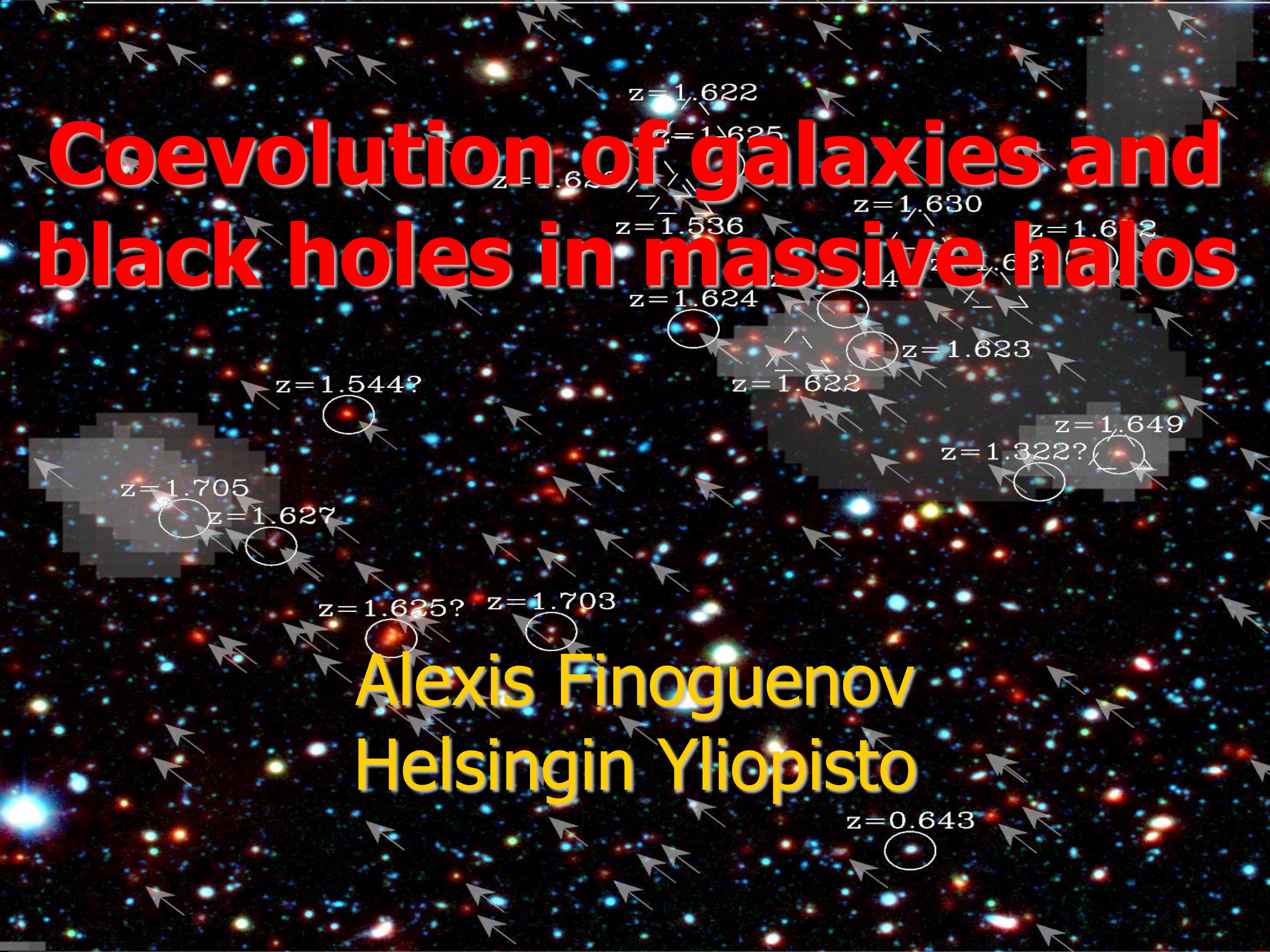
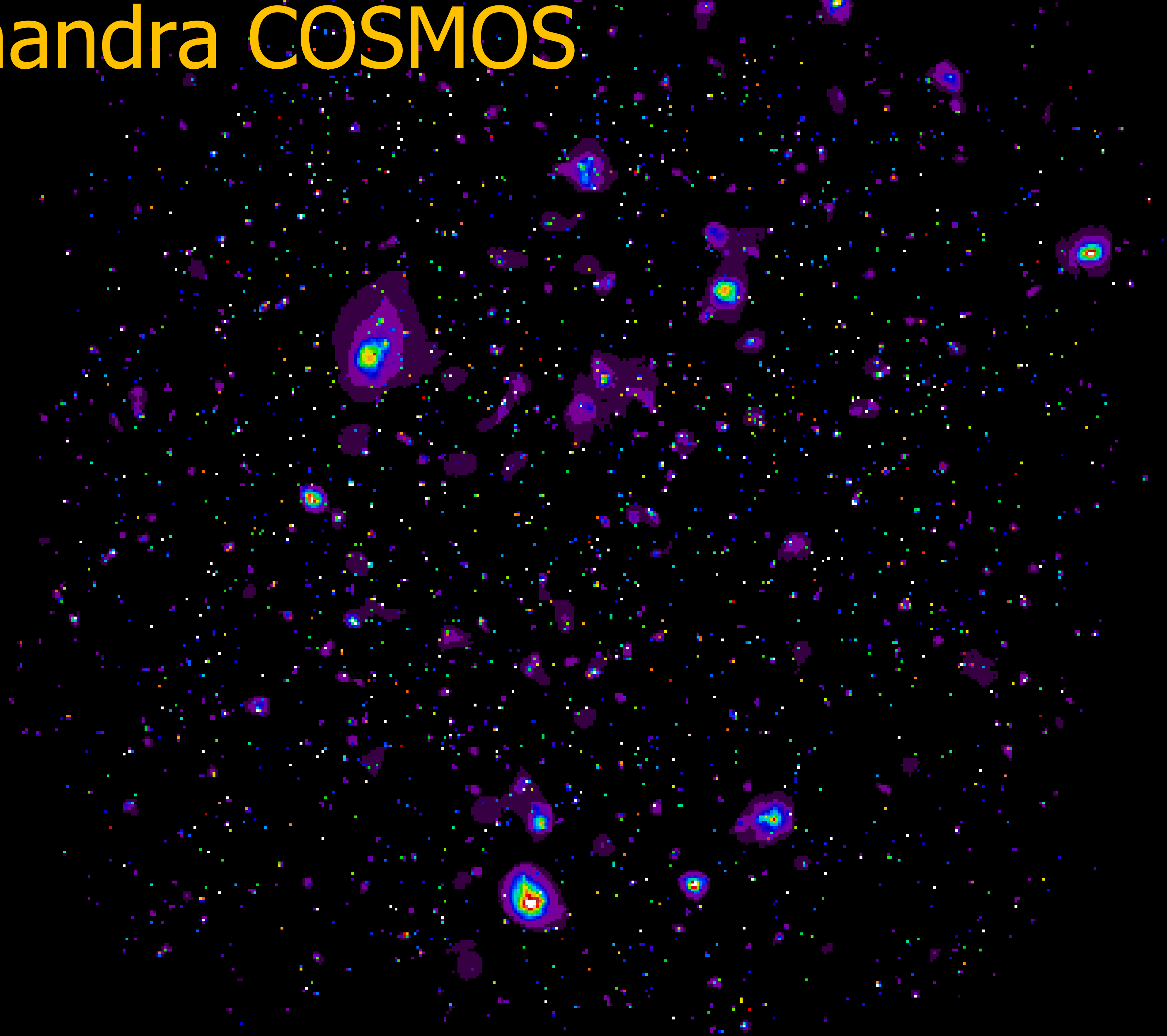
Coevolution of galaxies and black holes in massive halos

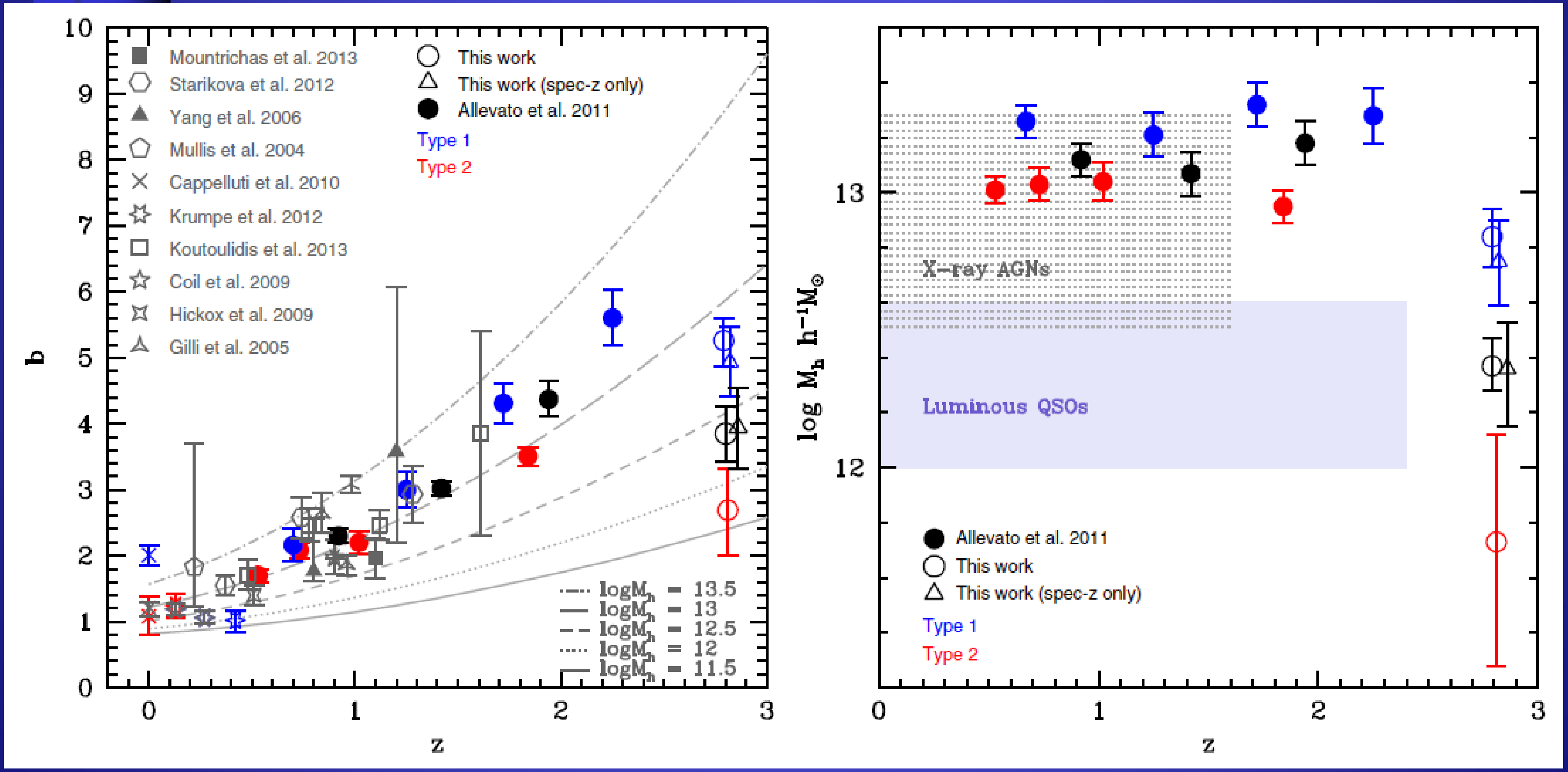
Alexis Finoguenov
Helsingin Yliopisto



Chandra COSMOS

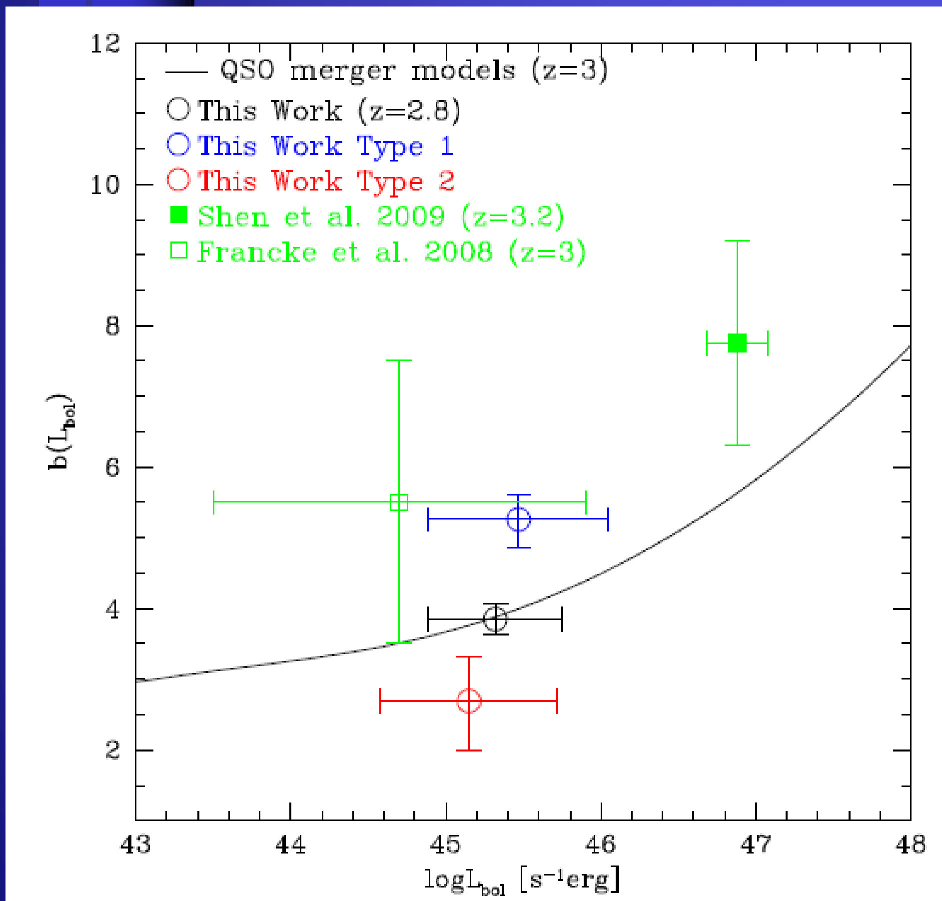


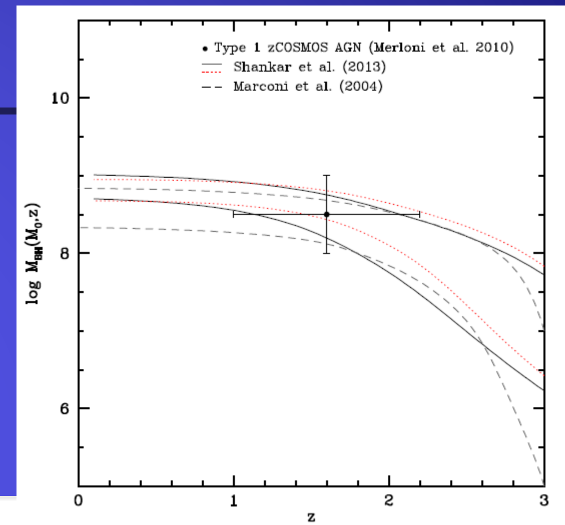
Bias and halo mass of AGN

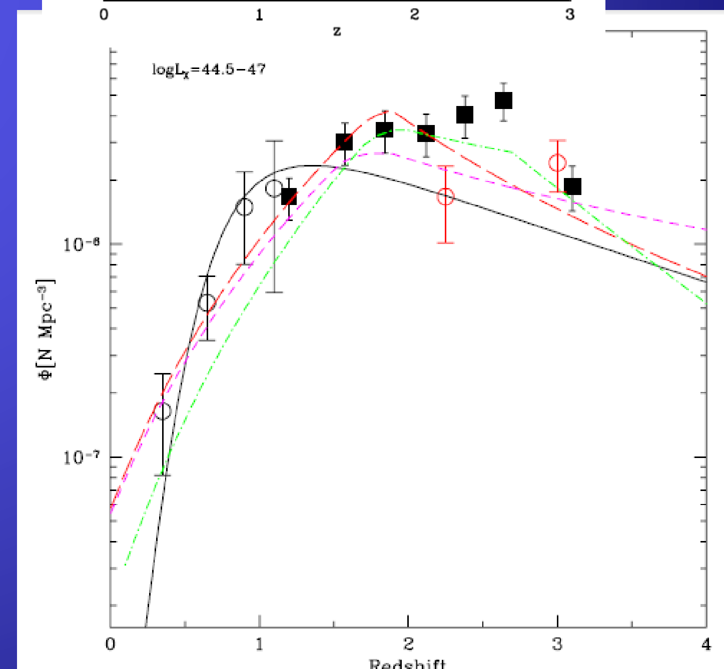


Allevato, AF, et al. 2014

X-ray AGN at high-z:
post-QSO or growing black holes







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COSMOS

Photoz
z=0.8
z=0.6
z=0.4
z=0.2

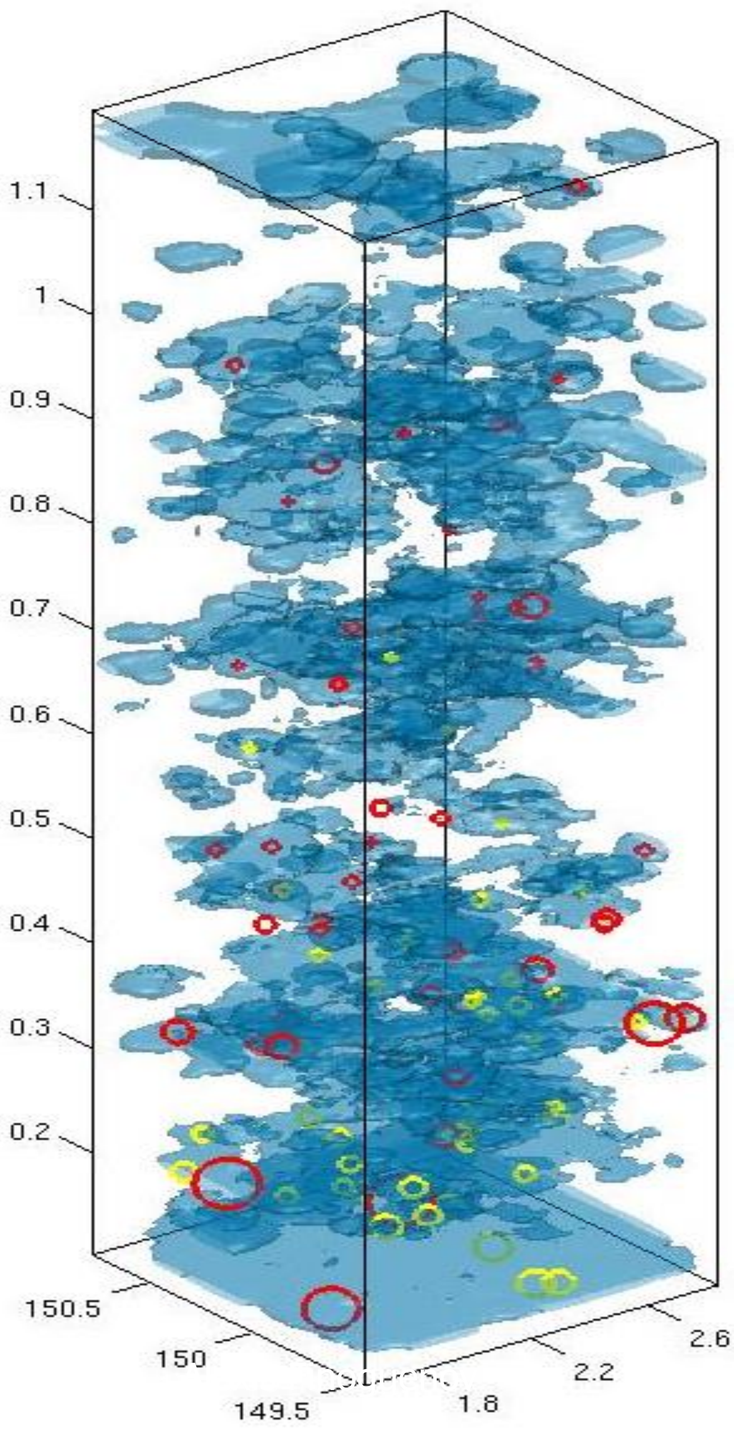
$I_{AB}<25$

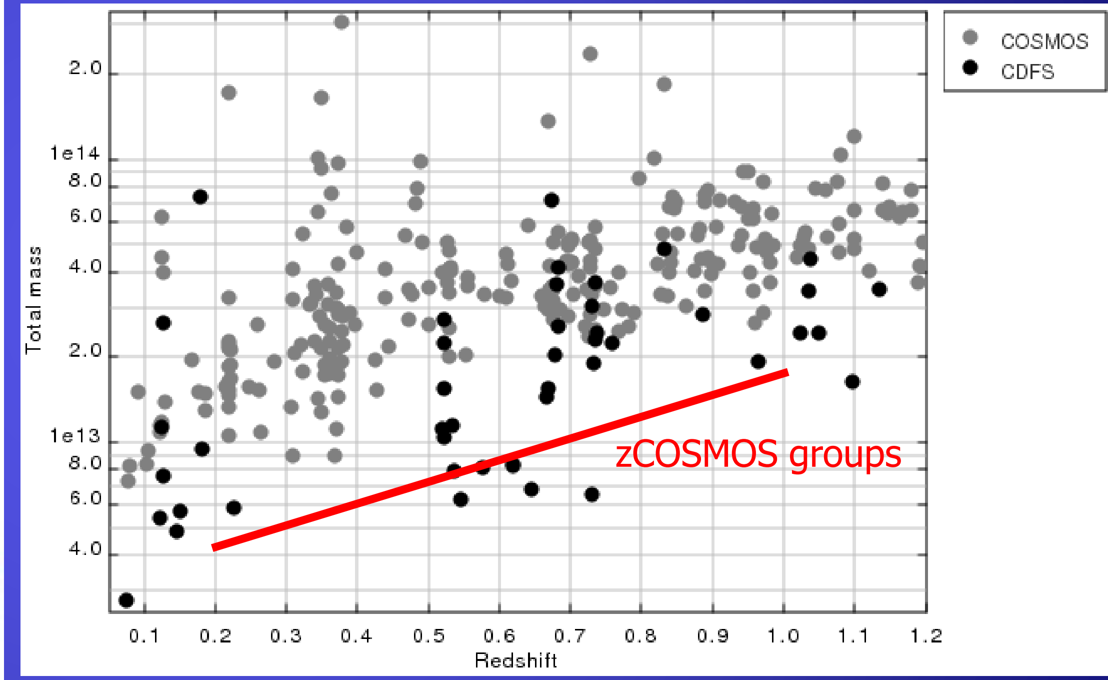
1.4Mio galaxies

X-ray contours

Finoguenov et al. 2007
George, AF et al. 2011
George, AF et al. 2012

Galaxy groups and LSS

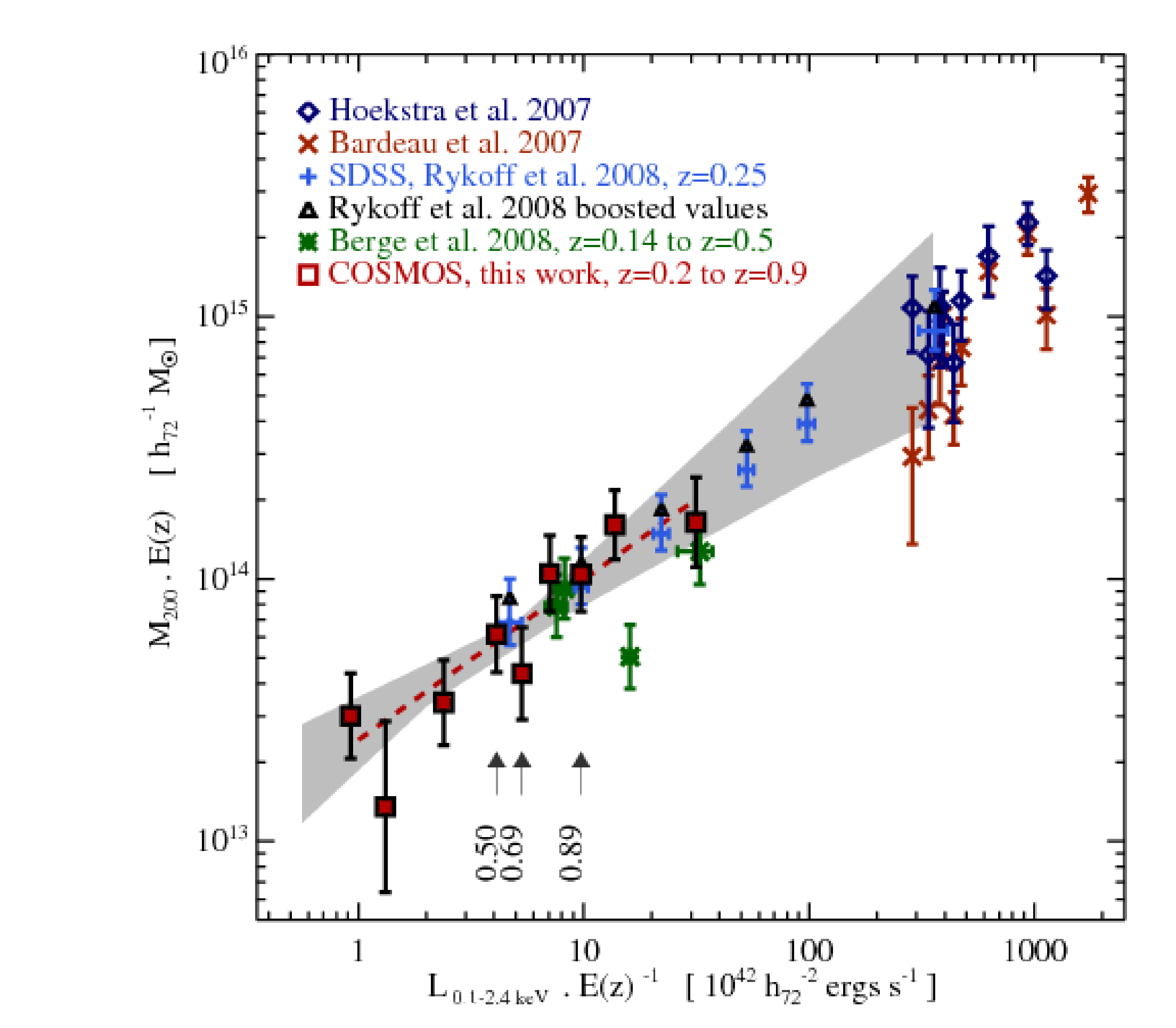




K.Kovac

LSS at 0.12, 0.22, 0.34, 0.37, 0.51, 0.73, 0.89

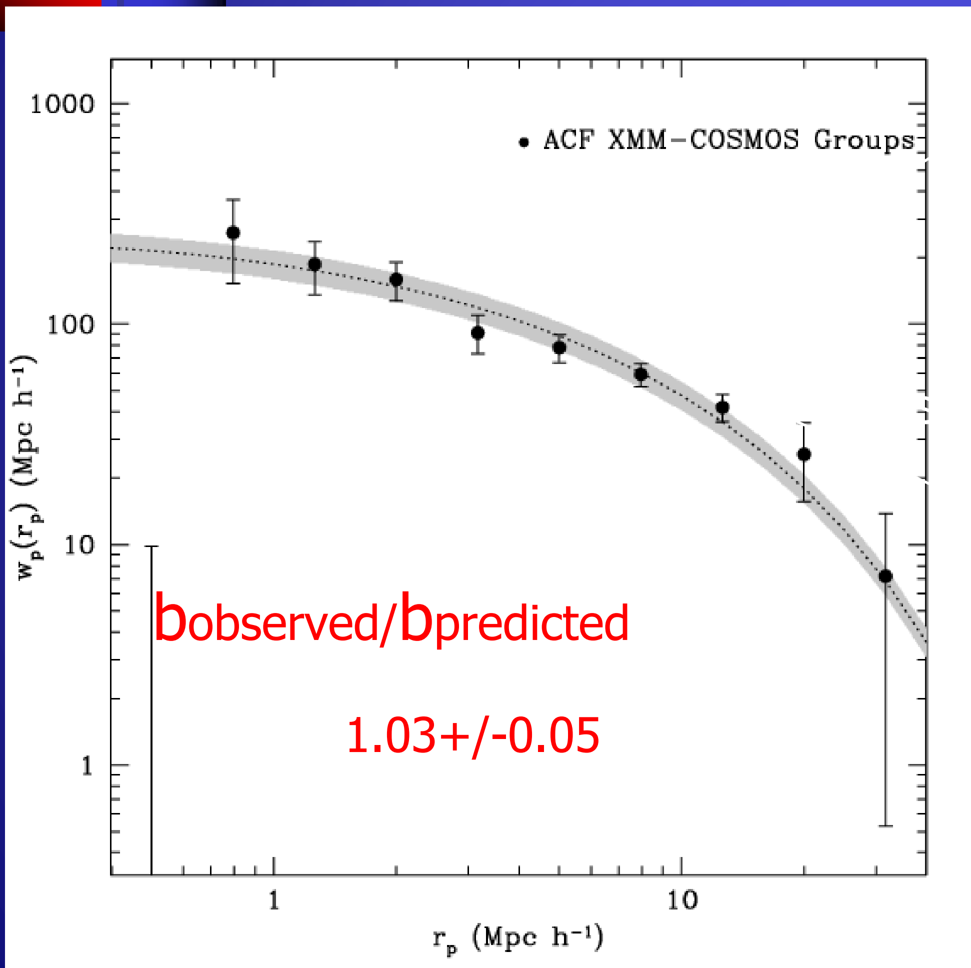
Weak lensing calibration of Lx-M relation

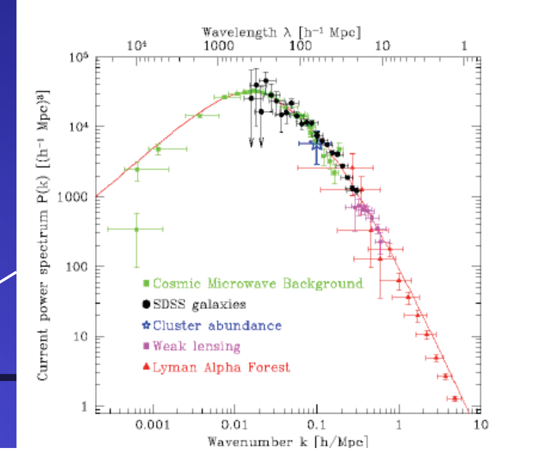


Leauthaud, AF et al. 2010

Alexis Finoguenov

ACF and mass



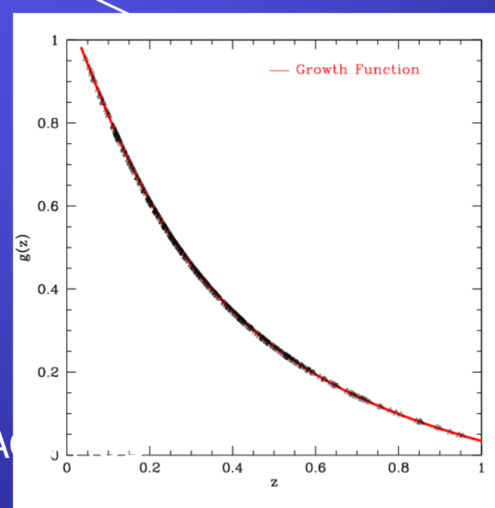


$$\bar{b}(M_0) = \sqrt{\frac{\sum_{i,j} b_i b_j g_{pair}}{N_{pair}}}$$

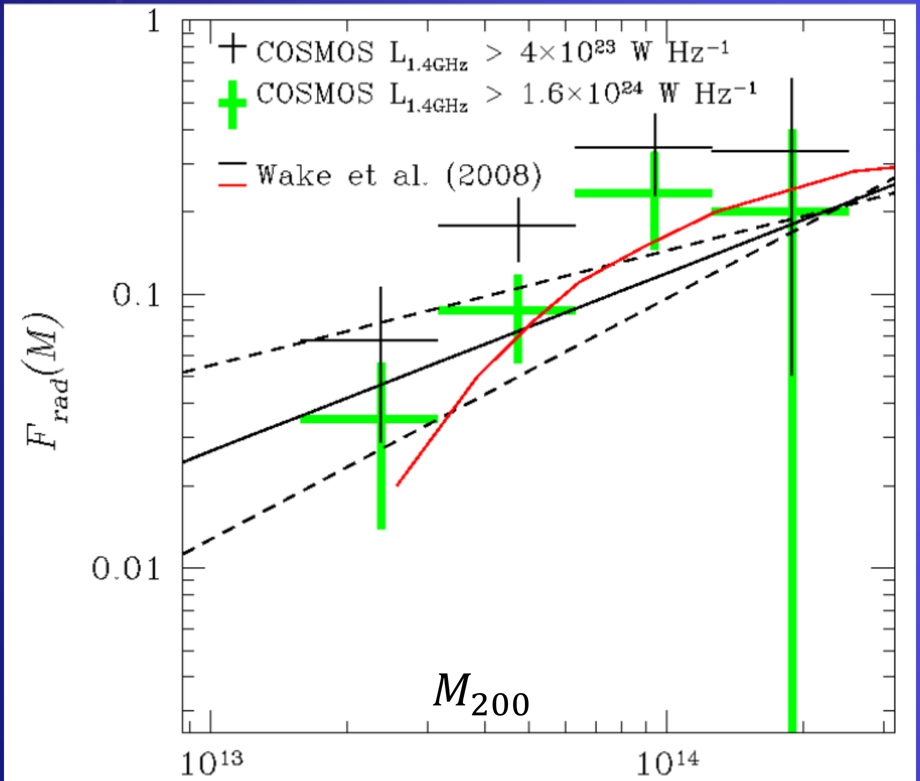
$$b_e = 1 + \frac{a\nu^2 - 1}{\delta_c} + \frac{2p/\delta_c}{1 + (a\nu^2)^p},$$

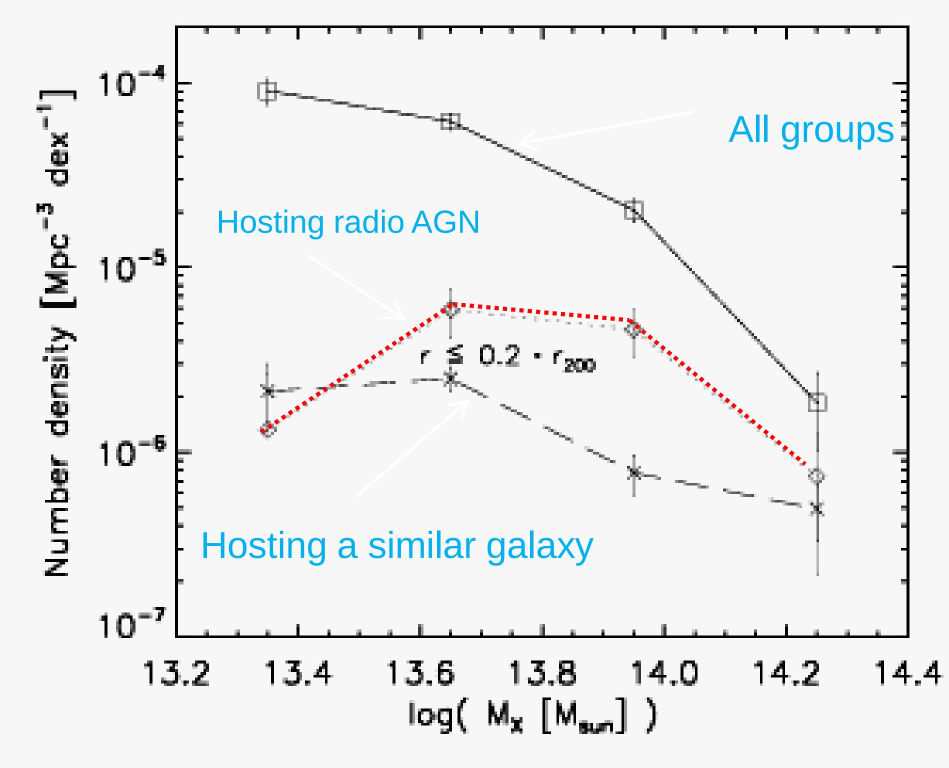
where A 0.322, a = 0.707 and p = 0.3.

Allevato, AF, et al. 2012

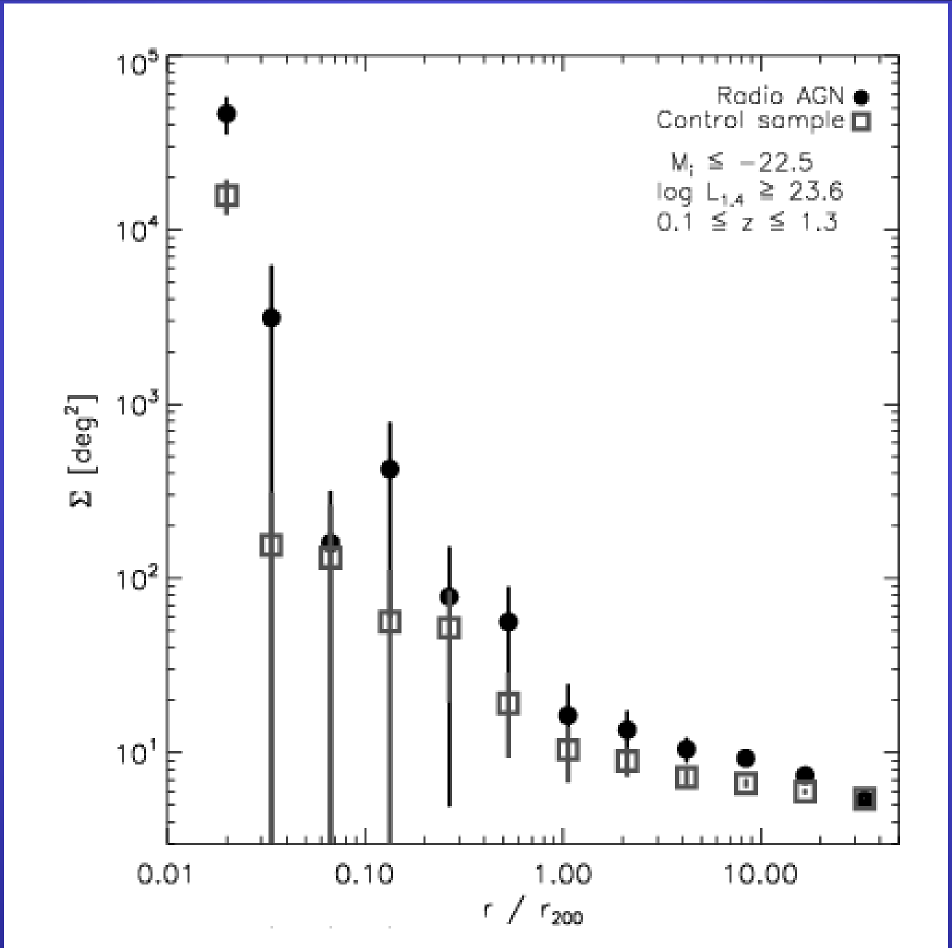


HOD of radio galaxies Smolcic, AF et al. 2011

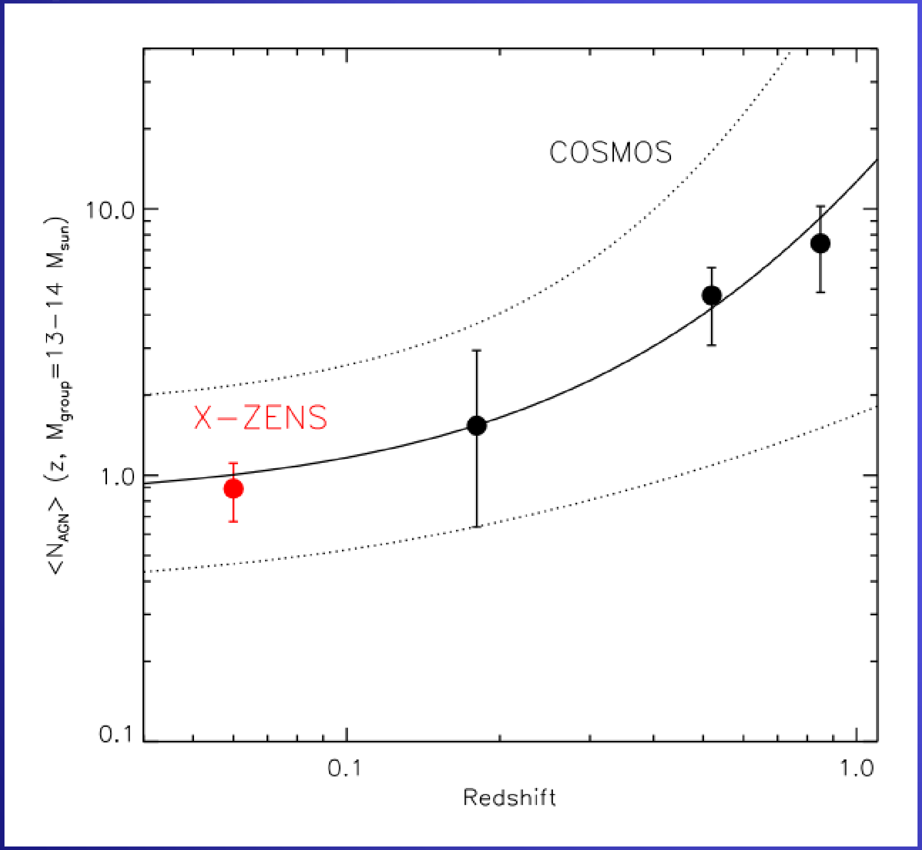


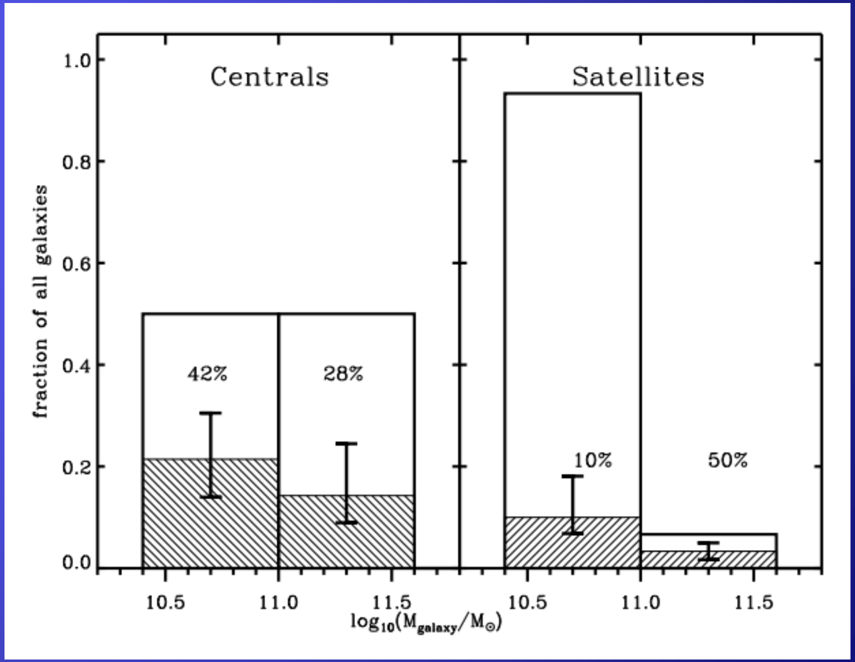


Radio distribution of Radio AGNs

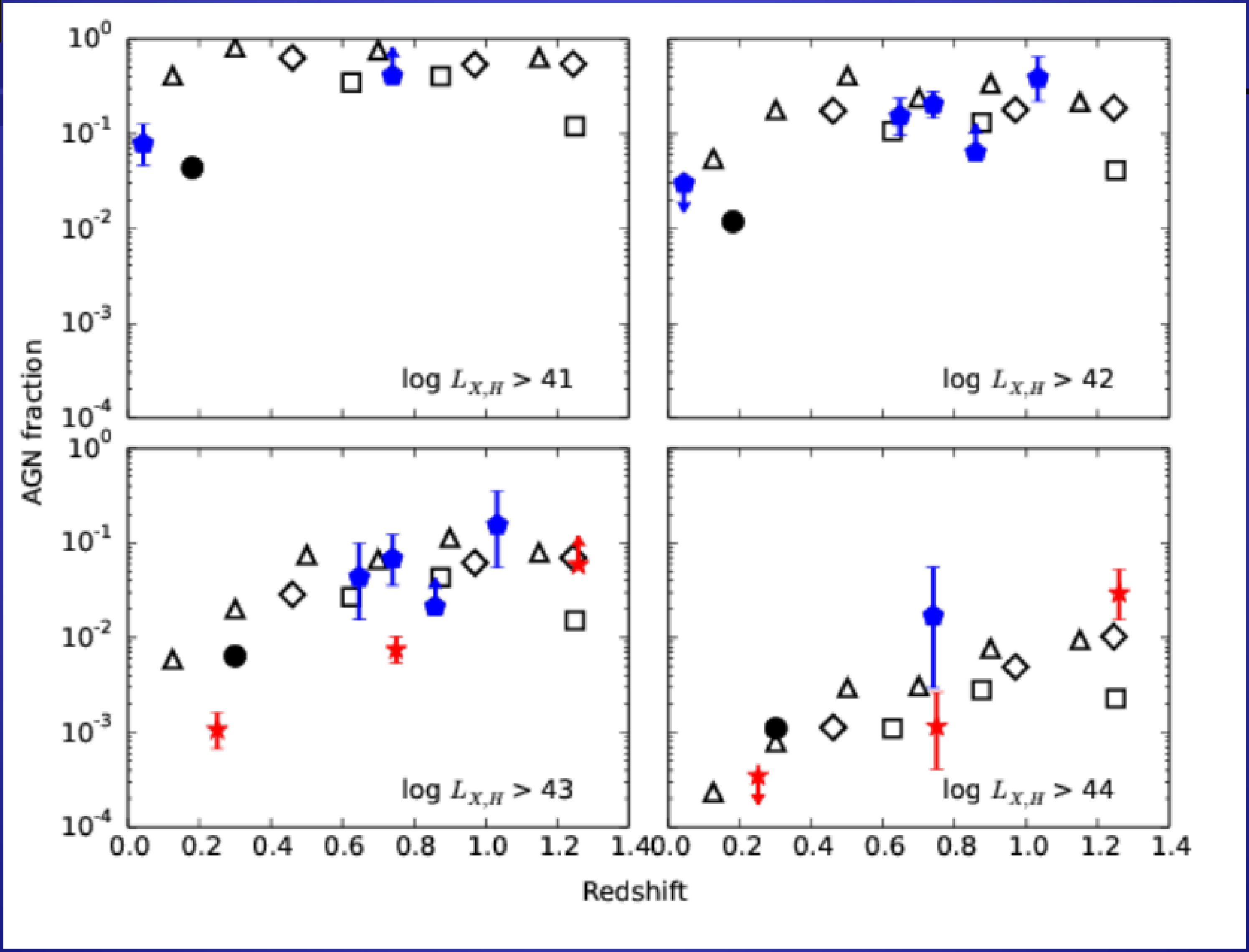


Silverman,..AF et al. 2014

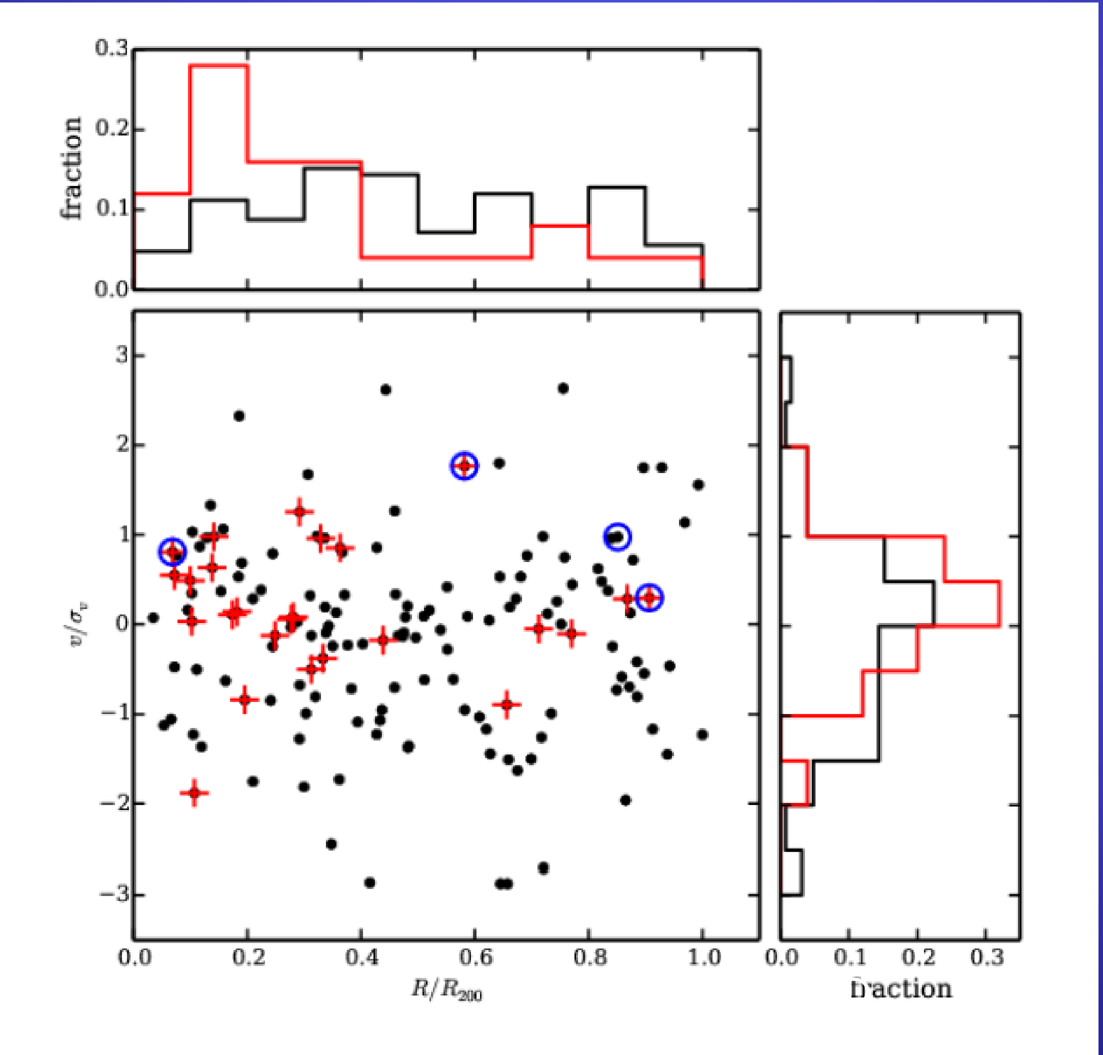




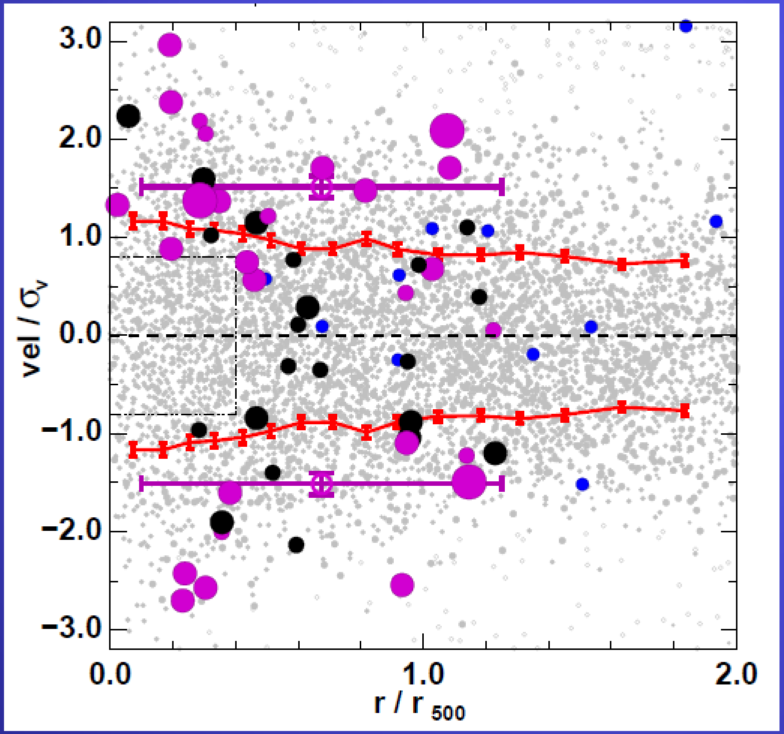
Oh, Mulchaey, AF, et al. 2014



X-ray AGNs inside CDFS galaxy groups (Oh..AF..2014)



Comparison to galaxy clusters (LoCuSS survey)



M>7.e14
0.15<z<0.3

Haines,..AF 2012

AGN within galaxy groups

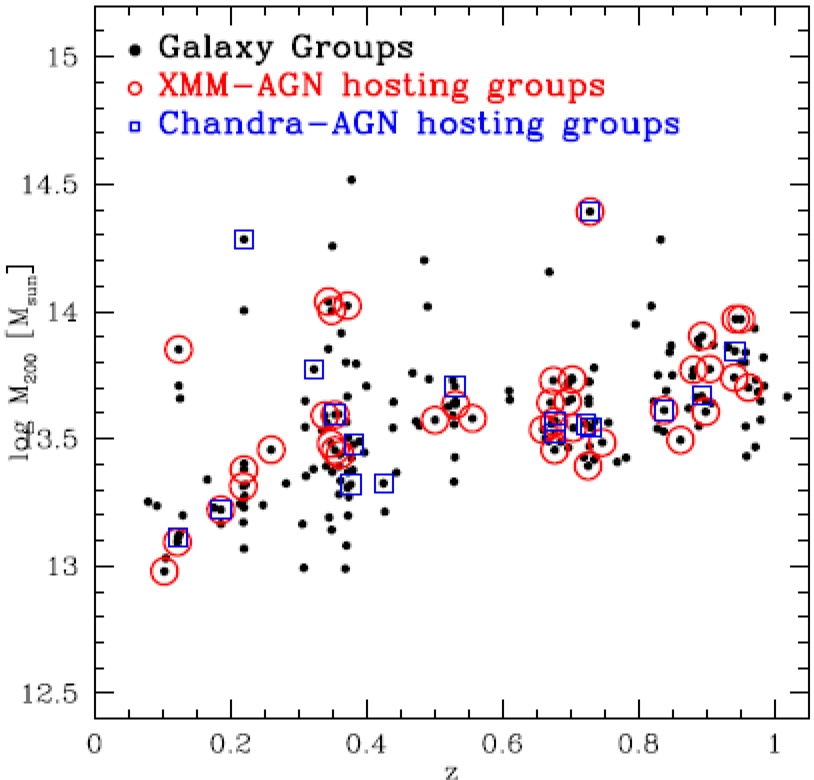
XMM-Chandra AGN

- 390 AGN with $z_{spec} < 1$;
- 144 AGN with $z_{phot} < 1$;

Galaxy groups

Finoguenov et al. (2007), Leauthaud et al. (2010), George et al. (2011)

- 189 objects at z<1
- log M_{200} [M_{sun}] = 13-14.5



XMM-Chandra AGN in groups:

- 58 AGN within < R_{200} and < 3σ;
- Galaxy membership catalog

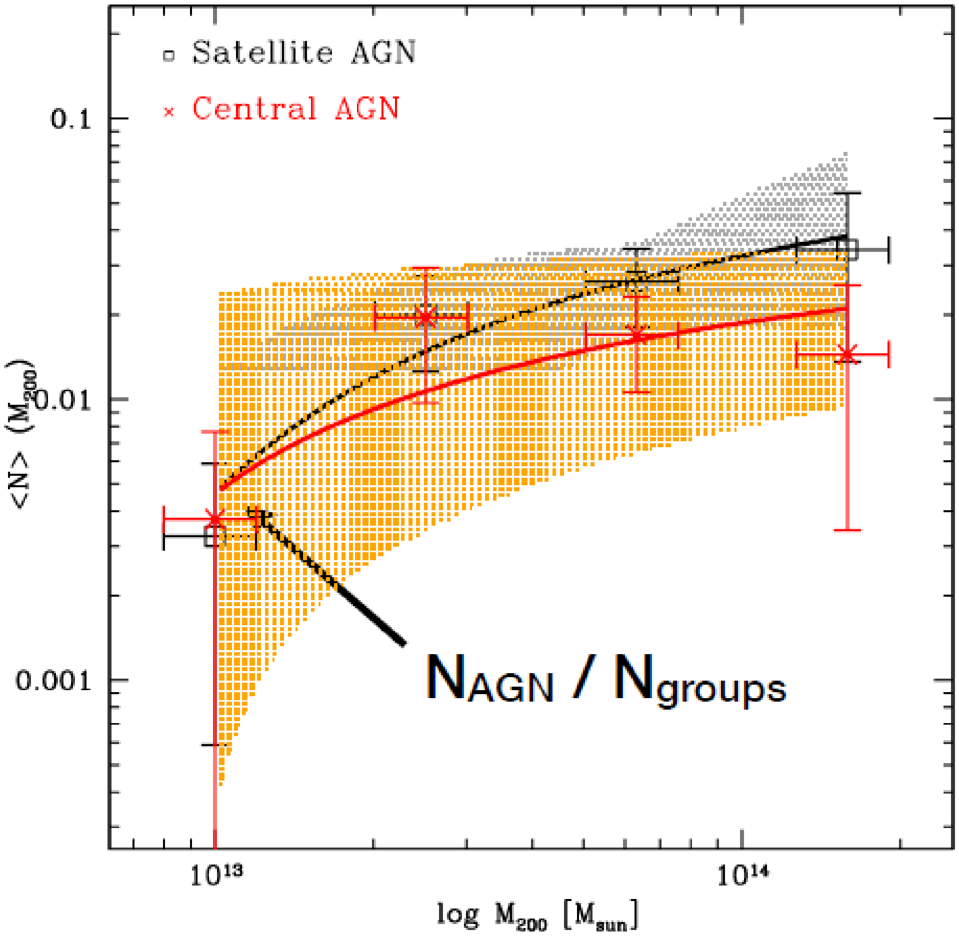
(George et al. 2011,2012)

- 22/58 AGN are in BCGs;
- 36/58 AGN are in satellites;

Allevato, AF, et al. 2012

Mean Halo Occupation

Allevato et al. 2012



- **Satellite AGN HOD:**

$$\langle N_{sat}\rangle(M_h) = f'_a \left(\frac{M_h}{M_1}\right)^{\alpha_s} exp(-M_{cut}/M_h)$$

- Increasing AGN fraction with M_h;
- $\alpha_s < 1$;
- AGN do not avoid satellite galaxies;

- Central AGN HOD:

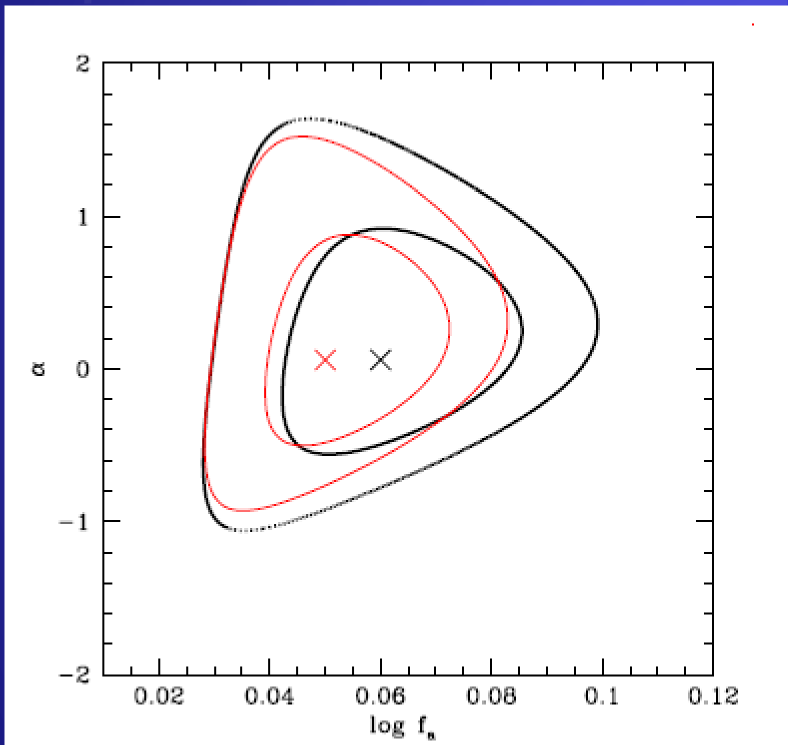
- log M_{min} [M_{sun}] = 12.7(12.1-12.9)

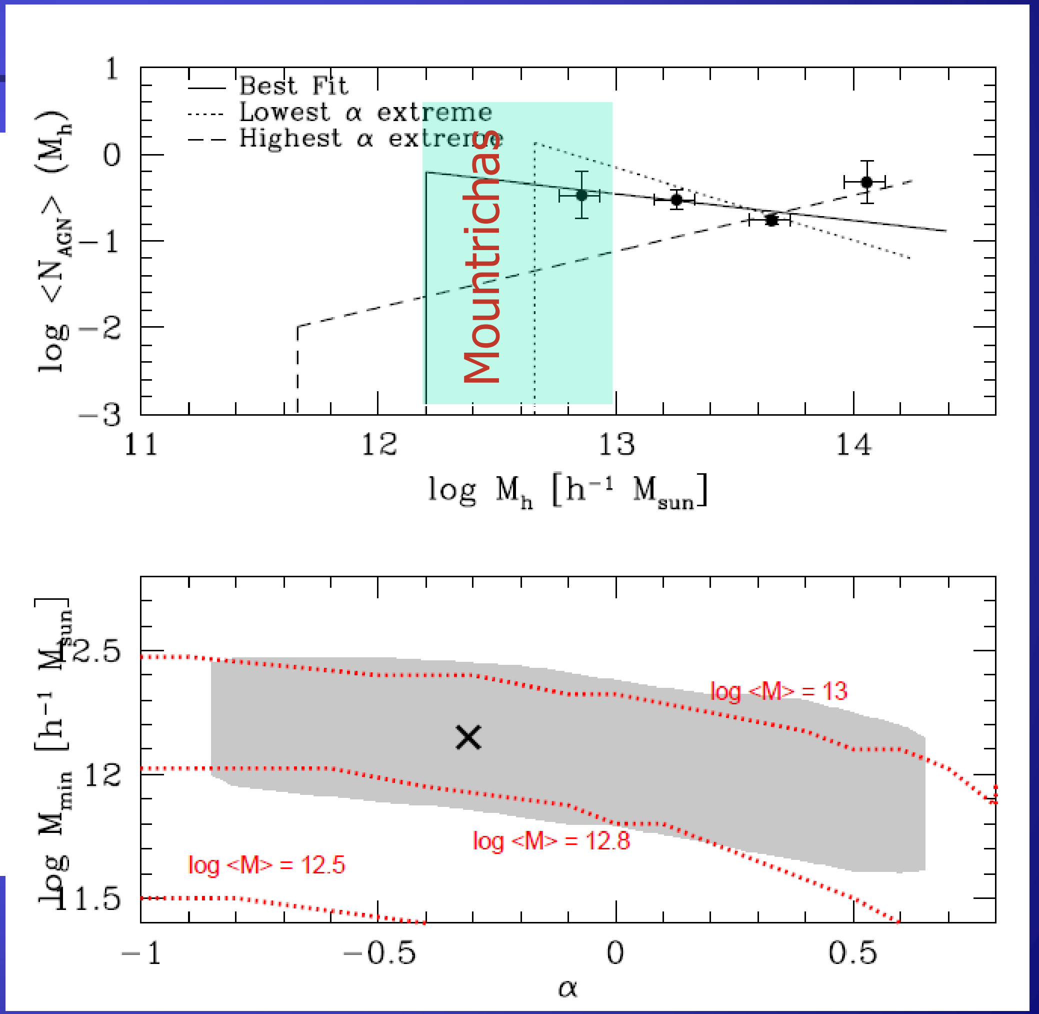
$$\langle N_{cen}\rangle(M_h) = f'_a \; erf\left(\frac{logM_h - logM_{min}}{\sigma_{logM}}\right)$$

Allevato, AF, et al. 2012

HOD model parameters

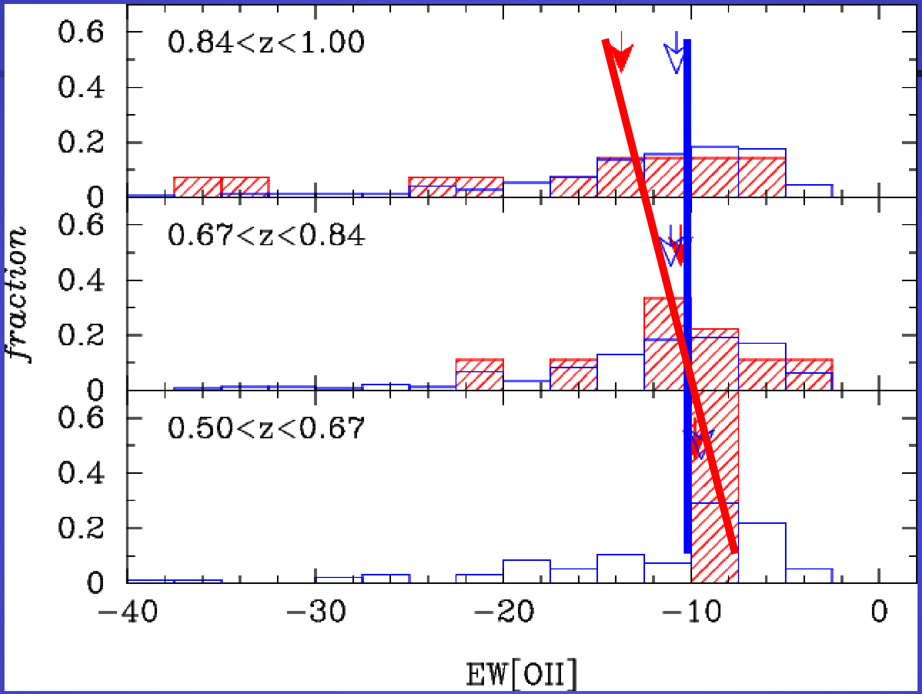
Allevato et al. 2012 (COSMOS); Mountrichas, Georgakakis, AF+ 2013 (AEGIS, COSMOS, ECDFS)





Residual r_o=4.5+/-0.4 (Mountrichas)
CDFN: 4.2+/-0.4 (Gilli'05)

Increased red [OII] emitters in groups at high redshifts

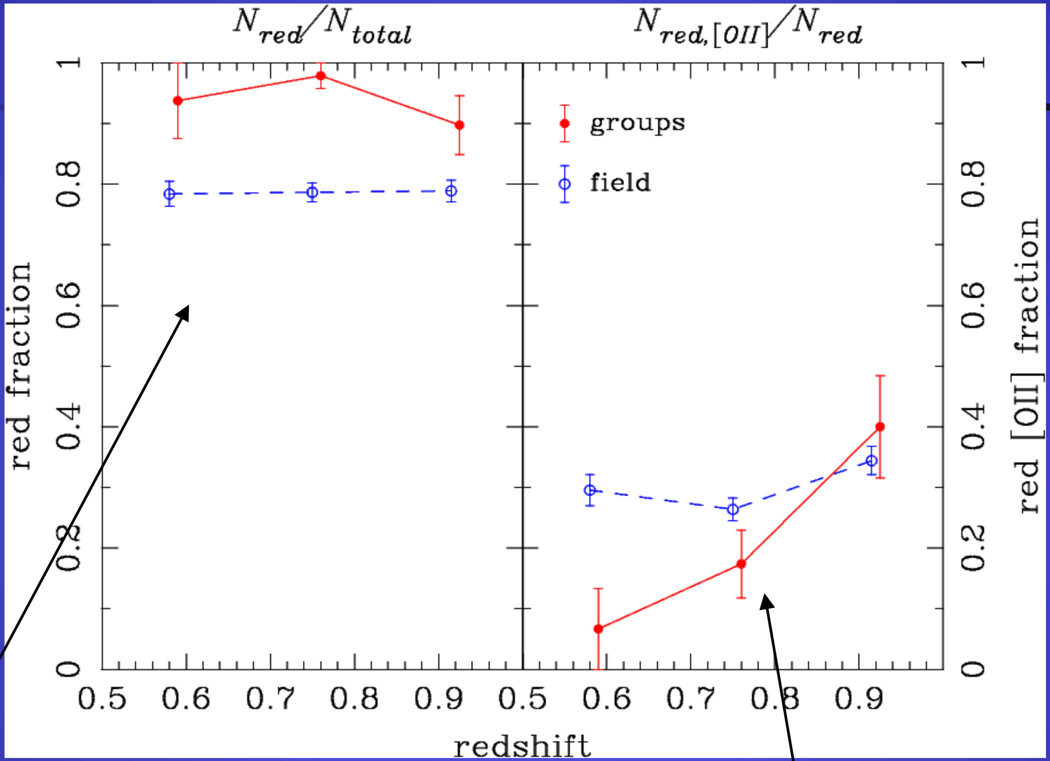


Not only the fraction, but the strengths of [OII] increases as well.

Based on the 30-band photometry (*NUV-r* from Ilbert et al. 2010), we find these red [OII] emitters are not undergoing active star formation. The [OII] emission is likely due to AGNs.

Tanaka et al. to be submitted soon

Increased red [OII] emitters in groups at high redshifts



groups

field

The red fraction clearly depends on environment. The red fraction does not strongly change with redshift (note that we are looking at very massive galaxies only).

But, the [OII] emitters on the red sequence strongly increases in groups at high redshifts.

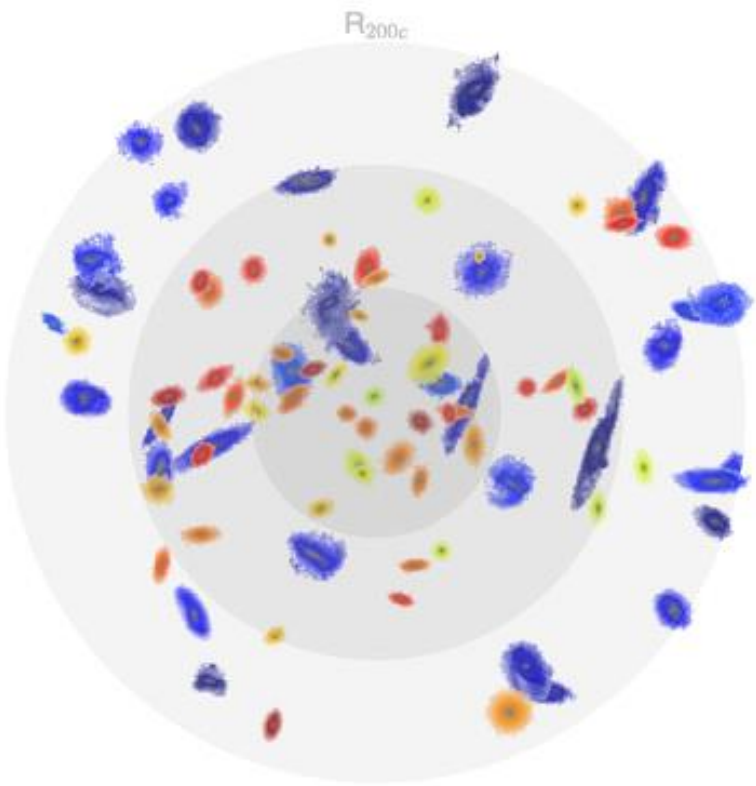
Tanaka et al. to be submitted soon

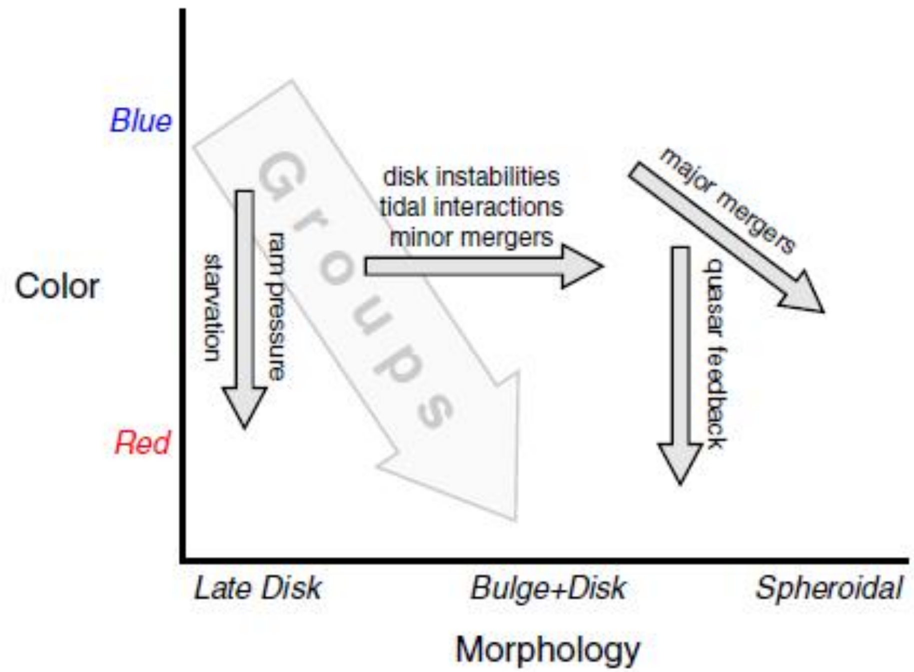
Summary on AGN

- z>3 fast growth of BH leads to a large population exceeding $10^8\ M_\odot$
- z<3 secular evolution
- z>1 groups contain typical AGN
- z<1 groups contain optically dull AGN
- M~$10^{13}\ M_\odot$ groups: extra triggering is seen in the center
- M~$10^{15}\ M_\odot$ survival AGN only through the first infall
- z<3 X-ray AGN trace galaxy transformation in massive environment

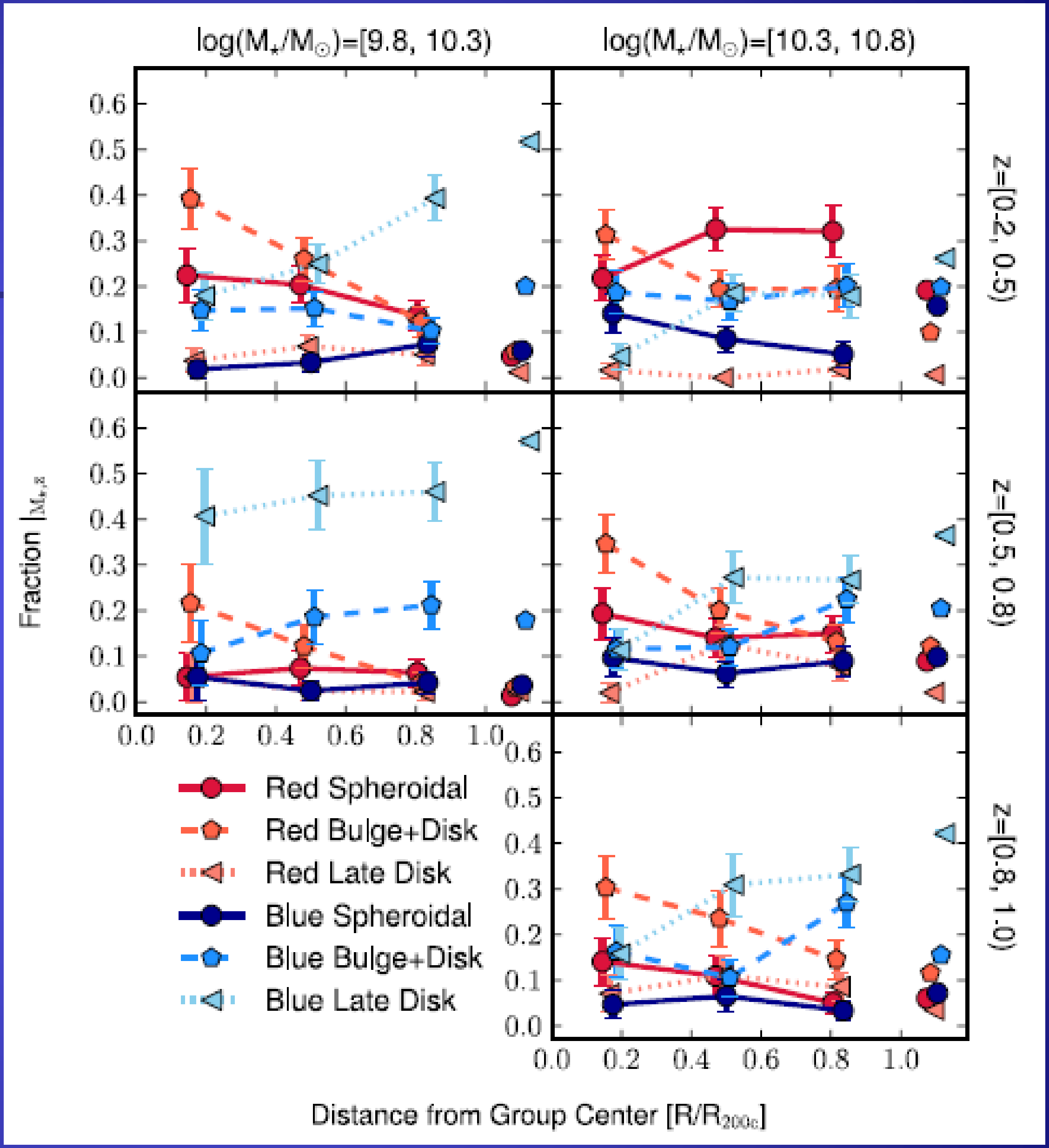
(clustering argument, as in a post-phase bias would be lower)

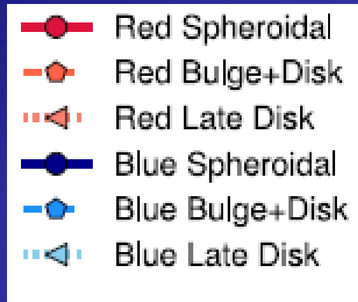
Galaxy transformation

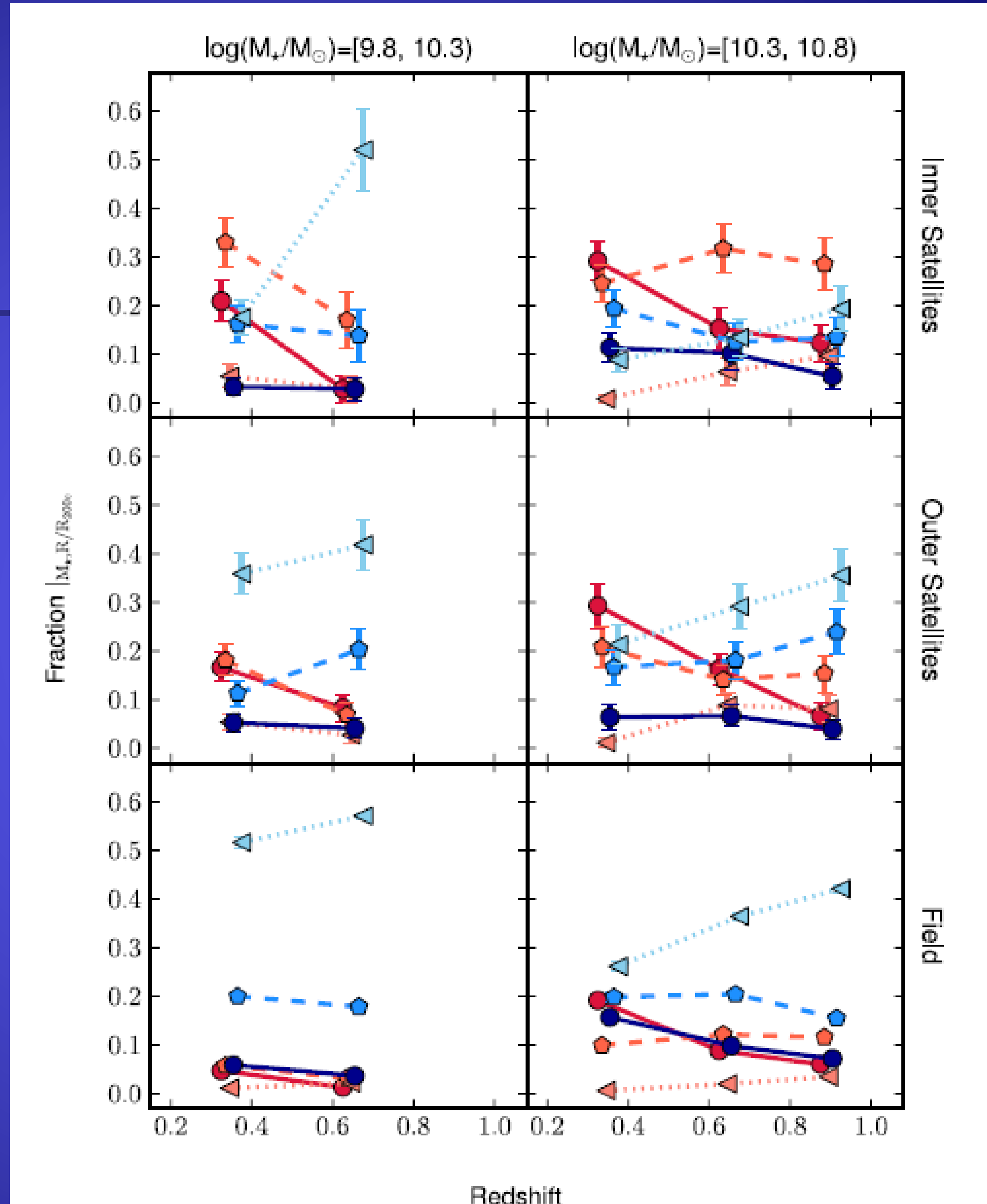




Strong radial trends get established at low-z

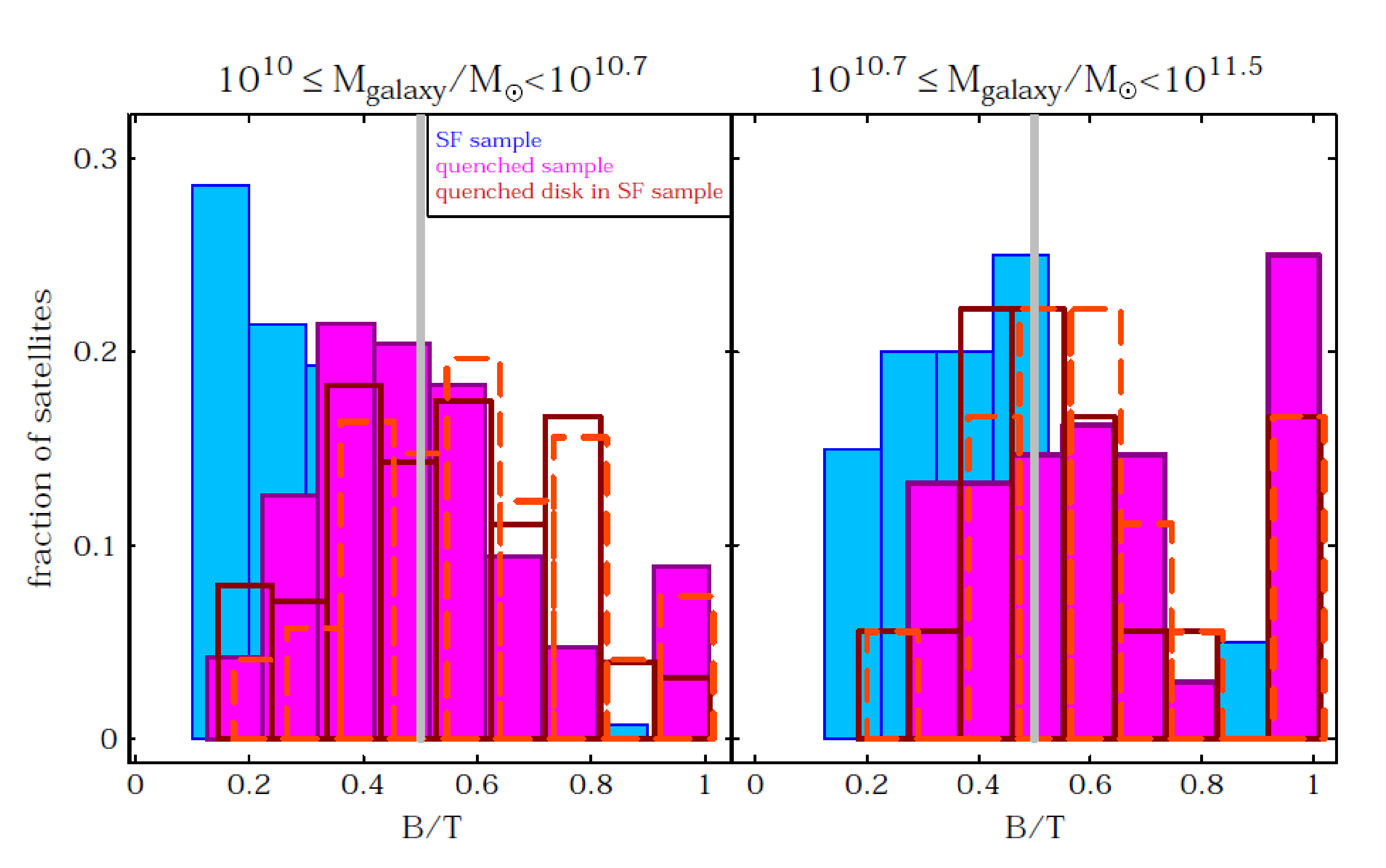




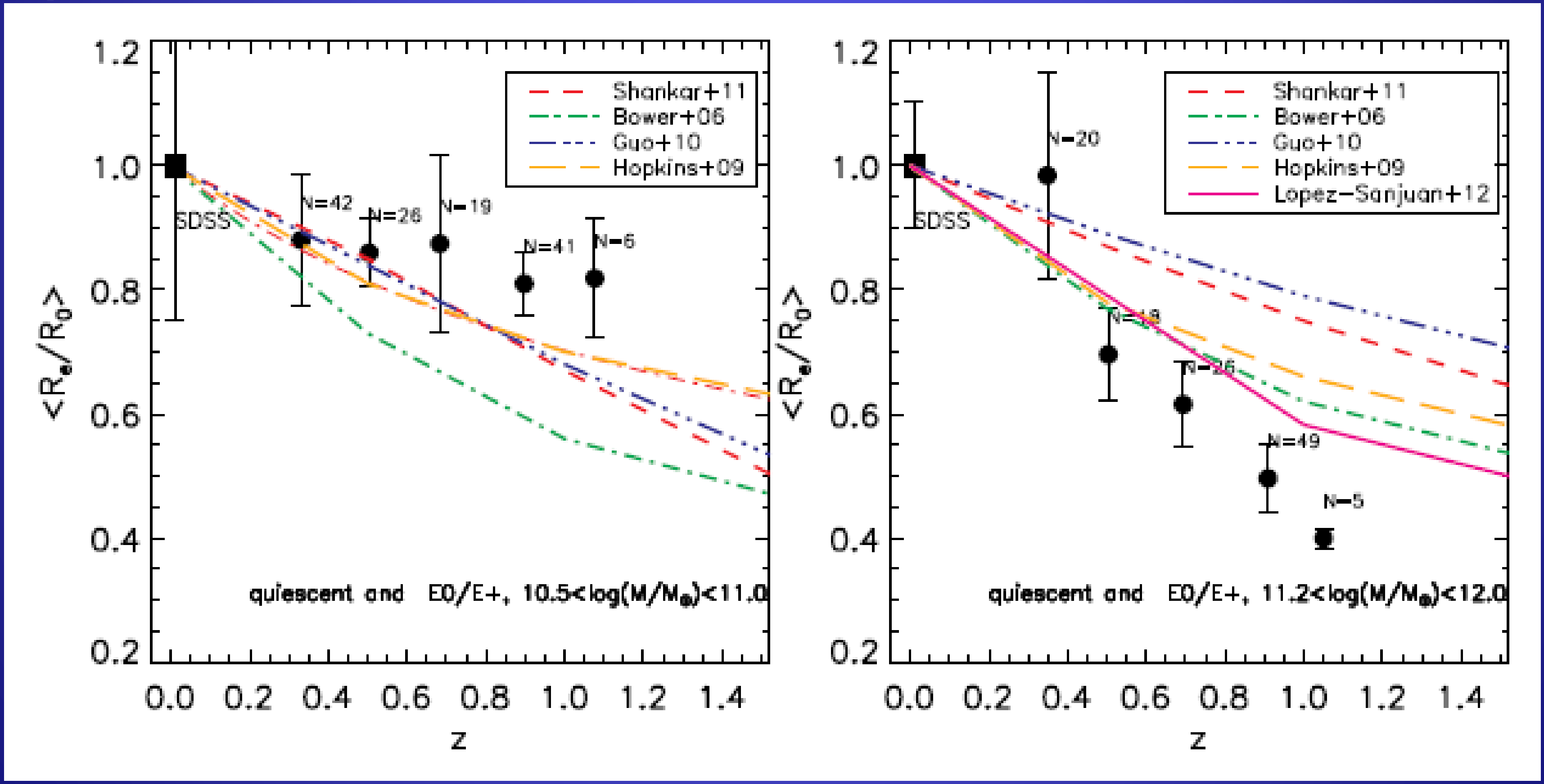


evolution of blue disks and red bulge+disk

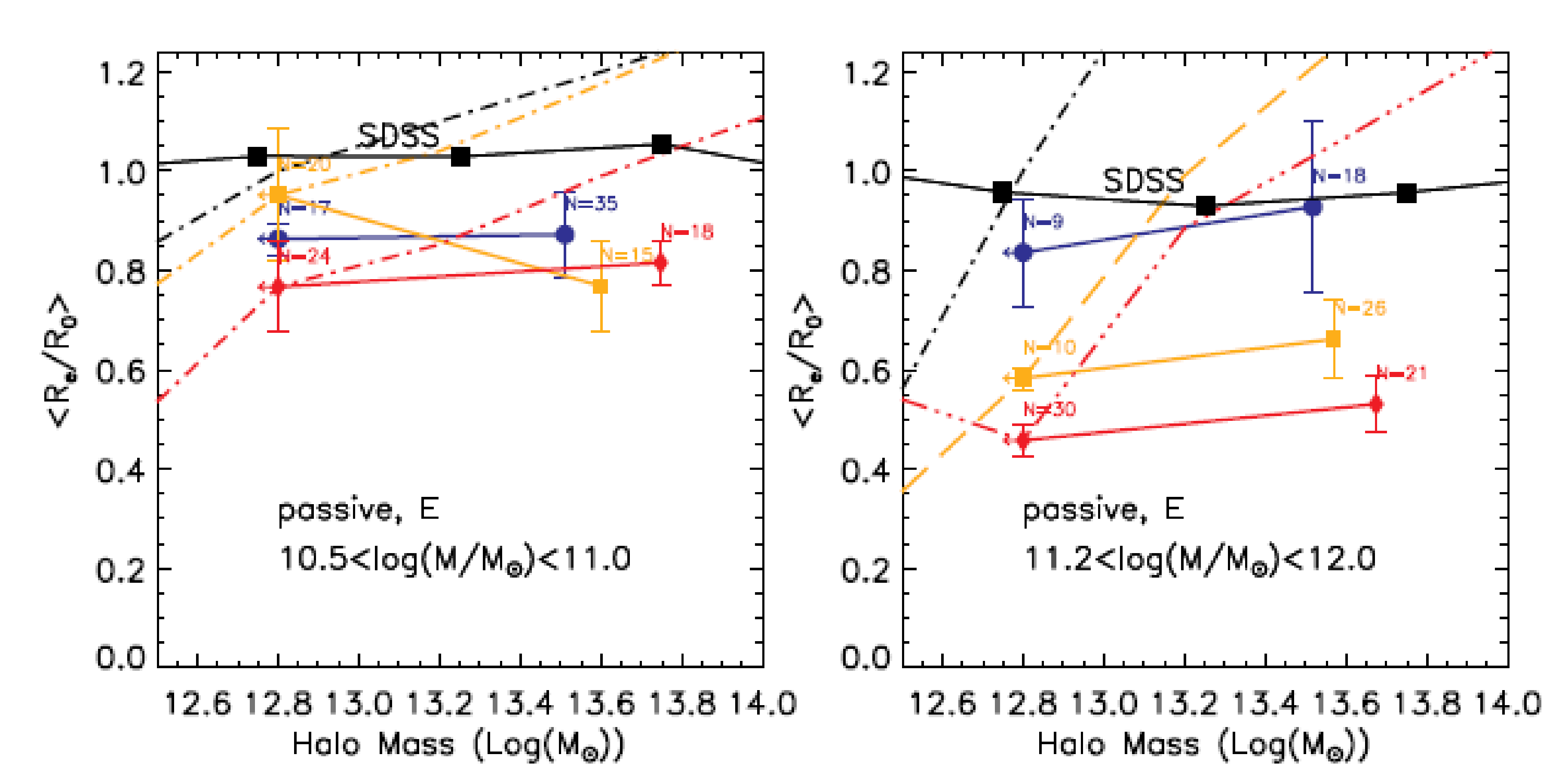
z~0: ZENS. Carollo+2014



Size evolution of Es



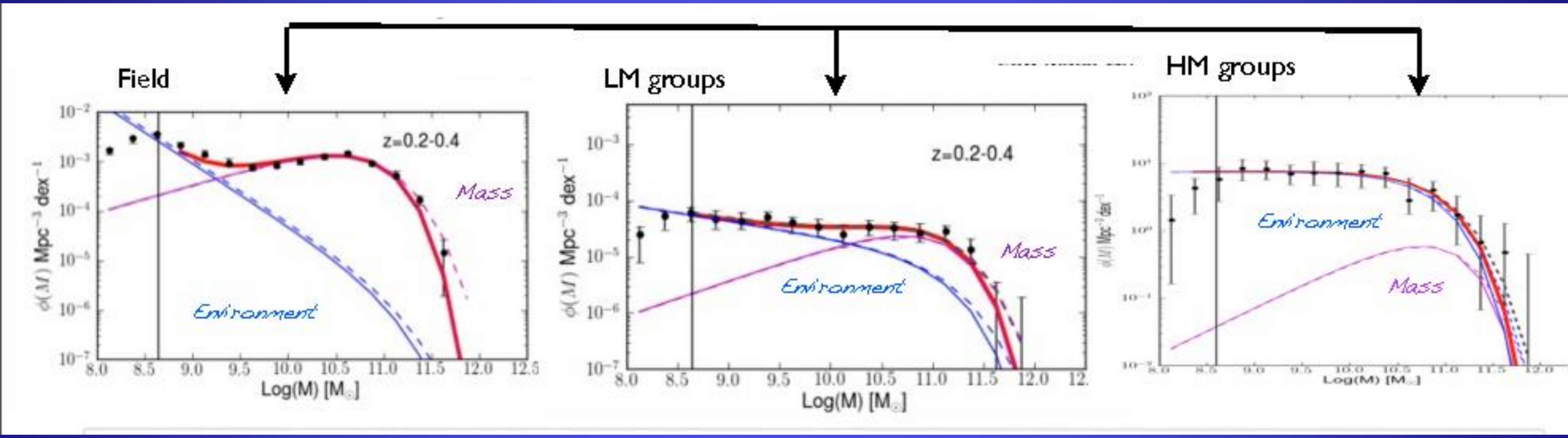
Group mass vs galaxy size



Huerto-Company, Mei, AF

Peng-Lilly argument

Quenched galaxies

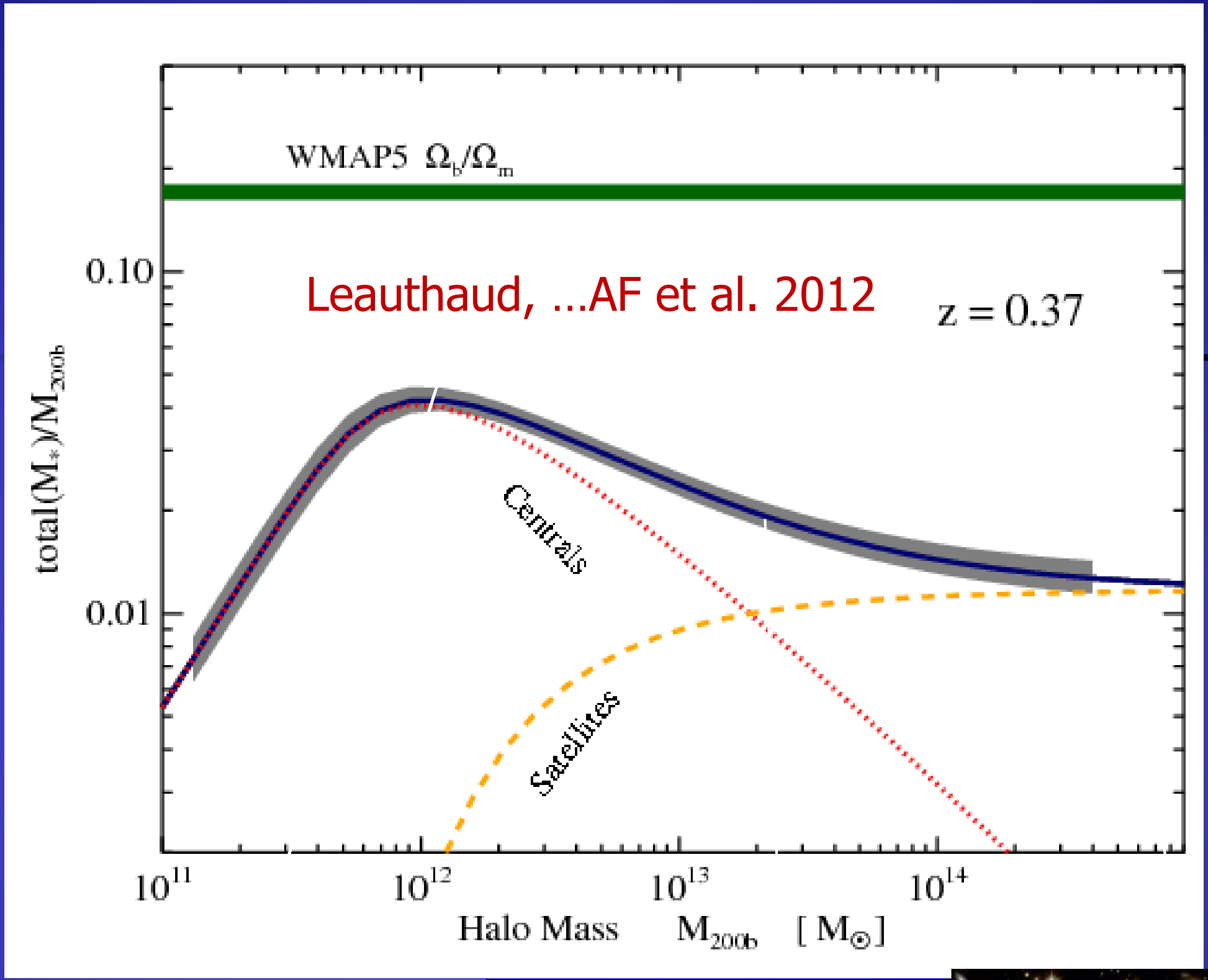


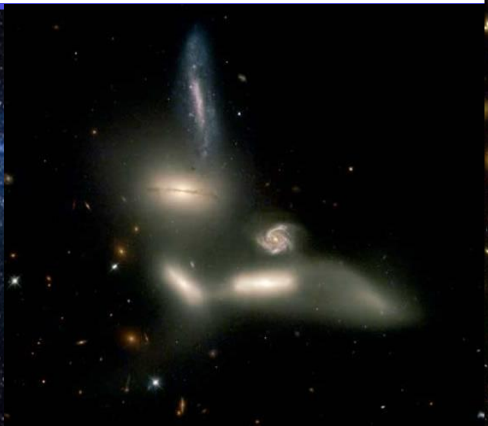
Giodini, AF, Peng, Lilly, et al. 2011

Mass=>feedback (AGN) quenching

- *Field: mainly dwarf galaxies are quenched by environment*
- *Both components are seen in 3.e13 groups*
- *Clusters are dominated by environmental quenching*

Groups and their galaxies





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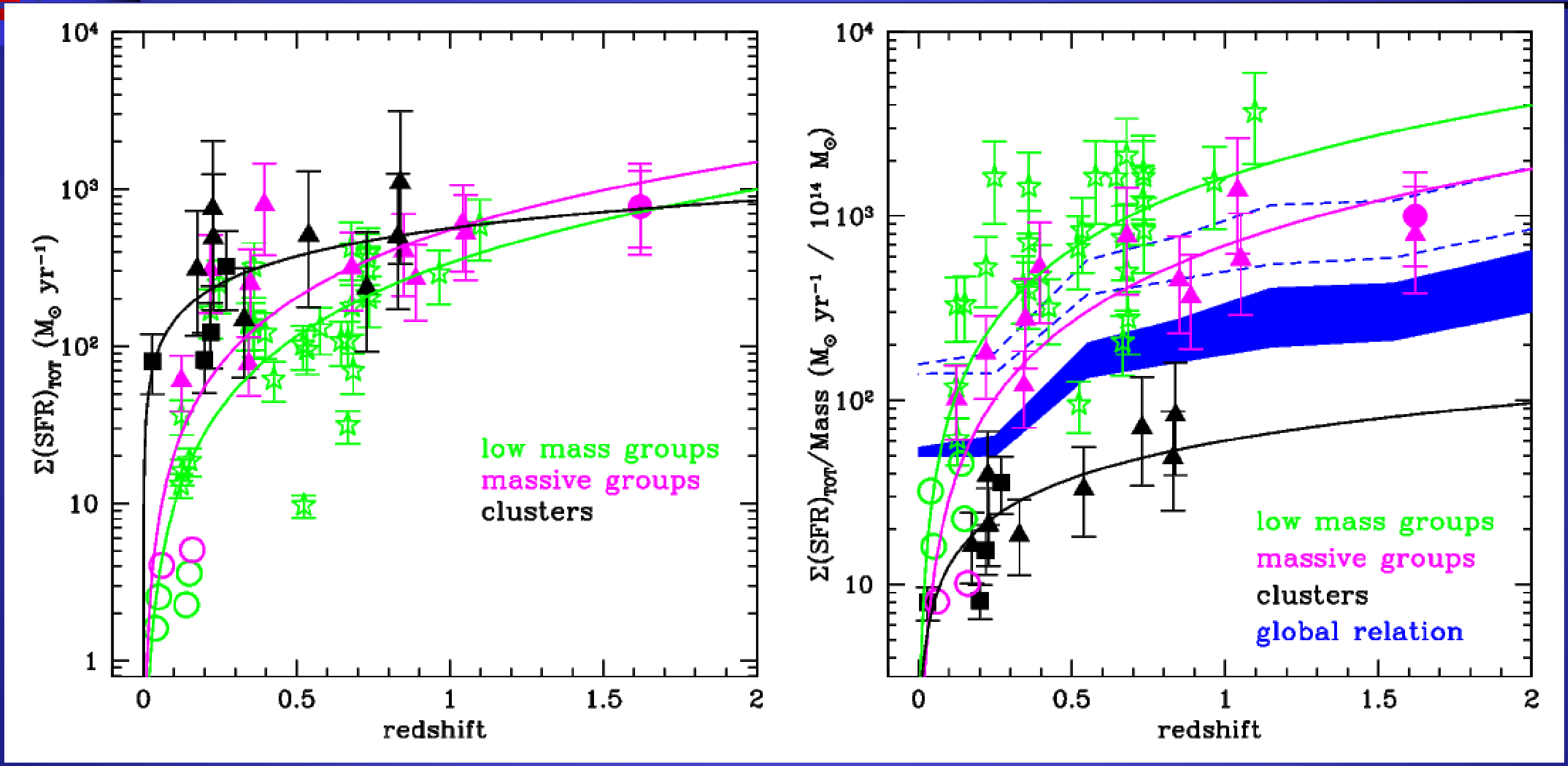
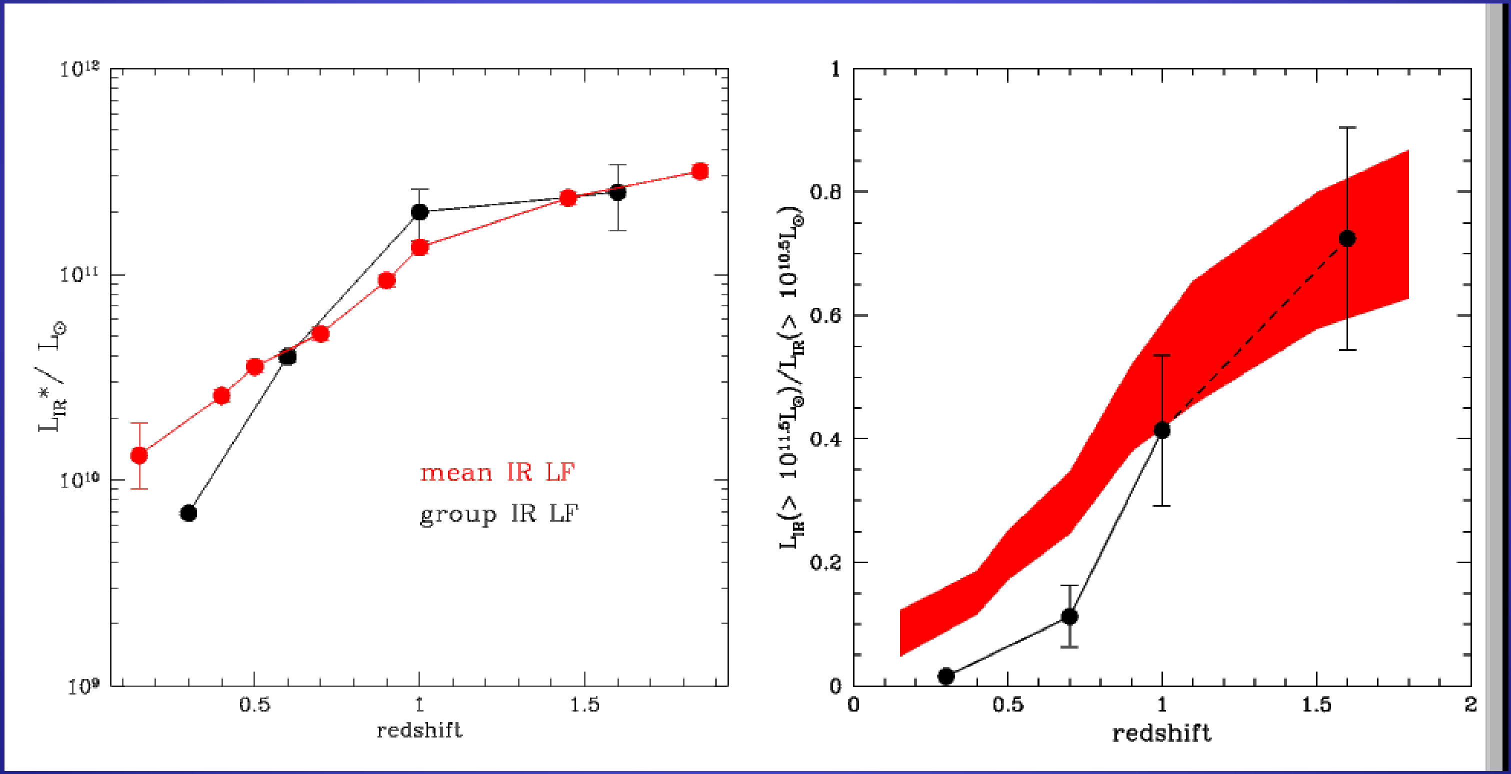
SFR evolution



Highest rate correspond to 6% of baryons per Gyr

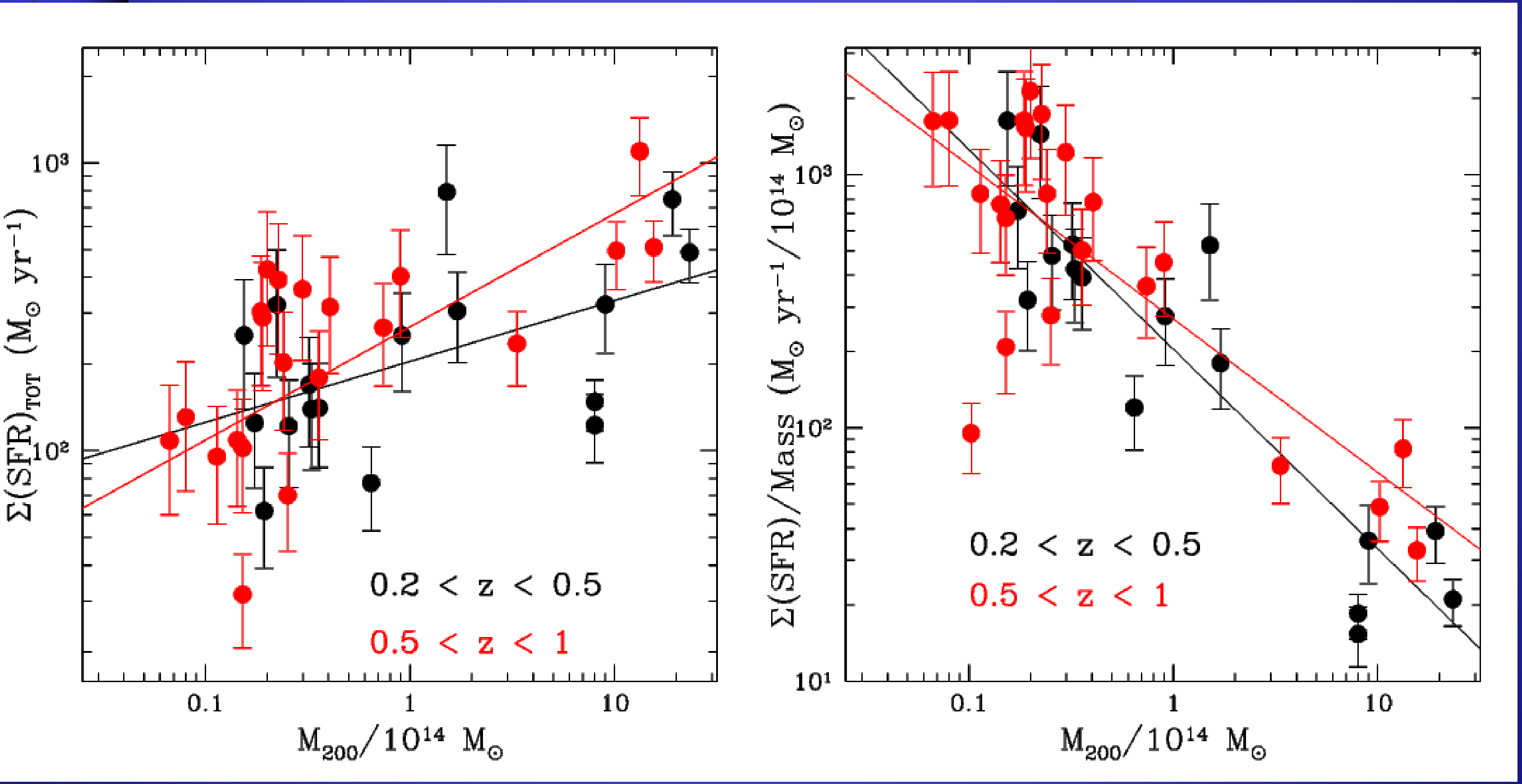
Popesso, Biviano, AF et al. 2014

IR-LF evolution in different environment



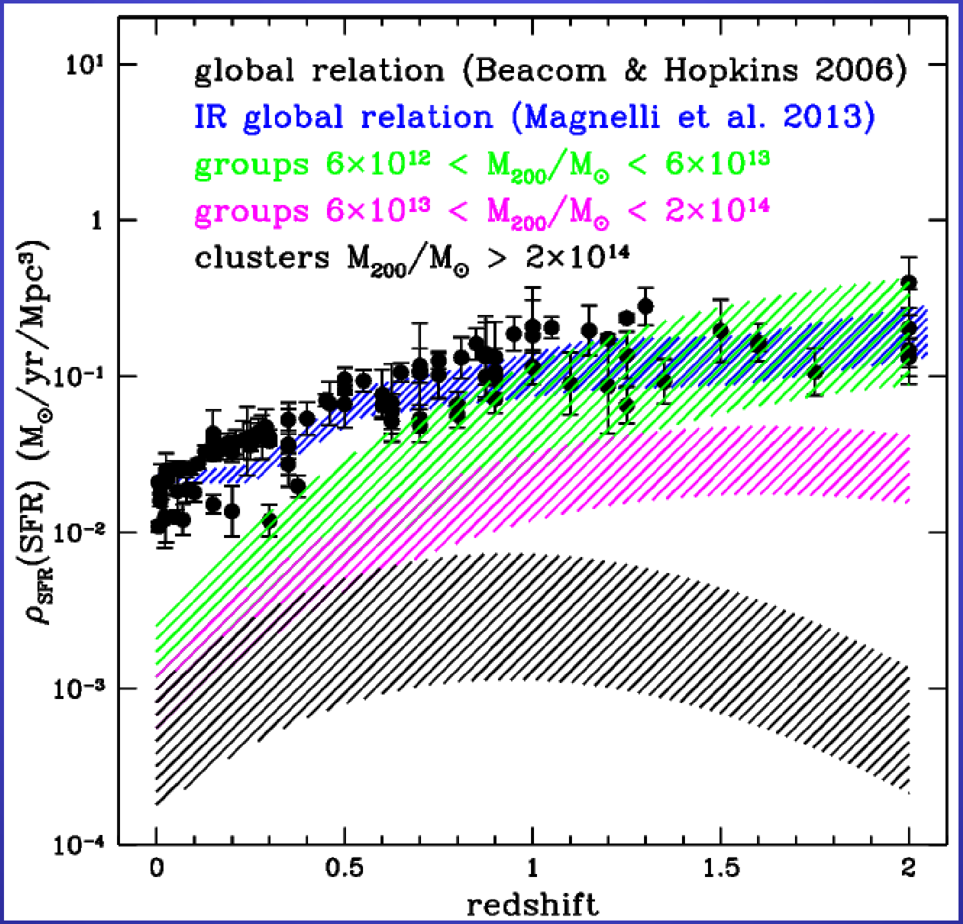
Popesso, Biviano, AF, et al. 2014

Mass trends in SFR



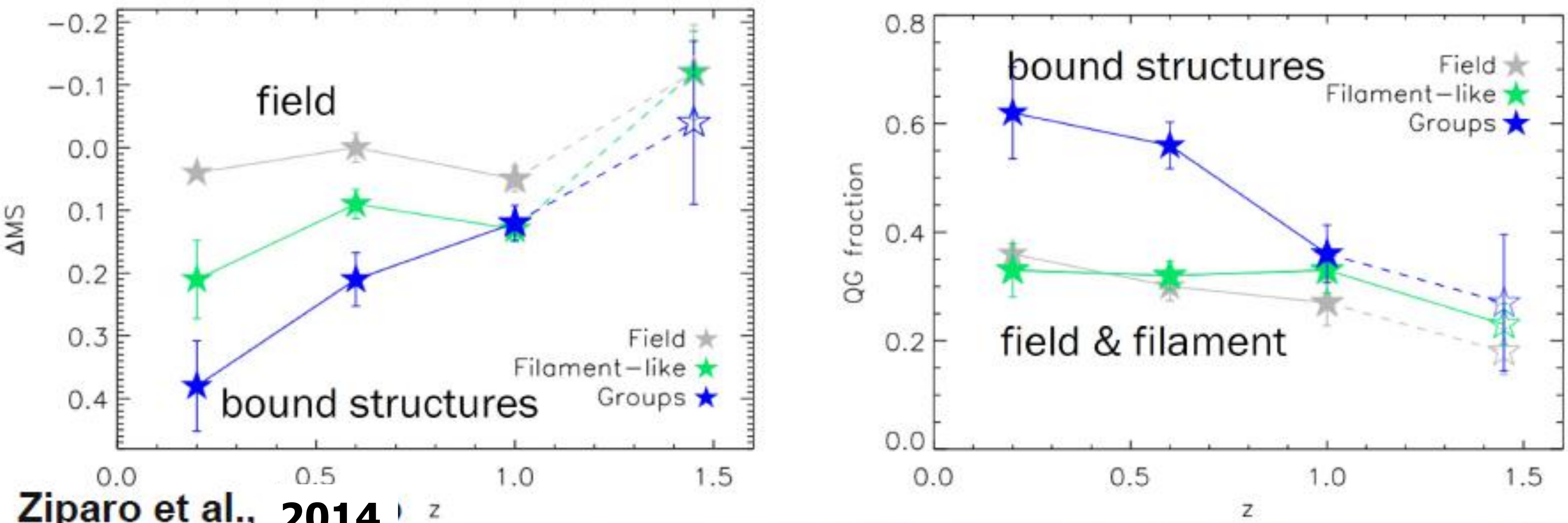
Popesso, Biviano, AF et al. 2014

Groups and global SFR



Popesso, Biviano ,AF+14

Halo mass dependence on SF quenching



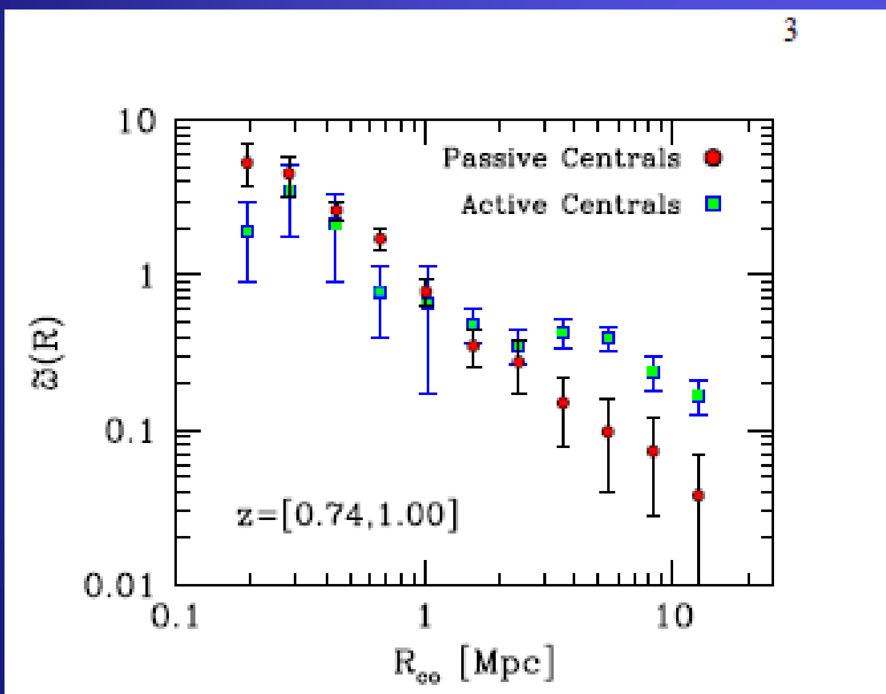
Ziparo et al., **2014**

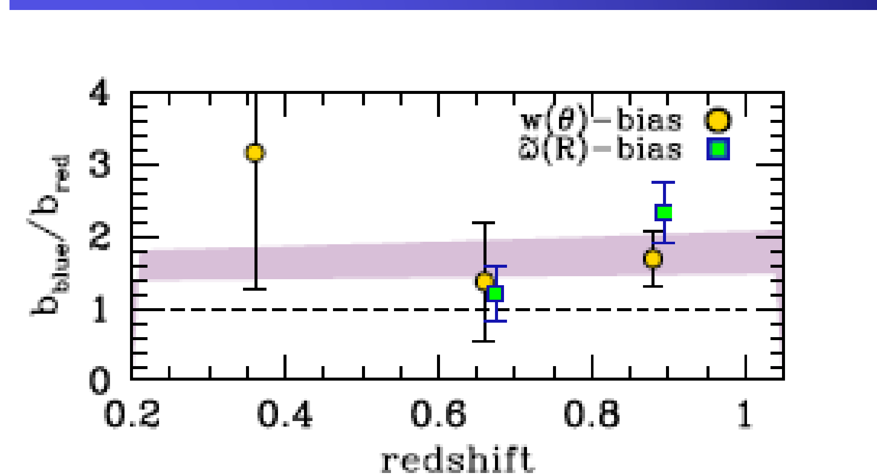
See a talk by Erfanianfar

- Quenching in groups more efficient than in filaments (same density)
- Different galaxy type mix in groups

➔ **Quenching is more DM than density dependent**

Role of halo formation (relevant for the conformity)
Tinker,… AF et al. 2012





Conclusions

- The shape of the AGN XLF is similar between the filed and galaxy groups, but not in clusters. Similarity to GSMF.
- AGNs are quenched during the first passage through the cluster. Similar to galaxies
- AGN activity in galaxy groups seems to proceed in parallel with formation of the bulge component of spirals and quenching of their star-formation activity. As such AGN in groups confuse the general trends of BH growth that proceed in parallel with SFR and due to direct matter infall.
- Groups contribute substantially to the star-formation budget at high redshifts
- Morphology studies indicate an importance of dynamical interaction in explaining the galaxy transformation

Size evolution of BCGs