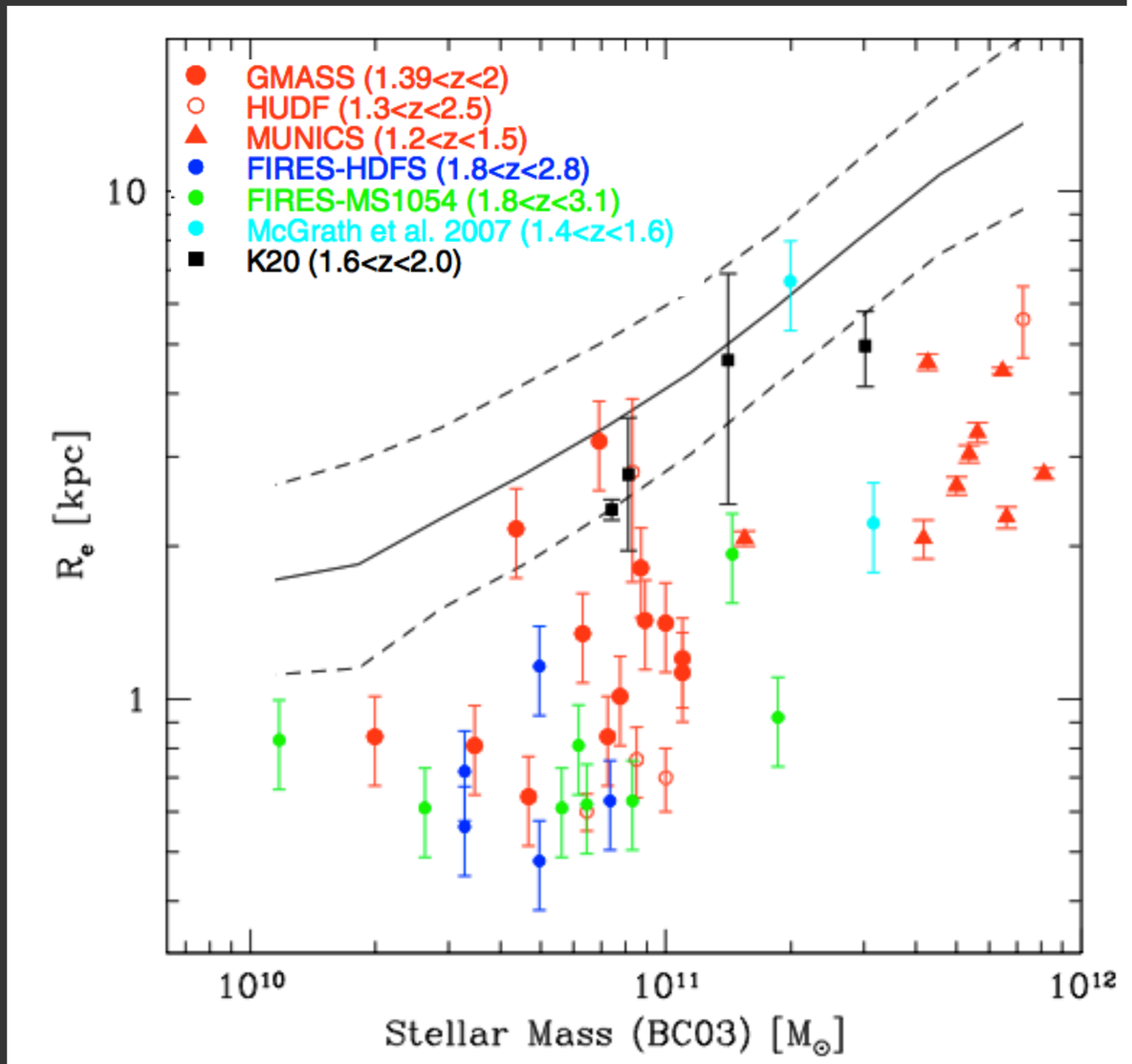
Compact massive (>$10^{11}M_{\odot}$) passive galaxies were found to be very common at high redshift, but this is not the case in the local Universe.

Did galaxies puff up via:

◆ internal processes such as feedback (e.g Fan et al., 2008, 2010, Damjanov et al., 2009)

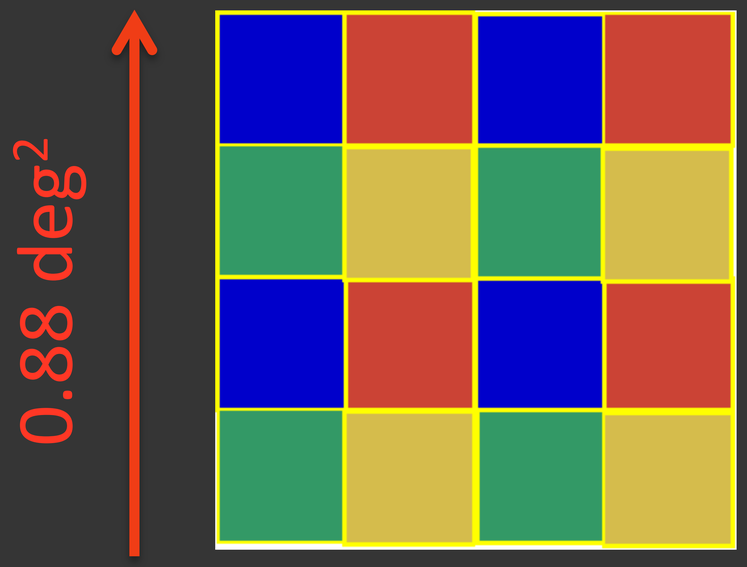
or

◆ mergers (e.g. Khochfar & Silk 2006, Naab et al., 2009)



Cimatti et al., 2008

THE DATA: UKIDSS UDS/CANDELS-UDS



Near-infrared imaging of ~ 1 deg²

Limiting magnitudes (AB, 5σ, 2"apertures):

DR8 (this work): J=24.9, H=24.2, K=24.6

(504 hours)

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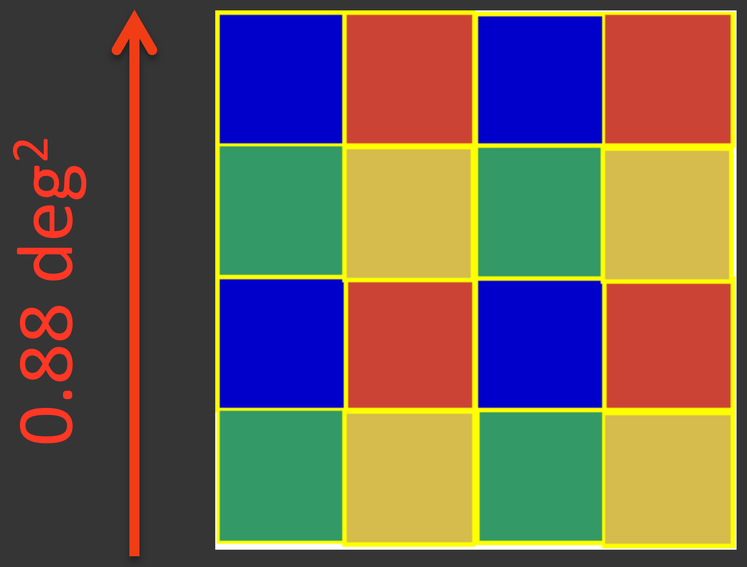

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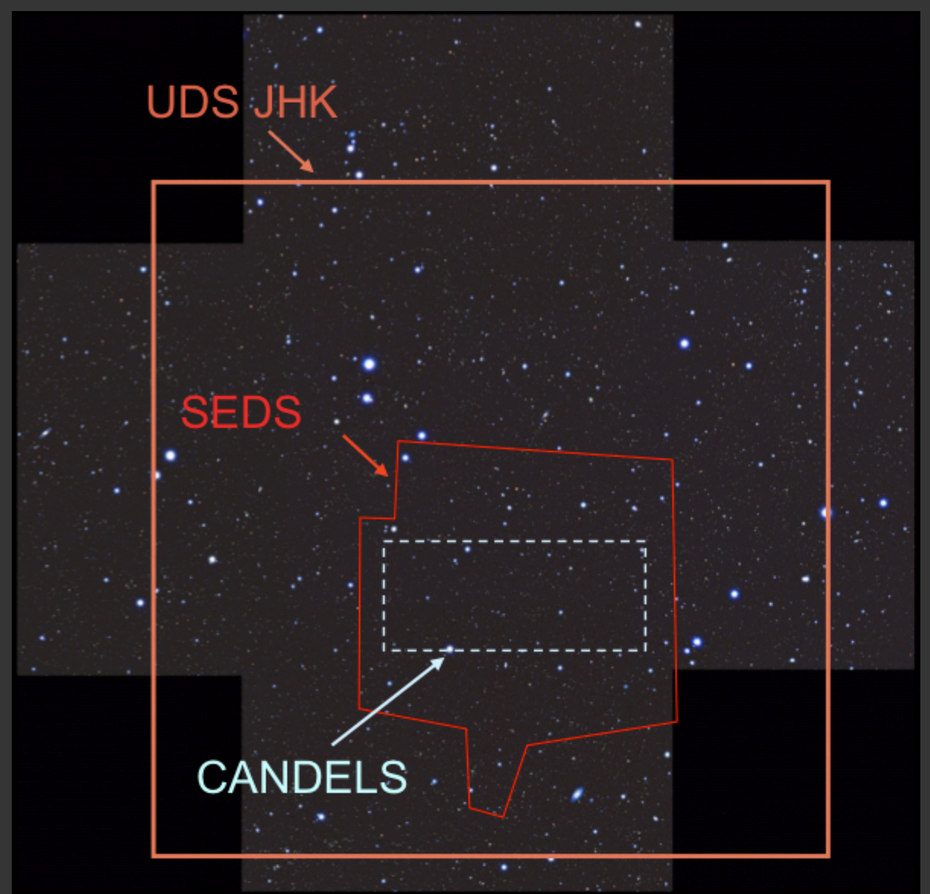


CANDELS-UDS: Wide program, 88 orbits & limiting magnitudes (AB, 5σ, 1 arcsec²):

J=26.22 H=26.32

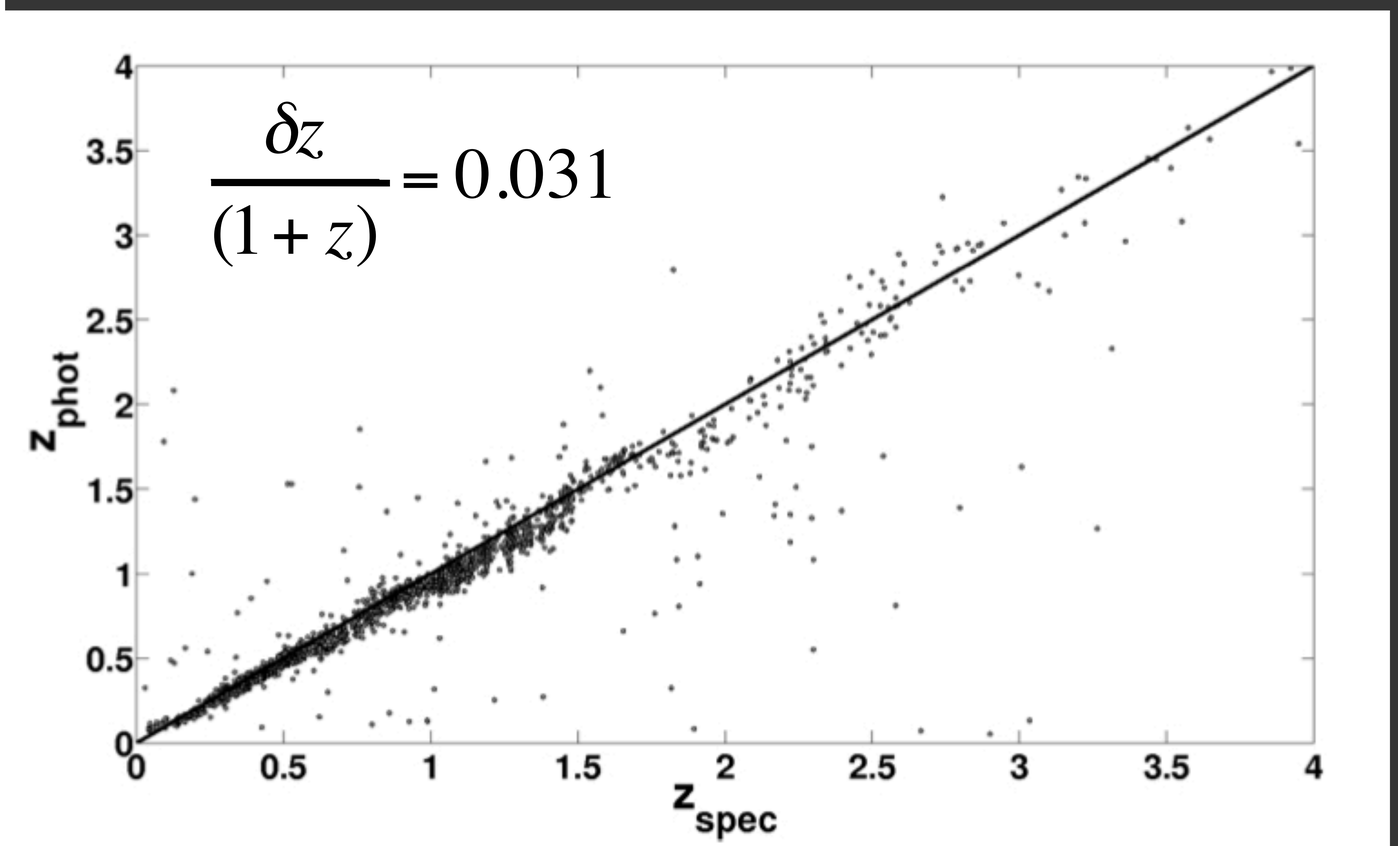
(Galametz et al., 2013)

◆ Full **UDS** field ≈ **10x CANDELS-UDS**

PHOTO z & STELLAR MASSES

Photometric redshifts and stellar masses were determined from **11-band photometric fitting**: **U, B, V, R, i' ,z', J, H, K, 3.6µm, 4.5µm.**

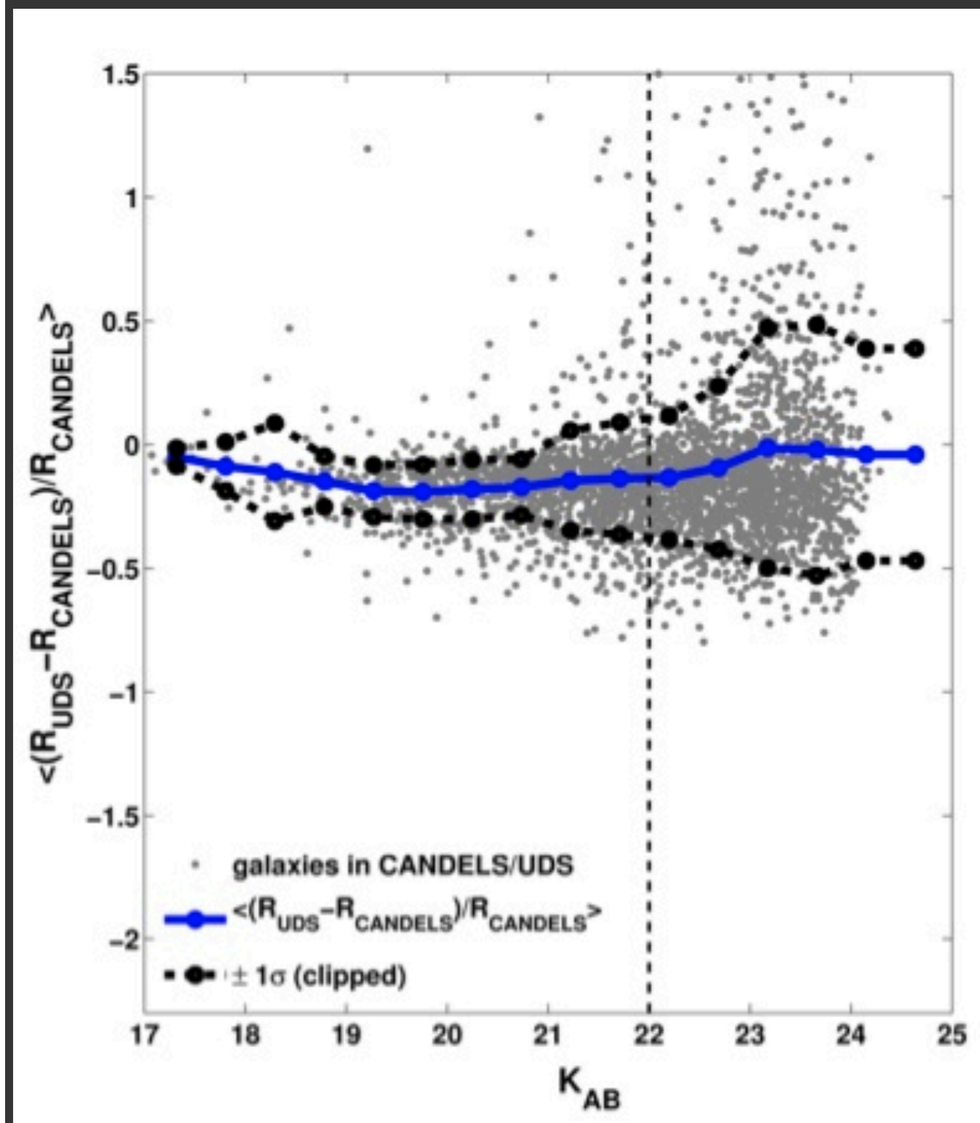
2000 spectra from UDSz were used to train and calibrate

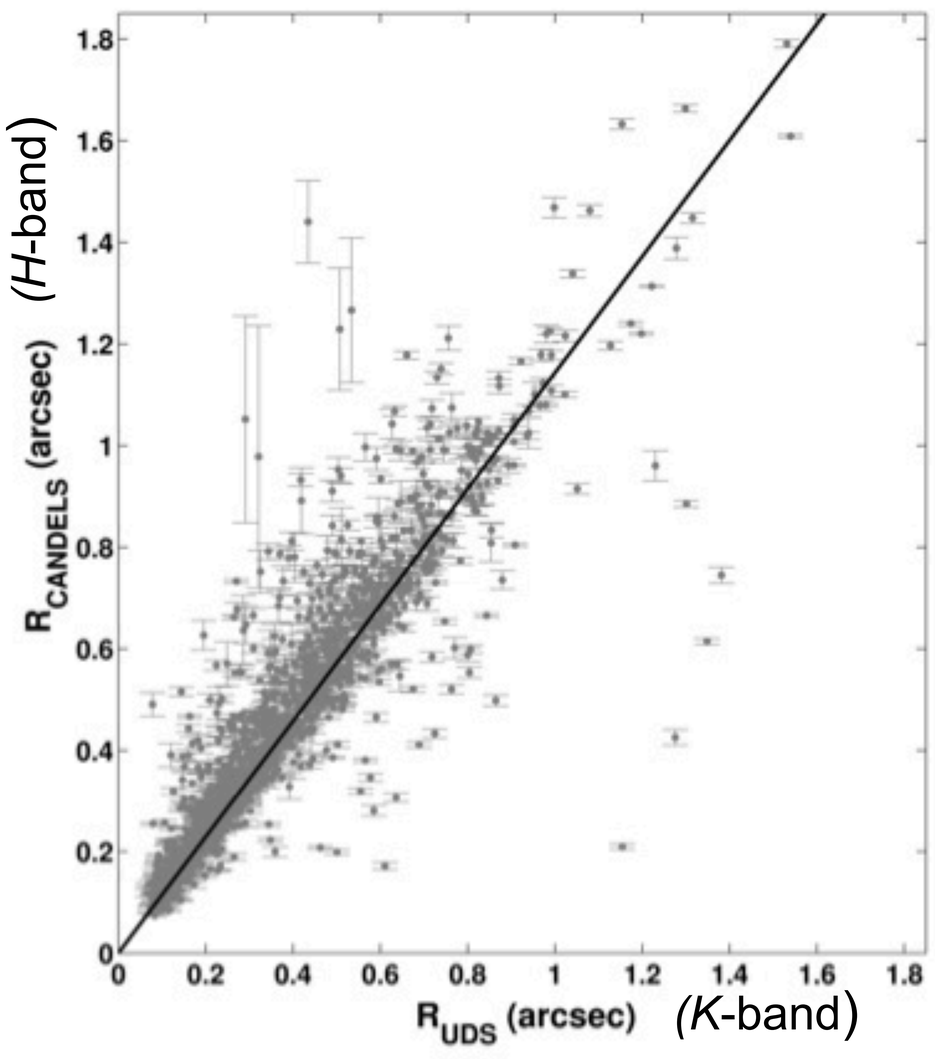


Stellar masses and rest-frame colours were obtained from **SED fitting**

MEASURING GALAXY SIZES

Sizes were measured on ground based *K*-band data and then calibrated against *H*-band HST CANDELS data (van der Wel et al. 2012)





≈14% offset is consistent with measuring sizes in different wavebands (see Kelvin et al., 2012)

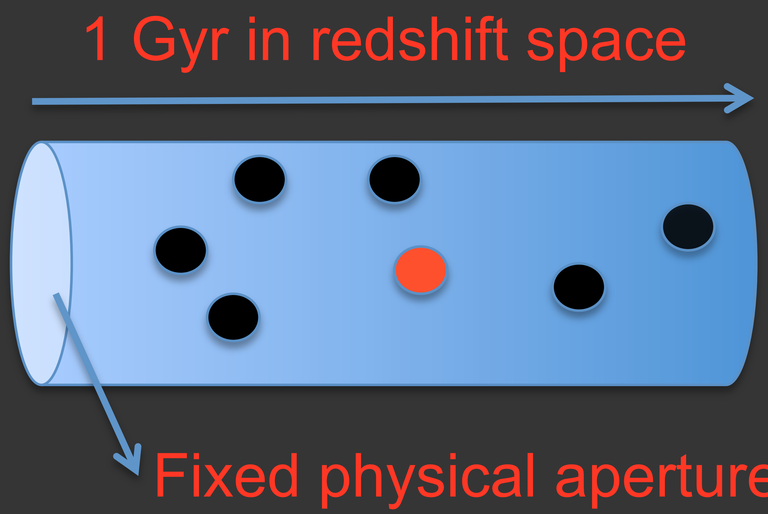
We alligned UDS sizes to CANDELS sizes to facilitate comparison with future work

Lani et al., 2013

APERTURE DENSITIES

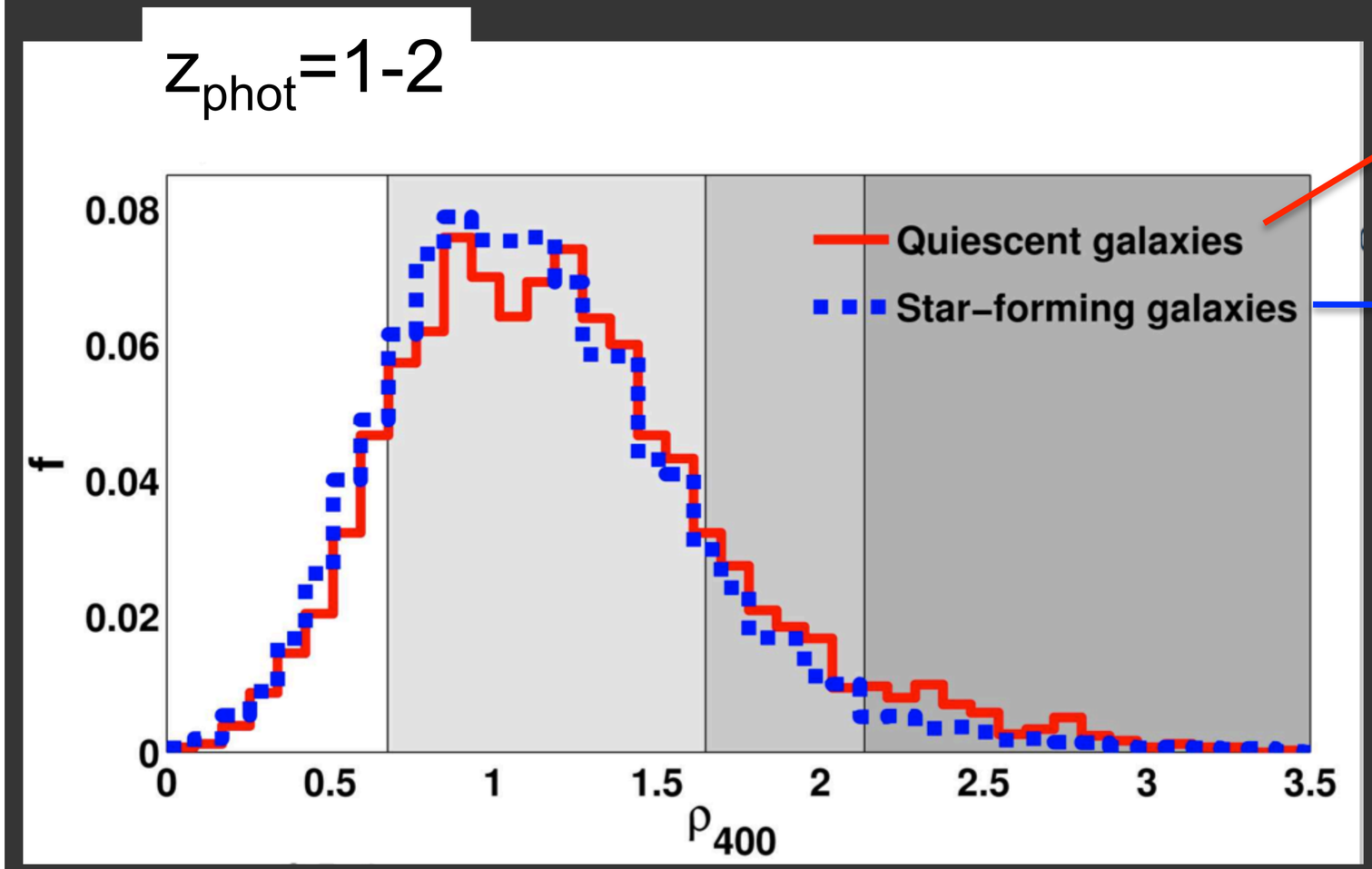
- **Counts of galaxies in an aperture**

  We counted the number of galaxies within a cylinder constructed around the galaxy under consideration. The radius was given by a fixed physical aperture size; the depth was set to 1 Gyr in redshift space. Holes and edges were accounted for by normalising for the number of good pixels within the aperture



$$\rho_{aperture} = \frac{N_g^{Aper}}{N_z} \times \frac{N_{Mask}^{Tot}}{N_{Mask}^{Aper}}$$

COLOUR vs ENVIRONMENT



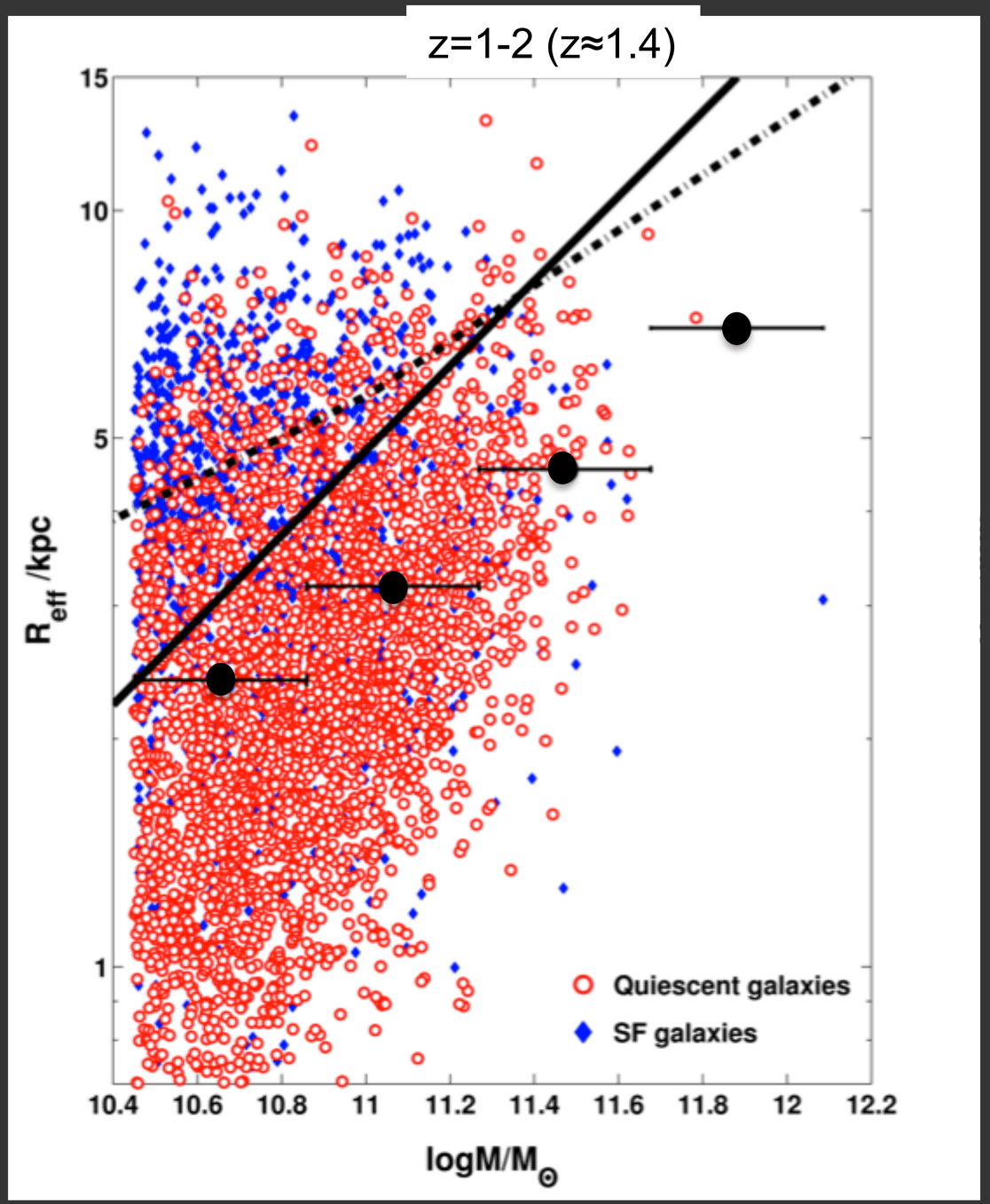
defined by UVJ (rest-frame) + sSFR

the remainder

Our environmental measure can recover previously know trends such as the colour-density relation.

Lani et al.,2013 and Chuter et al.,2011

HIGH z SIZE–MASS RELATION



For $M_* > 10^{11} M_\odot$:

◆ At z≈1.4 quiescent galaxies were typically 50% smaller

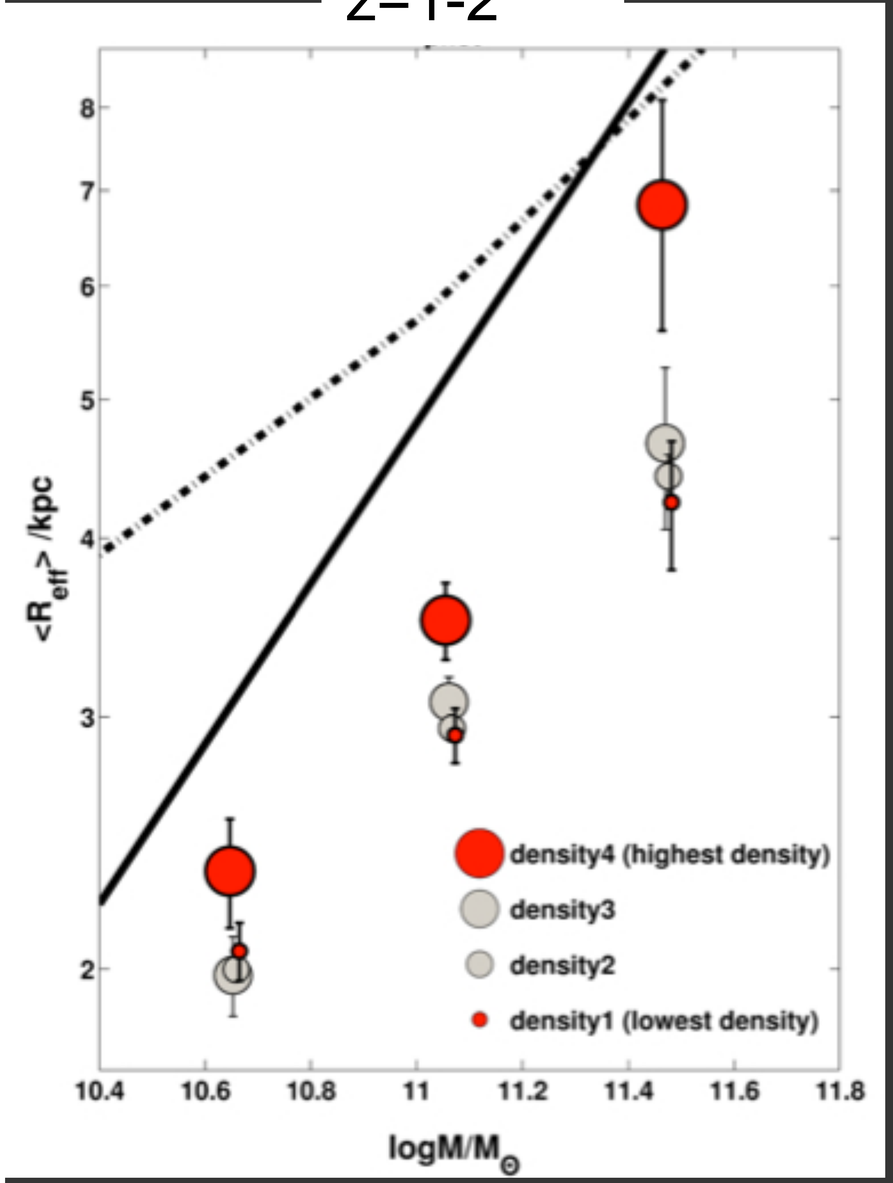
For $M_* < 10^{11} M_\odot$:

◆ At z≈1.4 quiescent galaxies were typically 40% smaller

Lani et al., 2013

HIGH z SIZE—MASS RELATION vs ENVIRONMENT

z=1-2



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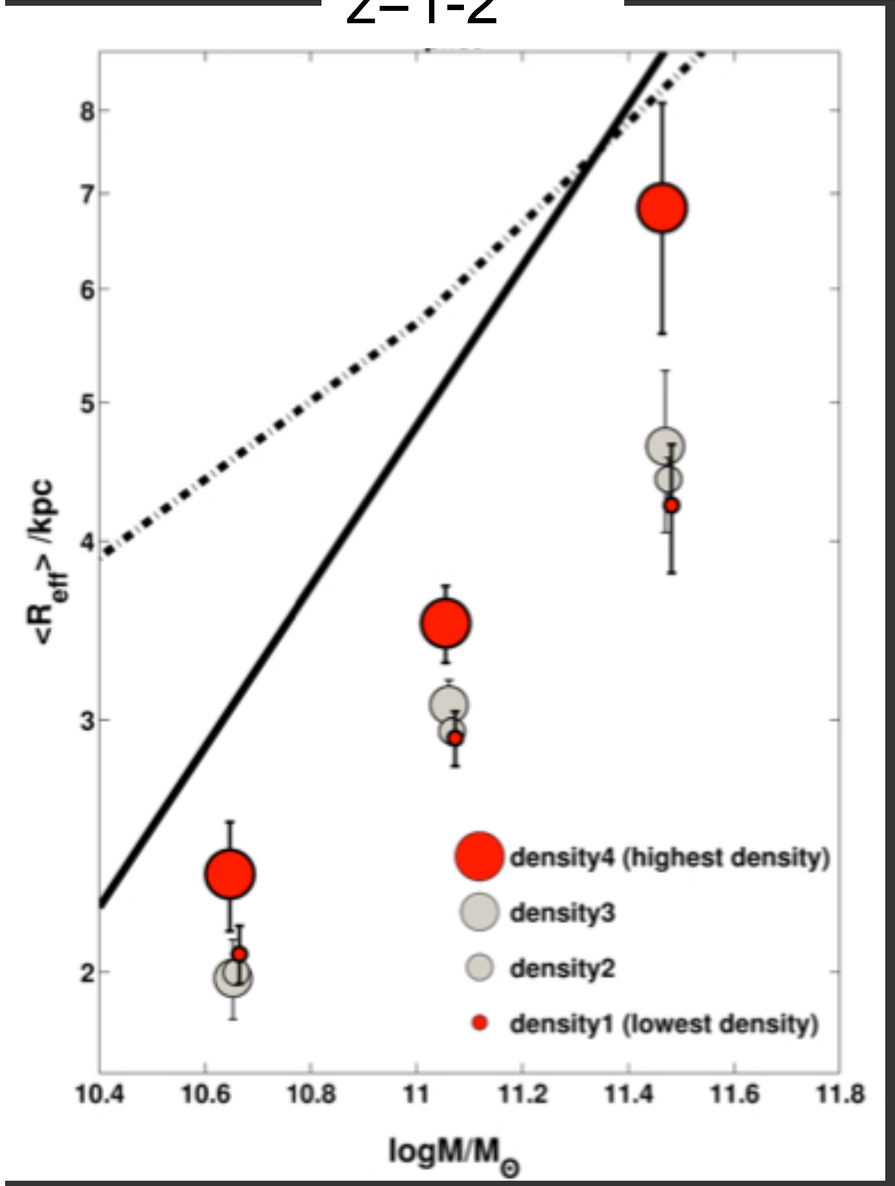
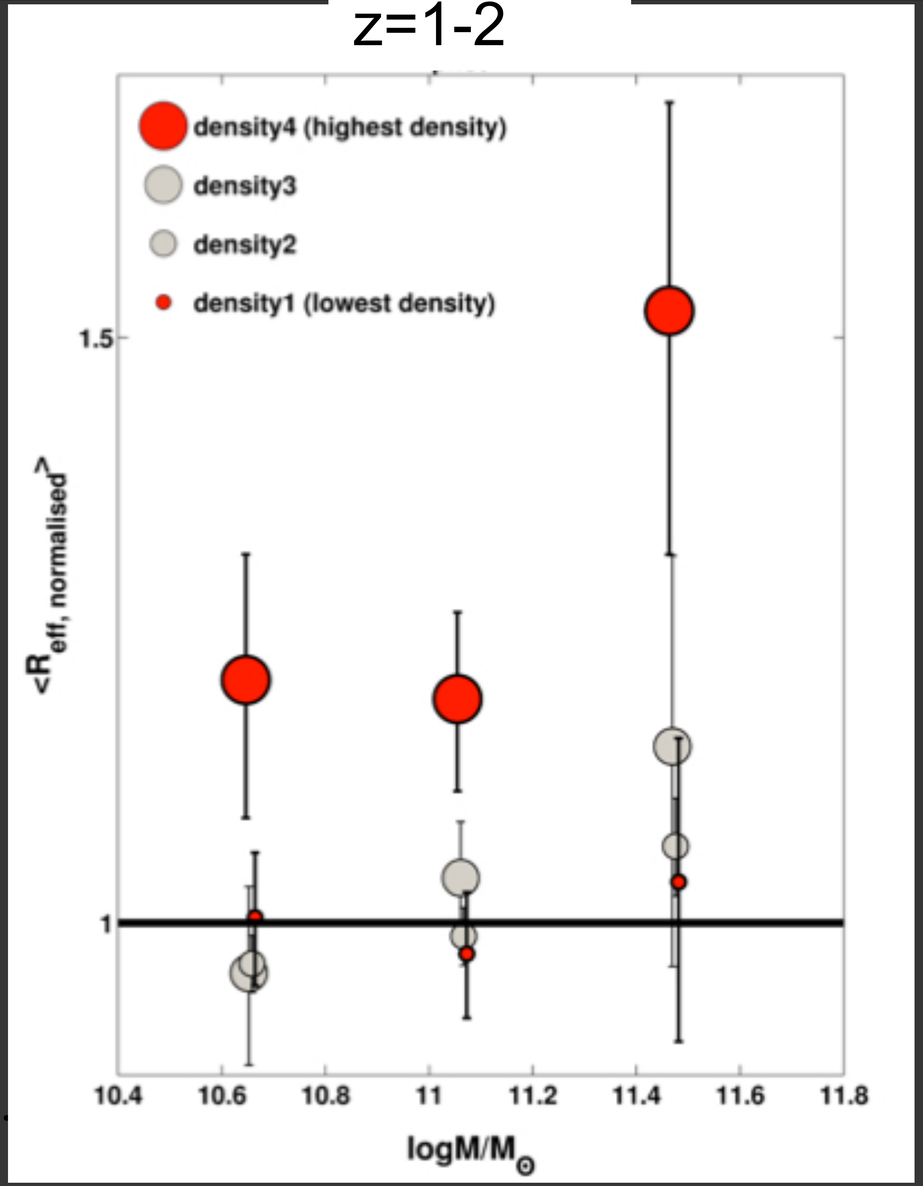


z=1-2



◆ Galaxies in the highest densities show $R_{eff,norm}$ which are (by increasing mass) 18±12%, 19±9%, 48±25% larger (from fractional difference) than objects in the lowest densities. MC tests!

Lani et al., 2013

WHAT IS DRIVING THE TREND?

More work is needed in order to identify the causes of the trends we observe. Thus far, we think galaxies in the densest environments could be larger due to having:

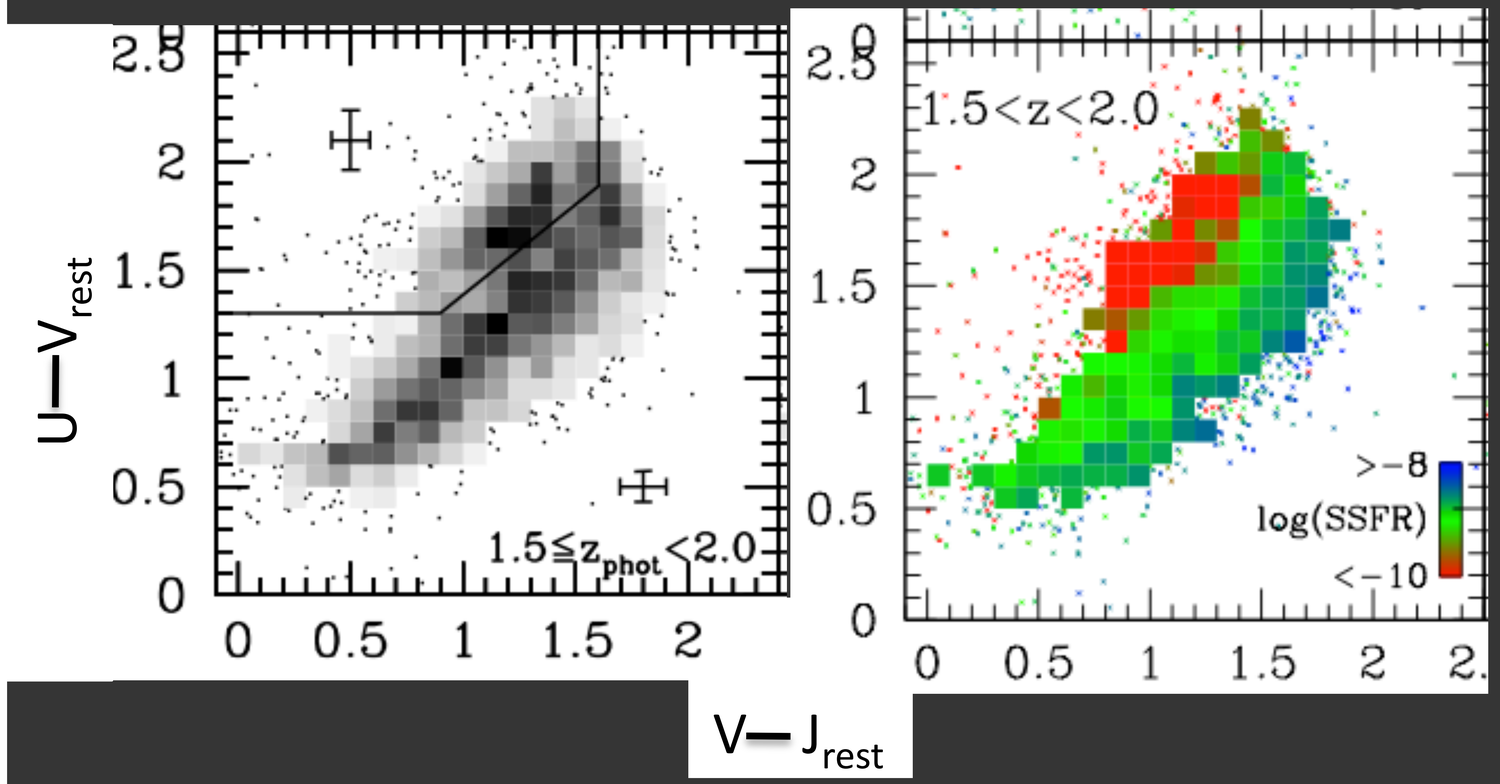
- undergone a higher number of minor mergers;
- undergone an accelerated evolution;
- other growth mechanisms (e.g. feedback) if these occurred in the most massive haloes first;
- a combination of the above (e.g. Damjanov et al., 2009).

CONCLUSIONS

- We observe the colour-density relation to hold up to z≈2.
- We confirm size evolution for the quiescent population.
- **We find that passive galaxies in denser environments (on scales of 400 kpc) are significantly larger at a given stellar mass at a significance > 4.8 σ at z>1.**

For more details see Lani et al. 2013 now virtually accepted and on arXiv next week

QUIESCENT SELECTION



Quiescent galaxies:

1) UVJ ✔

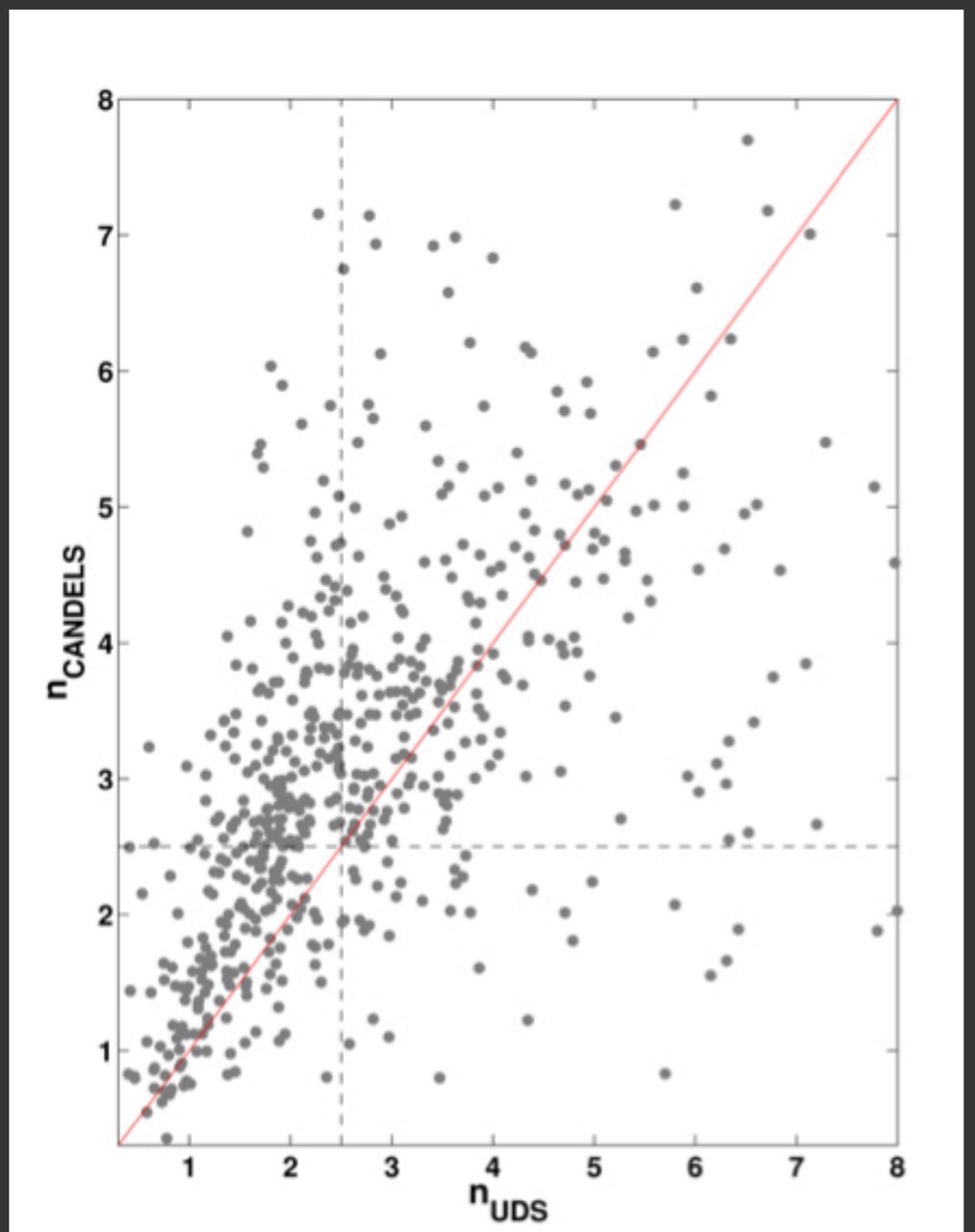
2) sSFR=<7.43x10^{-11} yr^{-1} ✔

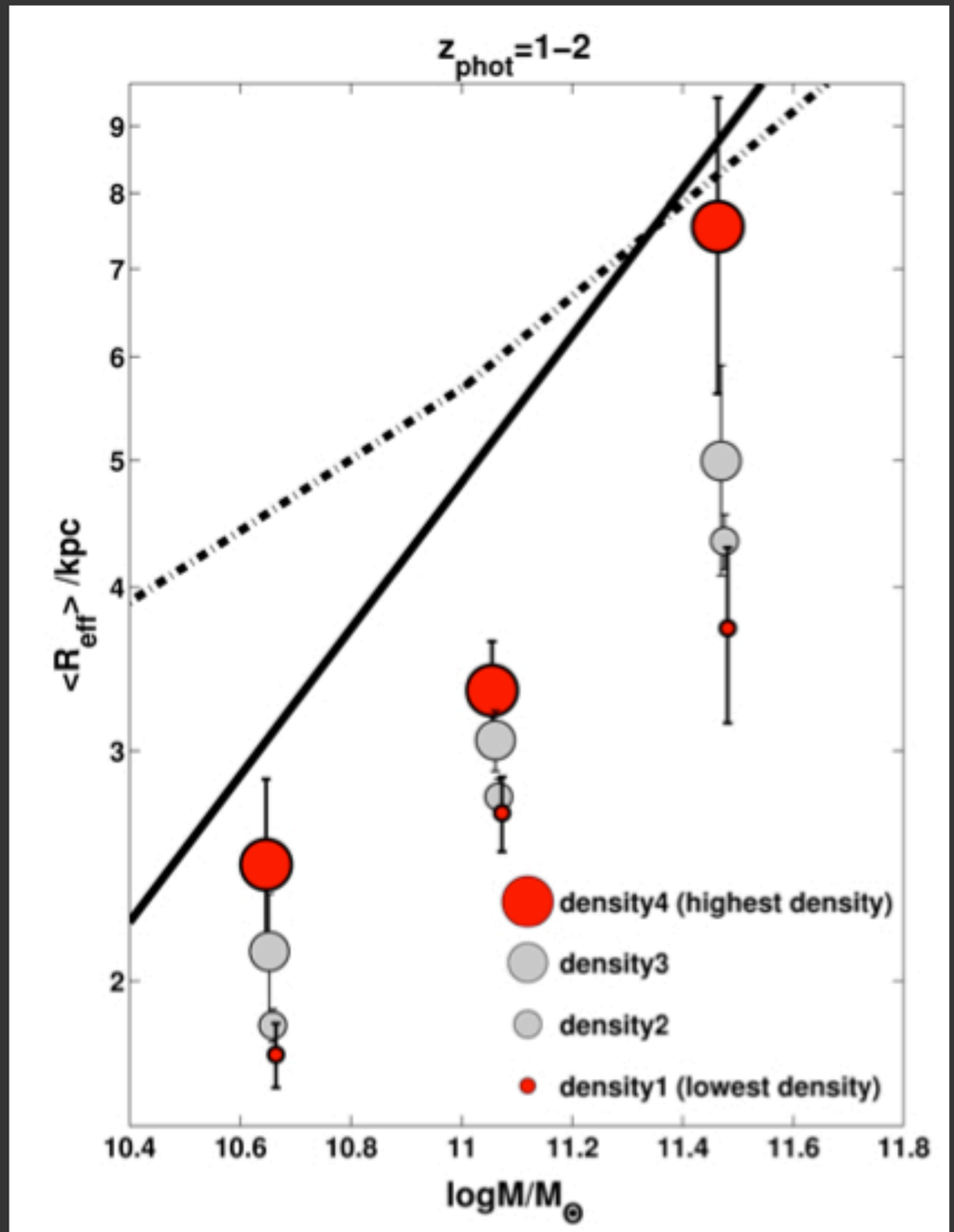
From SED fitting

Star-forming (SF) galaxies: the remainder

Williams et al., 2009 and Wuyts et al., 2007

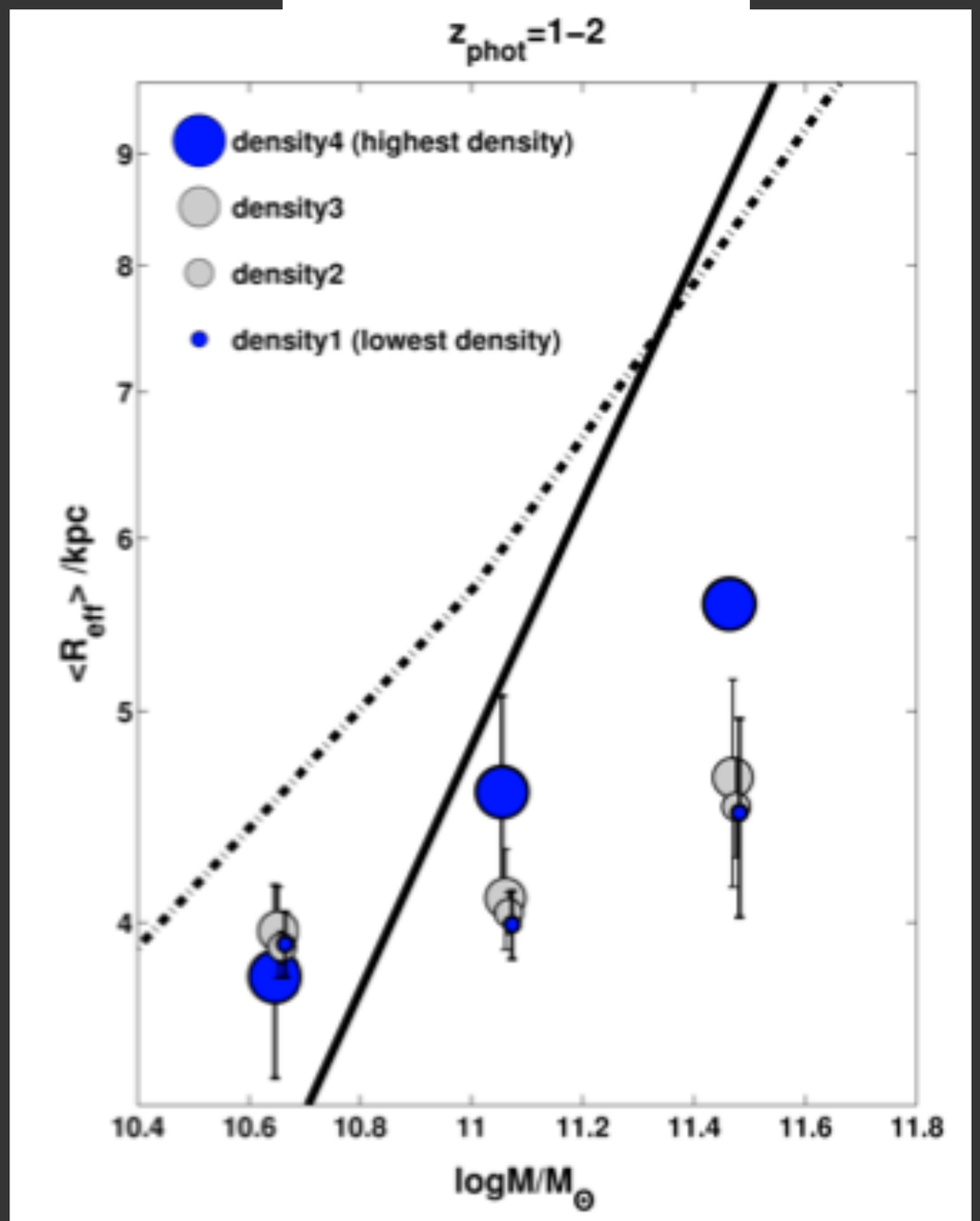
MORPHOLOGY CUT



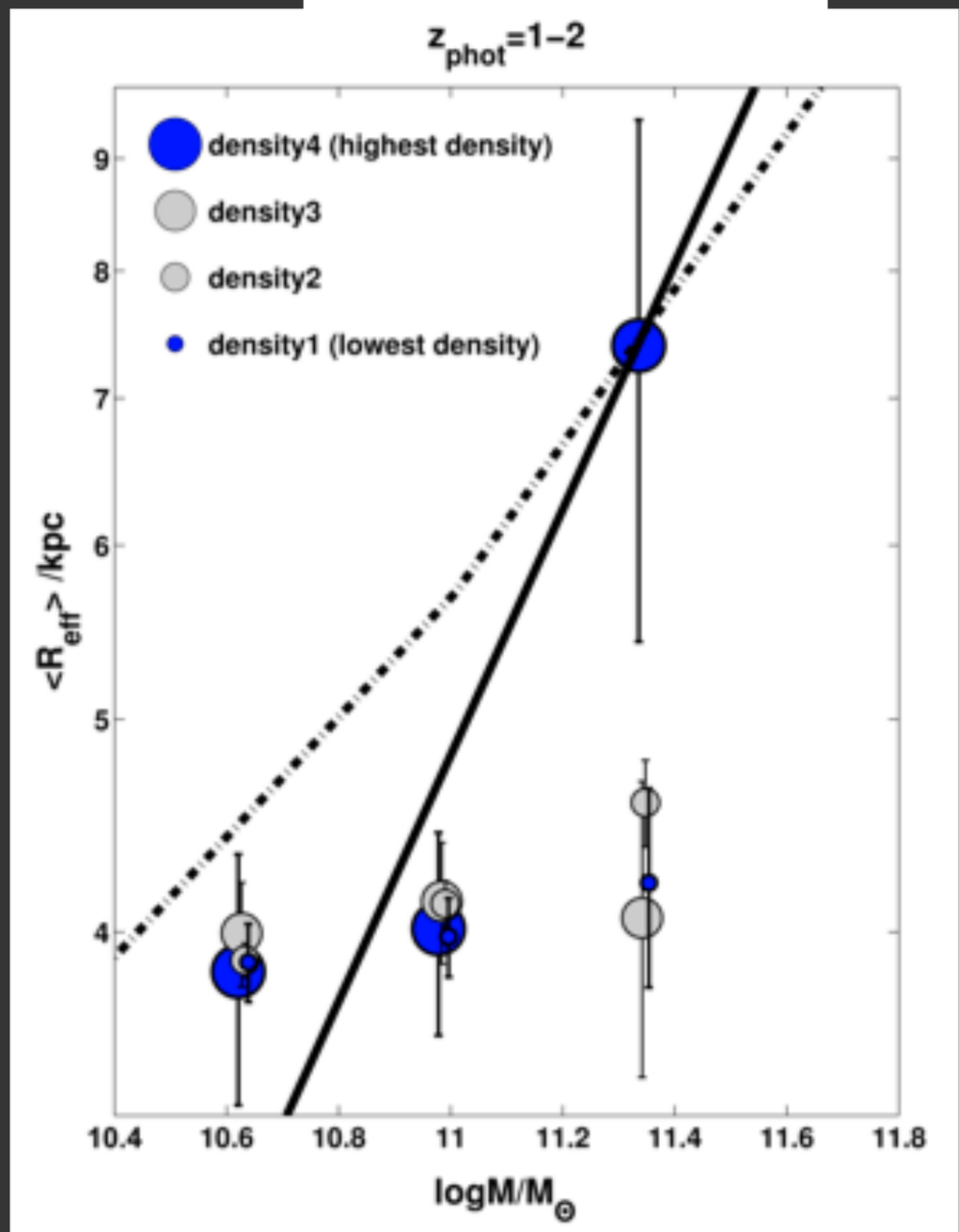


SF GALAXIES

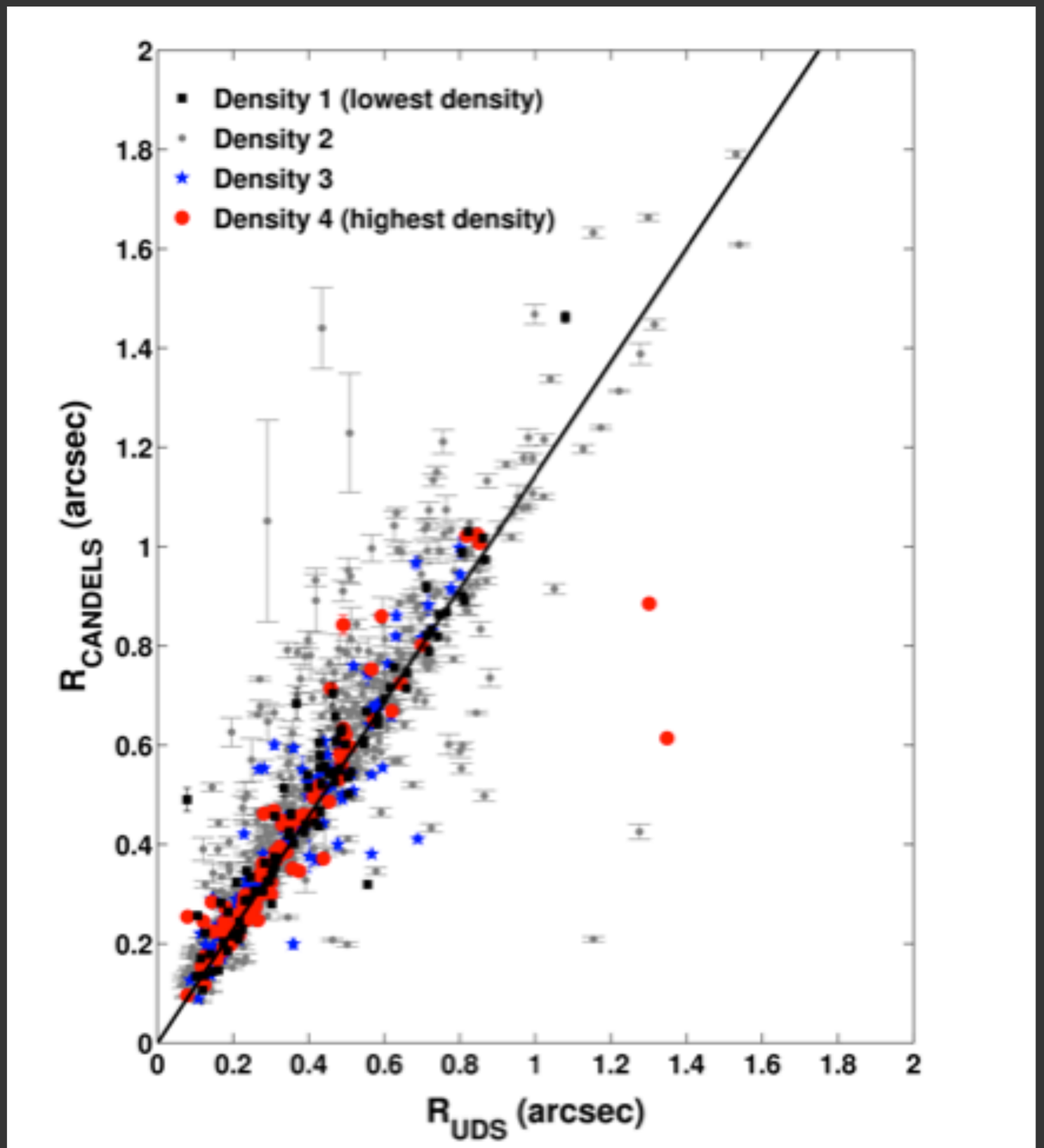
All star-forming



sSFR>1x10^{-11} yr^{-1}

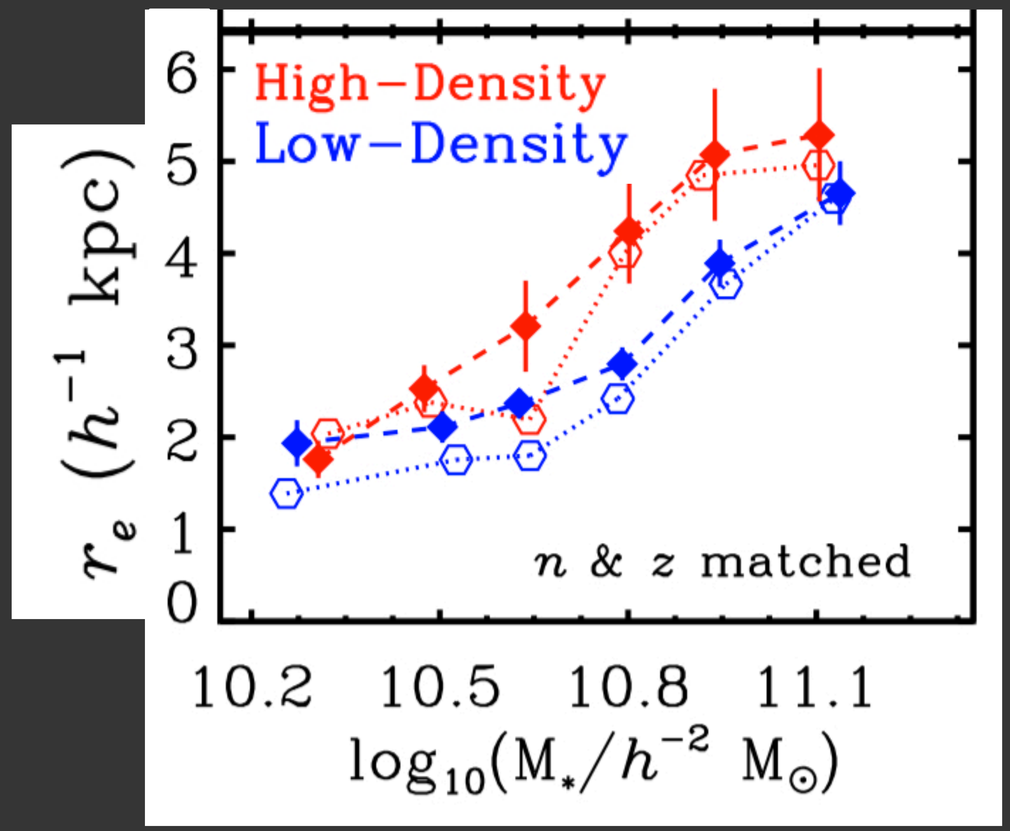


TEST


Density 1 (lowest density)
Density 2
Density 3
Density 4 (highest density)
$R_{CANDELS}$ (arcsec)
R_{UDS} (arcsec)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

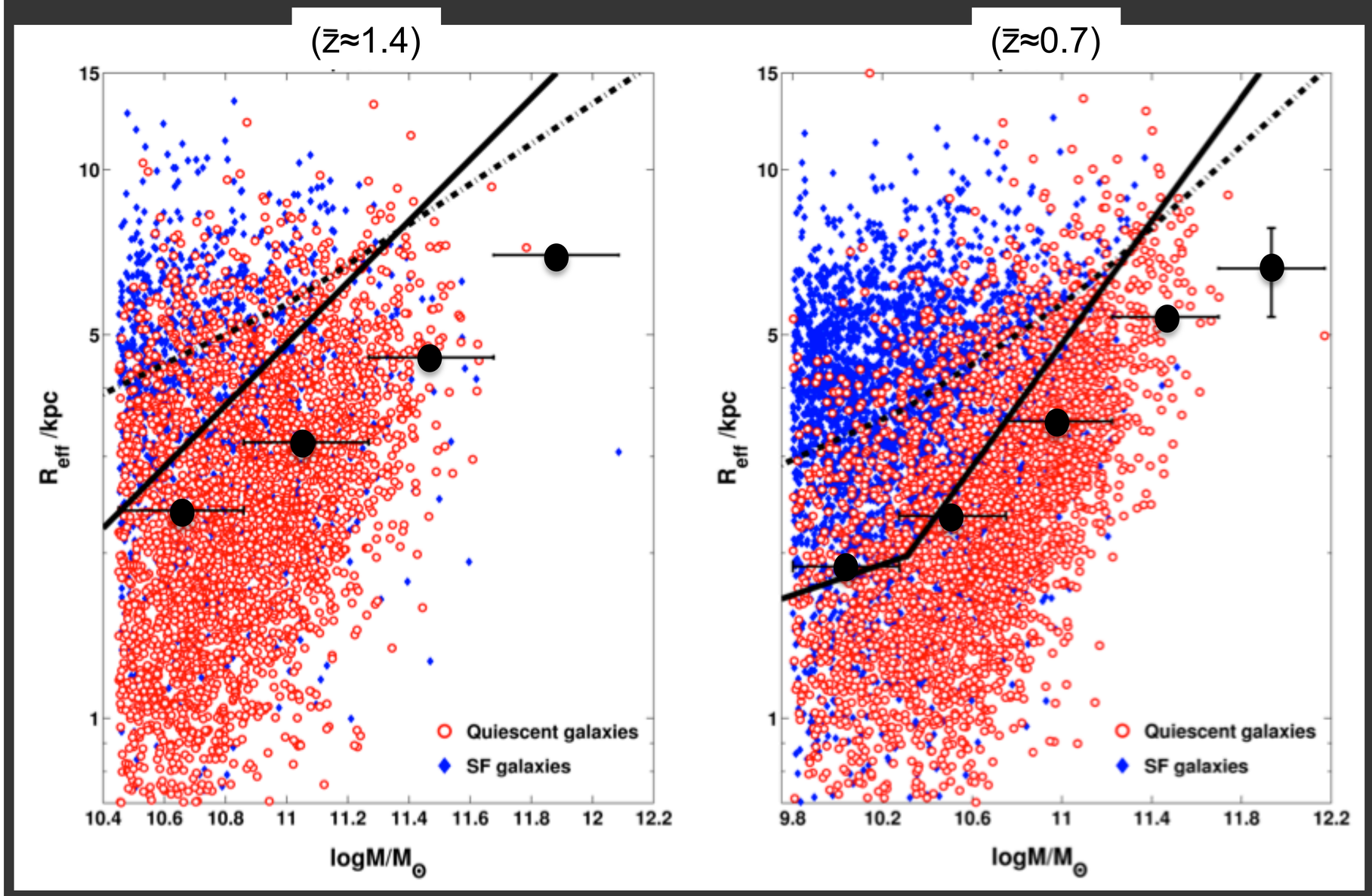
ENVIRONMENT AT HIGH z

Quiescent ETGs at z=0.4-1.2 (mostly z<0.8) & 25% size difference to 2σ significance



Cooper et al., 2012

SIZE—MASS RELATION



Lani et al., 2013

For $M_* > 10^{11} M_\odot$:

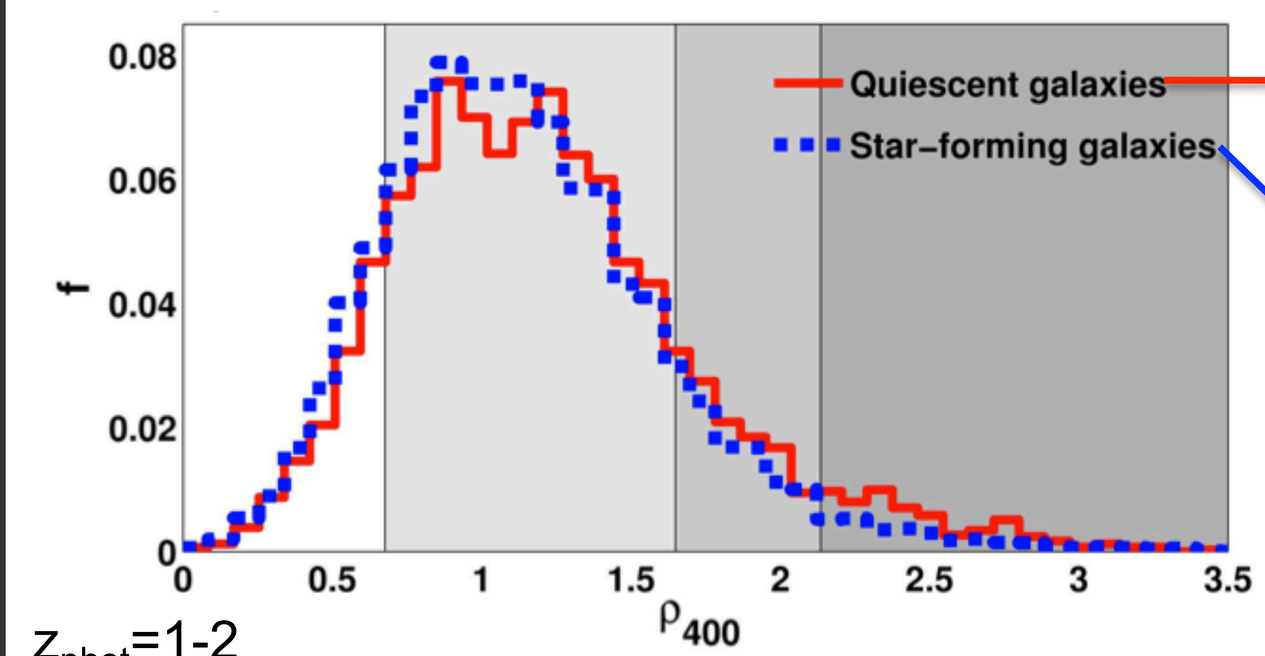
- z≈1.4 quiescent galaxies were typically 50% smaller
- At z≈0.7 quiescent galaxies were Typically 20% smaller

For $M_* < 10^{11} M_\odot$:

- At z≈1.4 quiescent galaxies were typically 40% smaller
- At z≈0.7 quiescent galaxies were typically 10% smaller

COLOUR vs ENVIRONMENT

z_{phot}=1-2



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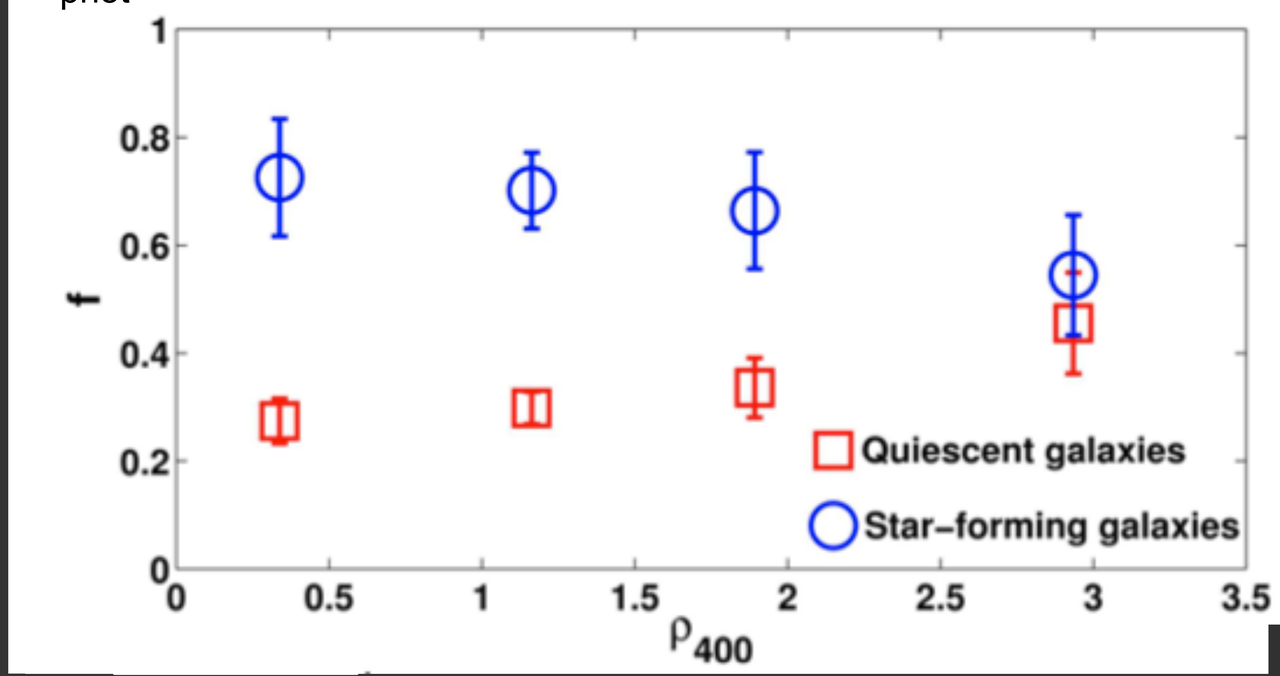

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