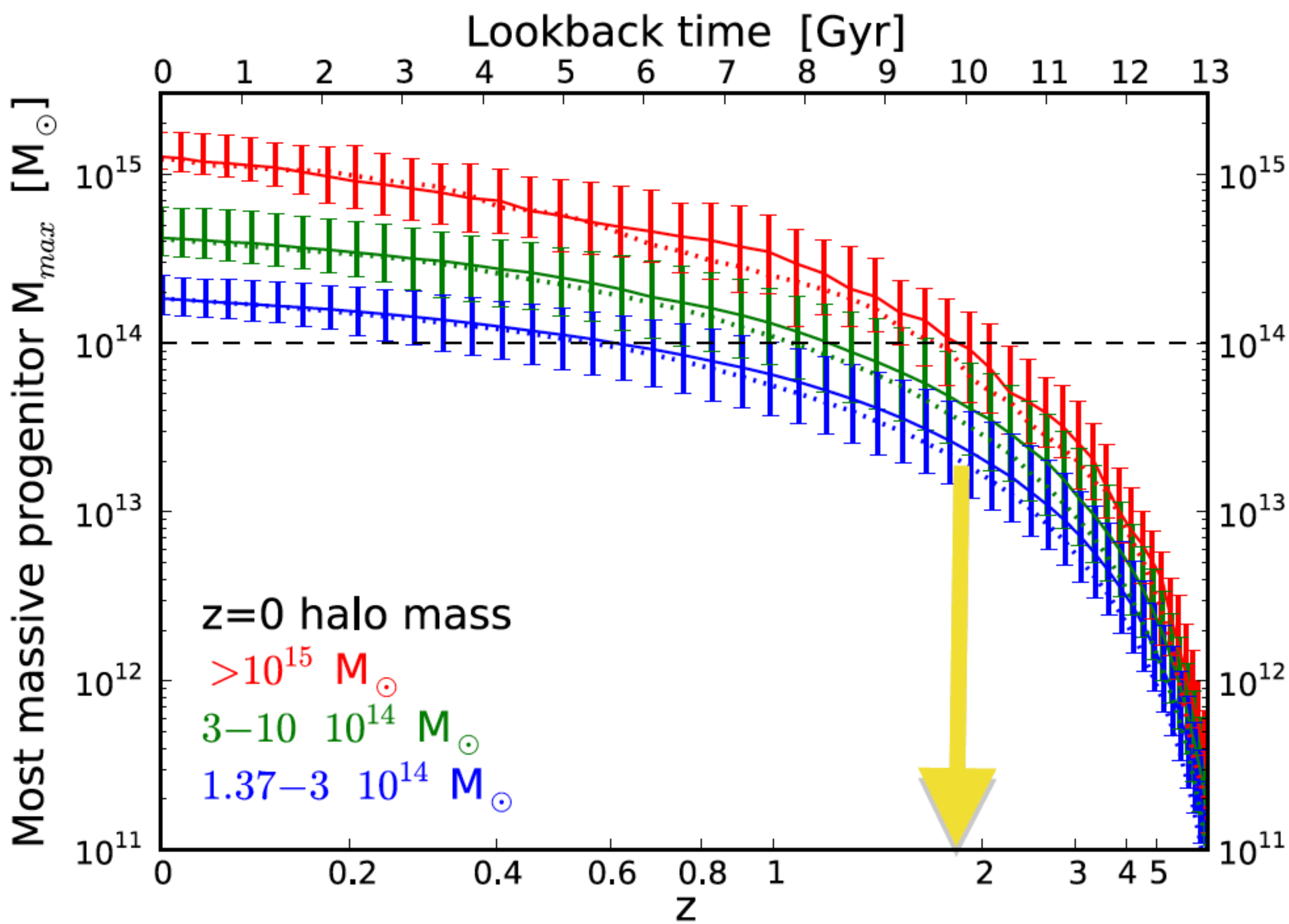
The progenitors of ETGs in clusters and proto-clusters at z~2

Simona Mei - GEPI - Observatory of Paris - University of Paris D. Diderot

Where and what are the progenitors of red/passive massive ETGs in local clusters?



Chiang et al. 2013

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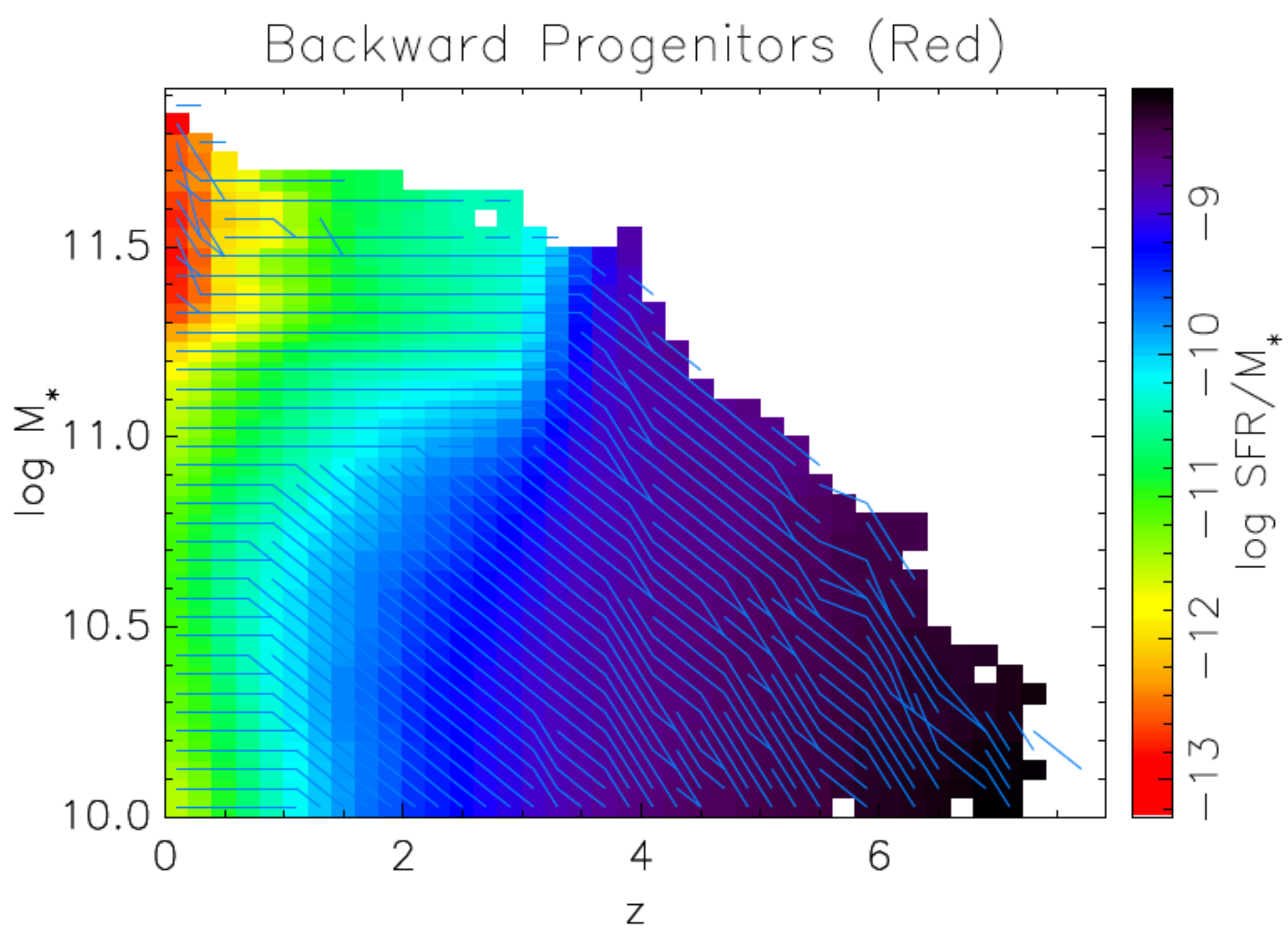
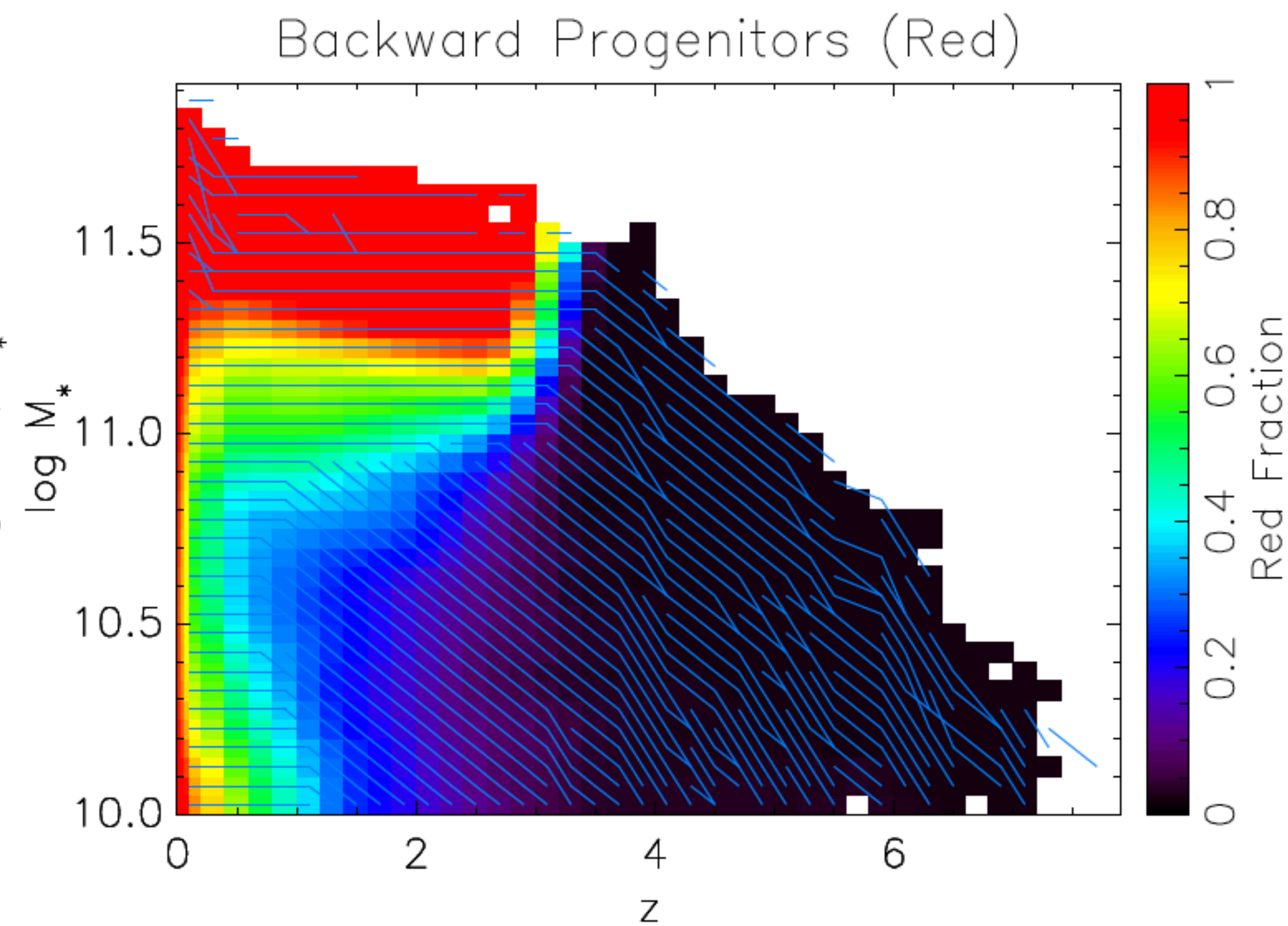
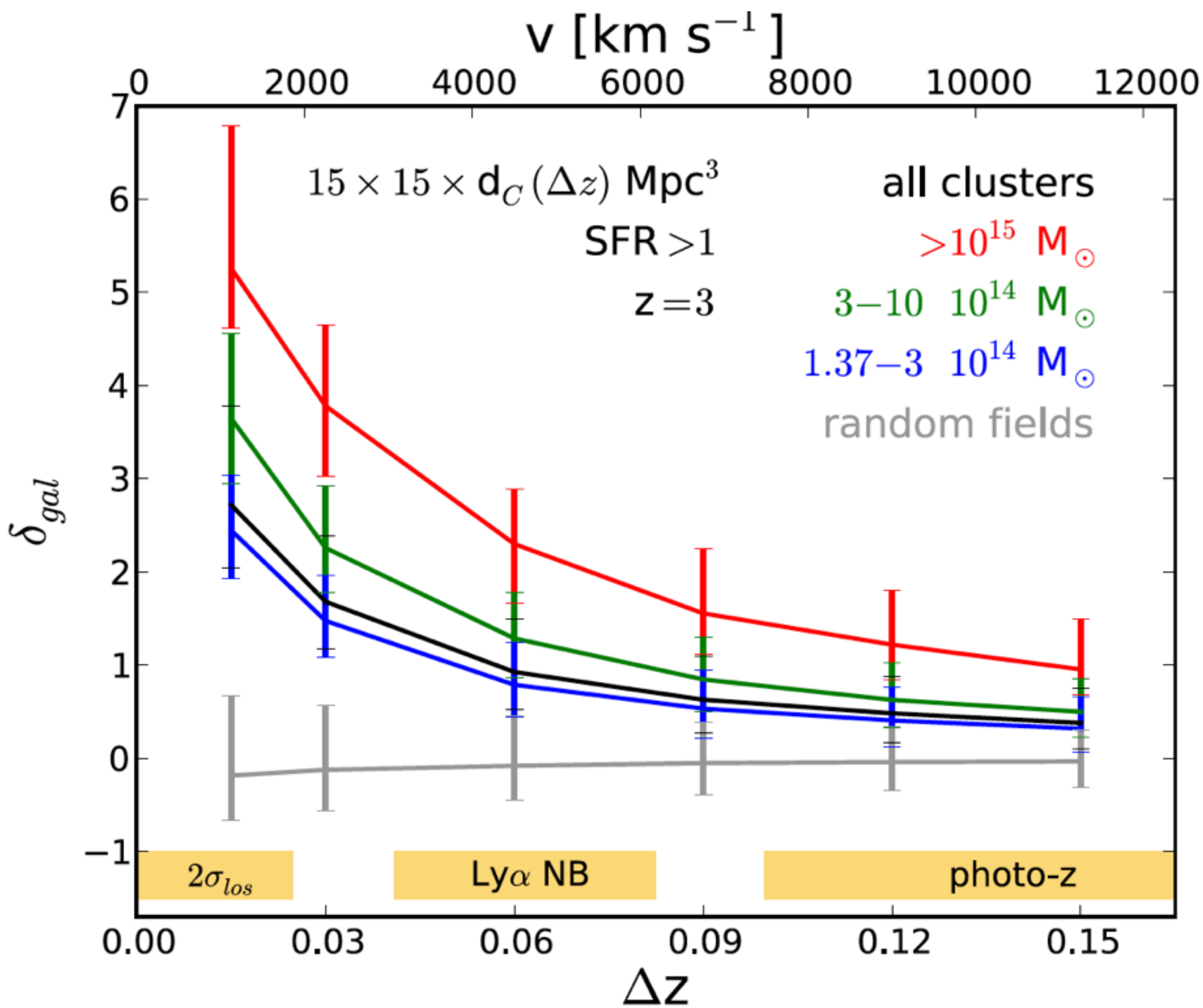




Cattaneo et al. 2013

How to detect cluster progenitors at high redshifts?



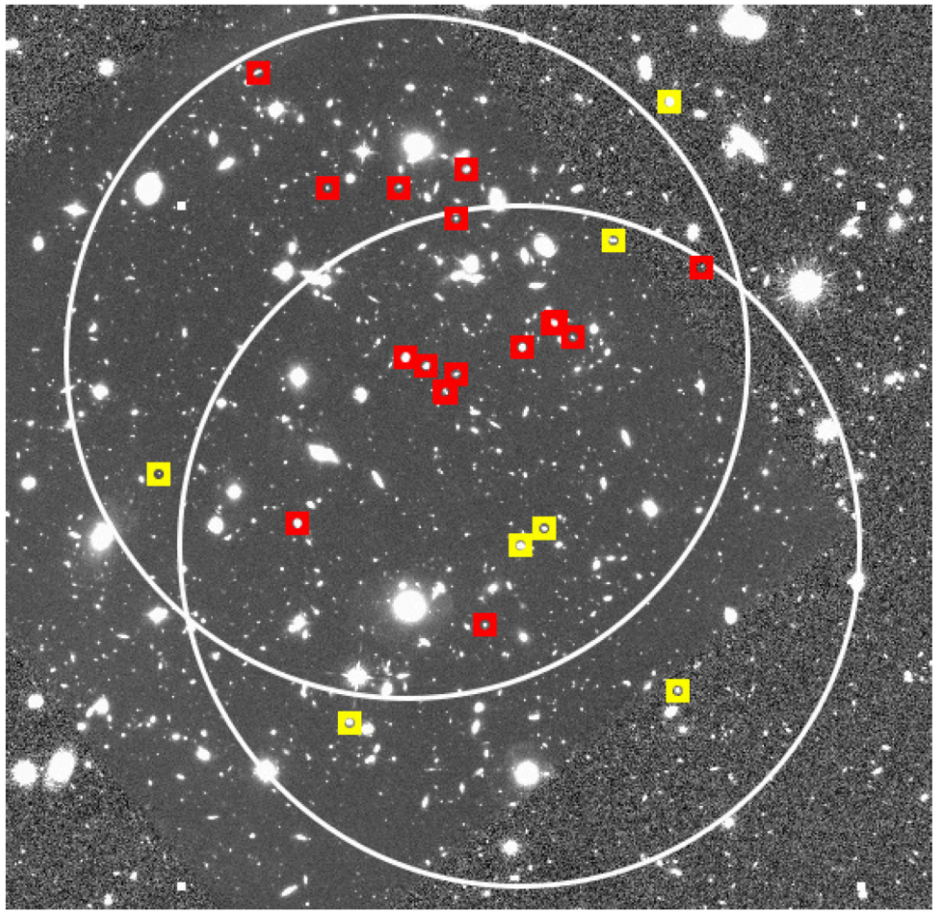
Chiang et al. 2013

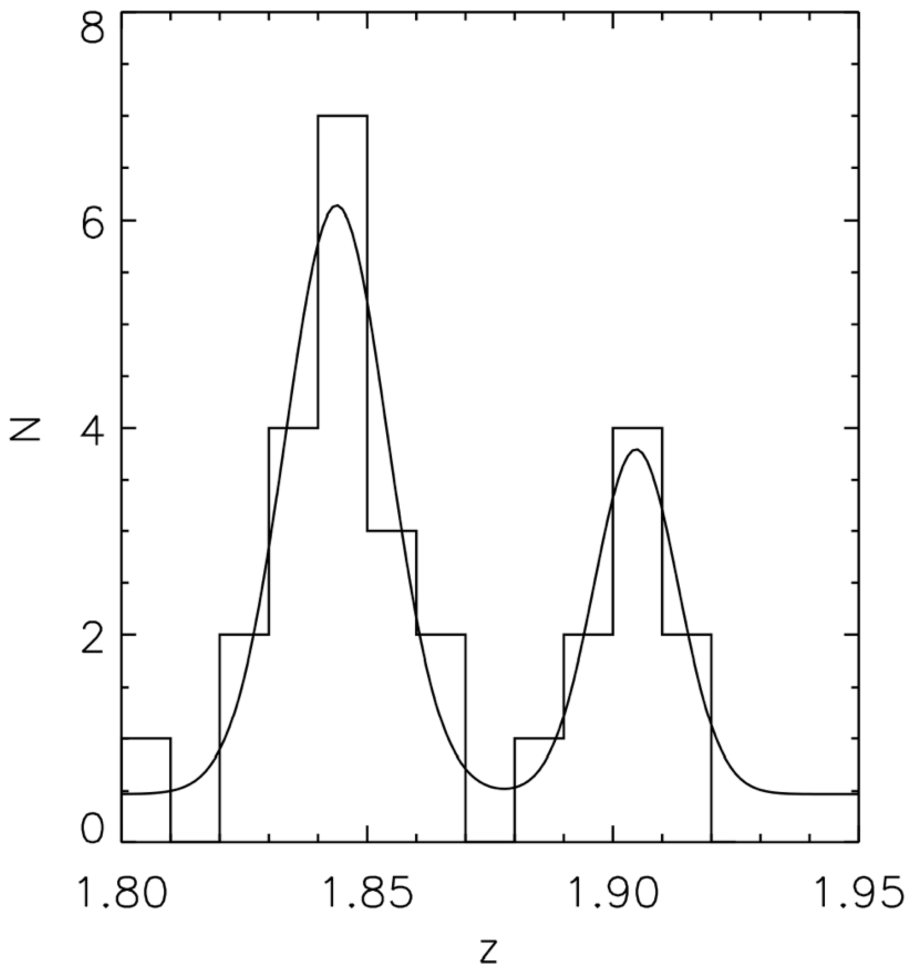
Star forming blue ETGs in a proto-cluster and a group at z=1.84 and 1.9

Mei et al. 2015, ApJ, in press; arXiv:1403.7524

Star–forming blue ETGs in two newly discovered galaxy overdensities in the HUDF at z=1.84 and 1.9: unveiling the progenitors of passive ETGs in cluster cores

Simona Mei[1,2,3], Claudia Scarlata[4], Laura Pentericci[5], Jeffrey A. Newman[6], Benjamin J. Weiner[6], Matthew L. N. Ashby[6], Marco Castellano[5], Chistopher J. Conselice[7], Steven L. Filkelstein[9] , Audrey Galametz [5], Norman A. Grogin[8], Anton M. Koekemoer[8], Marc Huertas–Company[1,2], Caterina Lani[7], Ray A. Lucas[8], Casey Papovich[11], Marc Rafelski[3] , Harry I. Tepliz[3]



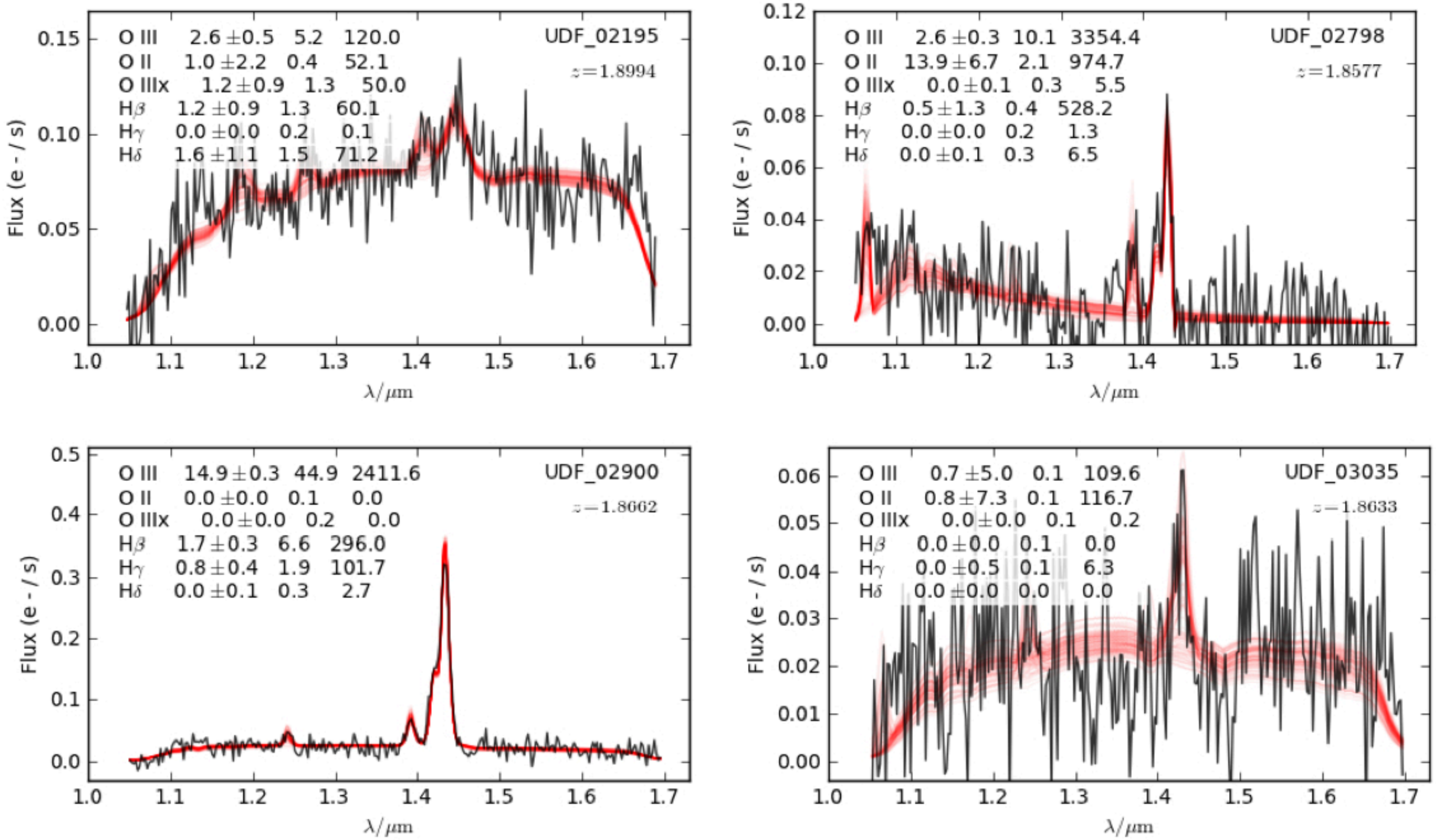


Clusters and proto-clusters at z~1.6-2

Name	Identification	z	Overdensity	σ_{disp} (km/s)	Mass ($10^{14} \times M_{\odot}$)	X–ray Lum./Detection (10^{43} erg s^{-1})	Reference
CL J033211.67-274633.8	Group	1.61	$\sim 5\sigma$	...	$M_{200}^{(a)} = 0.32 \pm 0.08$	1.8 ± 0.6	Tanaka et al.
IRC-0218A/XMM-LSS J02182-05102	Proto–cluster	1.62	$> 20\sigma$	860 ± 490	$M_{200}^{(b)} \sim 0.1 - 0.4$	$> 4\sigma$ Detection	Papovich et al. 2010; 2012
SpARCS J022427-032354	Cluster	1.63	...	...	...	Detection	Muzzin et al. (2013)
IDCS J1426+3508	Cluster	1.75	...	...	$M_{200}^{(a)} \sim 5.6 \pm 1.6$	55 ± 12	Stanford et al. 2012; Brodwin et al. 2012
JKCS 041	Cluster	1.80	...	...	$M_{200}^{(c)} \sim 2$	76 ± 5	Newman et al. 2013; Andreon et al. 2013
HUDFJ0332.4-2746.6	Proto–cluster	1.84	$\sim 20\sigma$	730 ± 260	$M_{200}^{(b)} = 2.2 \pm 1.8$	$< 1 - 6$	Mei et al. 2014
IDCS J1433.2+3306	Cluster	1.89	...	...	$M_{200} \sim 1$	...	Zeimann et al. 2012
HUDFJ0332.5-2747.3	Group	1.90	$\sim 4 - 7\sigma$	...	...	...	Mei et al. 2014
CL J1449+085	Cluster	1.99	$> 20\sigma$	...	$M_{200}^{(a)} = 0.53 \pm 0.09$	6.4 ± 1.8	Gobat et al. 2013

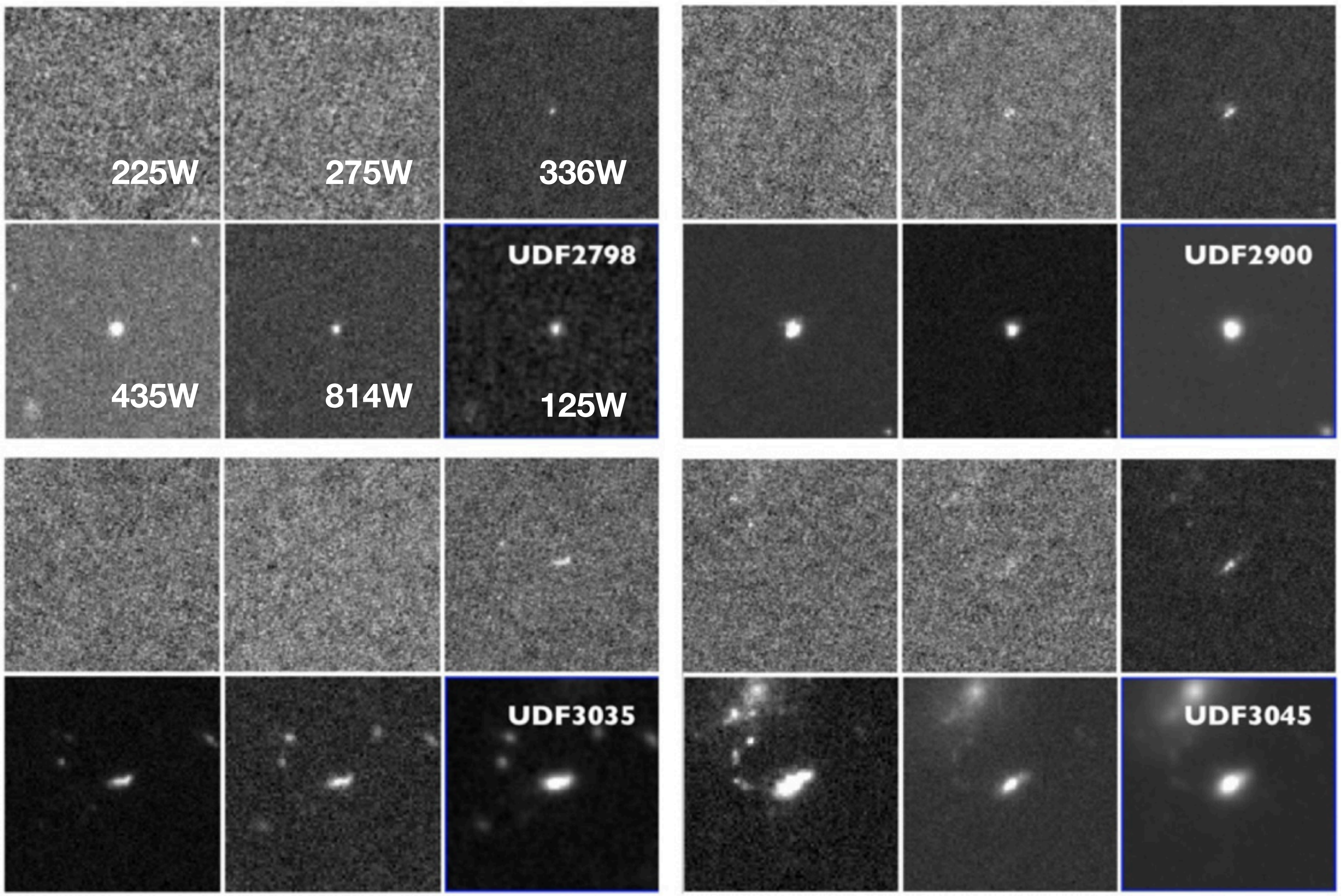
Mei et al. 2015, ApJ, in press; arXiv:1403.7524

WFC3 Grism Spectroscopy and photoz from CANDELS and 3D-HST+GMASS



3D-HST spectra from Brammer et al. 2012

Lyman break confirmation



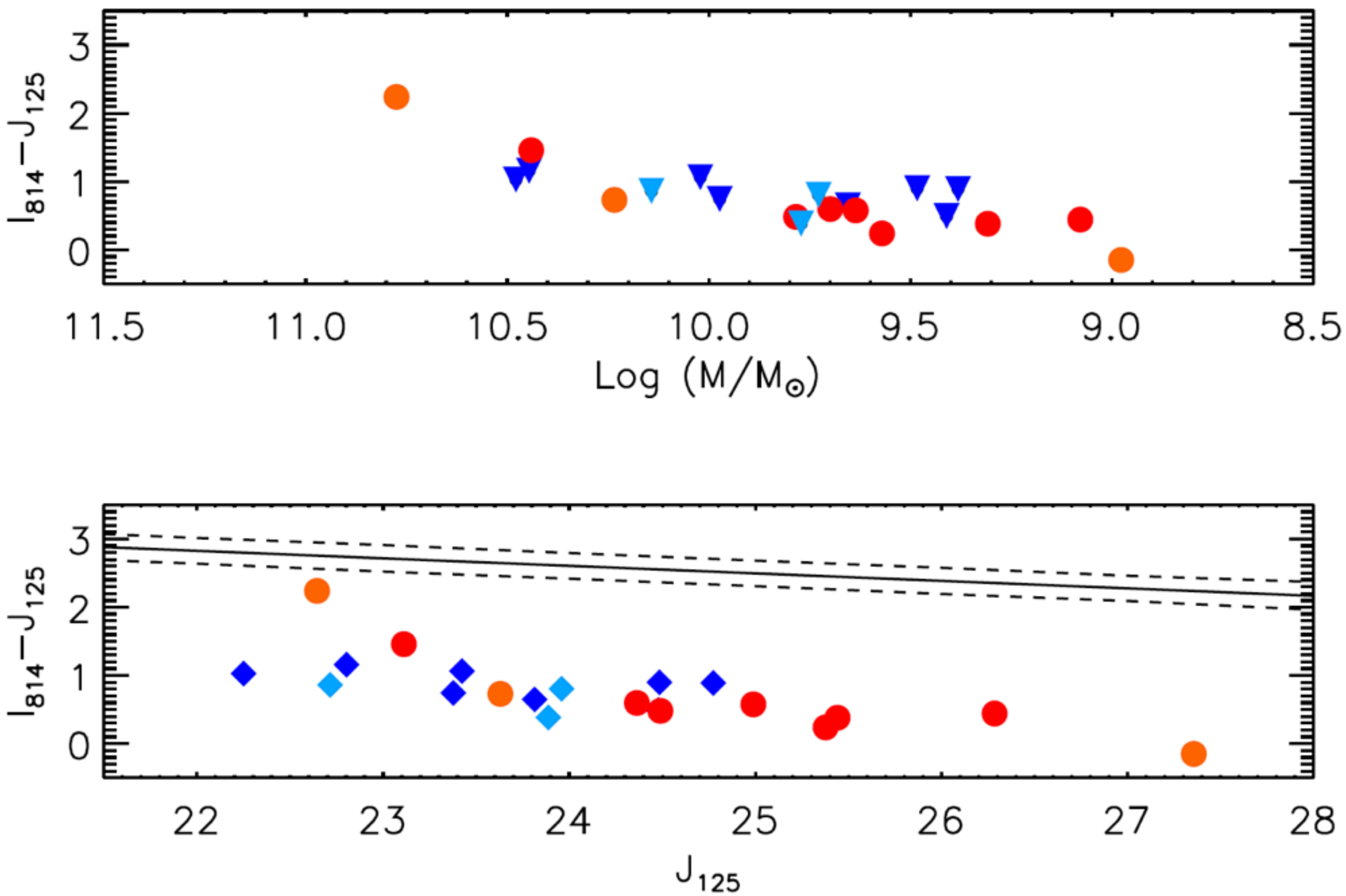
Mei et al. 2015

CANDELS imaging combined with HUDF UV (Teplitz et al. 2013)

Morphology

- 50% of the structures' members show possible interactions or disturbed morphologies, with asymmetries, faint substructures, and tails, all possible signatures of merger remnants or disk instabilities.
- The ETG fraction is 50%, compared to 80% in the cluster cores at z<1

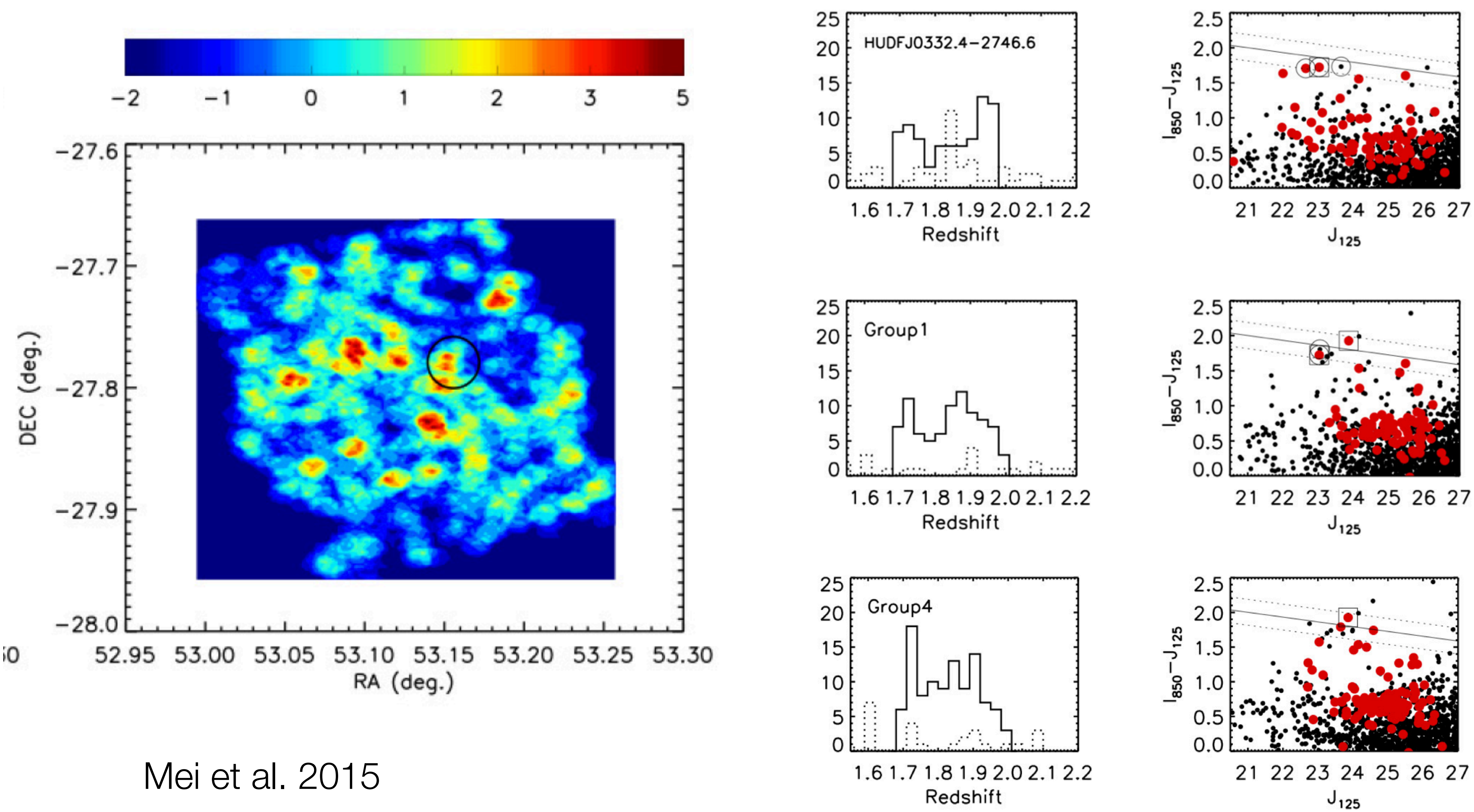
Blue ETGs, mostly star-forming



The continuous line if the passively evolved CMR from z~1.3 clusters from Mei et al. 2009

Mei et al. 2015

Extended structure at z~1.8-1.9 (photoz)

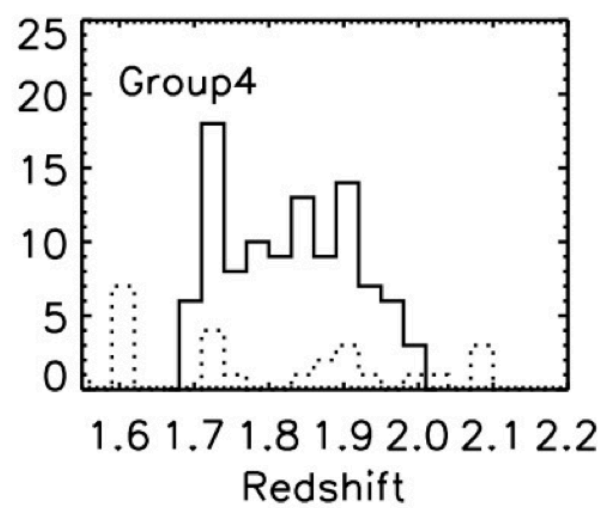


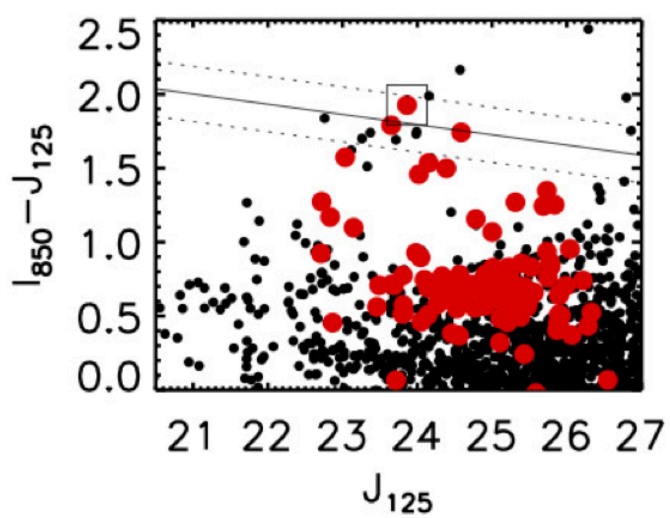
Mei et al. 2015

Extended structure

Name	RA (deg.)	DEC (deg.)	H_{160}^{lim}	N_{gal}	$N_{spec},\overline{z}_{spec}$	S/N	R(arcmin.)
HUDFJ0332.4-2746.6	53.15565	-27.77930	24.5	8		7	-
Group 1	53.11842	-27.78338	24.5	6	$5,1.89 \pm 0.01$	5	1.9
Group 2	53.11615	-27.87192	24.5	6	–	5	5.9
Group 3	53.19252	-27.82862	24.5	5	$3,1.88 \pm 0.03$	4	3.5
HUDFJ0332.4-2746.6	53.15565	-27.77930	26	13		2	-
Group 1	53.11842	-27.78338	26	13	$5,1.89 \pm 0.01$	2	1.9
Group 2	53.11615	-27.87192	26	14	–	2	5.9
Group 4	53.09392	-27.76772	26	18	$6,1.88 \pm 0.02$	3	3.3
Group 5	53.18884	-27.72558	26	15	$4,1.95 \pm 0.01$	2	3.7
Group 6	53.14208	-27.81992	26	14	$8,1.87 \pm 0.02$	2	2.5

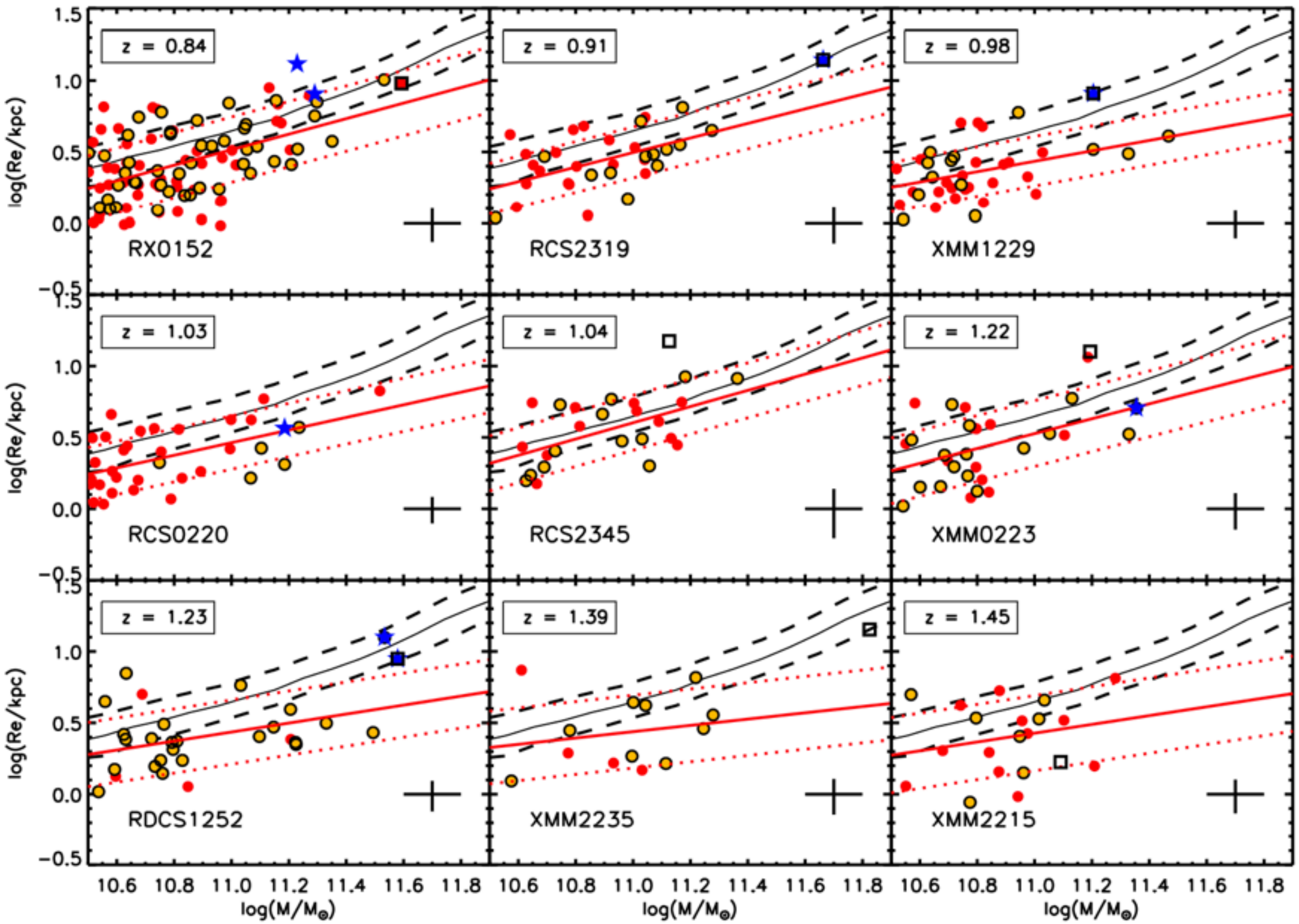
Mei et al. 2015





Clusters 0.8<z<1.5

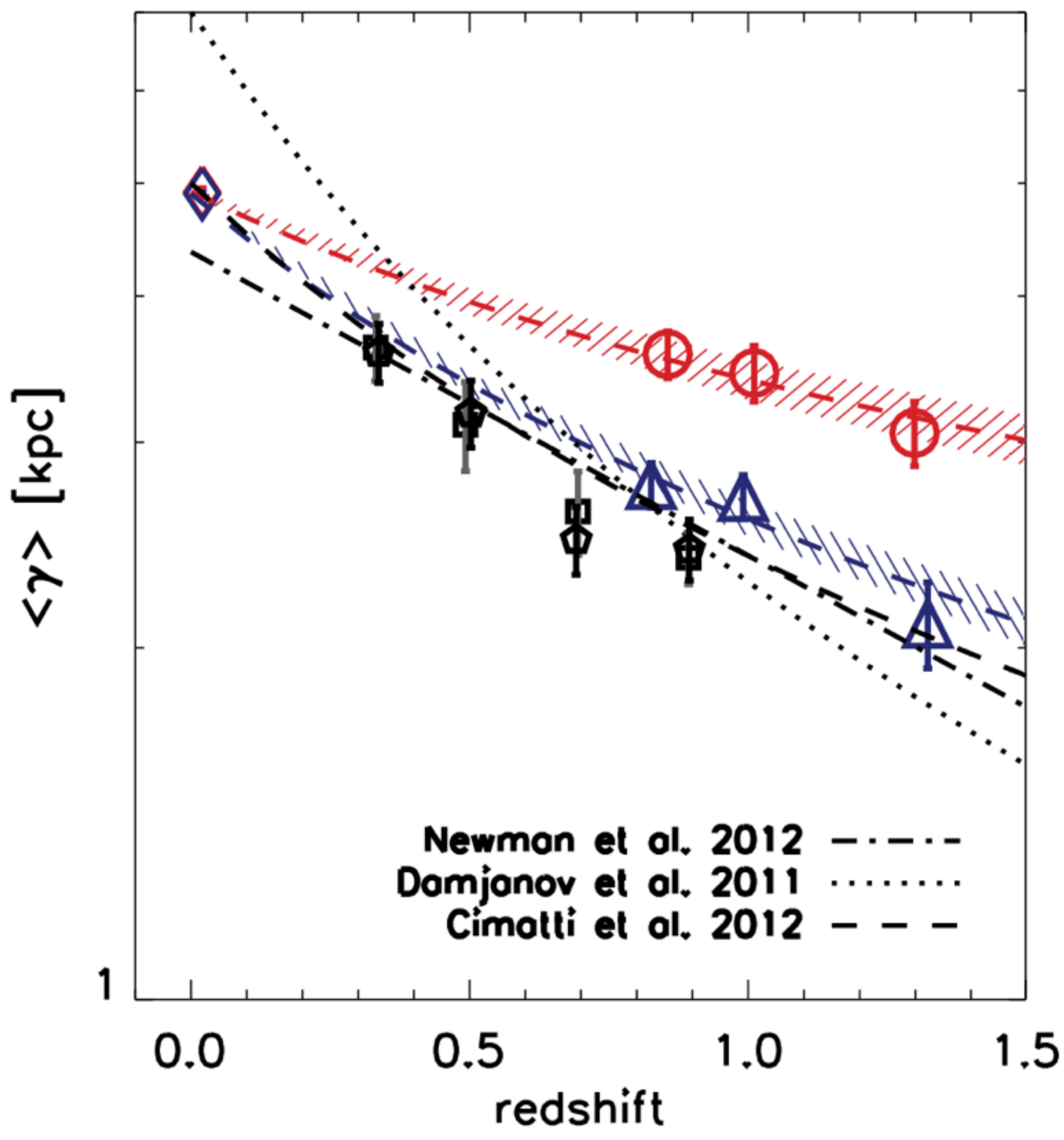
Delaye, Huertas-Company, Mei et al. 2014



Nine clusters (ACS GTO, Sparcs, RCS) with z~0.8-1.5 and mass in the range 2-7 x 10^{14} $M_\odot$ from the HAWKI Cluster survey (Lidman et al. 2013). ~400 ETGs (morphology selected and passive) with masses > $10^{10.5}$ $M_\odot$

Size evolution and Environment

Delaye, Huertas-Company, Mei et al. 2014



see also Weinmann et al. 2009; Maltby et al. 2010; Rettura et al. 2010, Valentinuzzi et al. 2010
Cooper et al. 2012, Papovich et al. 2012, Raichoor et al 2012, Poggianti et al. 2013, Lani et al. 2013, Bassett et al. 2013

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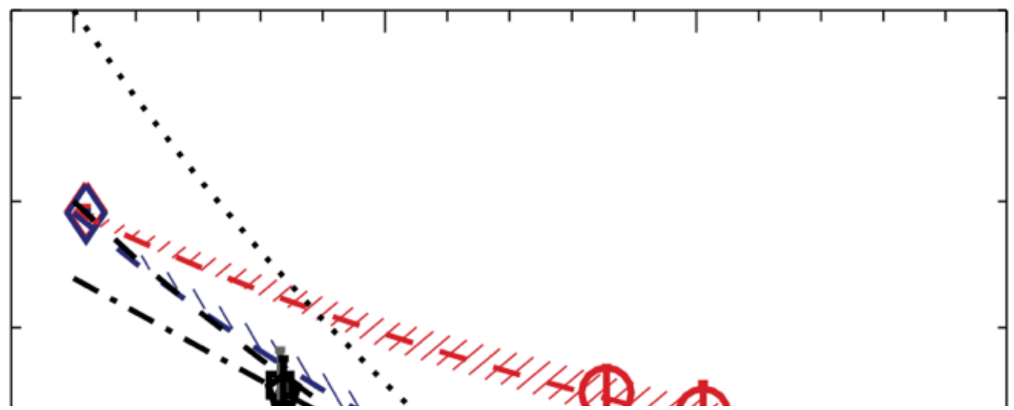

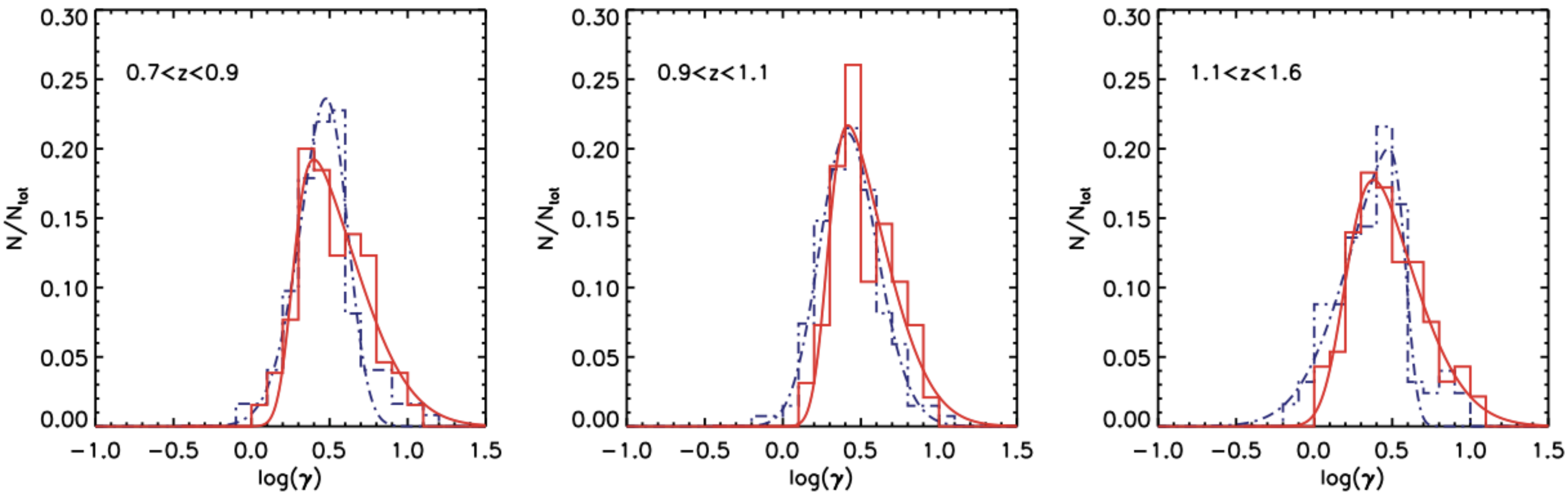

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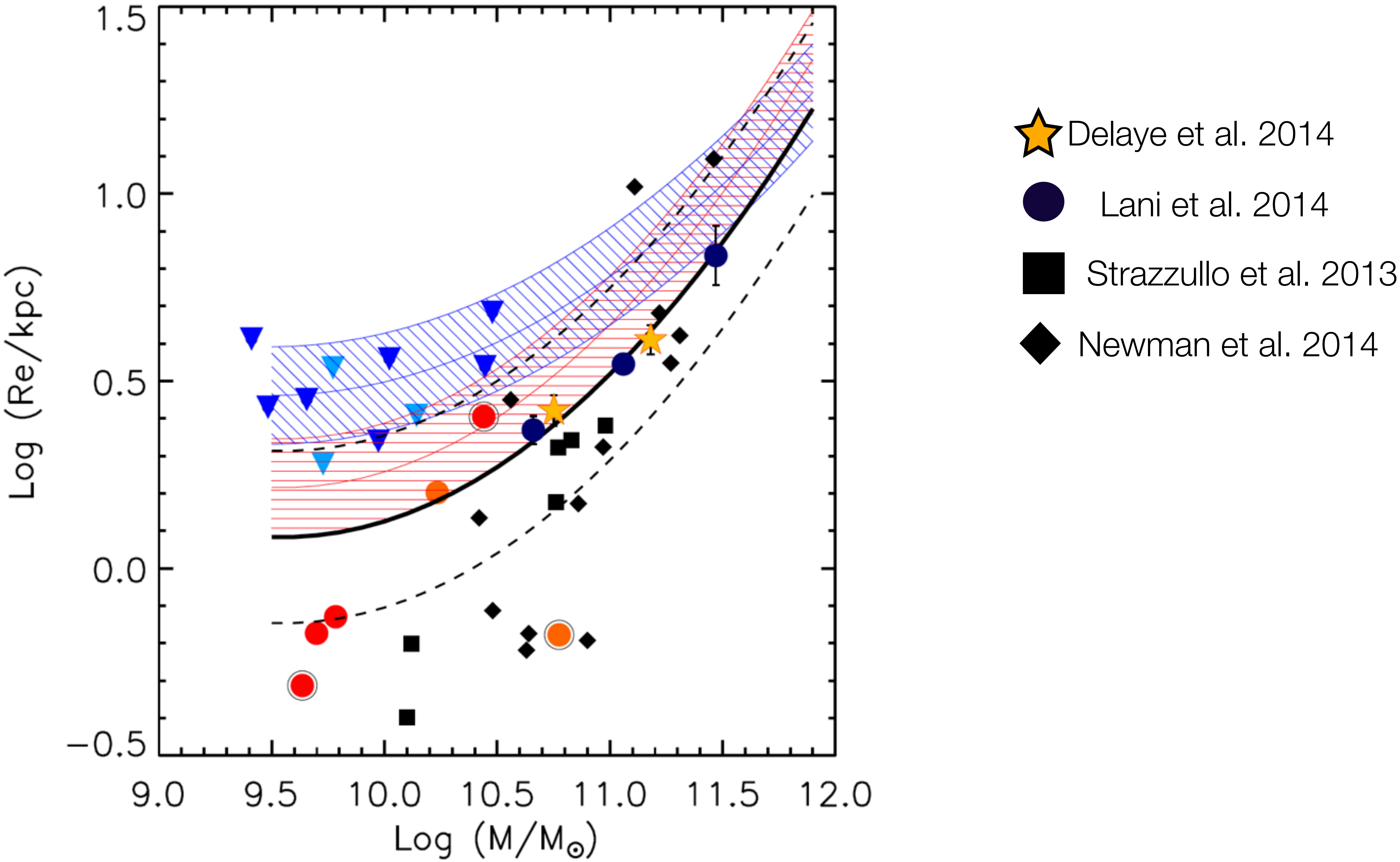
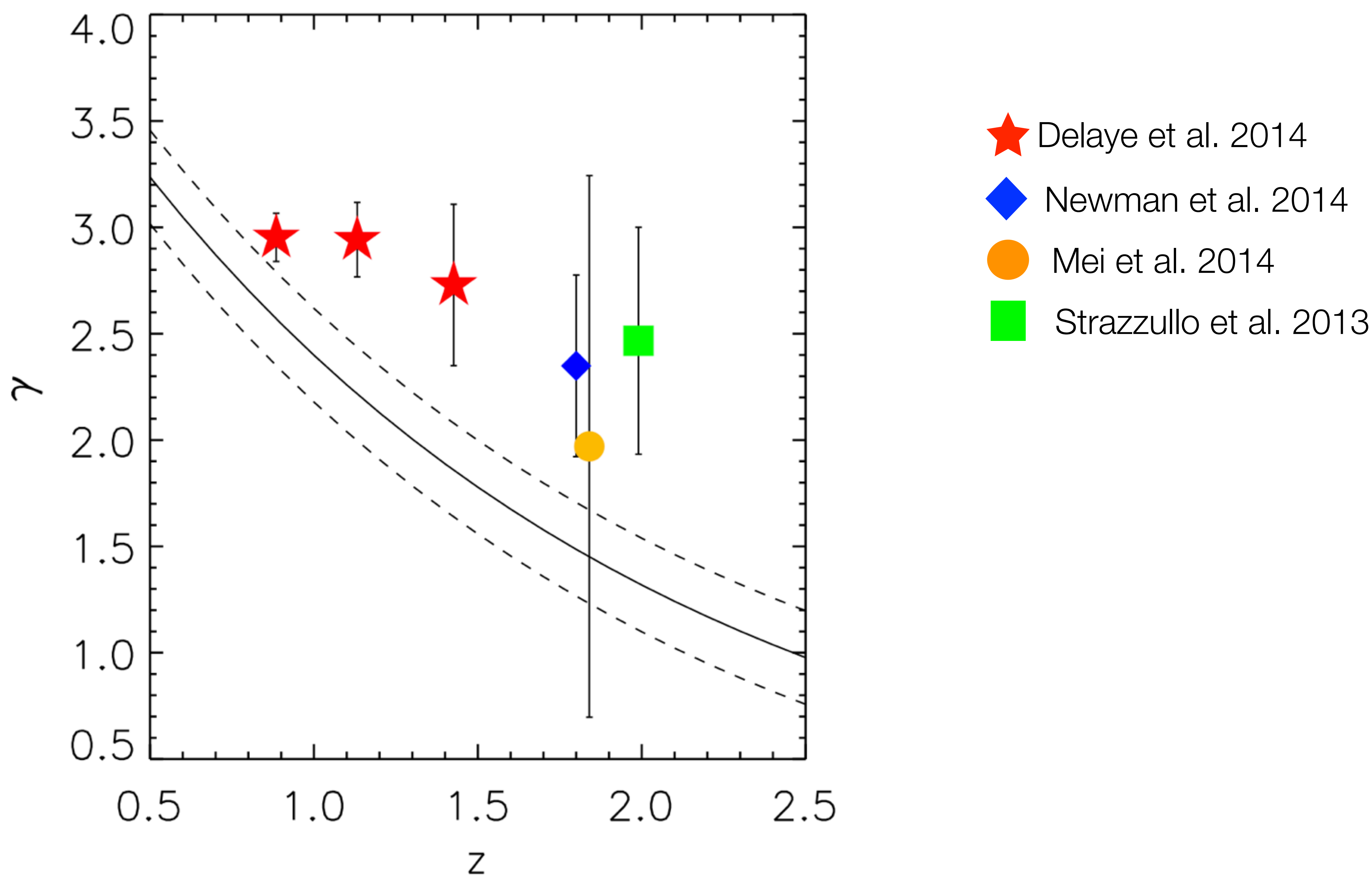
Mass-size relation at z~1.8



Mei et al. 2015, ApJ, in press; arXiv:1403.7524

Size growth - only ETGs

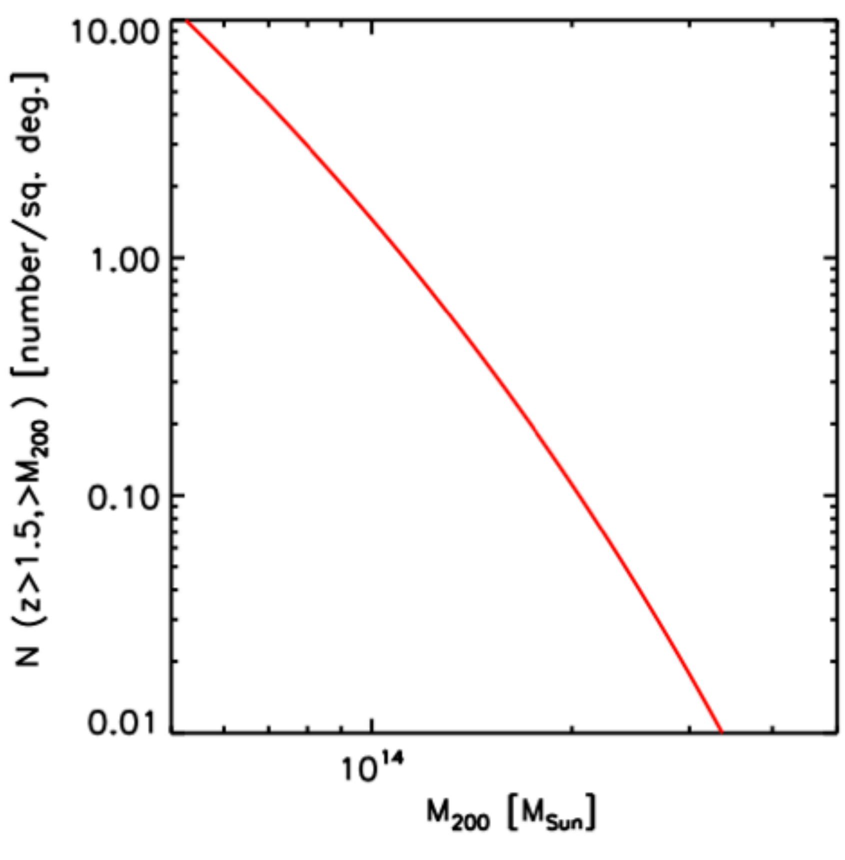


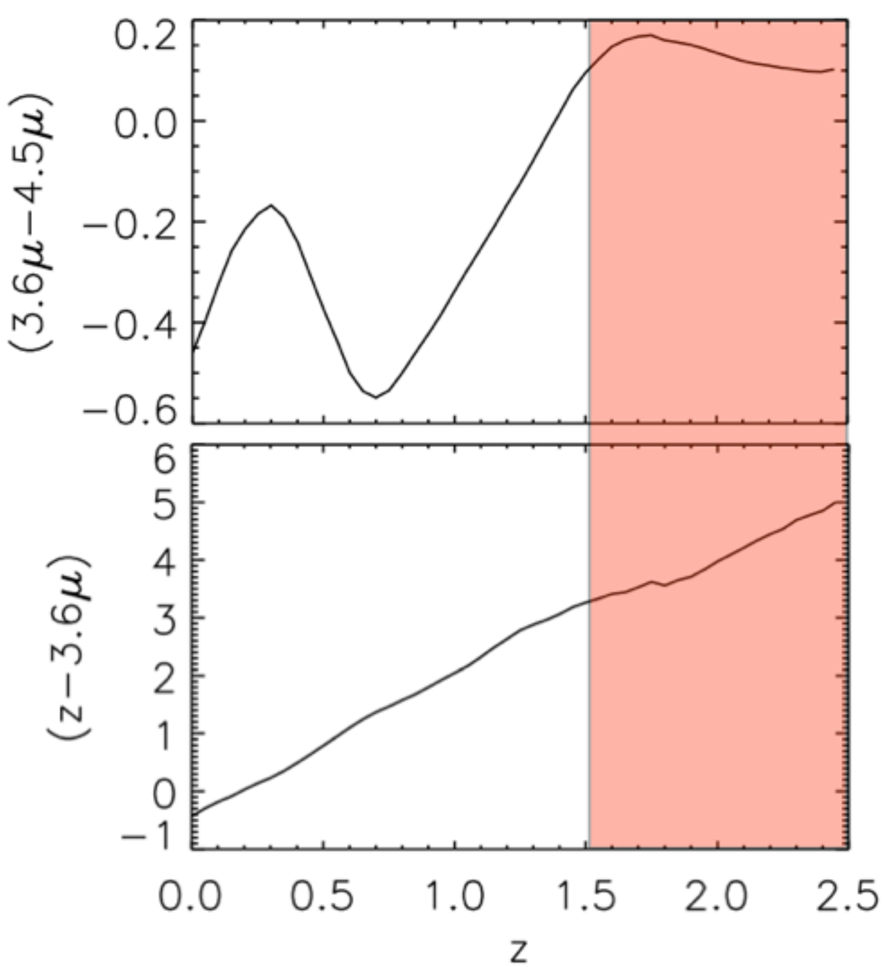
Mei et al. 2015, ApJ, in press; arXiv:1403.7524

South Pole Telescope Spitzer Deep Field (SSDF)

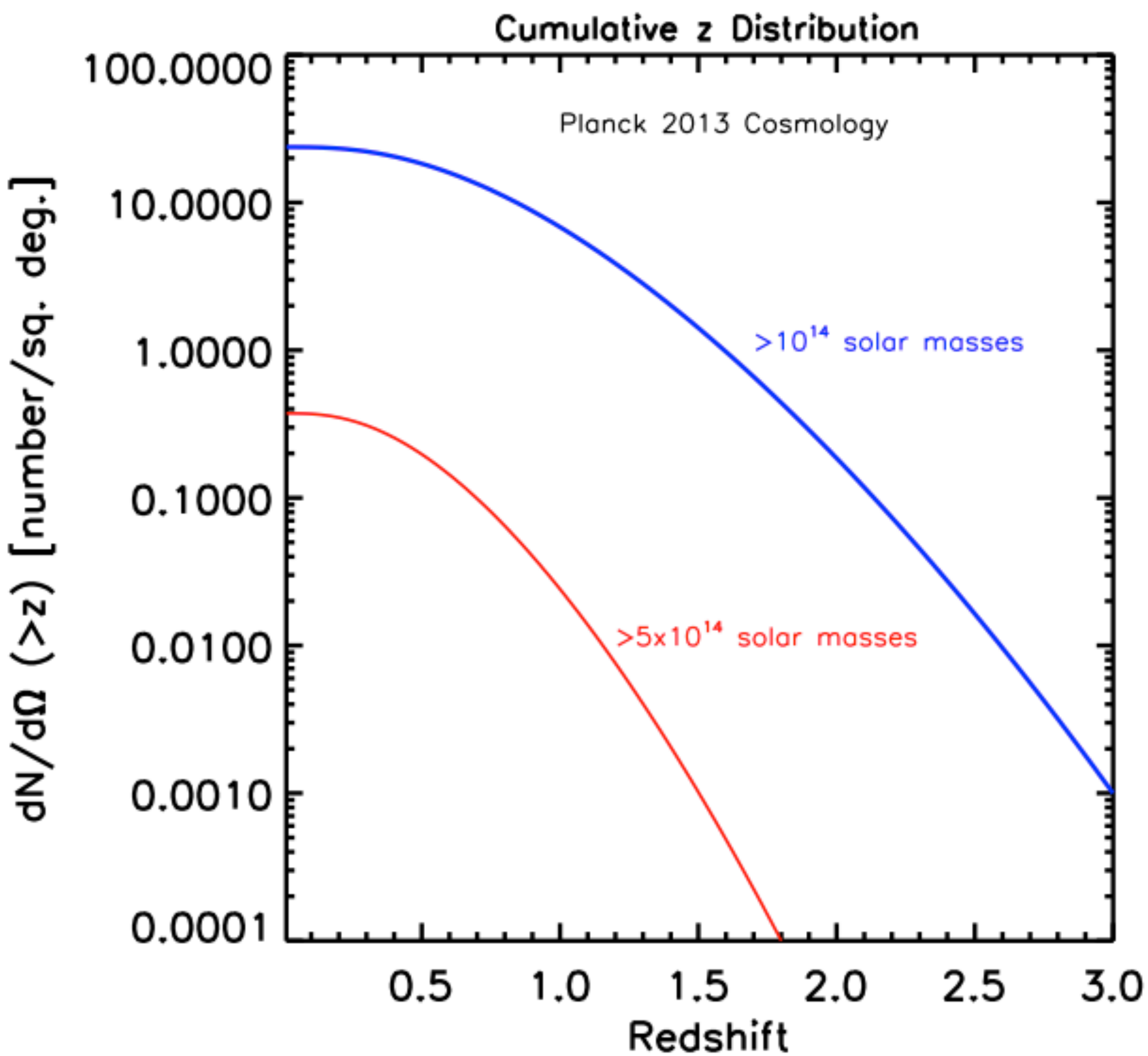
PI: A. Stanford - with Licitra, Lidman, Stanford, Ashby, Bartlett, Brodwin, Gettings, Gonzales, Martinez-Manso, Pierre, Rettura, Sadibekova, Stern

- 100 deg. sq. covered with Spitzer IRAC 3.6μ and 4.5μ in the SPTpol field
- Survey completed in 2012 (Ashby et al. 2013; Rettura et al. 2014)
- Optical coverage of 25 sq.deg. with CTIO/DECam from the XXL consortium (PI: Lidman)





Cluster number predictions for Euclid



Courtesy Jim Bartlett

Conclusions

- We discovered two galaxy overdensities in the HUDF: a proto-cluster at z = 1.84, HUDFJ0332.4-2746.6, and a group at z=1.9, HUDFJ0332.5-2747.3

- 50% of the structures' members show possible interactions or disturbed morphologies, with asymmetries, faint substructures, and tails, all possible signatures of merger remnants or disk instabilities.

- The two structures have not yet formed a red sequence. *For the first time, we confirmed a significant presence of star-forming blue ETGs in dense environments at z=1.84-1.9.* Their mass-size relation lies on the same mass{size relation observed for quiescent ETGs in clusters and dense regions at z = 0.7-2.

- Both the two structures' ETG fractions and their colors suggest that these star-forming blue ETGs are the most likely progenitors of at least part of the passive ETGs observed in clusters at z < 1.