

# ETGs mass-size relation and large scale environment over the last 10Gyr

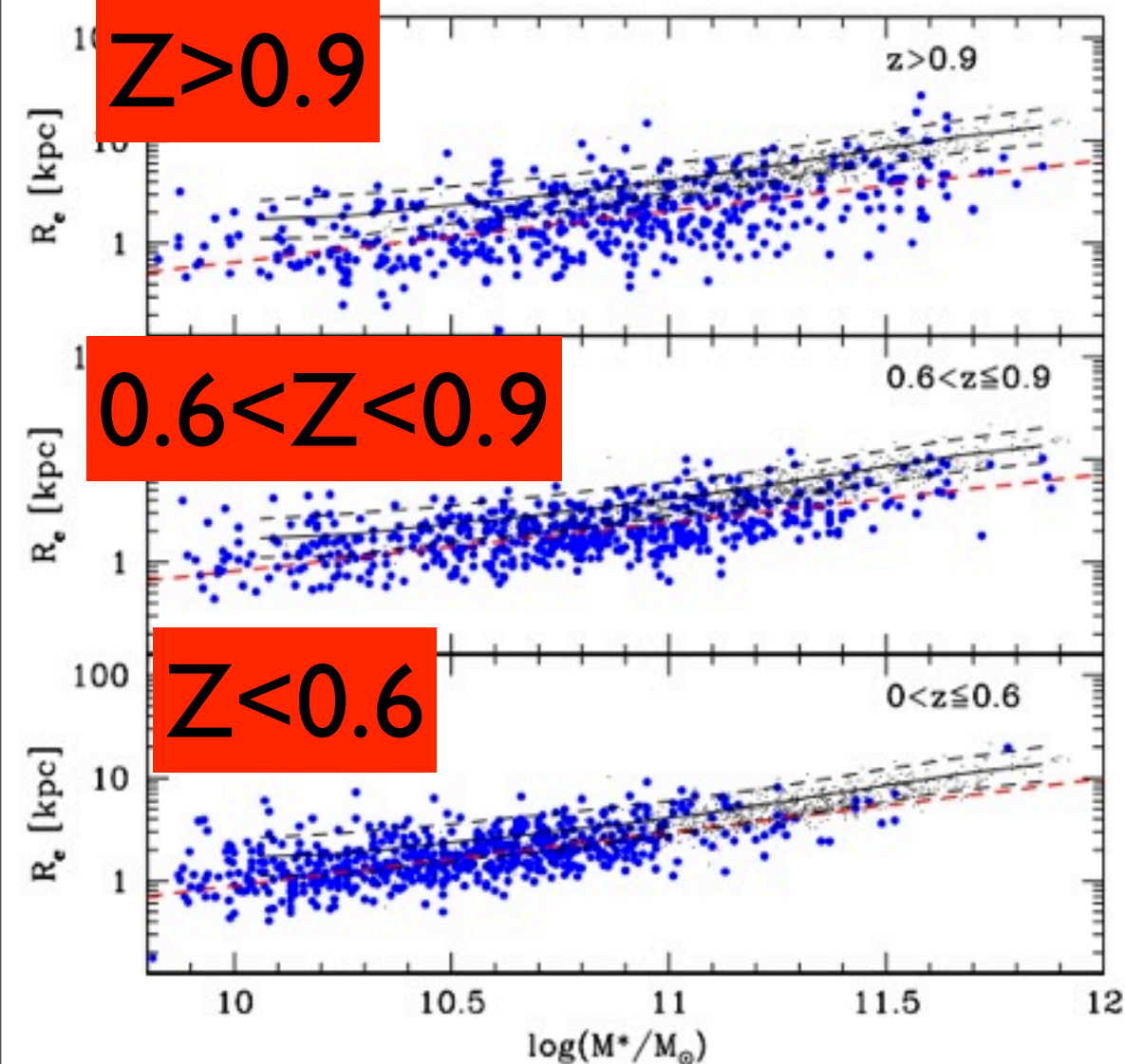
Marc Huertas-Company

Simona Mei, **Francesco Shankar**, **Lauriane Delaye**, Anand  
Raichoor, **Chris Lidman**, Mariangela Bernardi, J.A.L Aguerri, **Rossella  
Licitra**



ESAC, Madrid, september 11 2012

# mass-size relation as a tracer of mass assembly



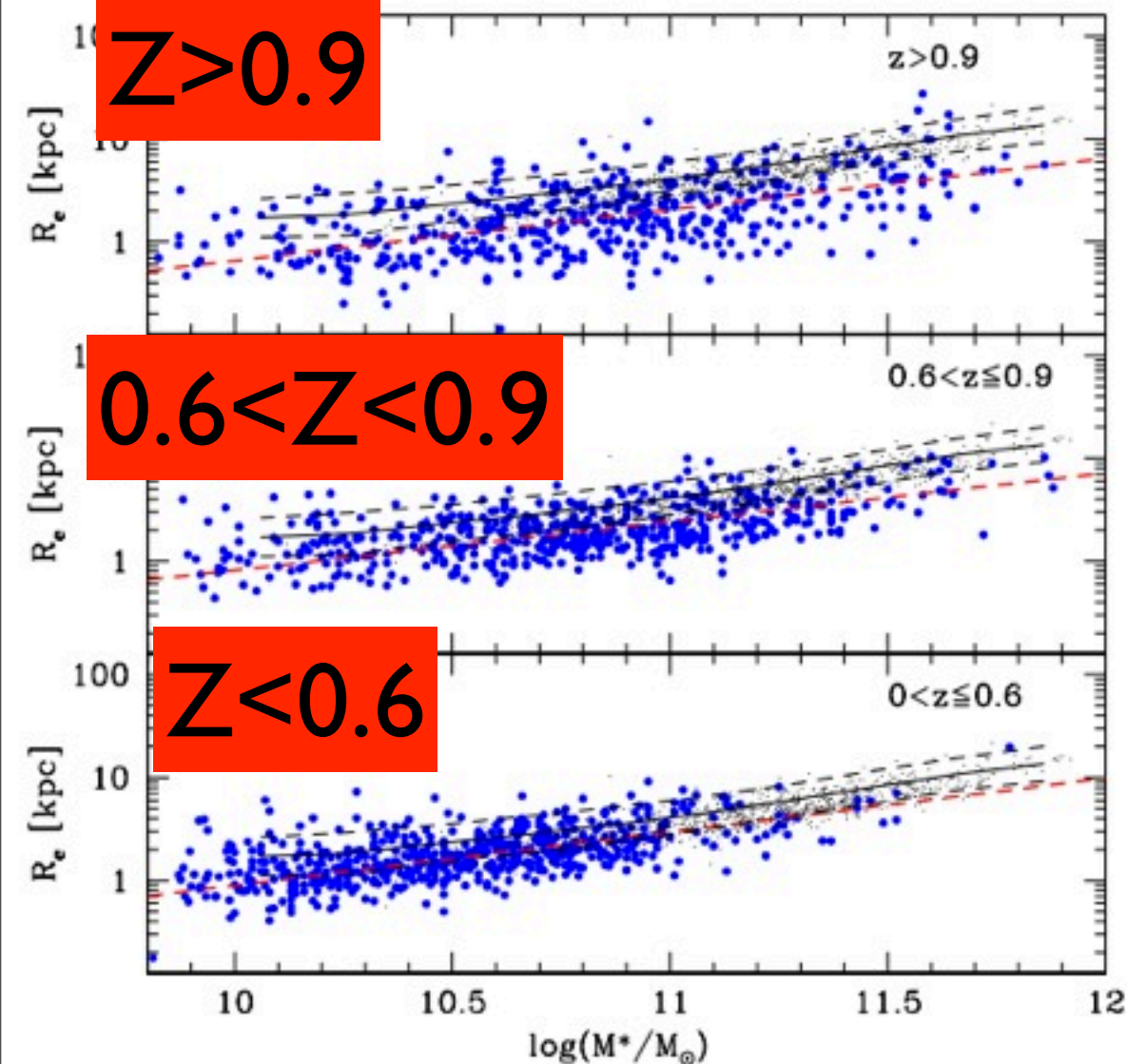
Cimatti+12

Patel's talk

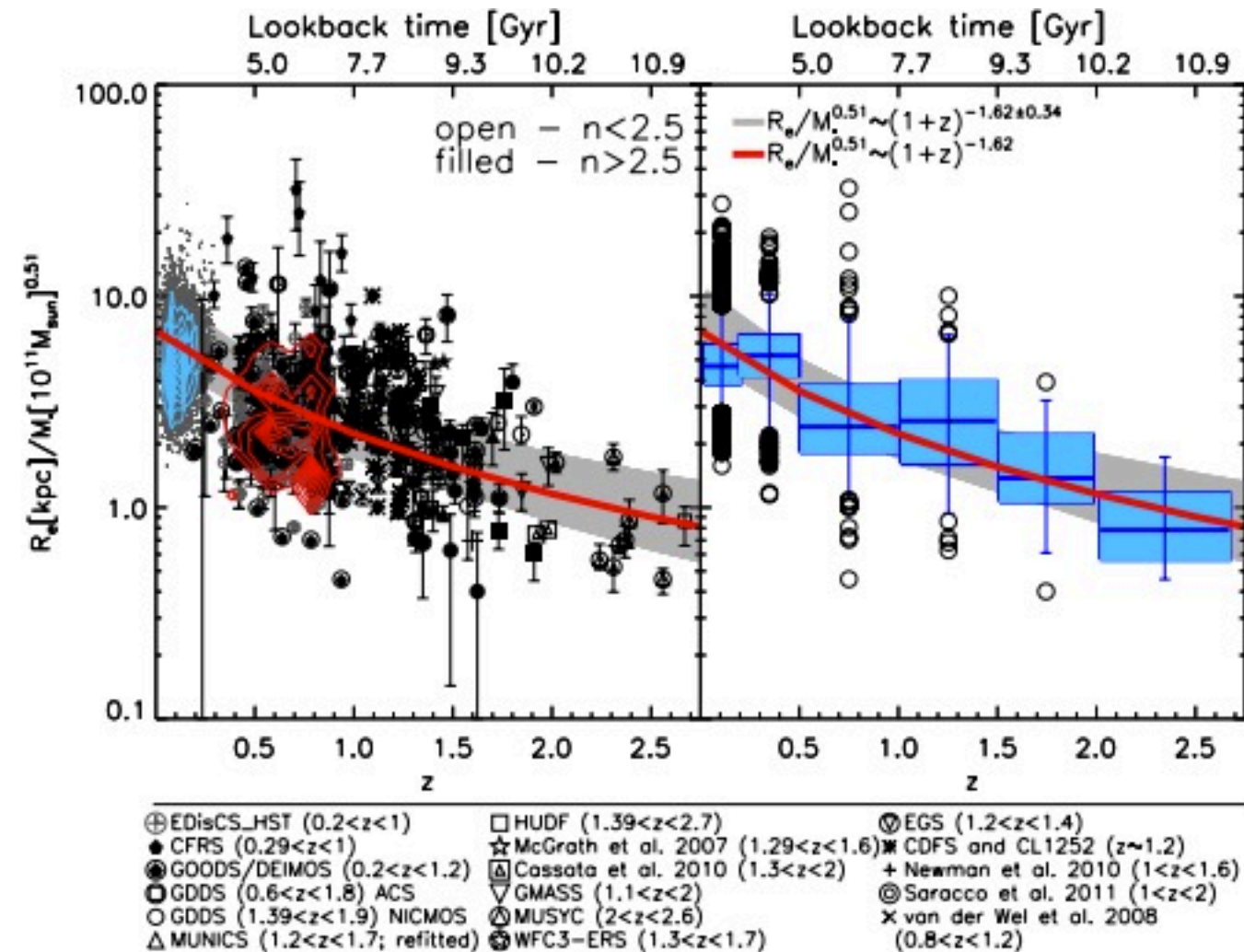
“ETGs/massive/passive” galaxies increased their size by a factor of  $\sim 4$  from  $z \sim 2$

# mass-size relation as a tracer of mass assembly

Damjanov+11



Cimatti+12



Patel's talk

“ETGs/massive/passive” galaxies increased their size by a factor of  $\sim 4$  from  $z \sim 2$

# A hot topic!

- Cooper et al. 2012
- Newman et al. 2012
- Trujillo et al. 2012
- Bluck et al. 2012
- Jiang et al. 2012
- Szomoru et al. 2012
- Ryan et al. 2012
- Cimatti et al. 2012
- Ichikawa et al. 2012
- Gabor et al. 2012
- Lopez-Sanjuan et al. 2012
- Whitaker et al. 2012
- Raichoor et al. 2012
- Marmol-Queralto et al. 2012
- Oser et al. 2012
- Papovich et al. 2012
- Saracco et al. 2012
- Song et al. 2012
- Nipoti et al. 2012
- Kaviraj et al. 2012
- Oogi et al. 2012
- Chevance et al. 2012
- Patel+12

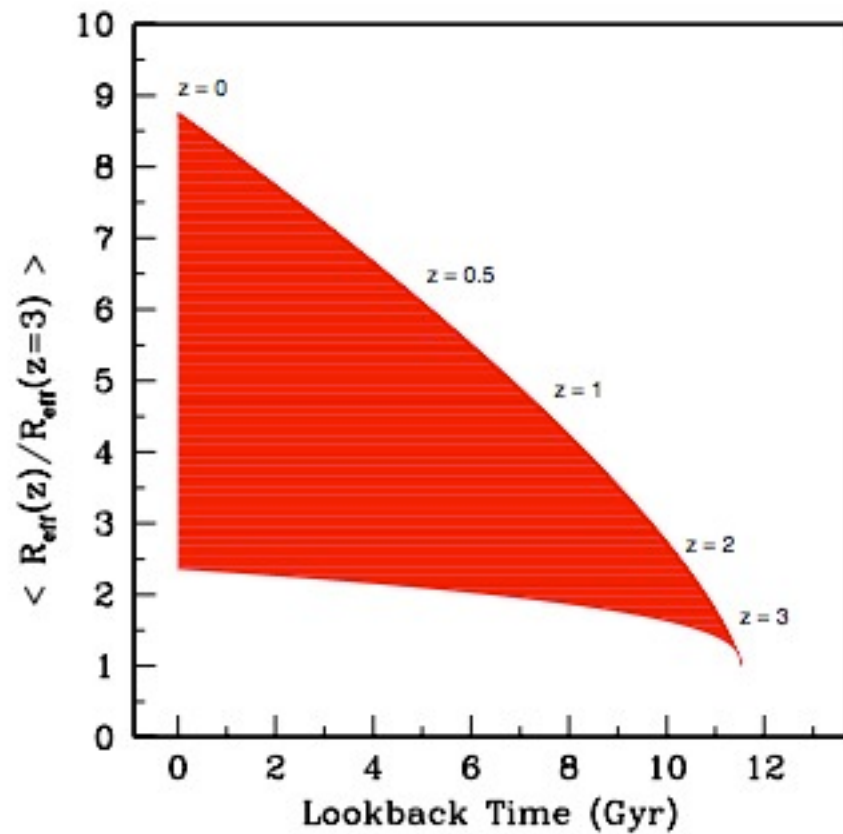
> 20 papers (theoretical +  
observational) in 2012  
~one paper/week on the topic

What physical mechanism is driving the size growth?

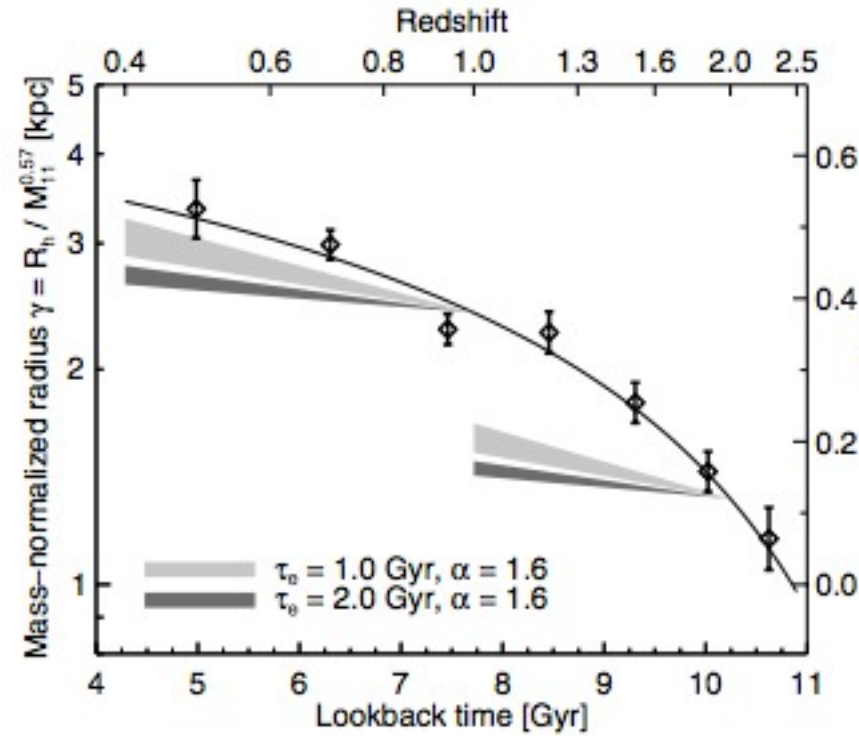
**1 - dry merging (Hopkins+, Naab+)**

**2- AGN feedback (Fan+)**





Bluck+12



Newman+12

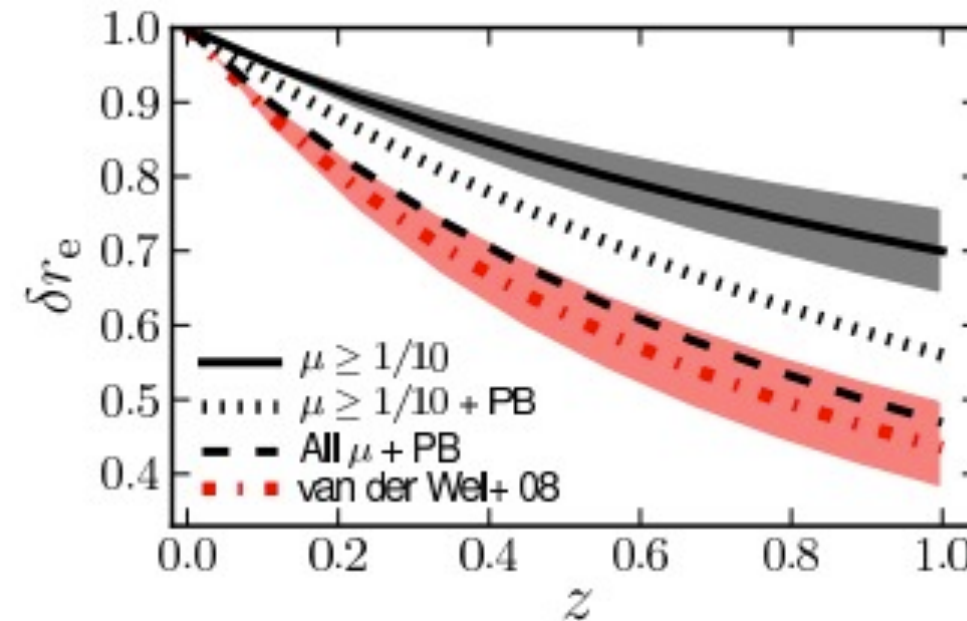
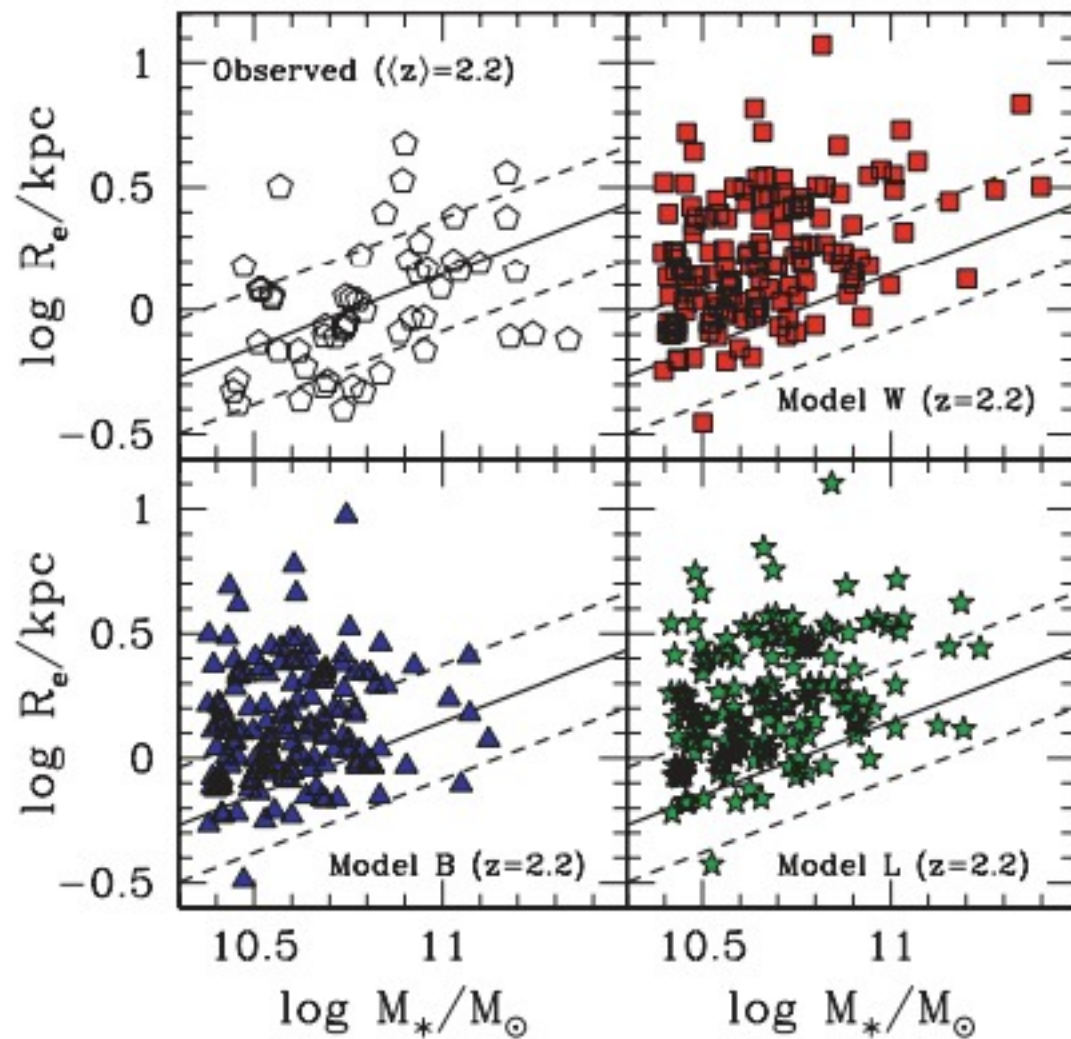
minor mergers could explain the growth at least from  $z \sim 1$

See also Tirit+11, McLure+12, Patel+12, Rettura+12...

What physical mechanism is driving the size growth?

- 1- dry merging (Hopkins+06, Naab+00)
- 2- AGN feedback (Fan+08)

or not...



Lopez-Sanjuan+12

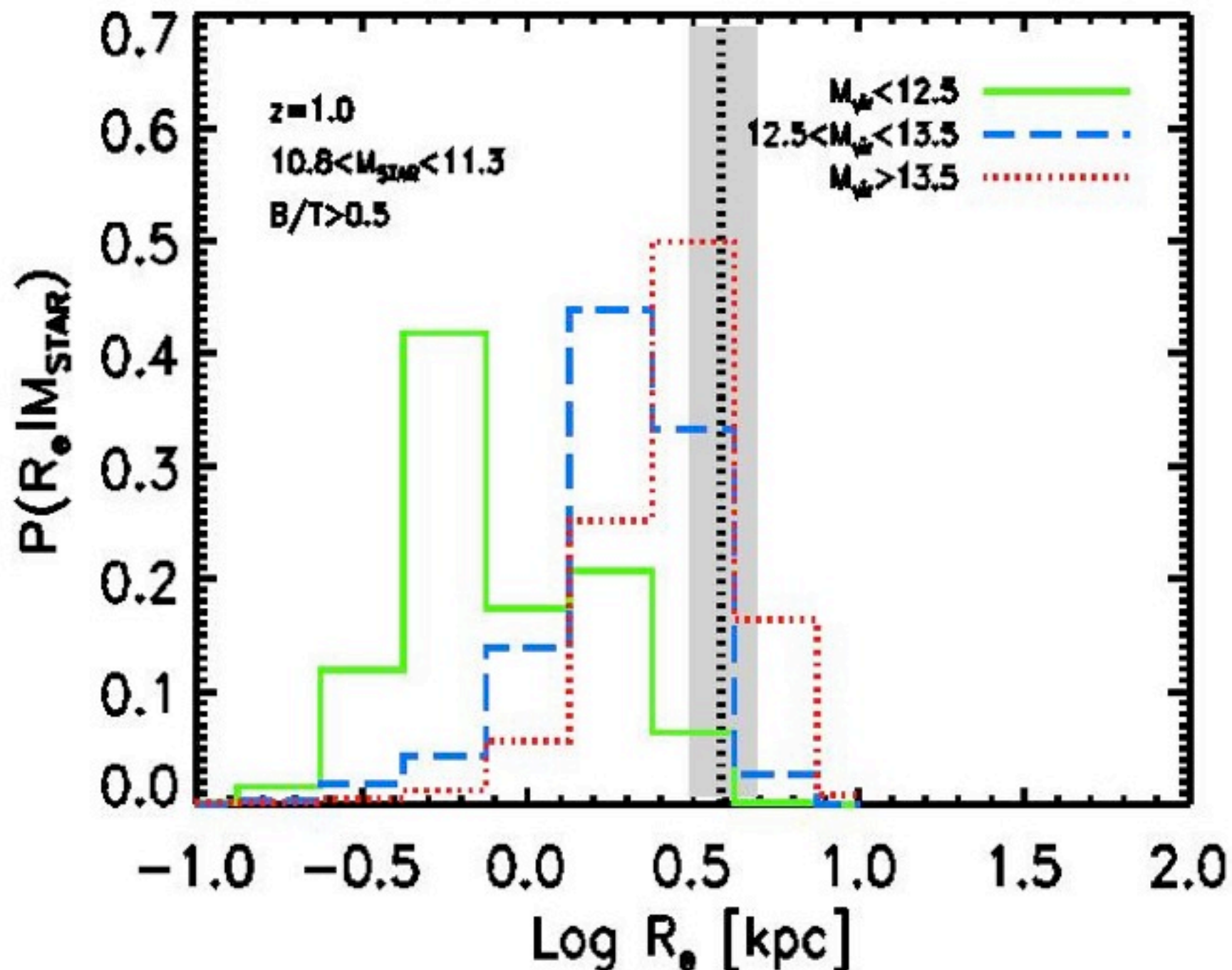
Nipoti+12

What physical mechanism is driving the size growth?

- 1- dry merging (Hopkins+06, Naab+00)
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# Environment as a test of a hierarchical scenario

Larger galaxies are predicted in bigger halos

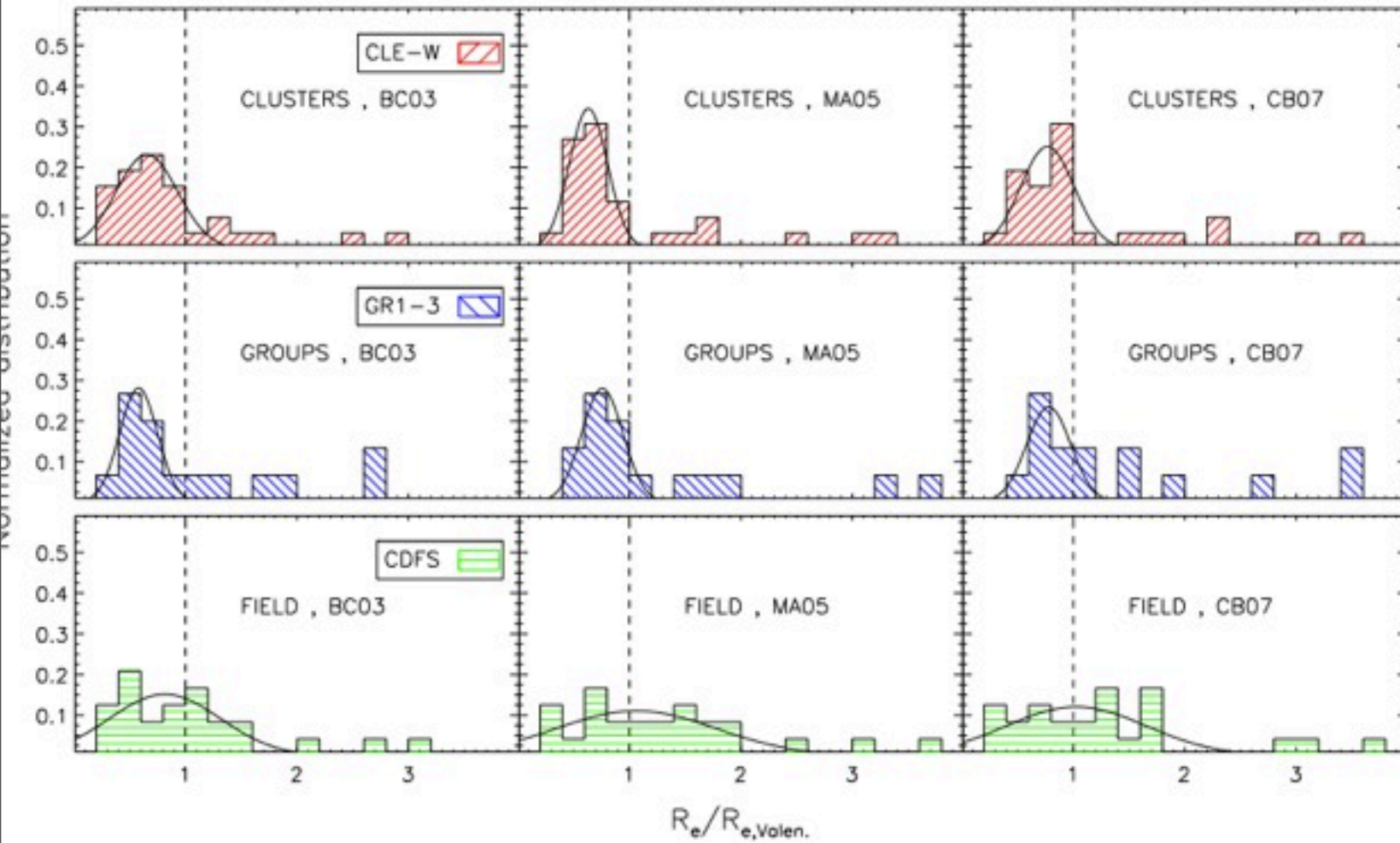


Shankar+11



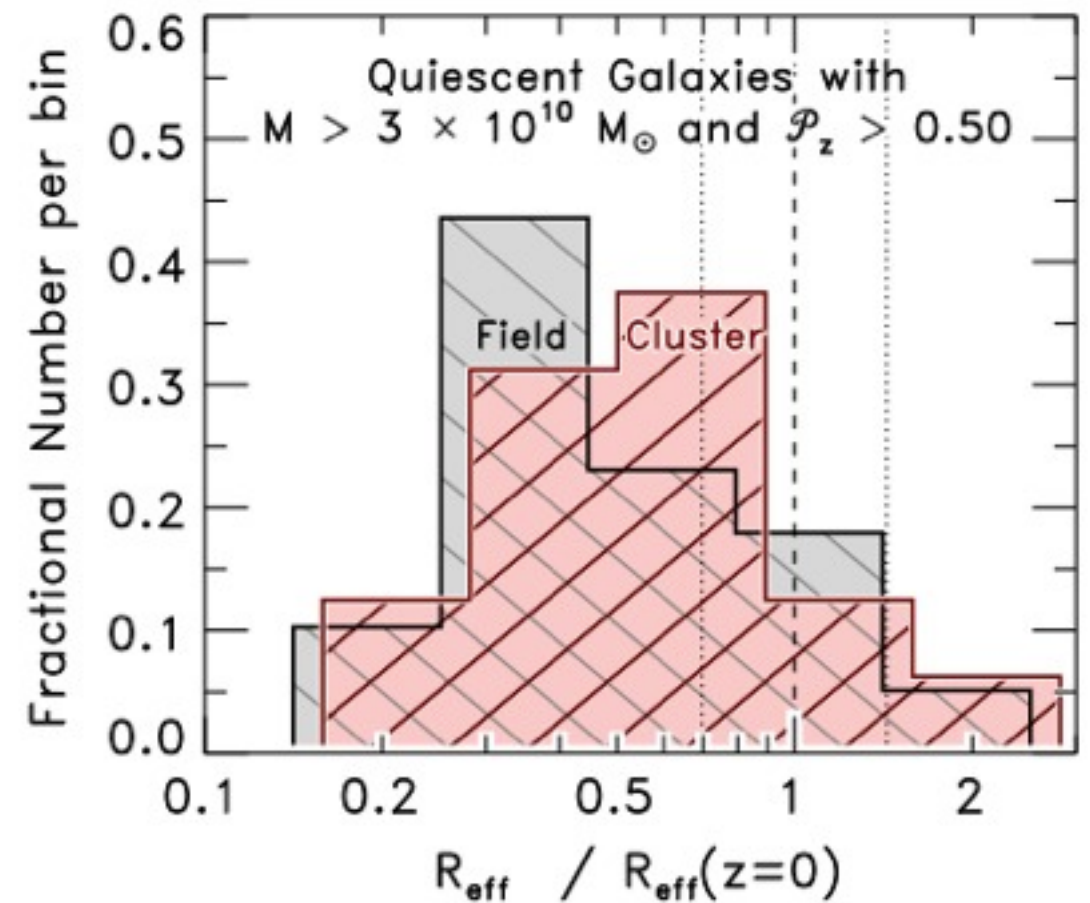
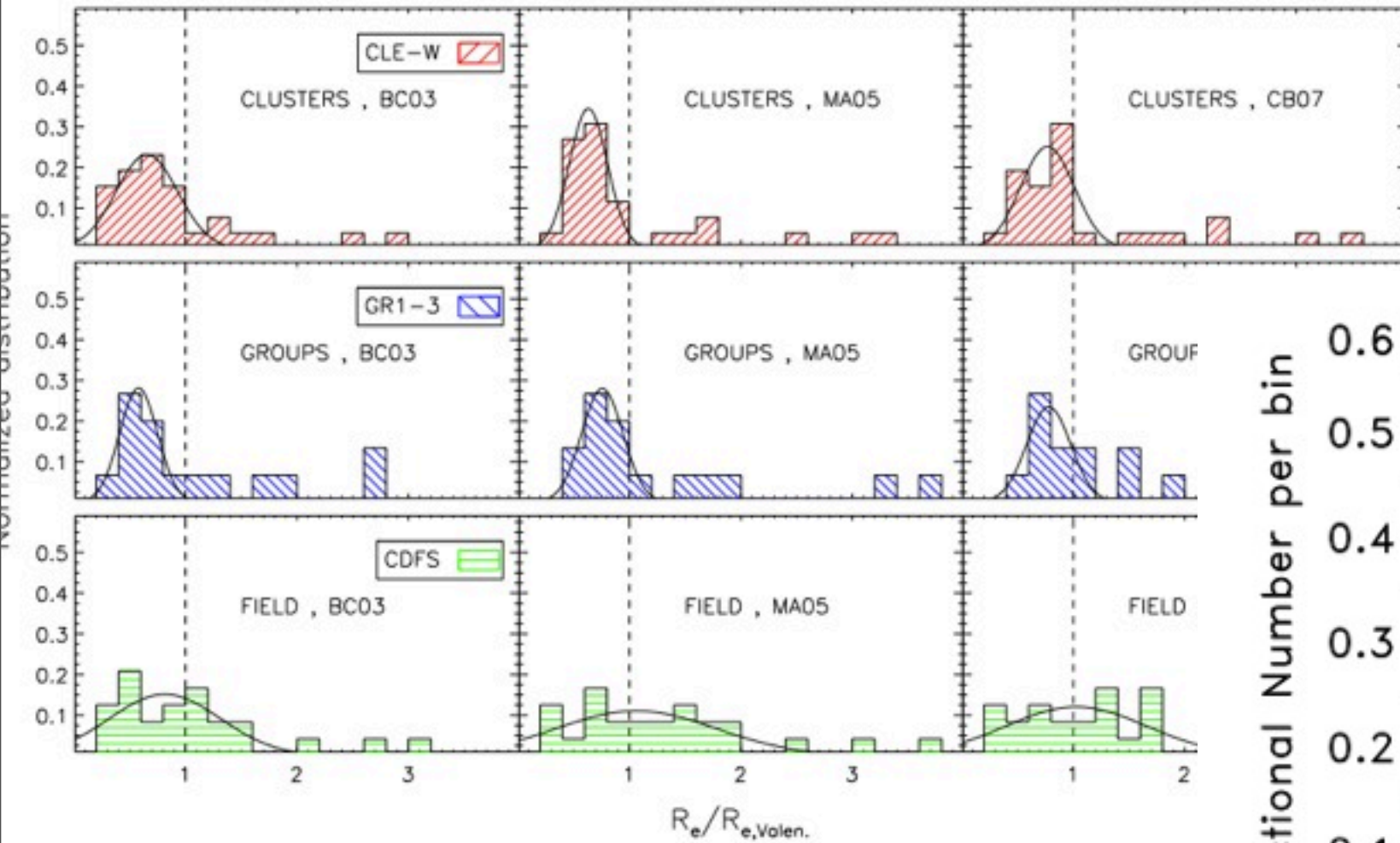
# observational results are controversial/not clear

Raichoor+12



# observational results are controversial/not clear

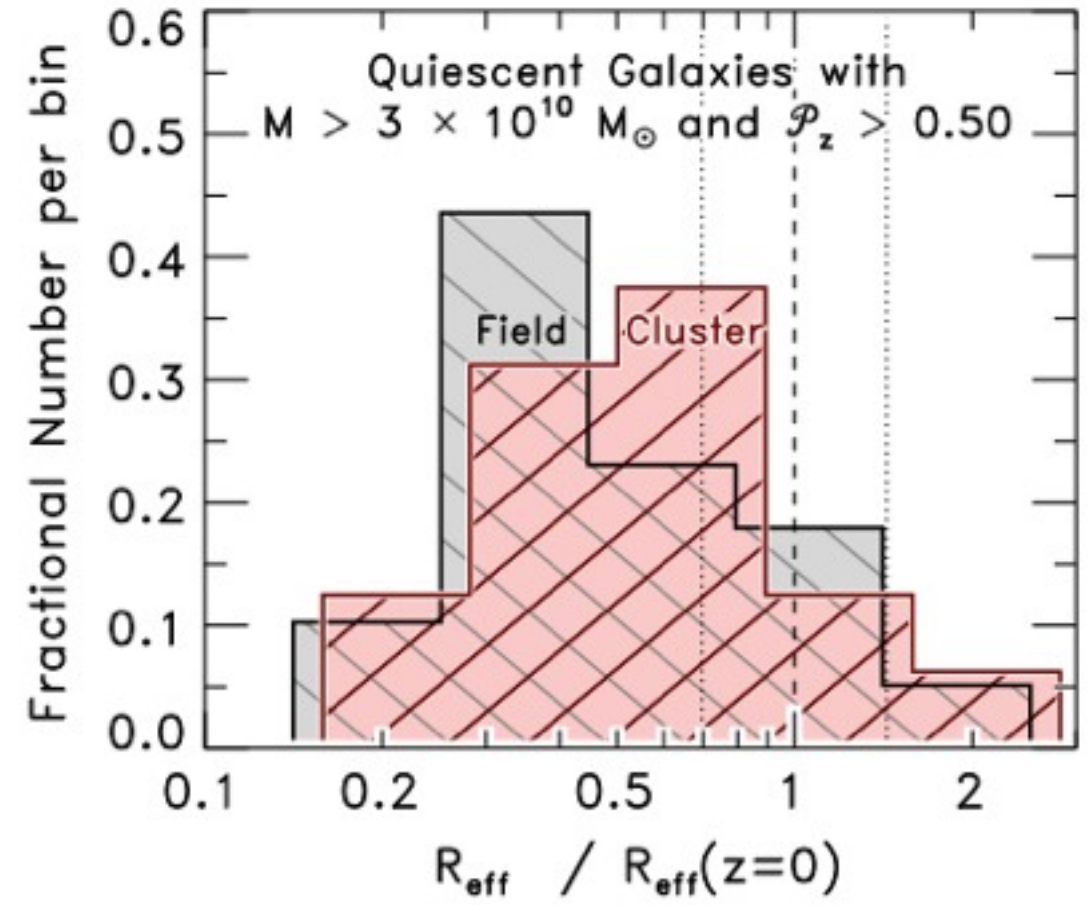
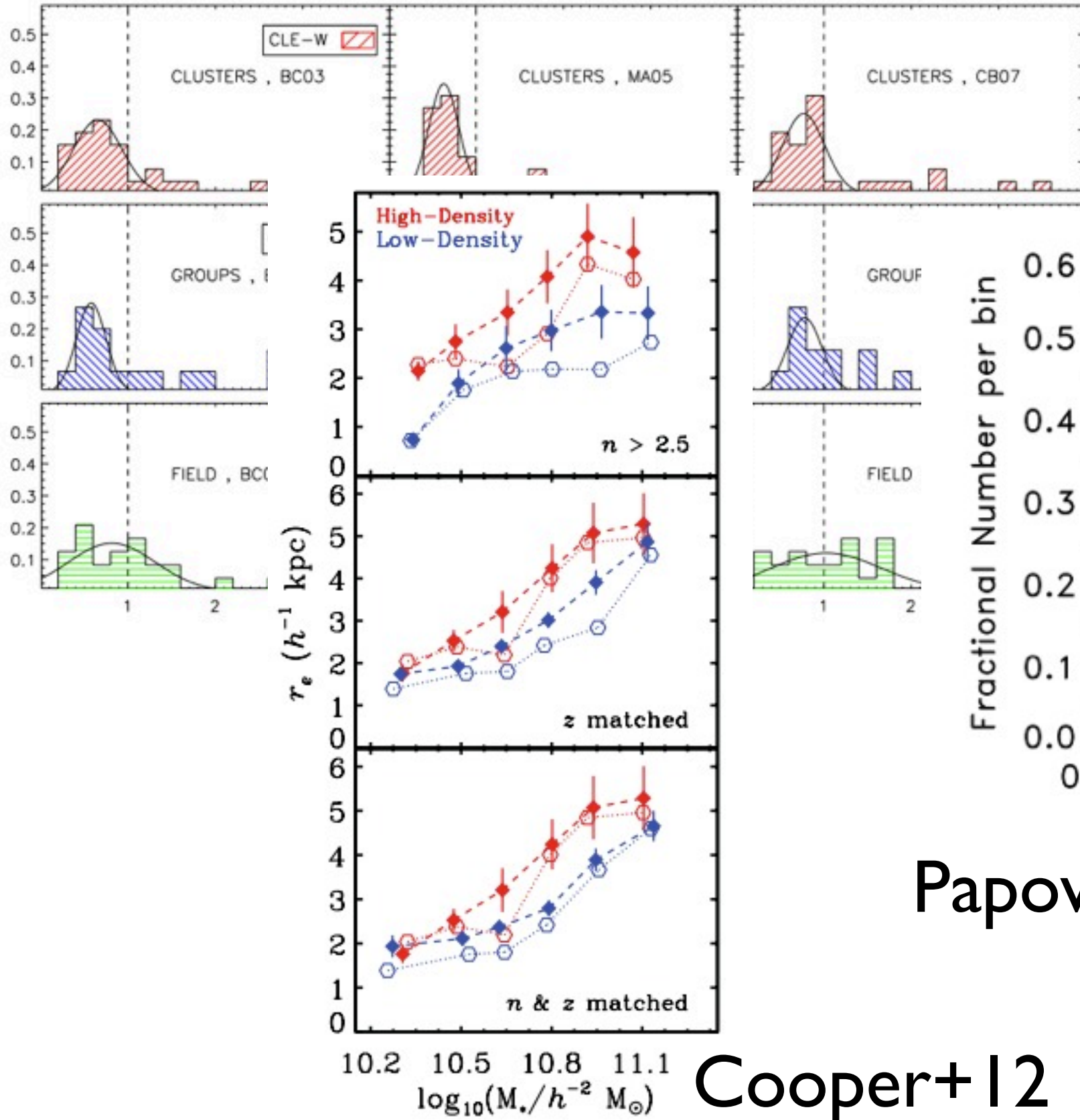
Raichoor+12



Papovich+12 (Basset's talk)

# observational results are controversial/not clear

Raichoor+12

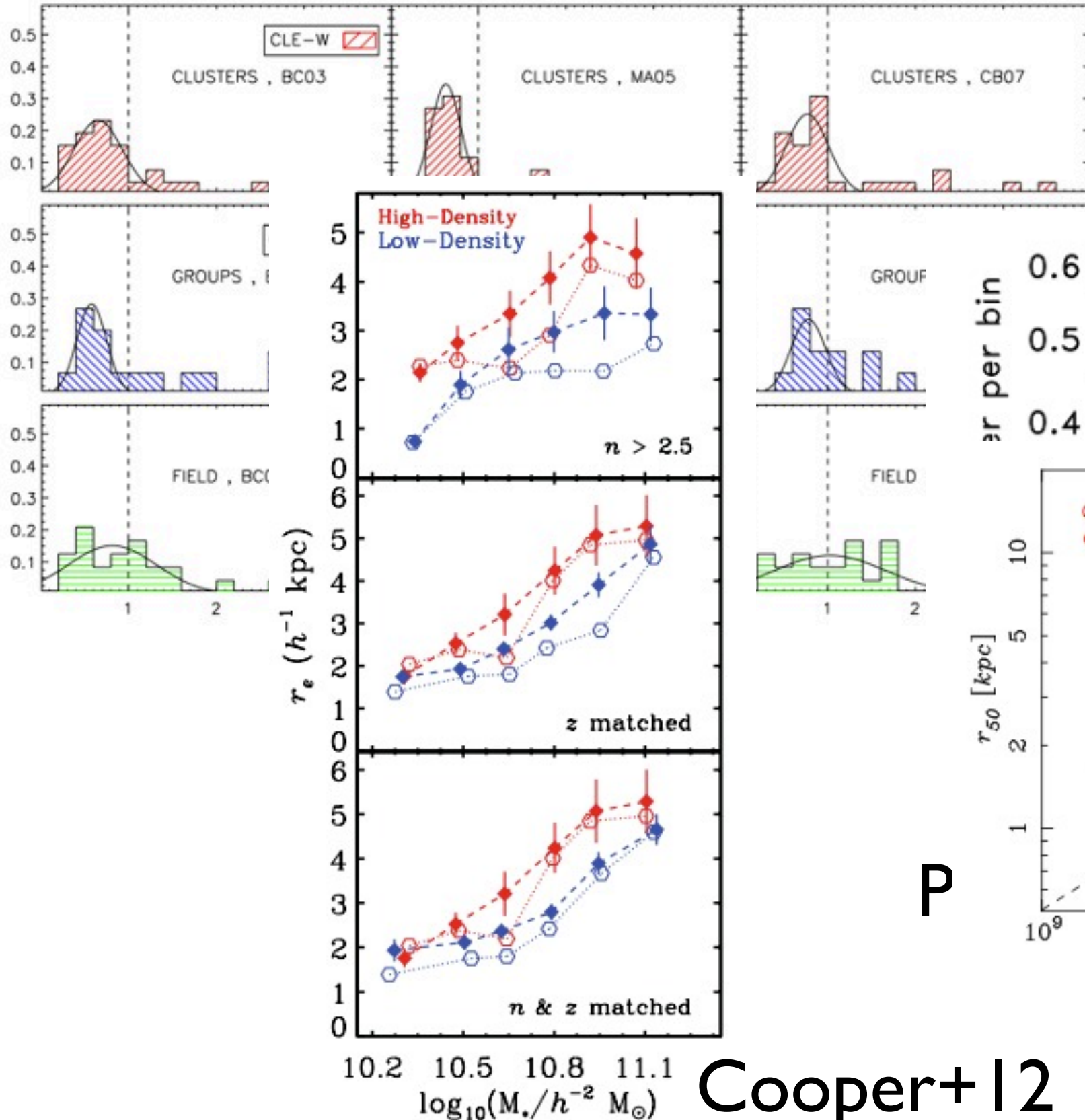


Papovich+12 (Basset's talk)

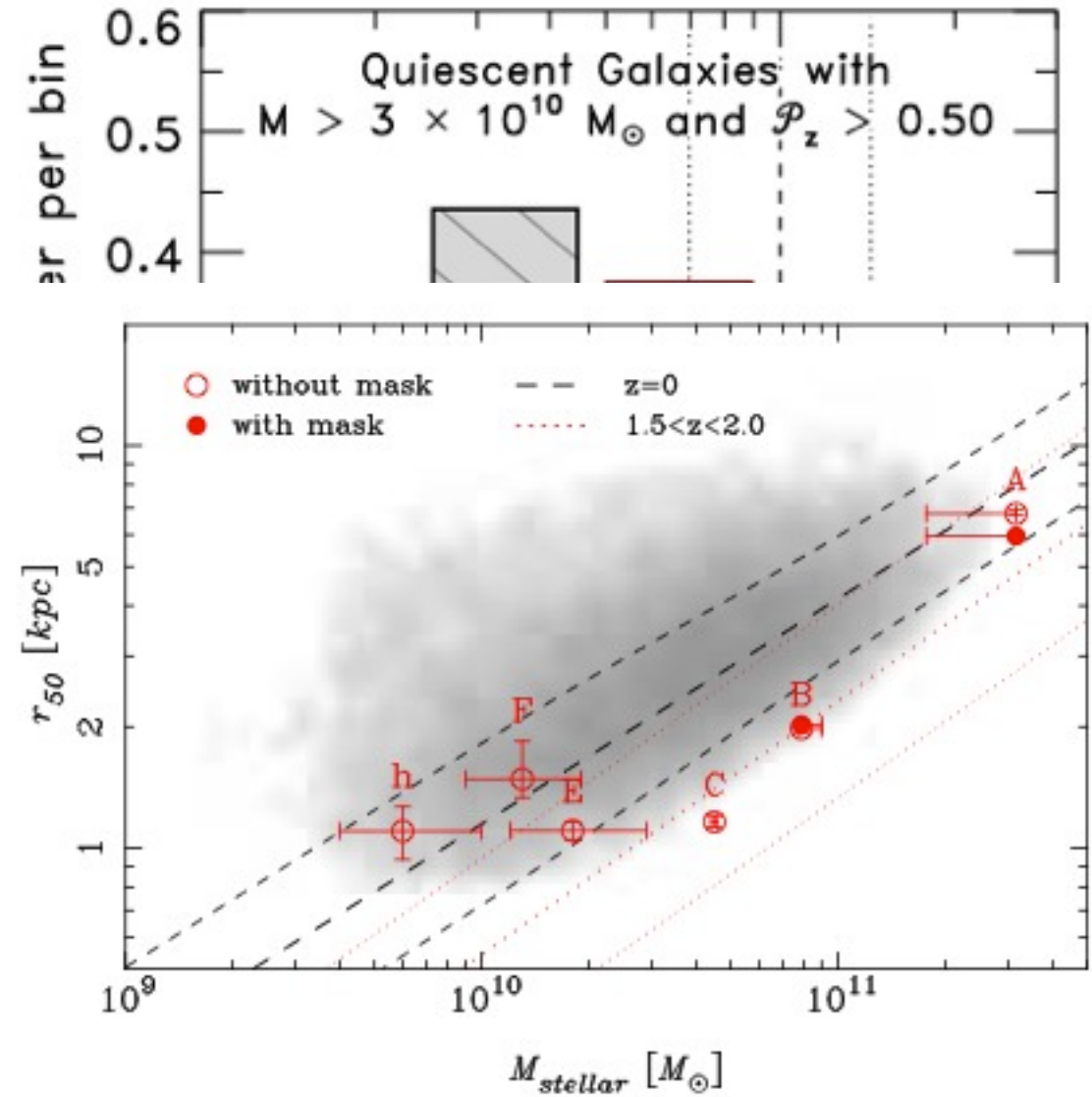


# observational results are controversial/not clear

Raichoor+12



Cooper+12



Tanaka+12

# Main topics

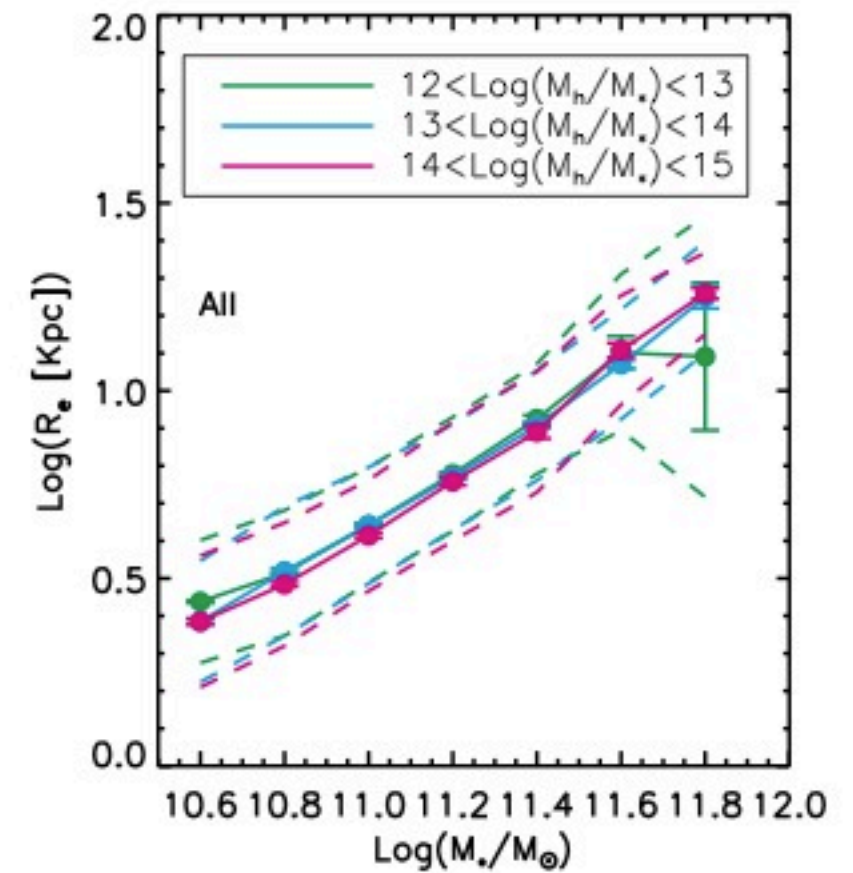
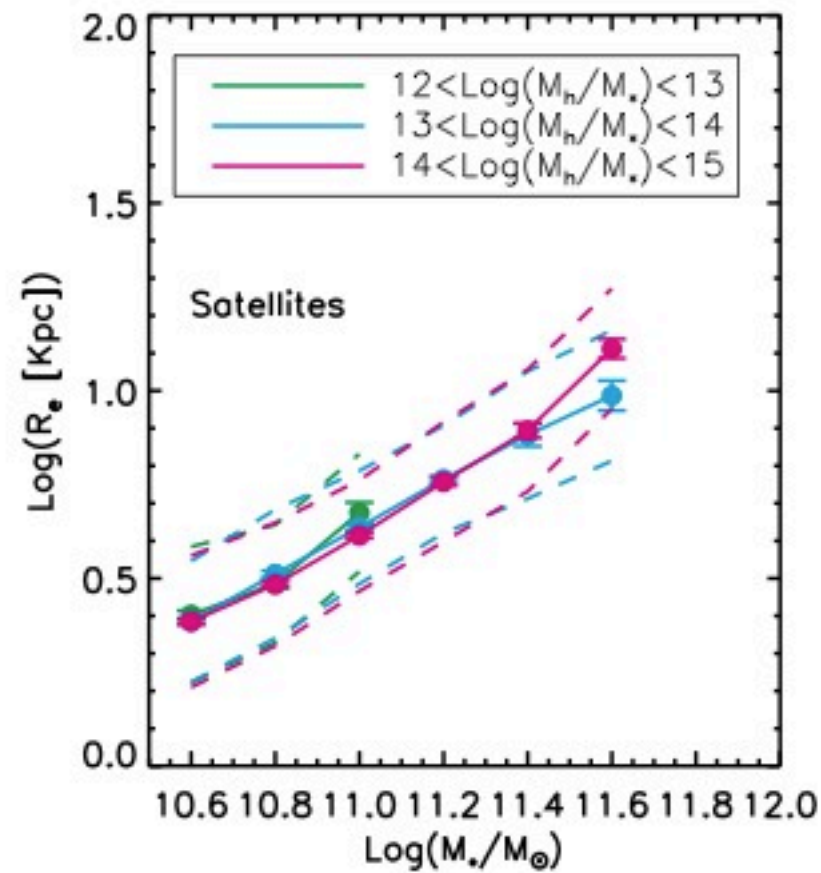
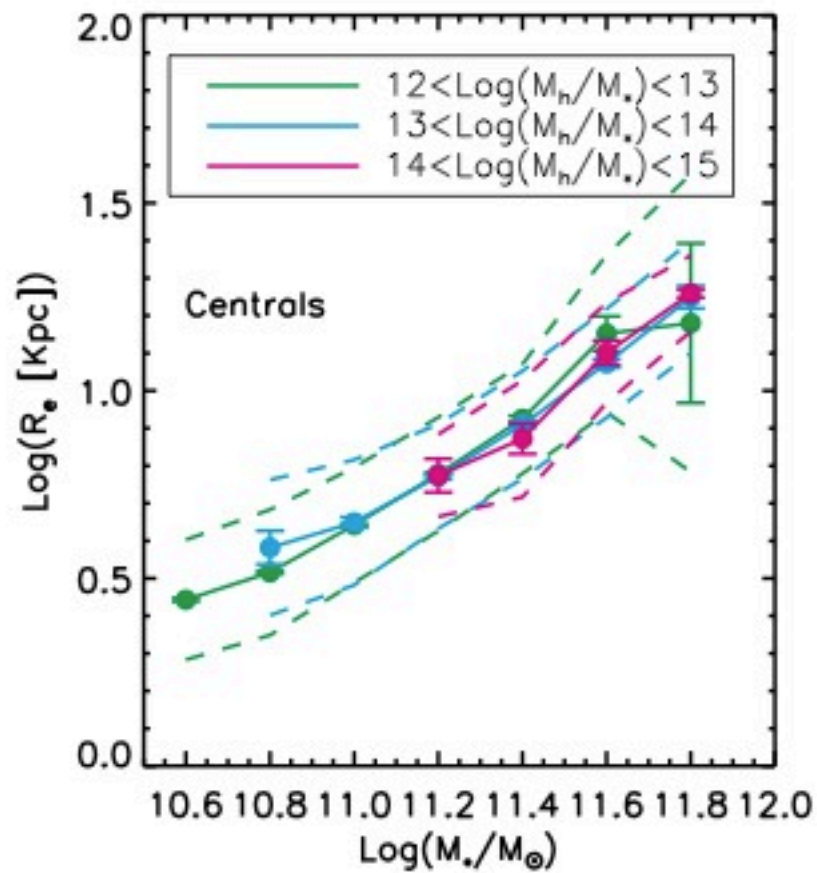
- Do we see environmental effects in the mass-size relation (and size growth) of ETGs in the last 10Gyrs?
- How does it compare to model predictions?
- Test of the merger driven growth?



At  $z=0$

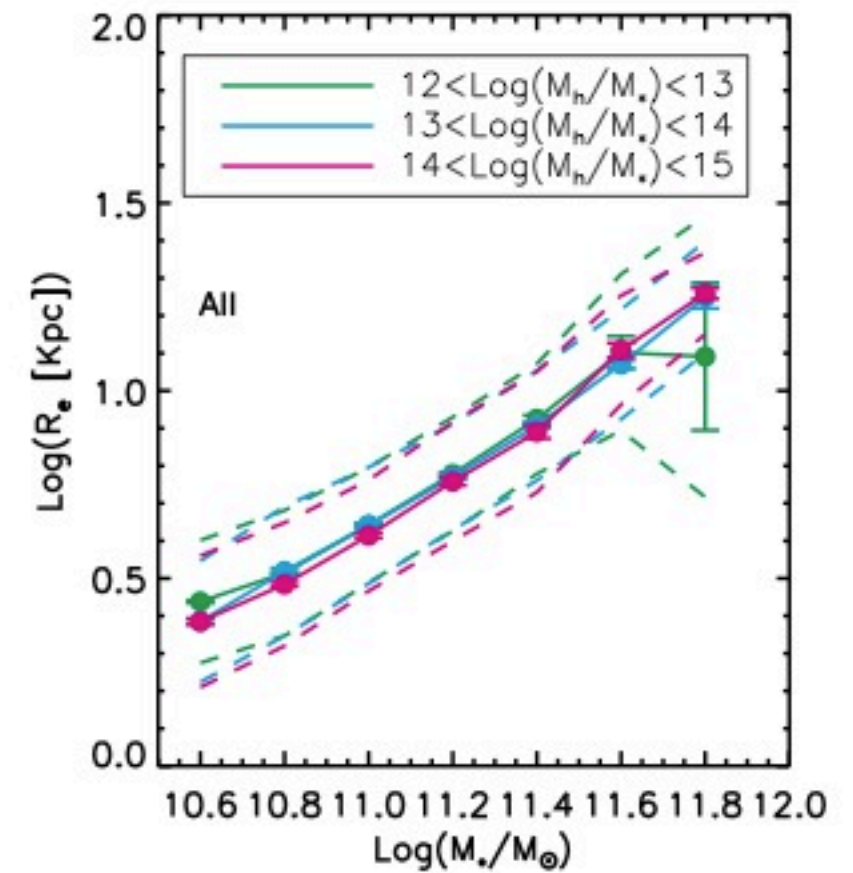
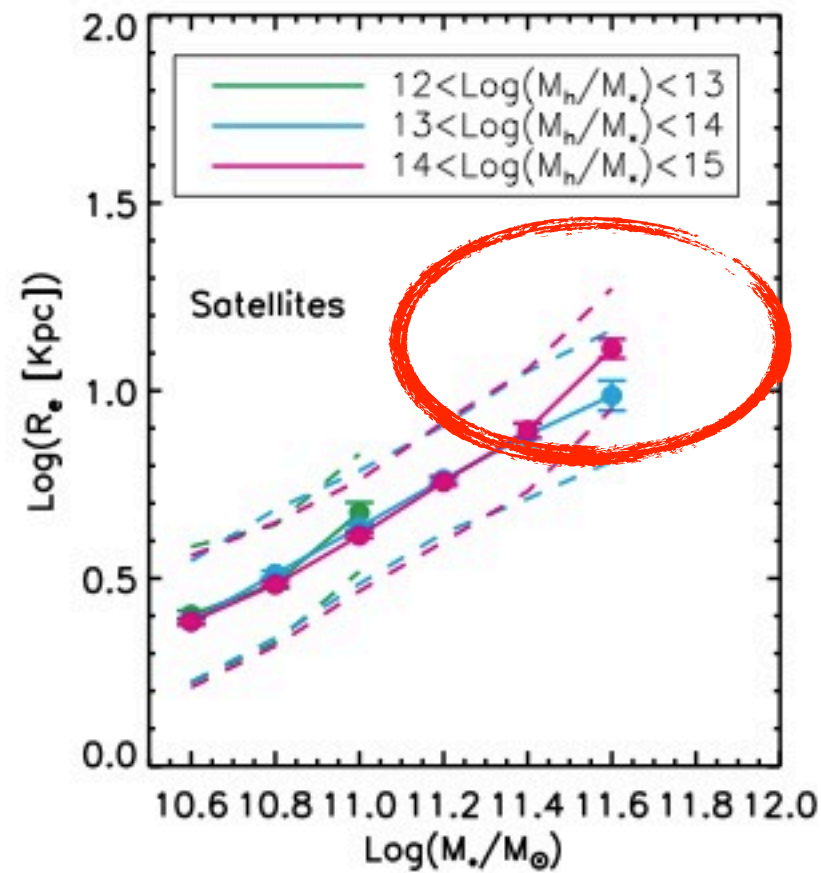
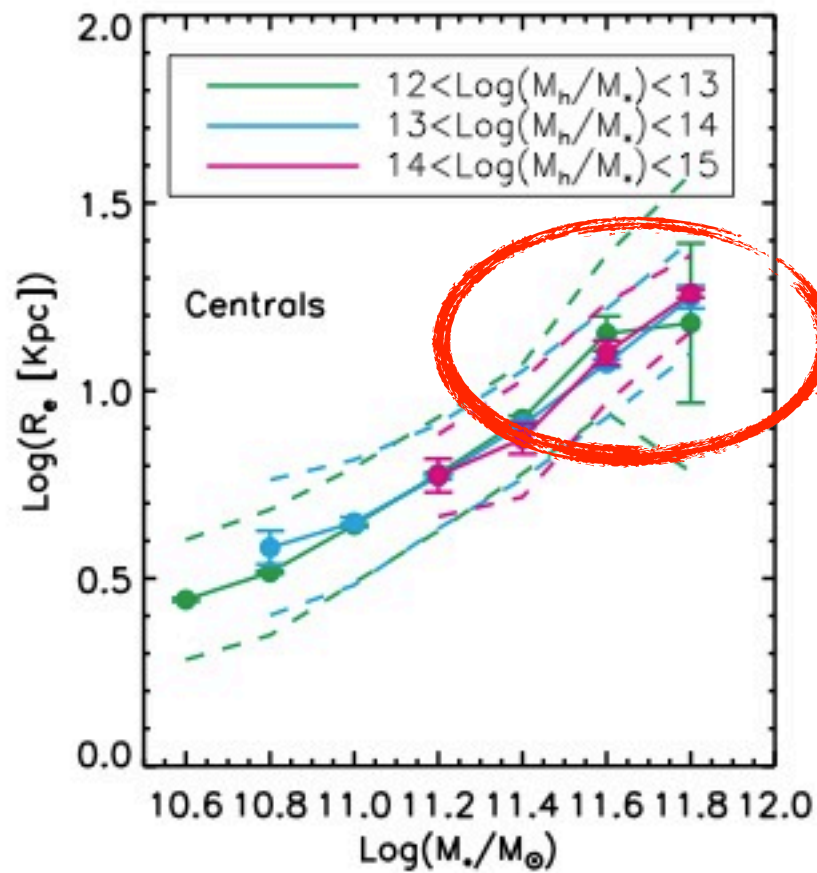


- Group/cluster catalog from Yang+07 updated to the DR7 ( $z < 0.09$ )
- ETG selection based on the morphological catalog by Huertas-Company+11
- Sizes based on Sersic fits done by Bernardi+12



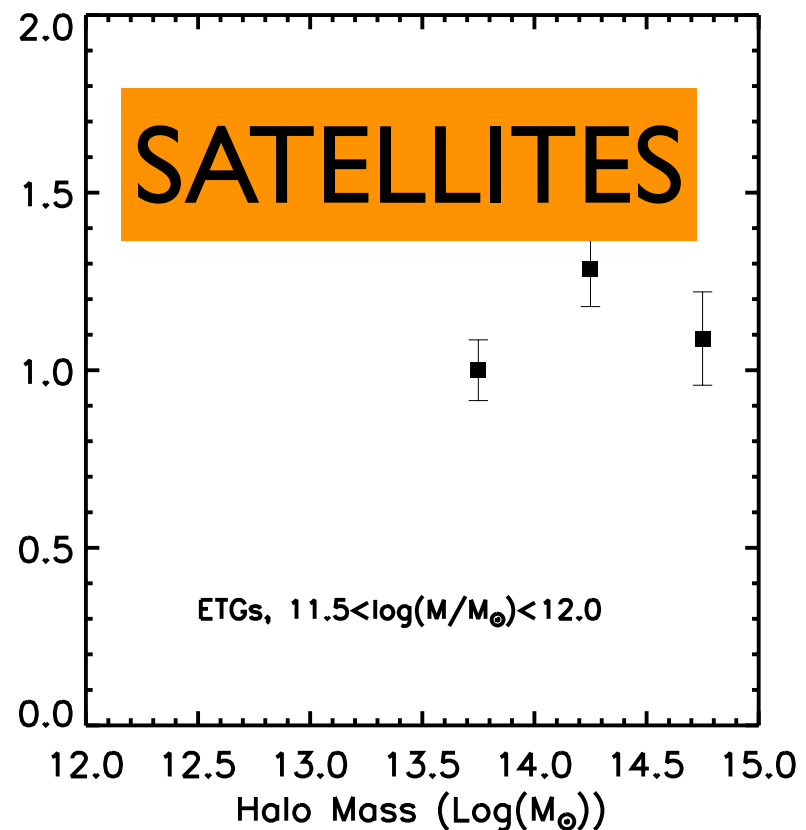
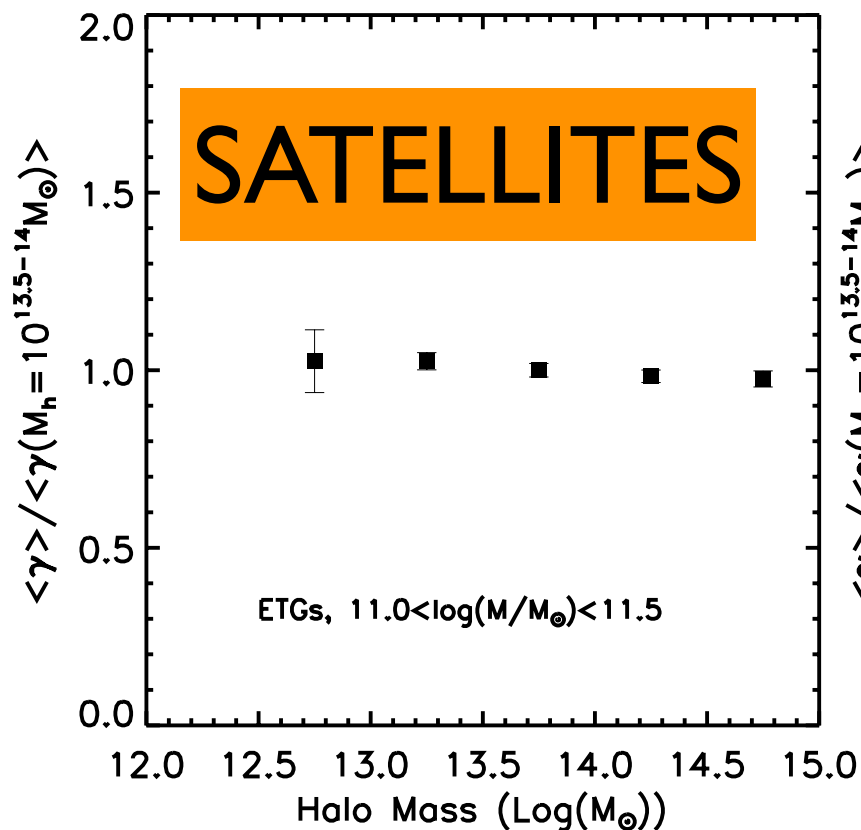
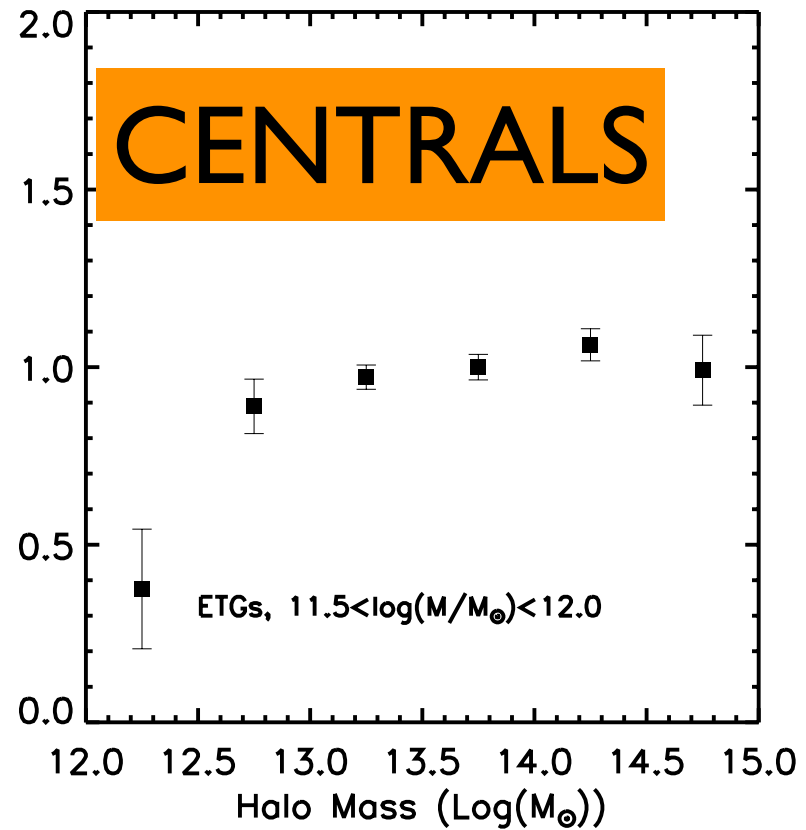
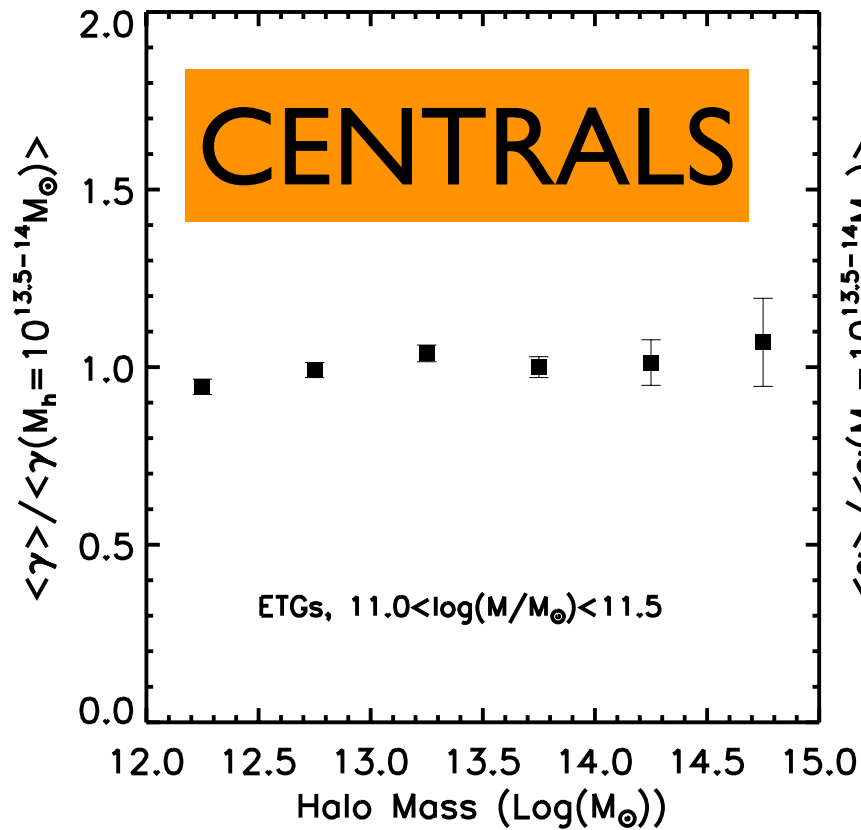
huertas-company+12b

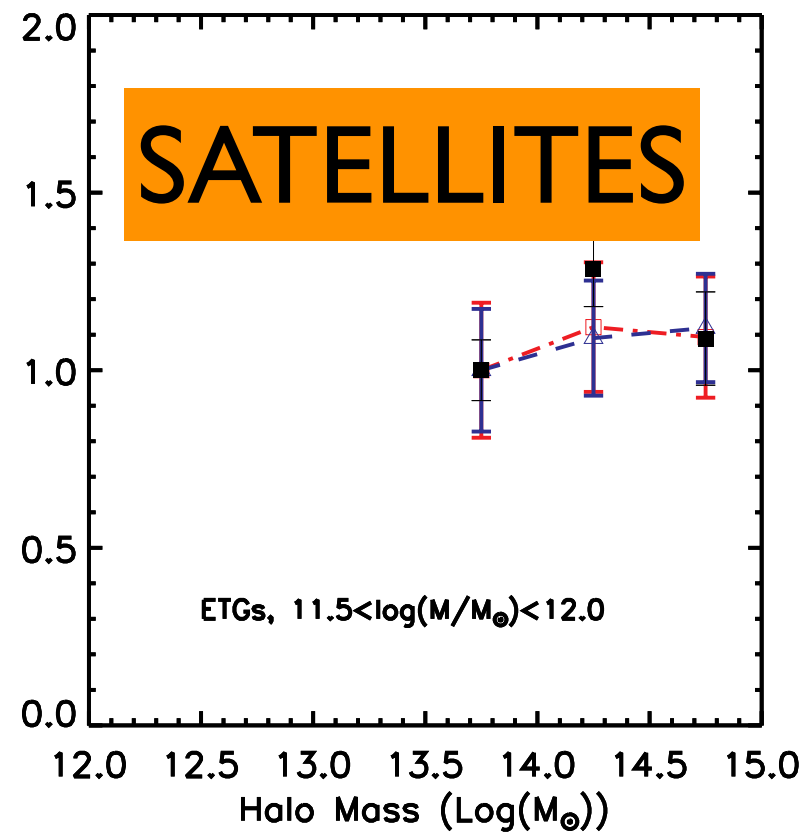
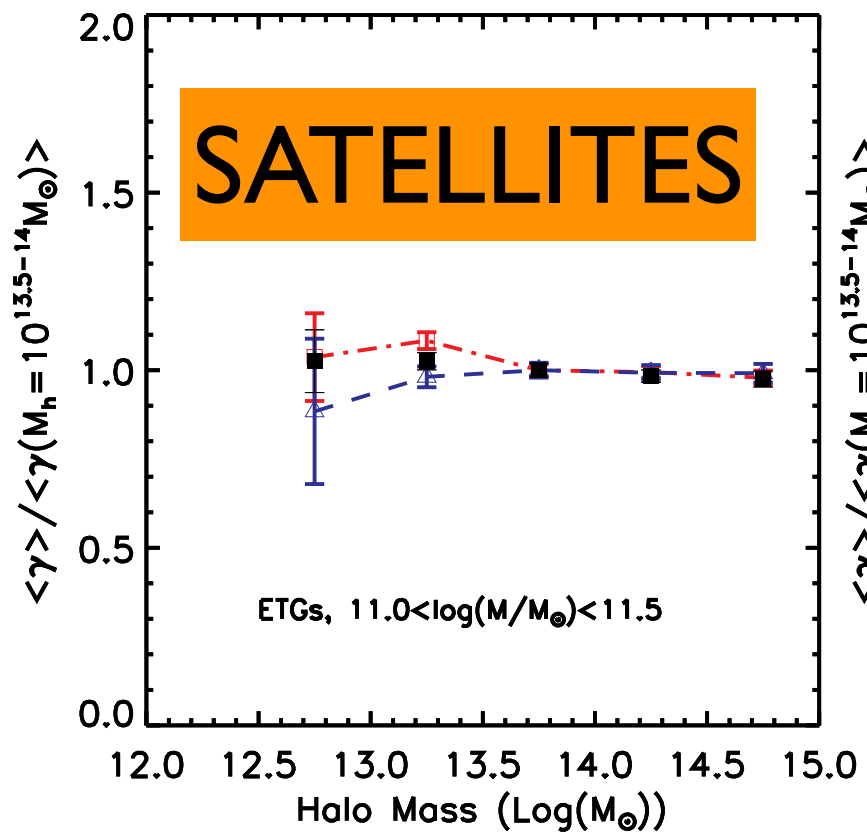
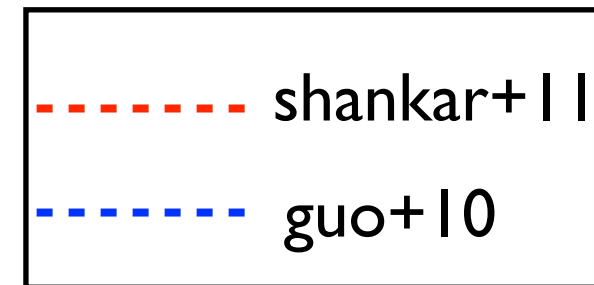
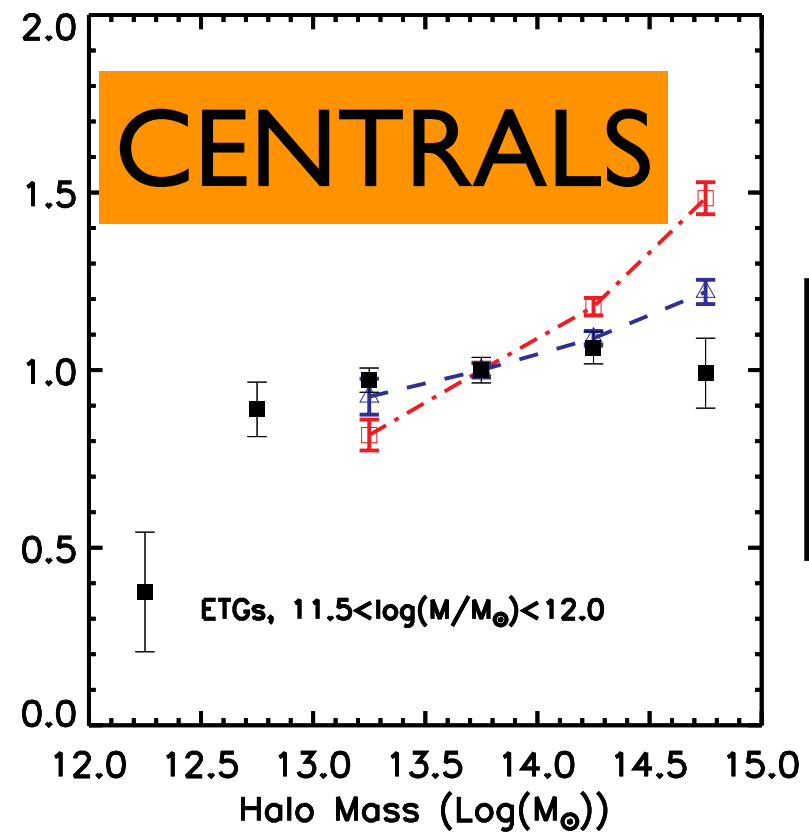
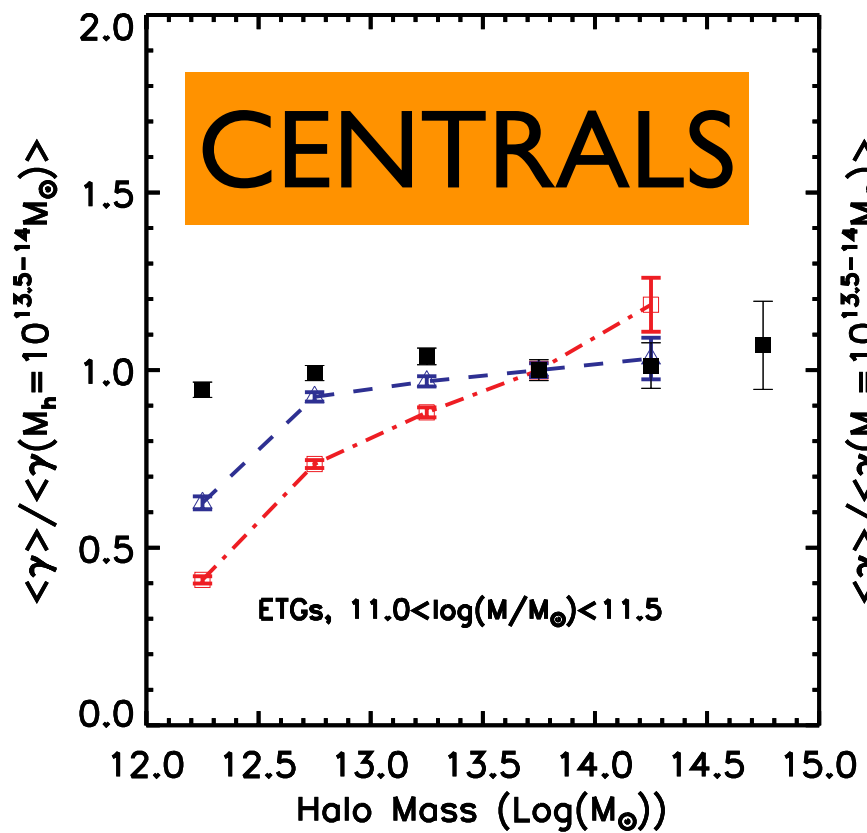
- Similar mass-size relation from the field to the cluster scale
- Satellites and centrals also follow similar mass-size relations



huertas-company+12b

- Similar mass-size relation from the field to the cluster scale
- Satellites and centrals also follow similar mass-size relations

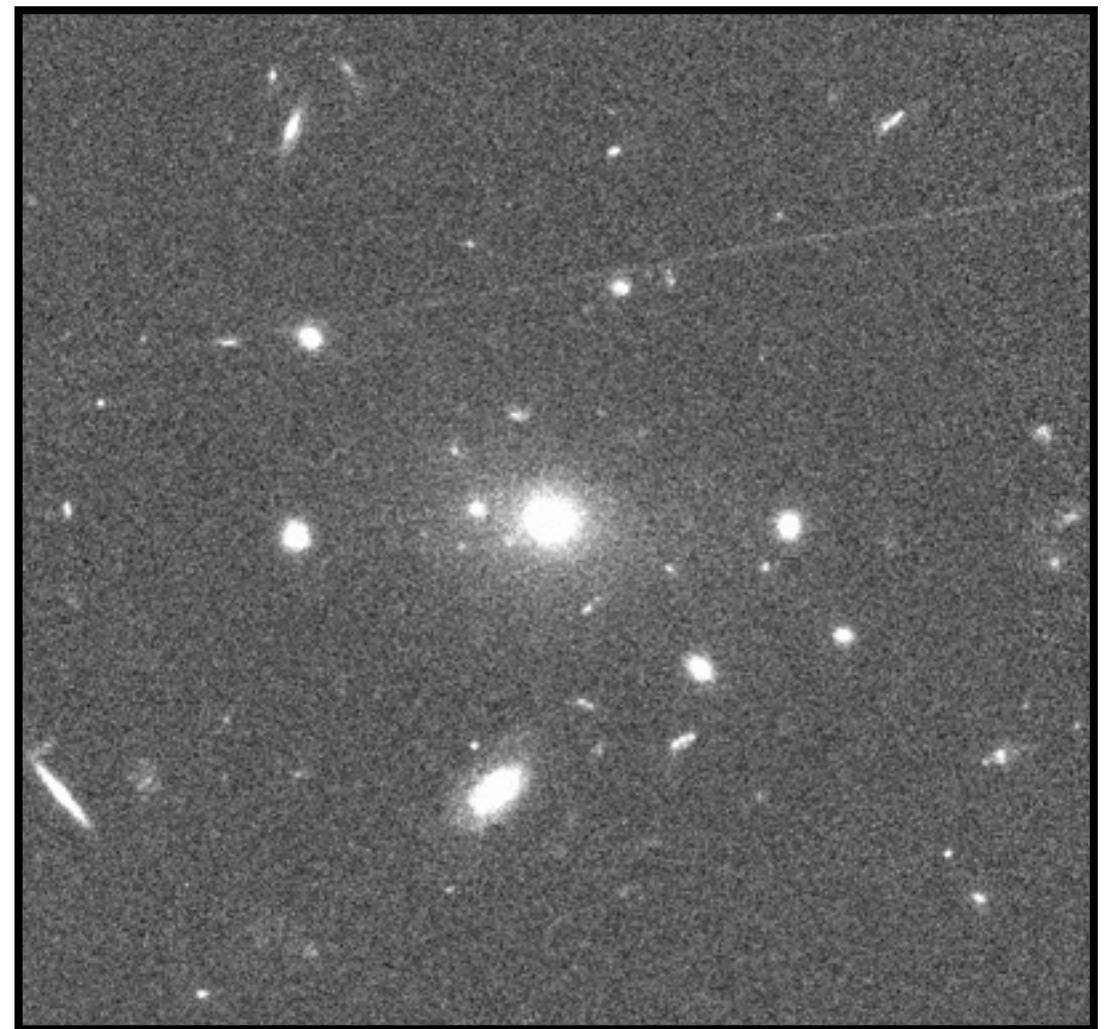






# At $z=0.2-1$

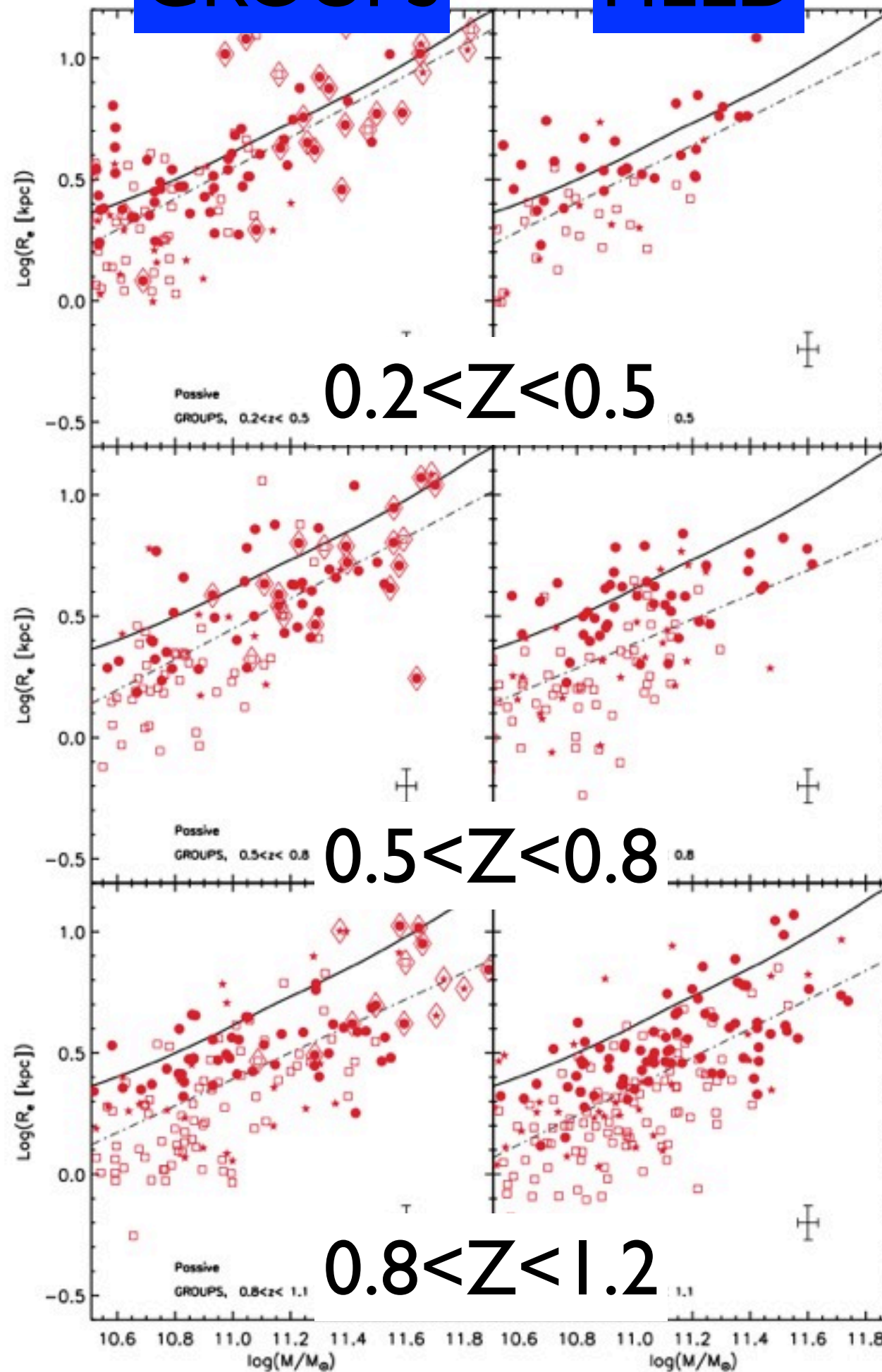
- 70 X-ray detected groups in COSMOS + WL mass (Finoguenov+2007, Leauthaud +2010)
- $0.2 < z < 1.0$
- 300 ETGs,  $M^* > 10^{10.5}$
- Field control sample from the COSMOS field

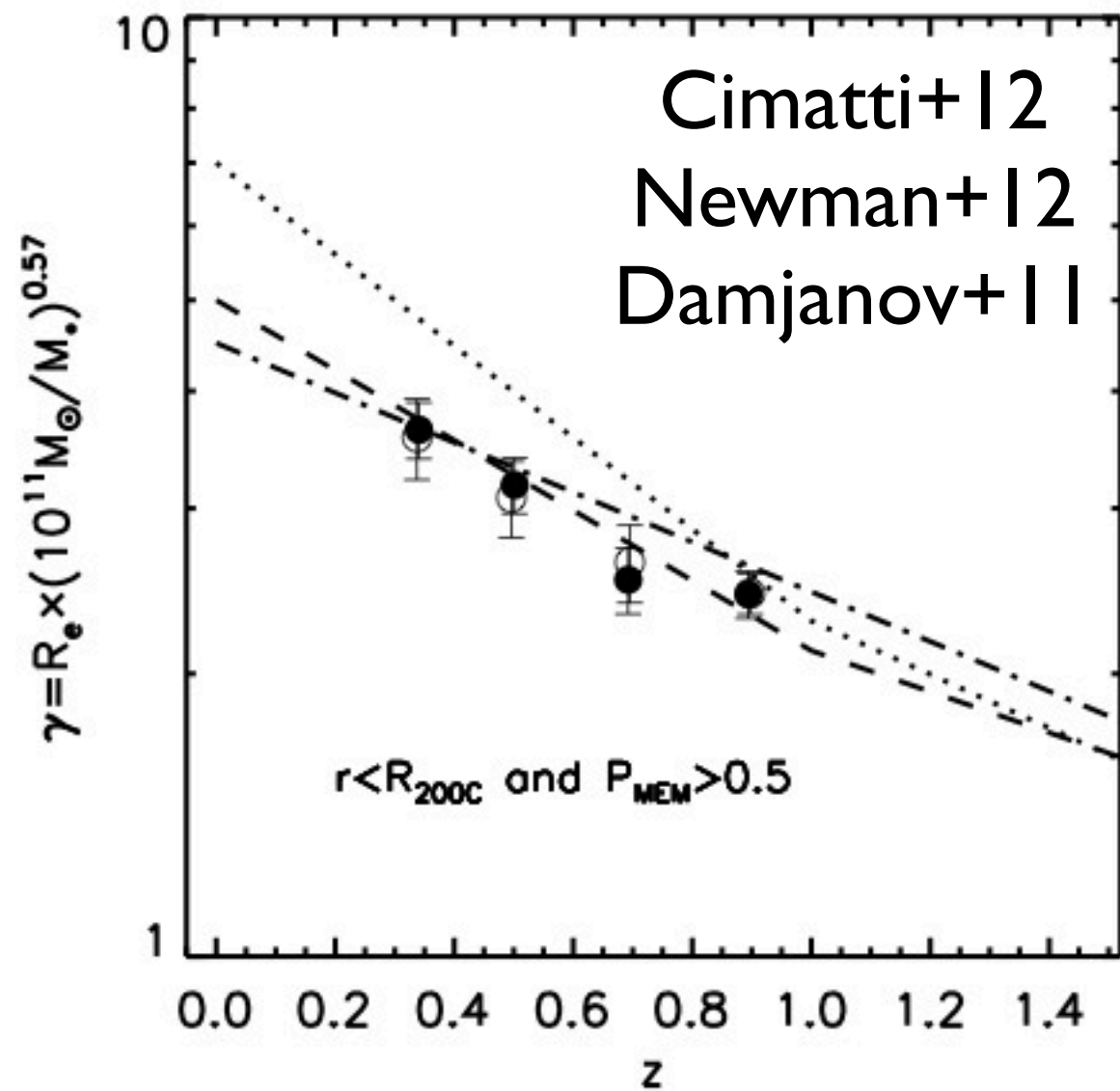


@ $z=0.67$   $\log(M_h/M_{\text{sol}})=13.6$

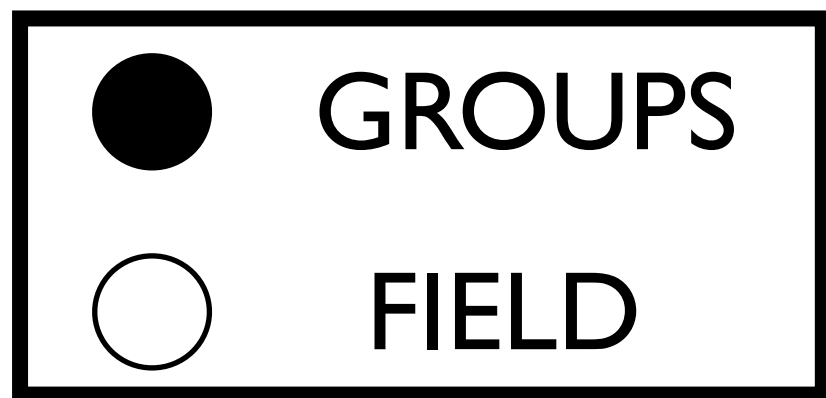
**GROUPS**

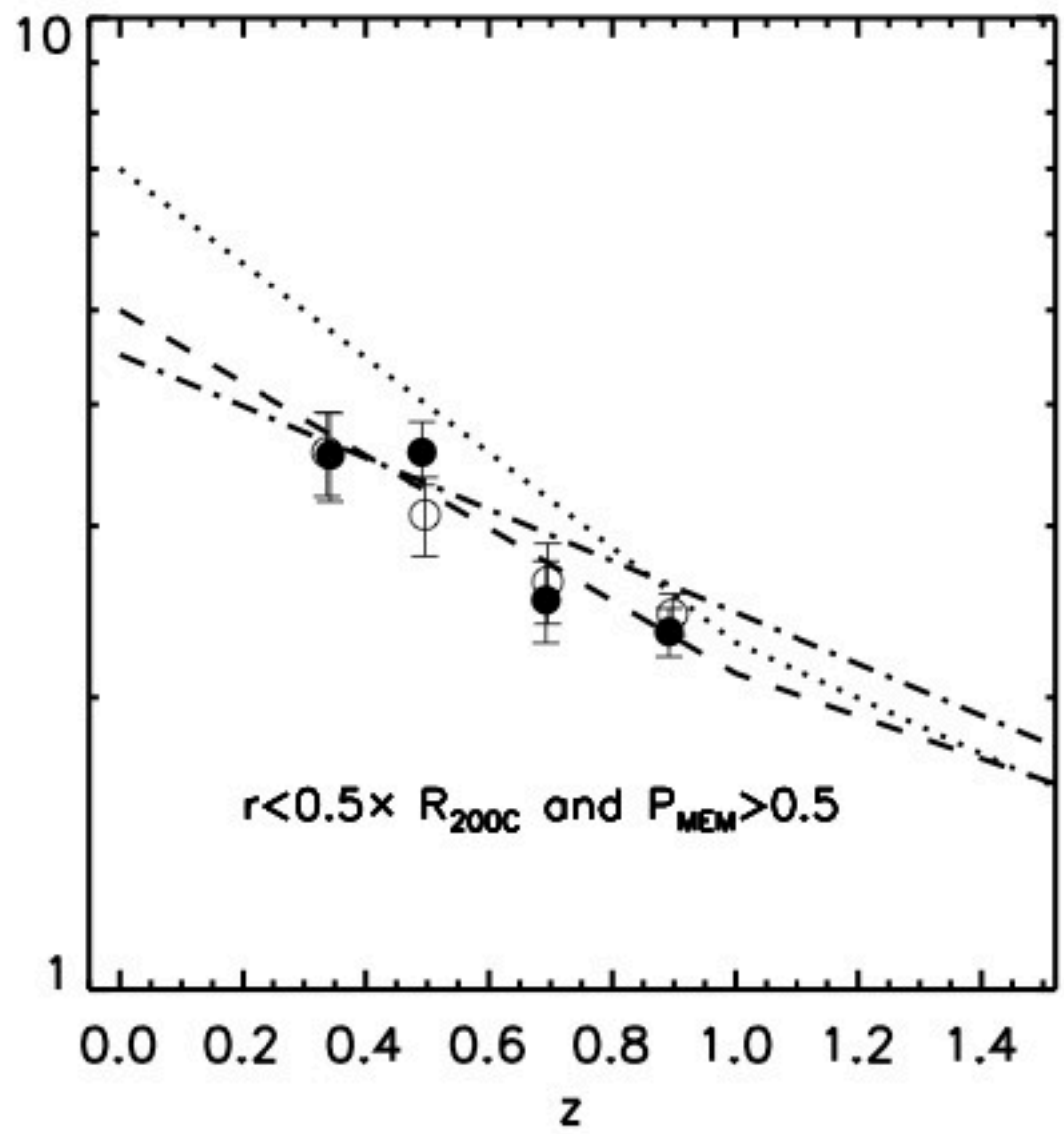
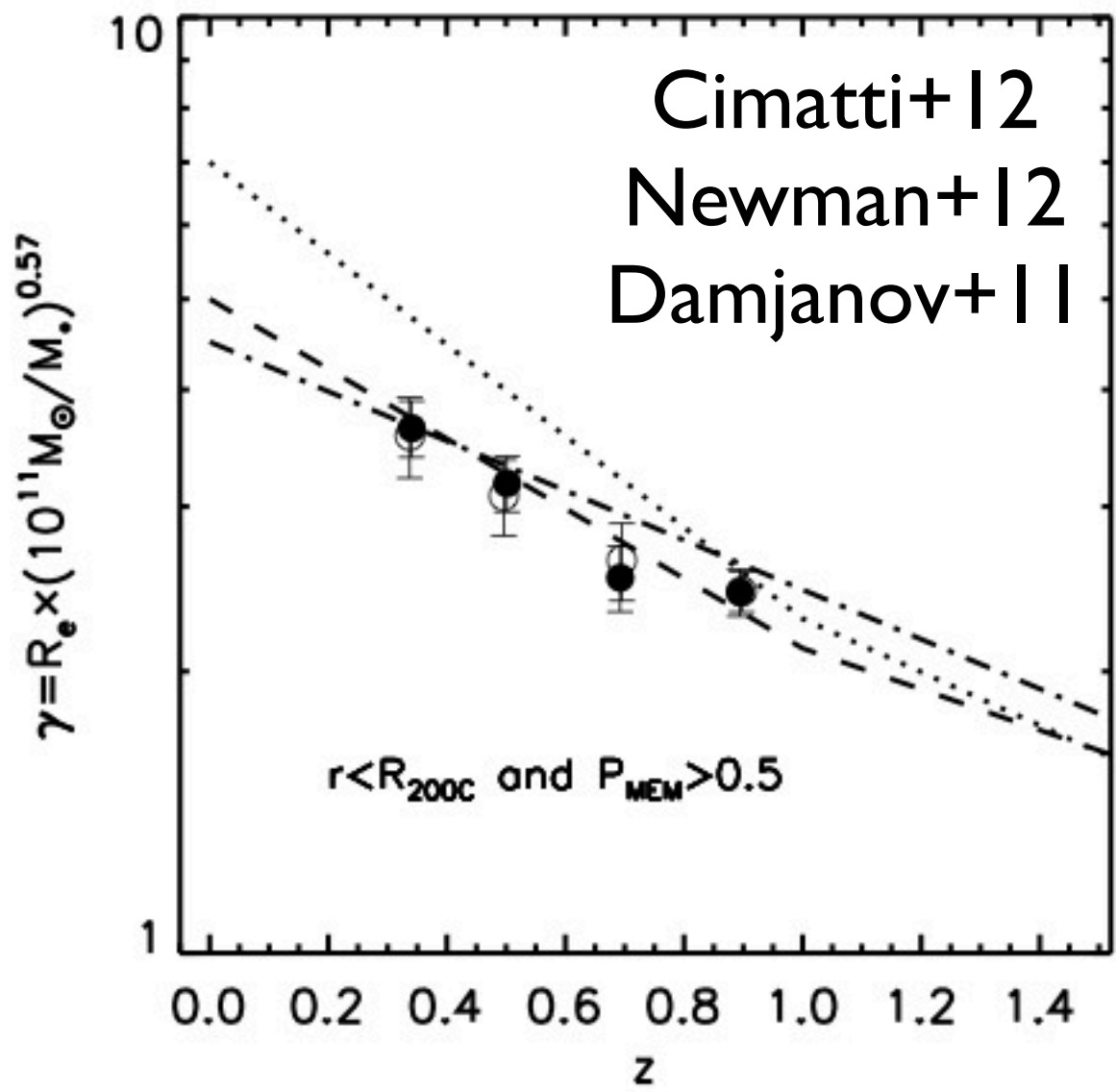
**FIELD**



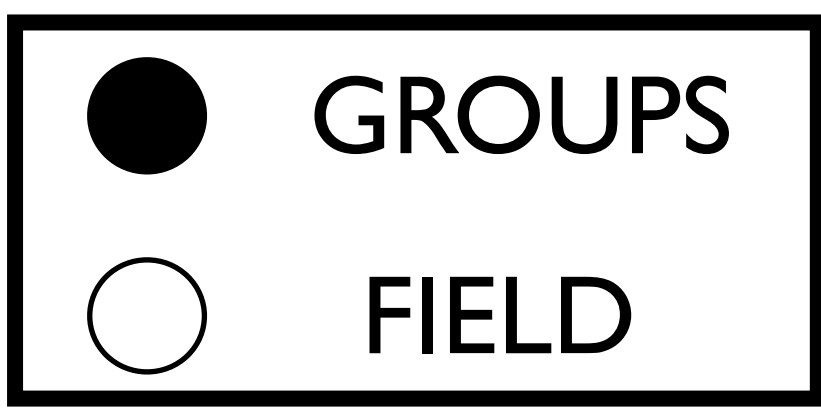


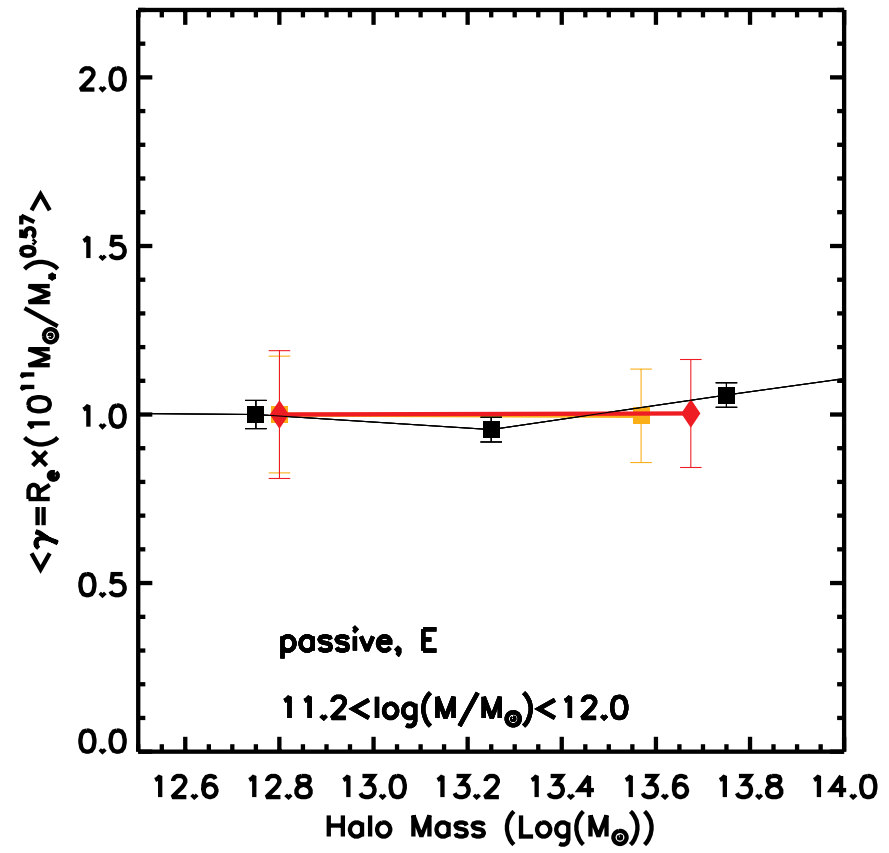
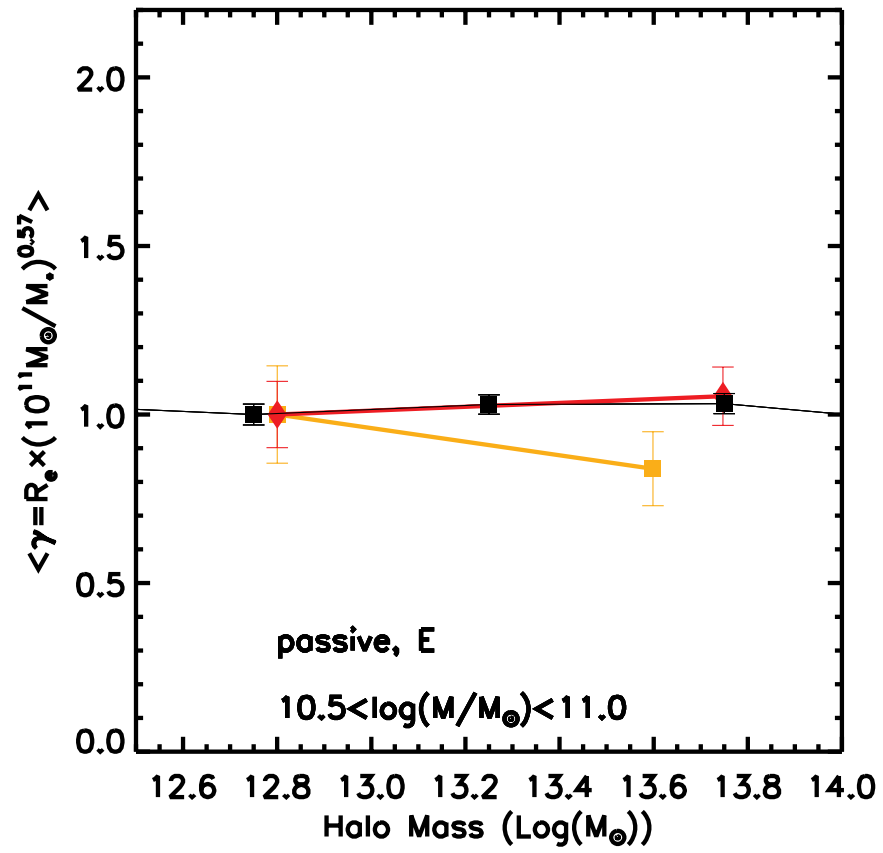
huertas-company+12a



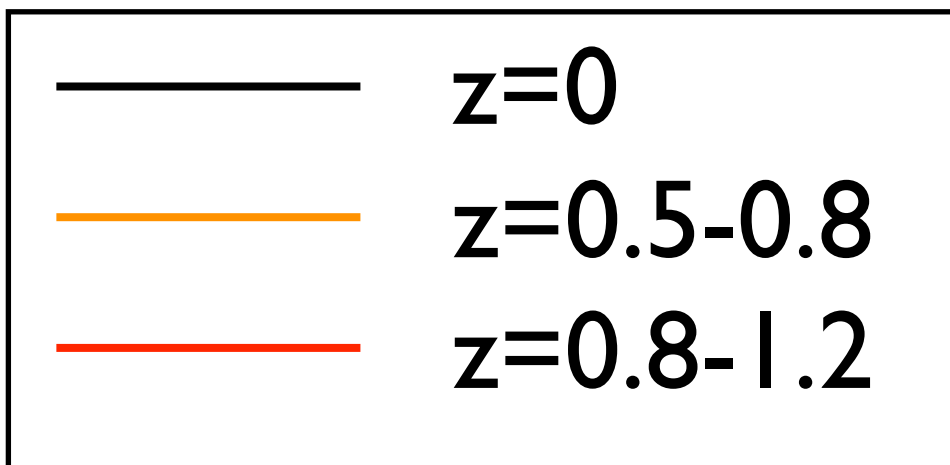


huertas-company+12a



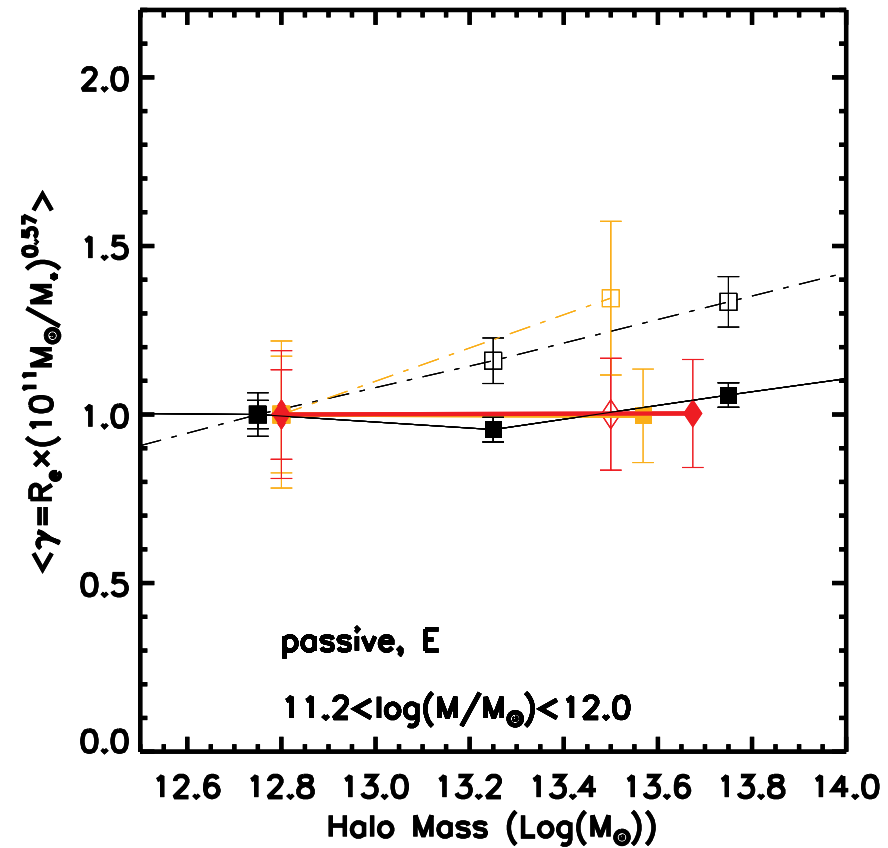
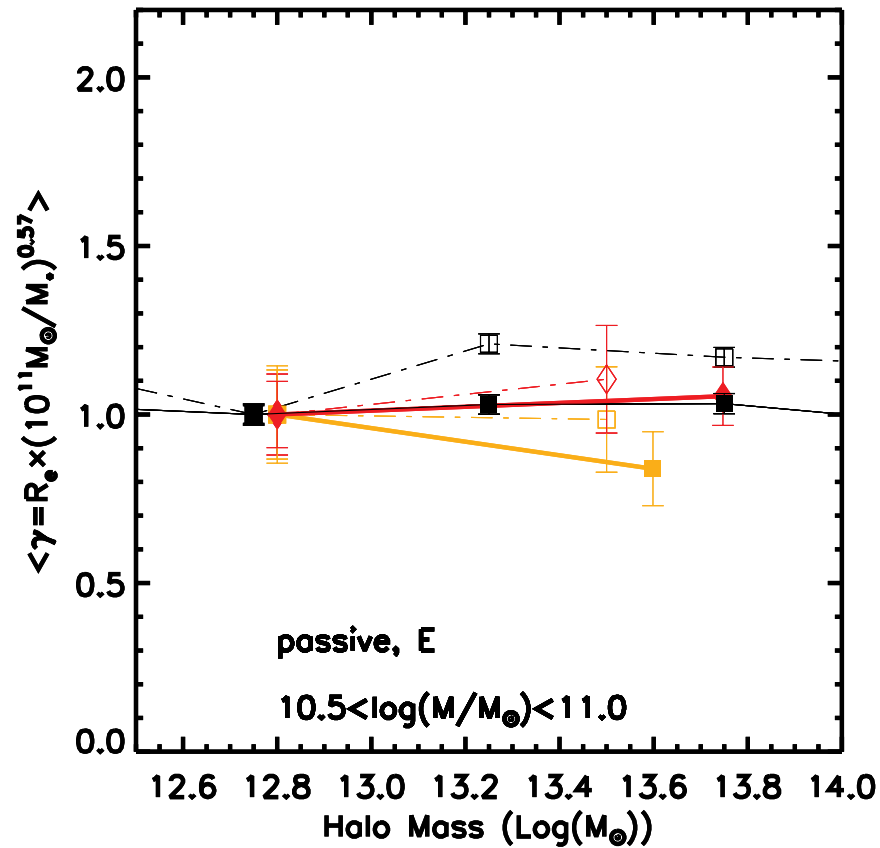


huertas-company+12

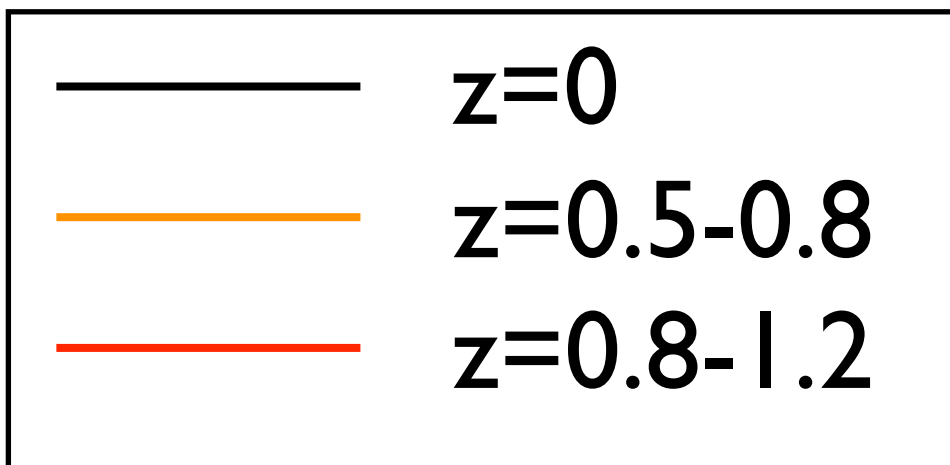




# hierarchical models tend to over predict the size dependence with halo mass of $M^* > 10^{11} M_\odot$ ETGs

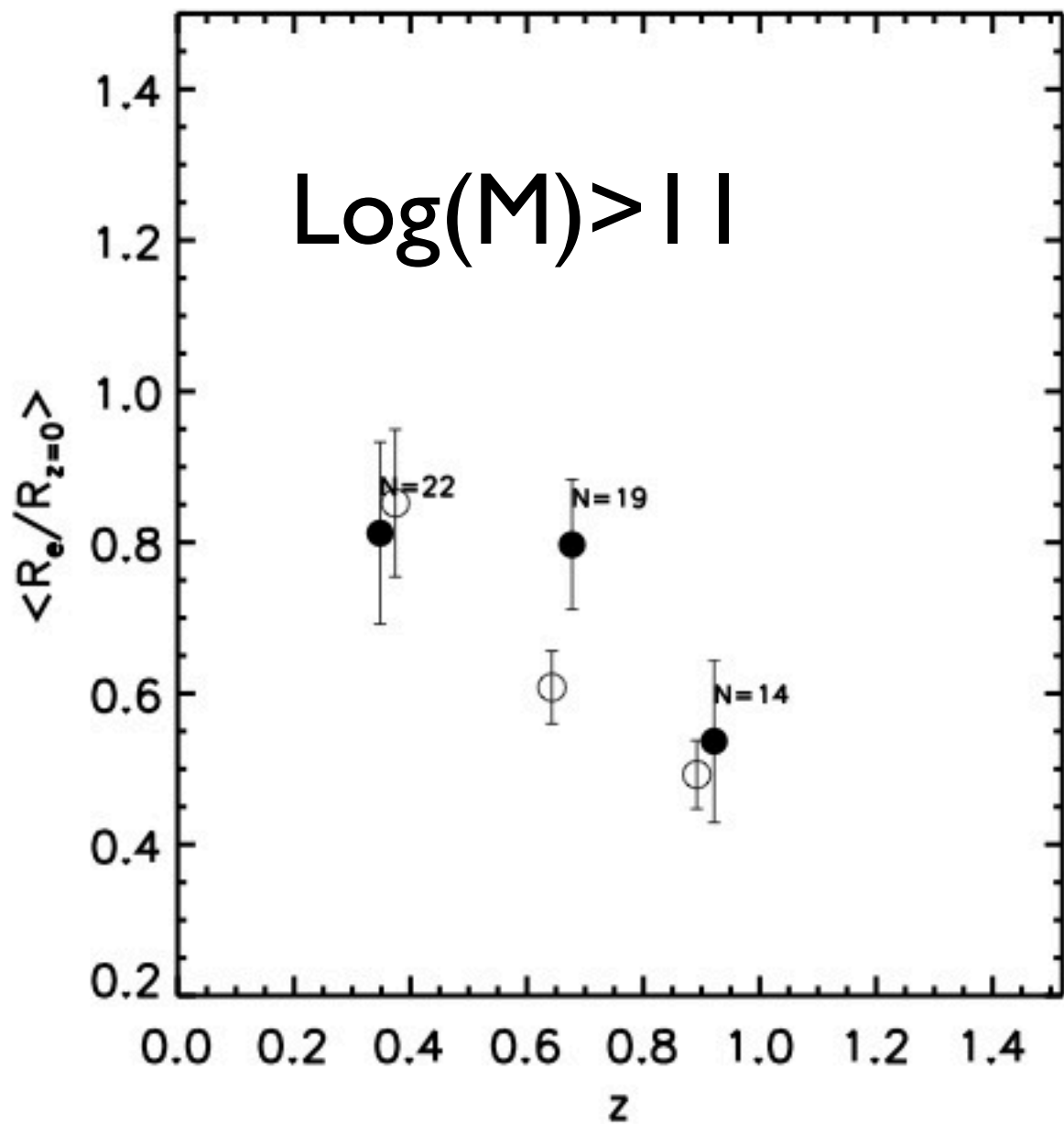


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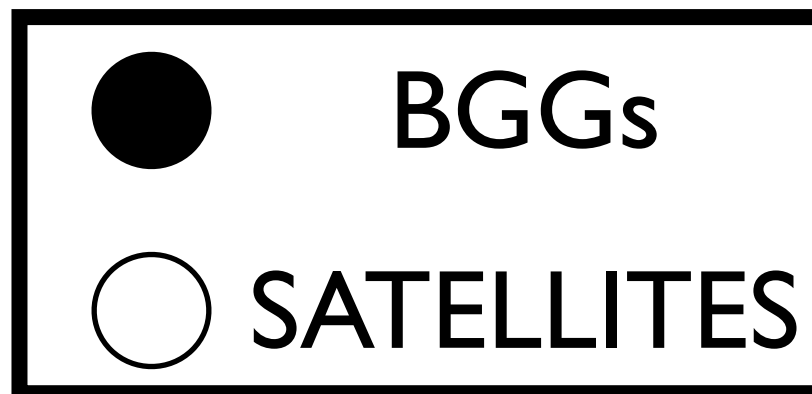


More objects needed...

# Satellites/Centrals



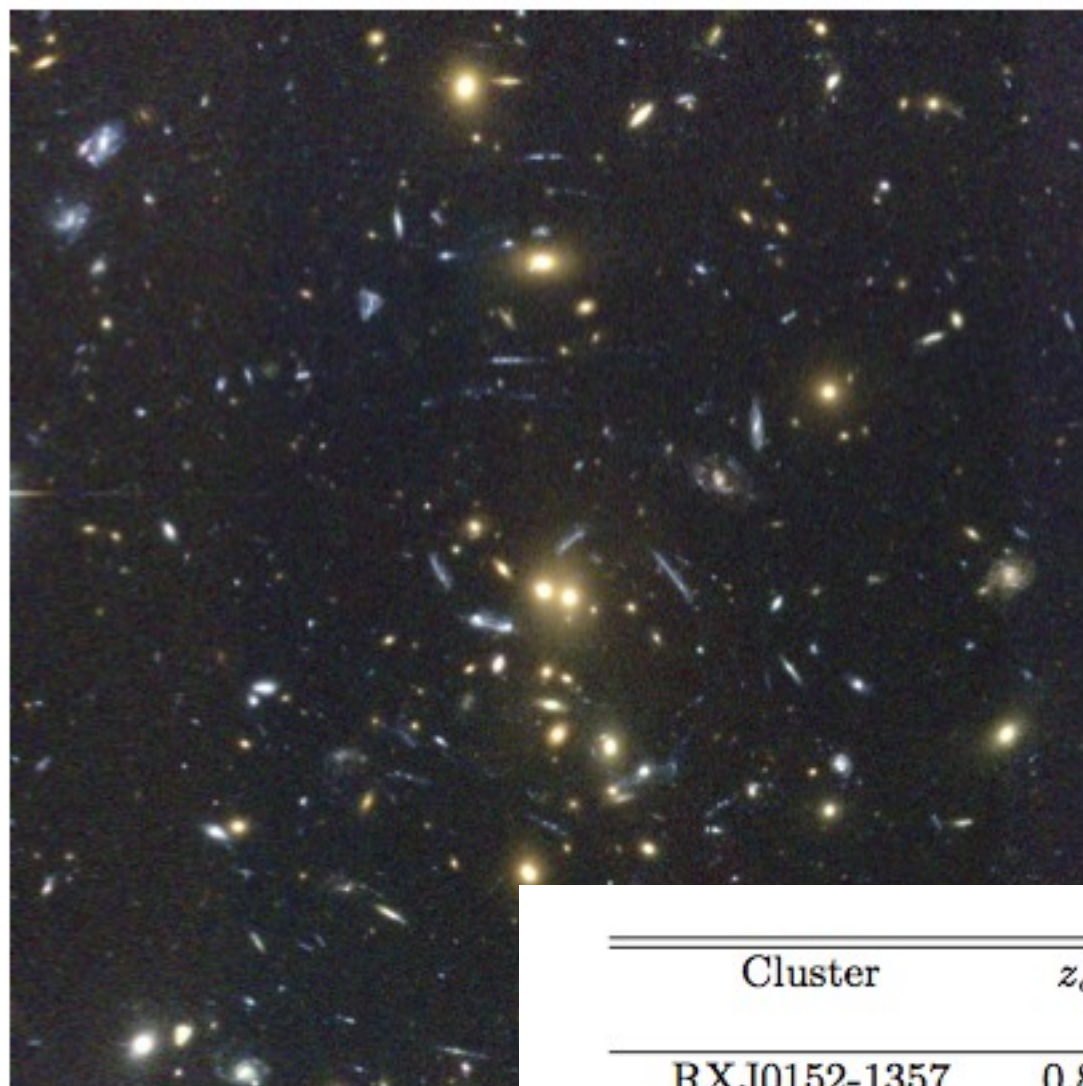
BGGs and satellites of same stellar mass grow in a similar way



At  $z > 0.8$

# HAWK-I cluster survey

(PI C.Lidman, hcs.obspm.fr)



**RX0152**

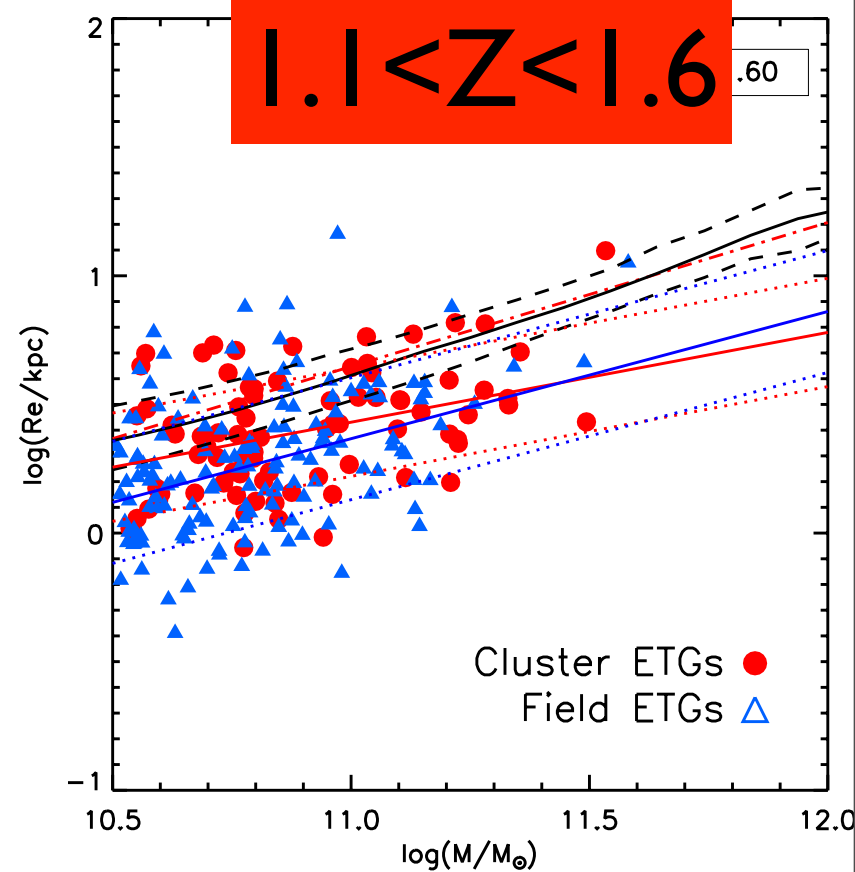
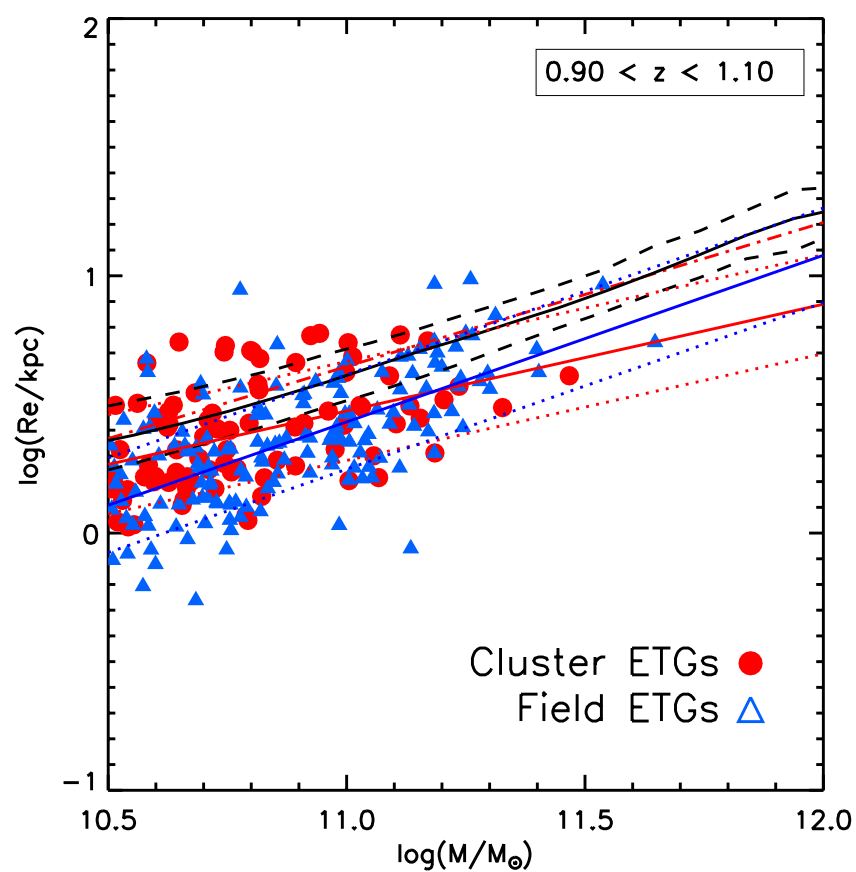
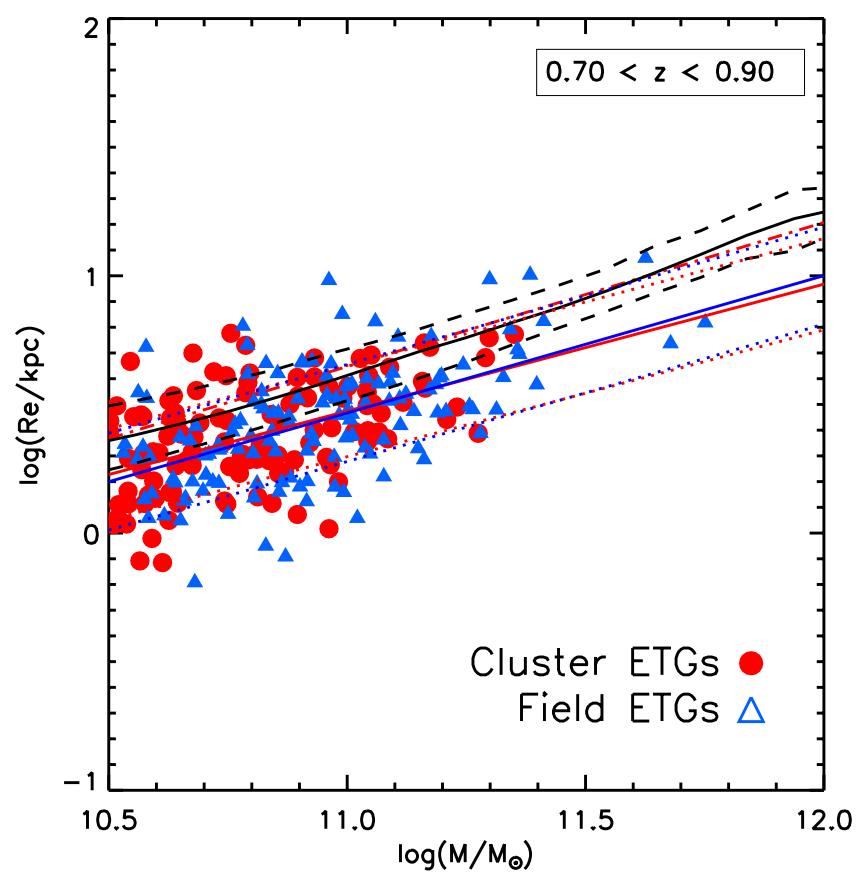
- 9 massive clusters between  $z=0.8$  and  $z=1.4$
- Full coverage in the optical (ACS) and IR (HAWK-I+ WFC3)
- Between 20 and 100 spec. confirmed members

Cluster	$z_{cl}$	$\sigma_{vel}$ (km/s)	$T$ (keV)	$M_{200}^X$ ( $10^{14} M_{\odot}$ )	$R_{200}$ (Mpc)	$M_{200}^L$ ( $10^{14} M_{\odot}$ )
RXJ0152-1357	0.84	$919 \pm 168$	$6.7 \pm 1.0$	$7.3^{+1.8}_{-1.7}$	$1.17^{+0.09}_{-0.06}$	$4.4^{+0.7}_{-0.5}$
RCS2319+0038	0.91	$990 \pm 240$	$6.2^{+0.9}_{-0.8}$	$5.4^{+1.2}_{-1.0}$	$1.22^{+0.15}_{-0.13}$	$5.8^{+2.3}_{-1.6}$
XMMJ1229+0151	0.98	$683 \pm 62$	$6.4^{+0.7}_{-0.6}$	$5.7^{+1.0}_{-0.8}$	$1.12^{+0.11}_{-0.10}$	$5.3^{+1.7}_{-1.2}$
RCS0220-0333	1.03	...	...	...	$1.09^{+0.12}_{-0.11}$	$4.8^{+1.8}_{-1.3}$
RCS2345-3633	1.04	$670 \pm 190$	...	...	$0.87^{+0.11}_{-0.10}$	$2.4^{+1.1}_{-0.7}$
XMMJ0223-0436	1.22	$799 \pm 129$	$3.8^{+1.9}_{-1.9}$	$2.4^{+1.5}_{-1.5}$	$1.18^{+0.12}_{-0.11}$	$7.4^{+2.5}_{-1.8}$
RDCSJ1252-2927	1.23	$747^{+74}_{-84}$	$7.6 \pm 1.2$	$4.4^{+1.1}_{-1.0}$	$1.14^{+0.06}_{-0.06}$	$6.8^{+1.2}_{-1.0}$
XMMU2235-2557	1.39	$802^{+77}_{-48}$	$8.6^{+1.3}_{-1.2}$	$6.1^{+1.4}_{-1.2}$	$1.13^{+0.08}_{-0.07}$	$7.3^{+1.7}_{-1.4}$
XMMJ2215-1738	1.45	$720 \pm 110$	$4.1^{+0.6}_{-0.9}$	$2.0^{+0.5}_{-0.6}$	$0.9^{+0.17}_{-0.14}$	$4.3^{+3.0}_{-1.7}$

# Field comparison sample:

redshift bin	HCS		COSMOS		GOODS-S		CANDELS	
	#ETGs	# $n > 2.5$	#ETG	# $n > 2.5$	#ETG	$n > 2.5$	#ETG	$n > 2.5$
[0.7, 0.9]	14	14	122	110	...	...	42	34
[0.9, 1.1]	15	11	98	85	...	...	68	61
[1.1, 1.6]	22	21	40	39	24	21	115	81

**Table 6.** Final sample of field galaxies with HCS and COSMOS data. Here, RS means galaxies on the red sequence with  $M > 10^{10} M_{\odot}$ .



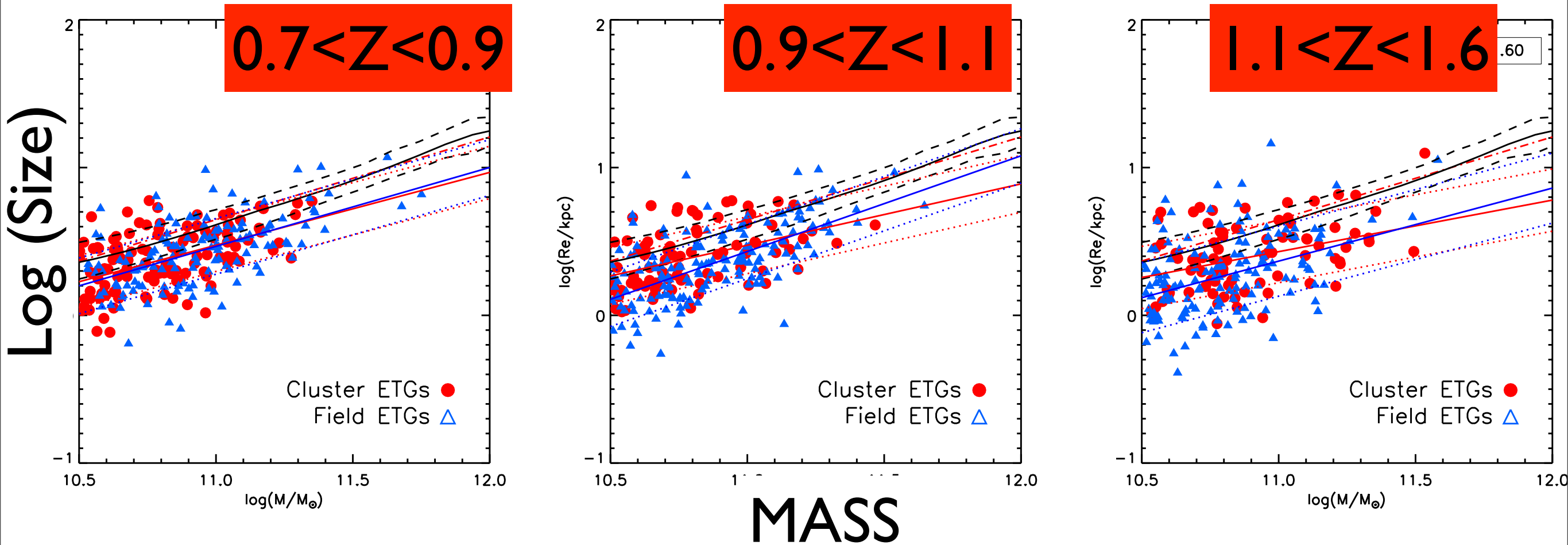
Delaye+12 (in prep)



# Field comparison sample:

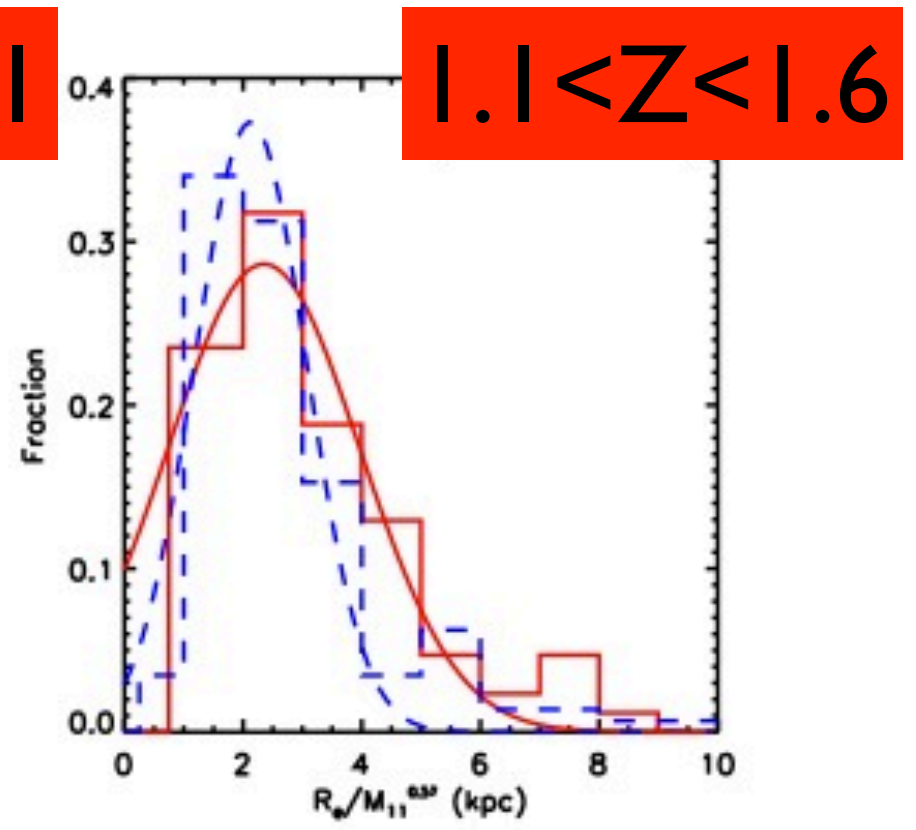
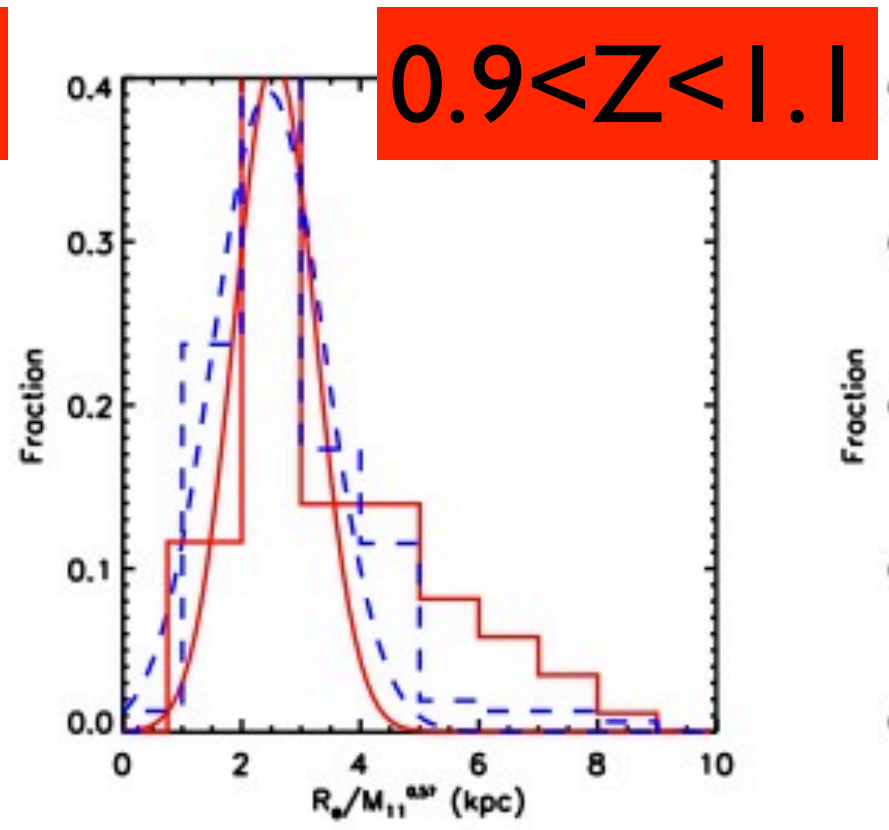
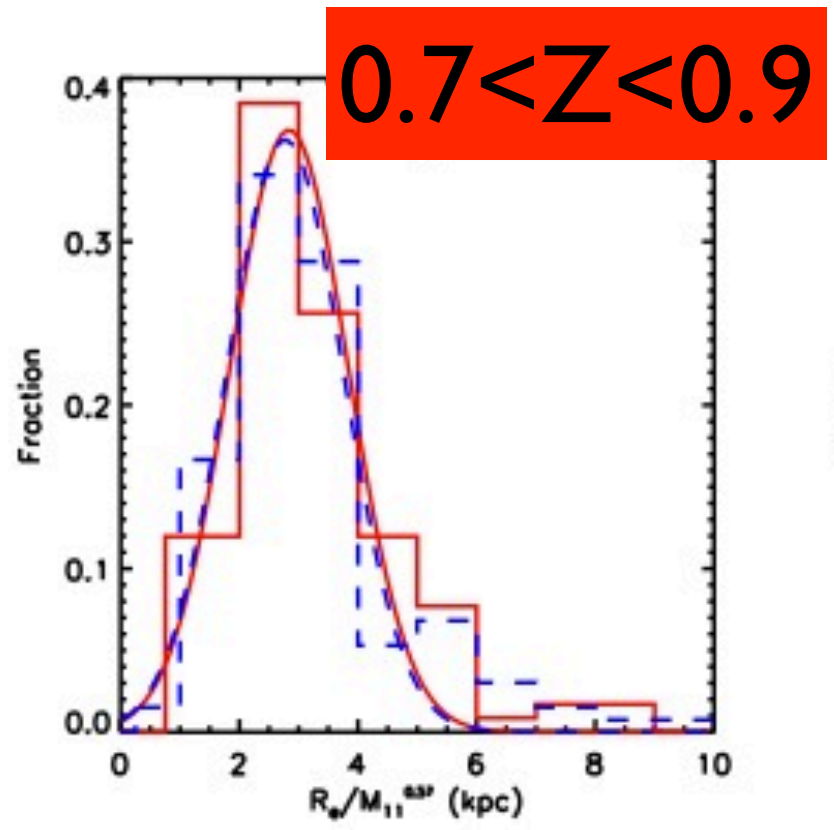
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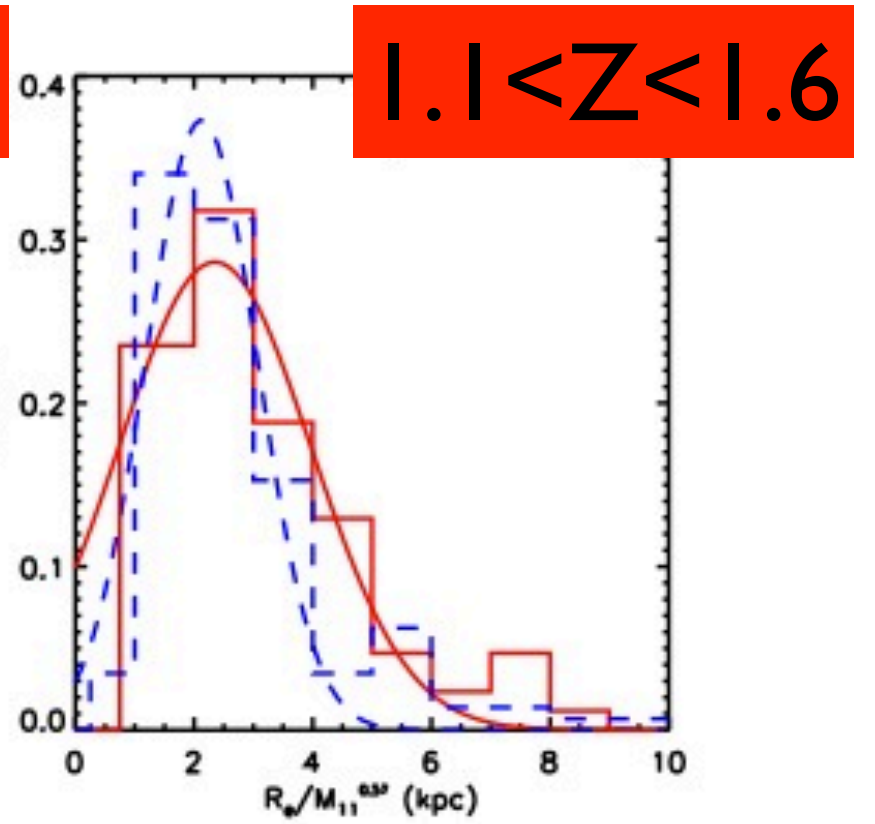
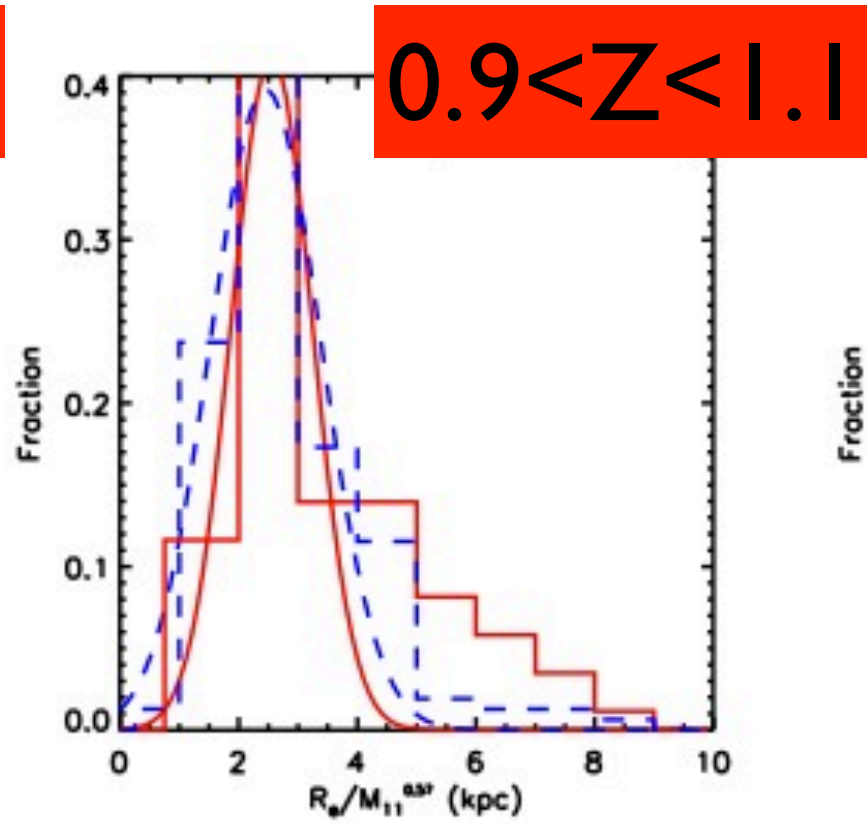
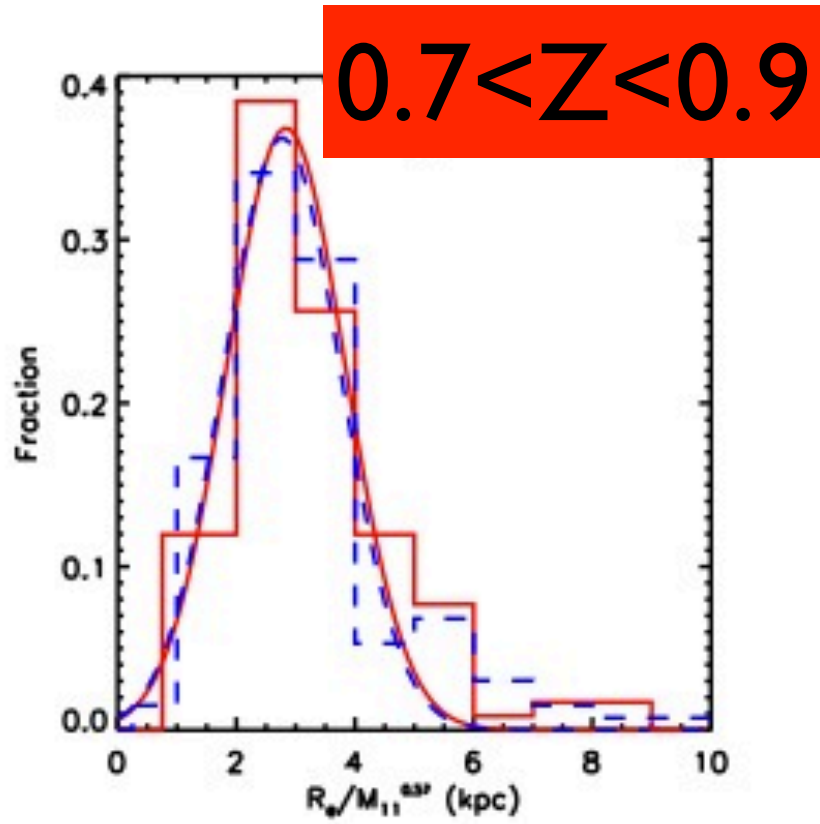




Delaye+12 (in prep)

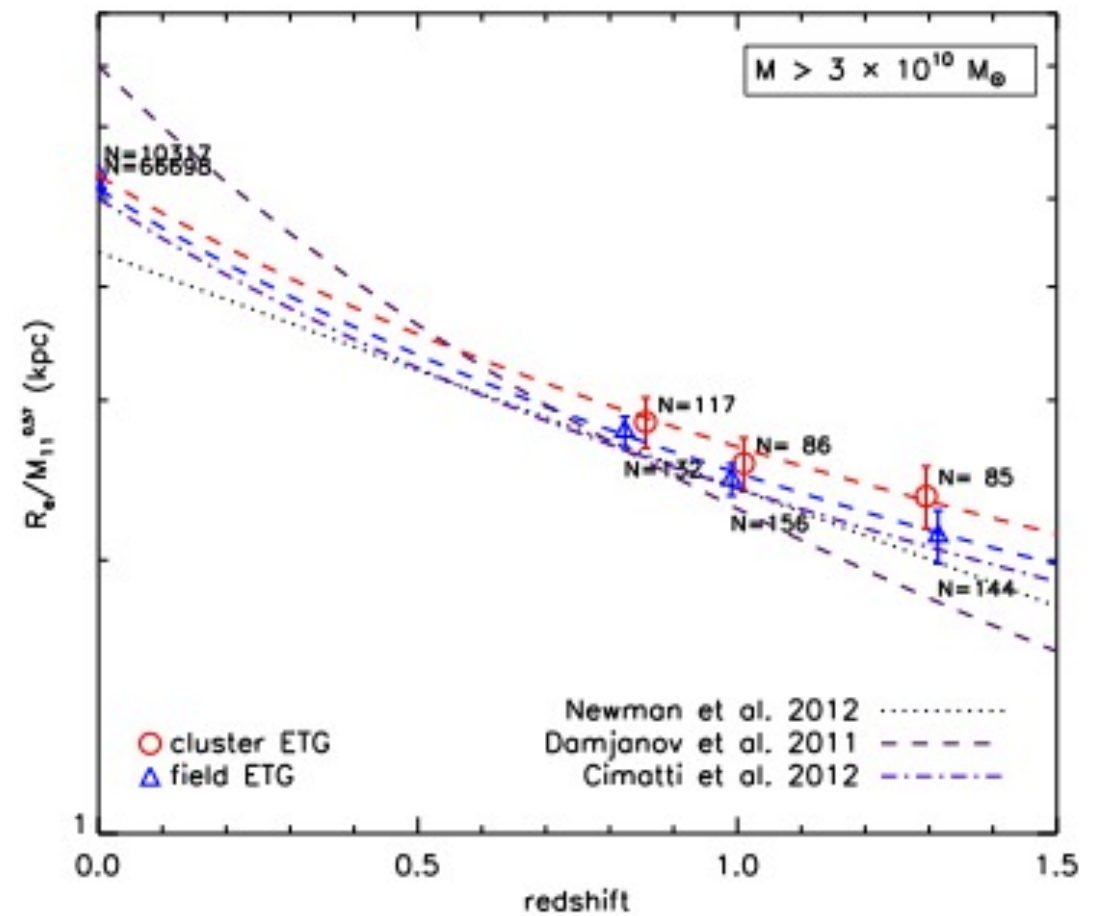




— cluster  
— field

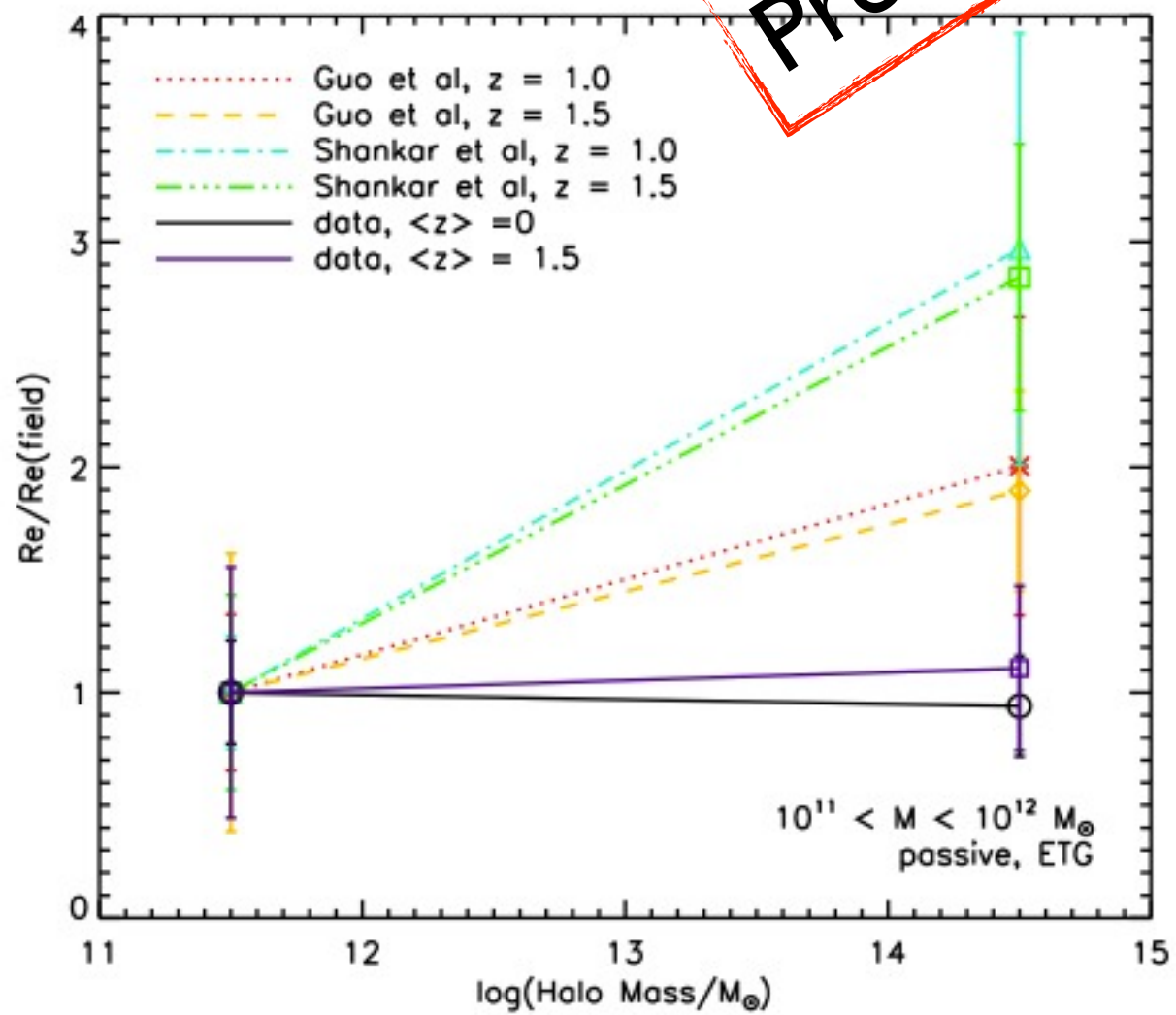


 cluster  
 field



Delgado-García et al. (in prep)

Preliminary!



Delayer+12 (in prep)

# Summary

- Do we see environmental effects in the mass-size relation (and size growth) of ETGs in the last 10Gyrs?
  - *NO, very weak correlation between sizes of massive ETGs and large scale environment from  $z \sim 1.6$  from the group to the cluster scale*
- *How does it compare to model predictions?*
  - *Models tend to over estimate the sizes of ETGs in big haloes*
- Test of the merger driven growth?
  - *Weak signal, big uncertainties ... still need to understand how observational uncertainties are taken into account in the models*