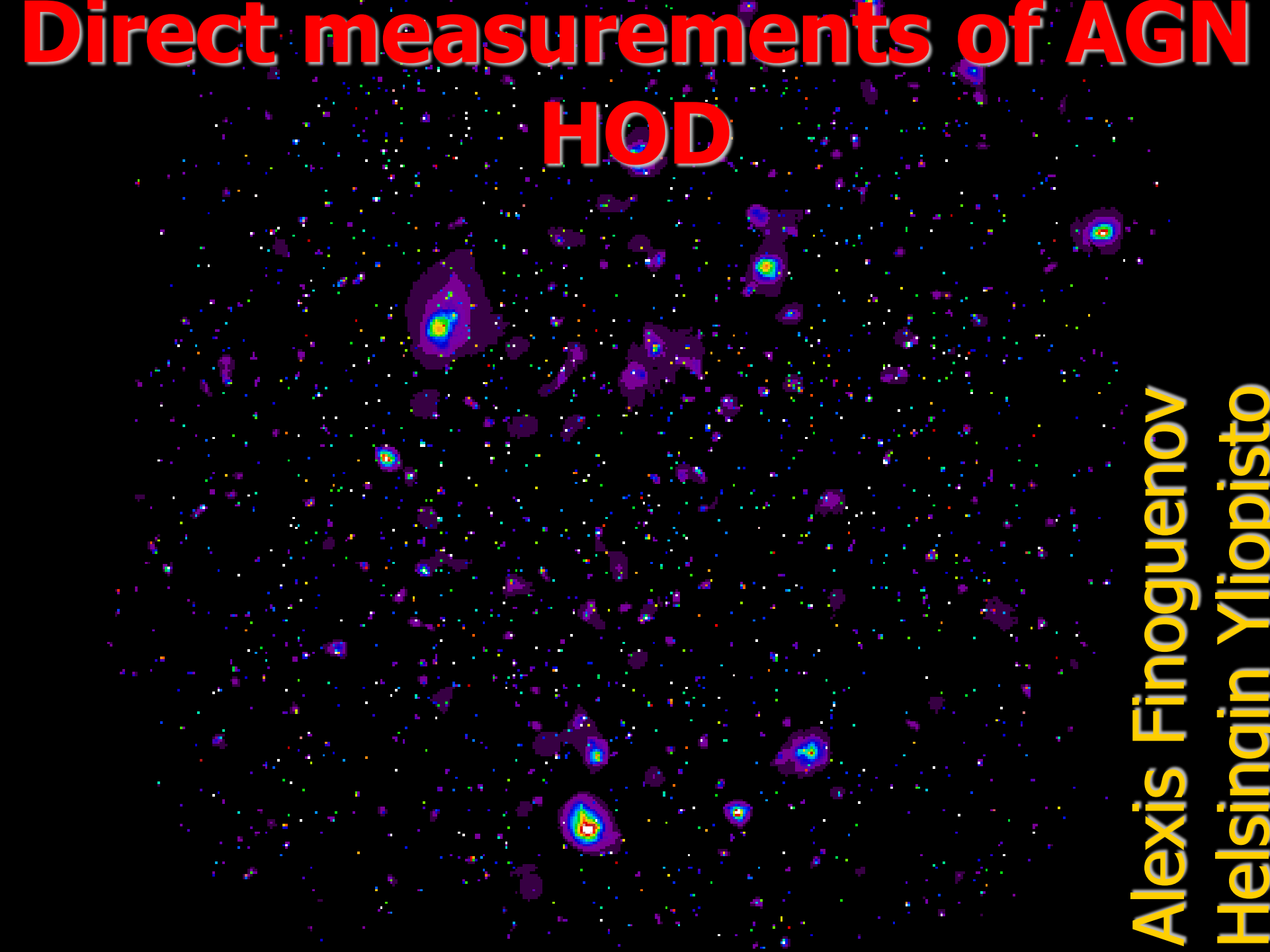
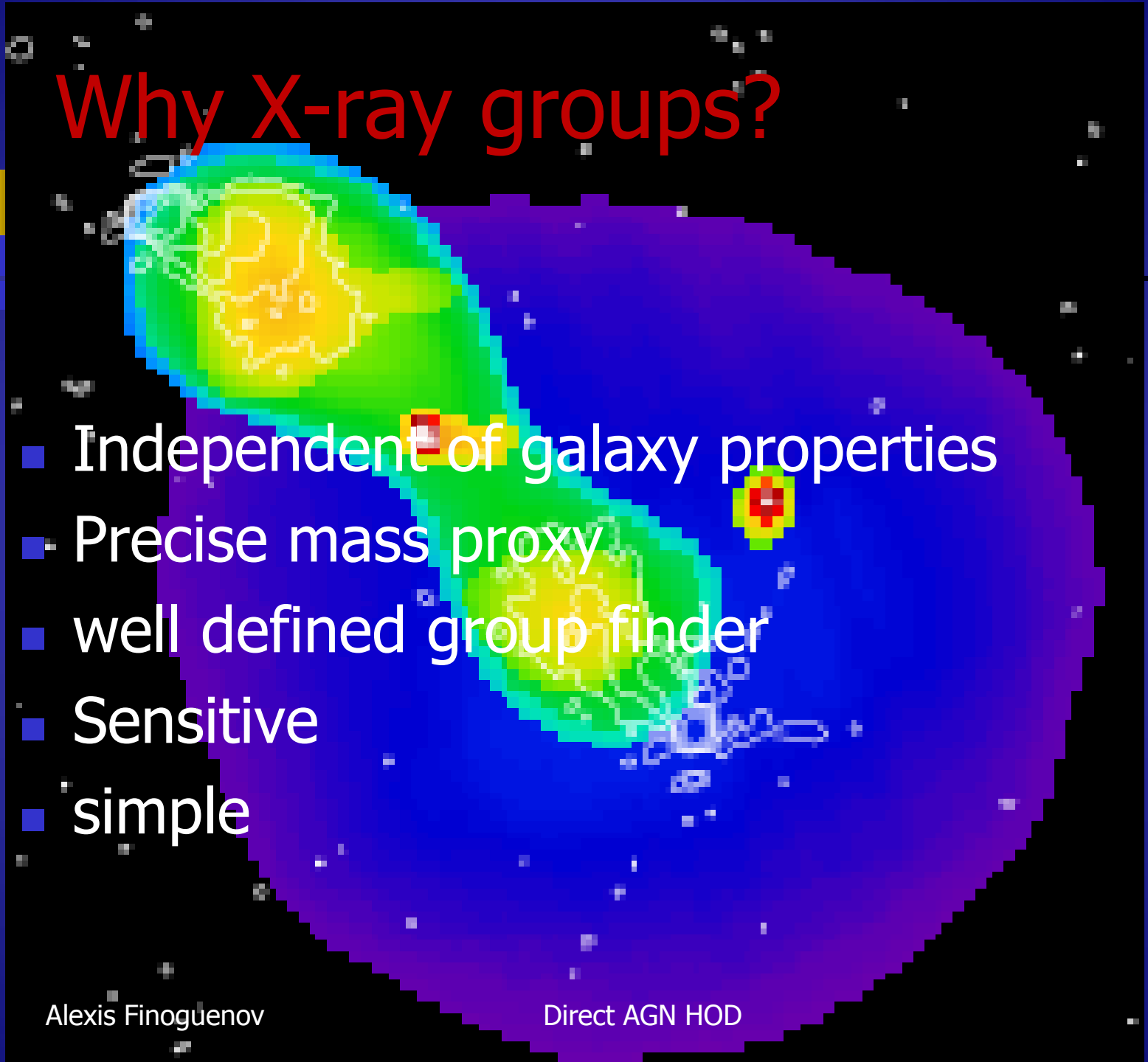
Direct measurements of AGN HOD

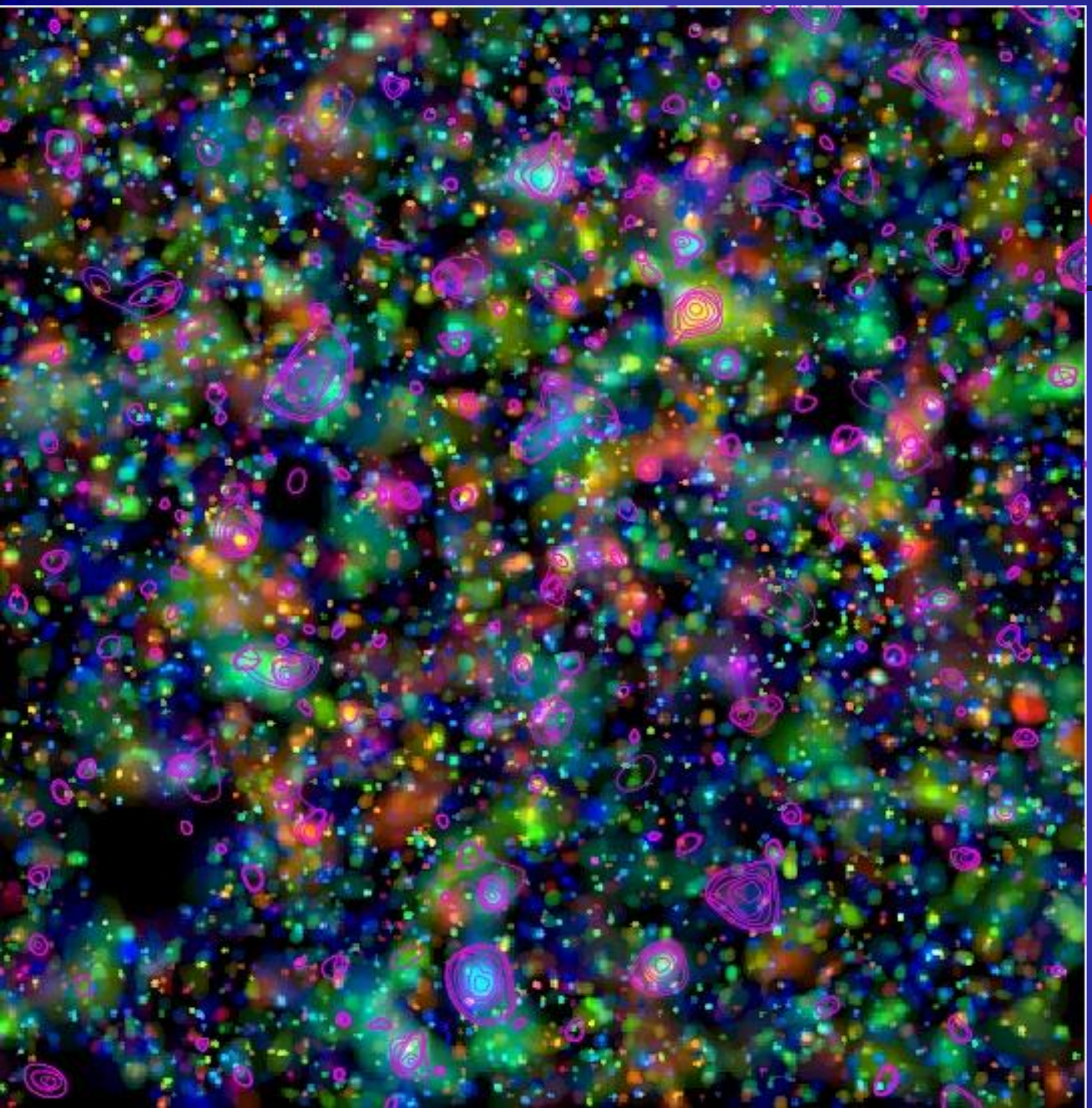


Alexis Finoguenov
Helsingin Yliopisto

Why X-ray groups?



- Independent of galaxy properties
- Precise mass proxy
- well defined group finder
- Sensitive
- simple



COSMOS

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

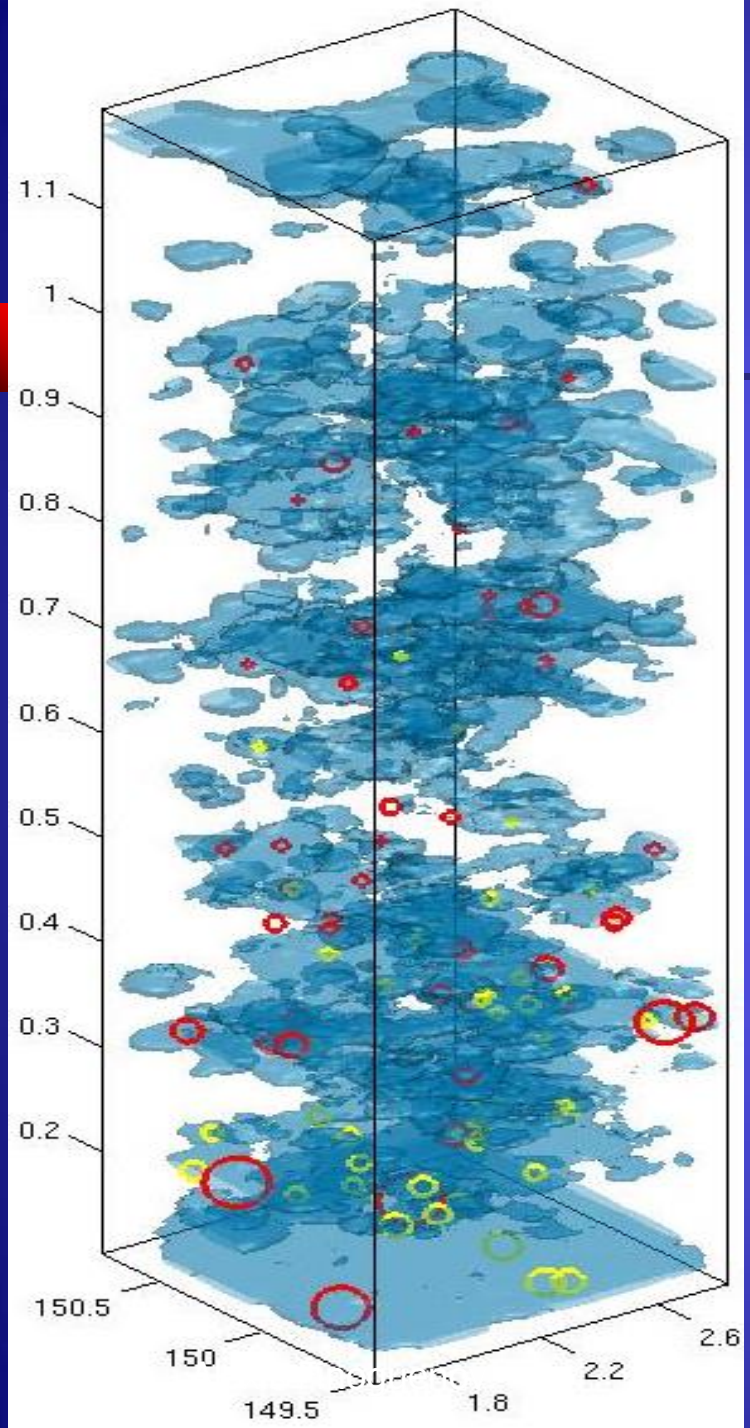
$I_{AB}<25$

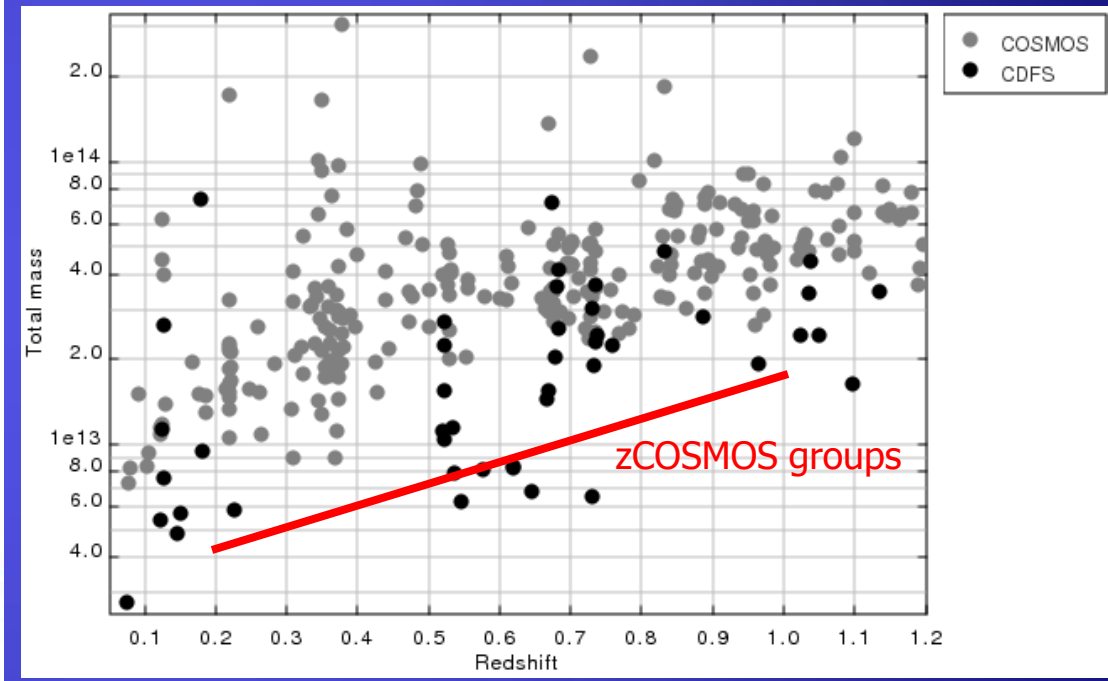
1.4Mio galaxies

X-ray contours

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

Galaxy groups and LSS

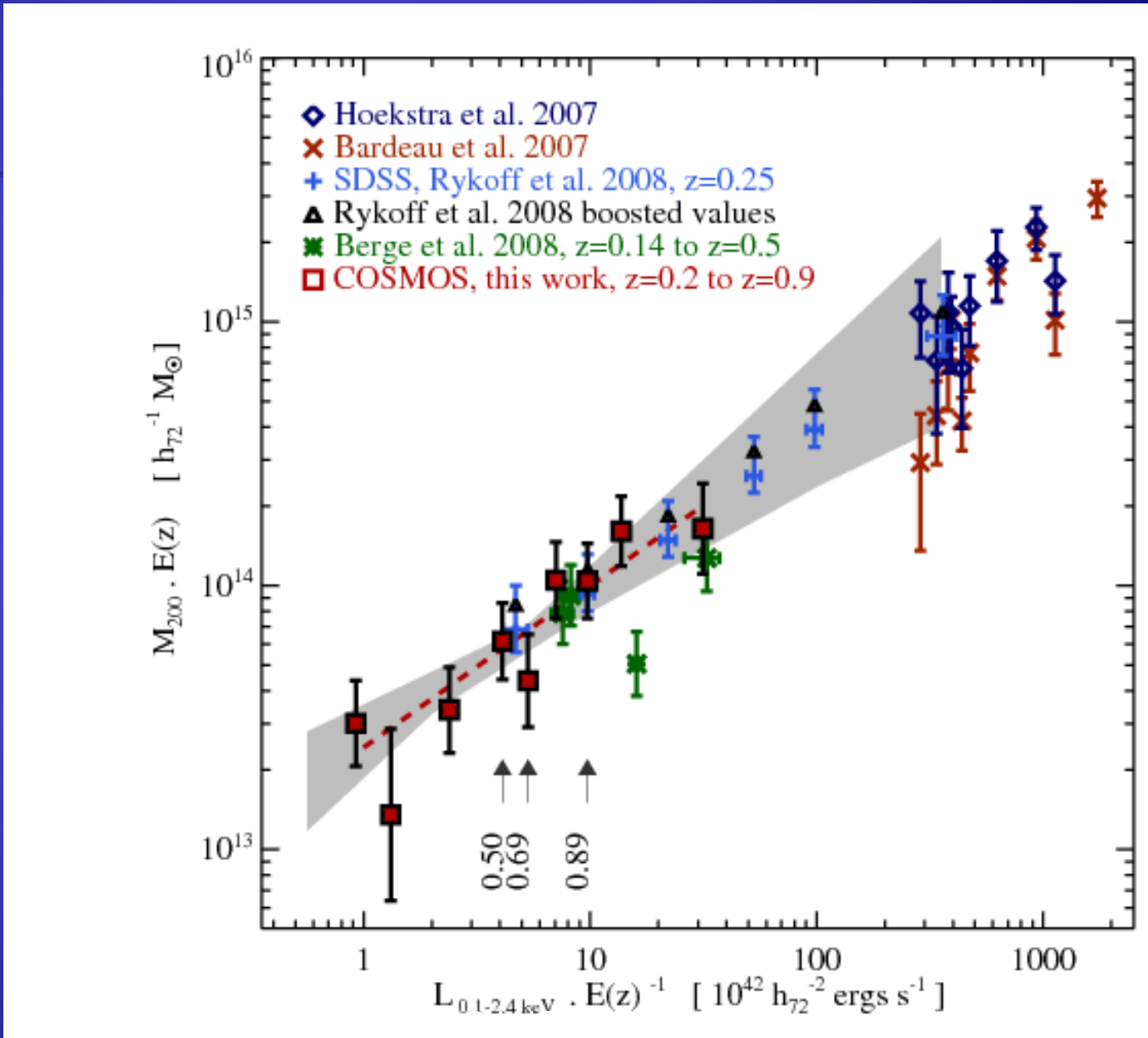




K.Kovac

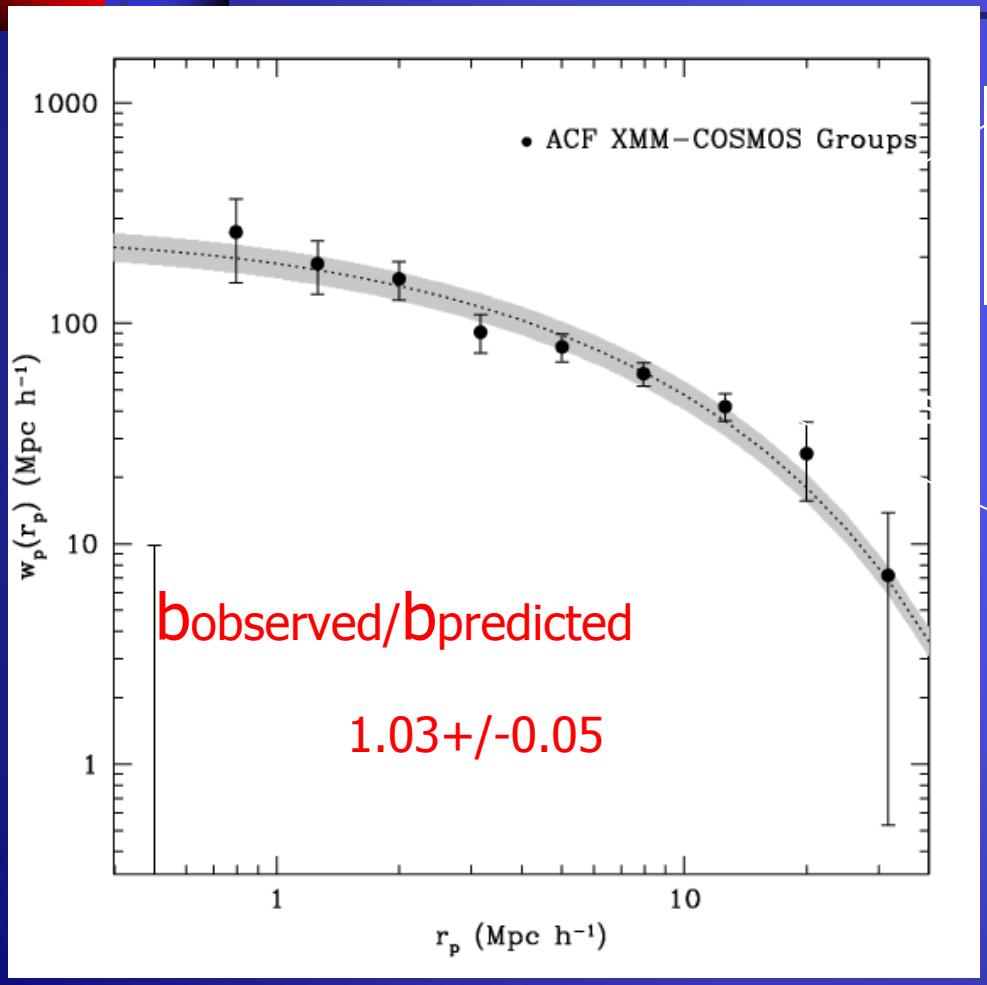
LSS at 0.12, 0.22, 0.34, 0.37, 0.51, 0.73, 0.89

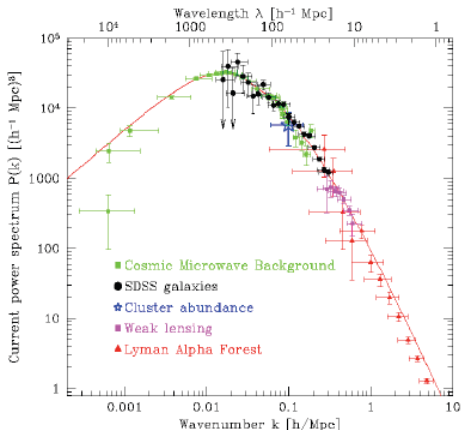
Weak lensing calibration of Lx-M relation



Leauthaud, AF et al. 2010

ACF and mass



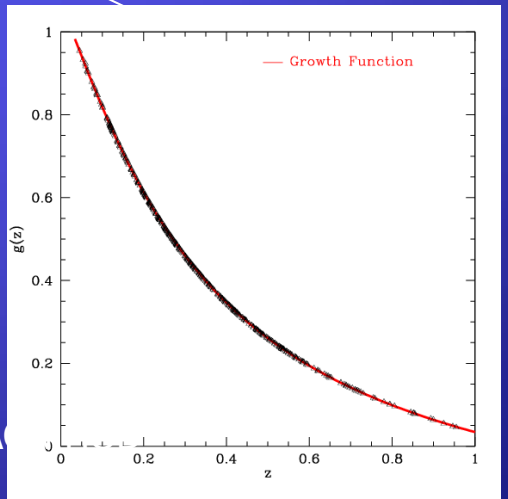


$$\bar{b}(M_0) = \sqrt{\frac{\sum_{i,j} b_i b_j g_{pair}}{N_{pair}}}$$

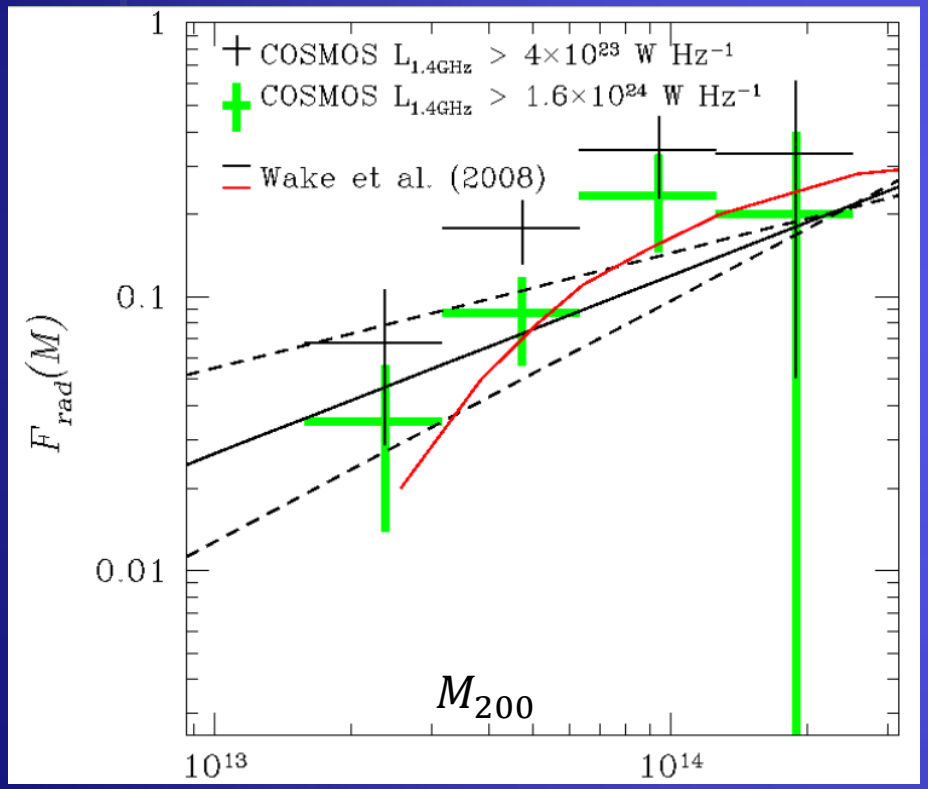
$$b_c = 1 + \frac{a\nu^2 - 1}{\delta_c} + \frac{2p/\delta_c}{1 + (a\nu^2)^p},$$

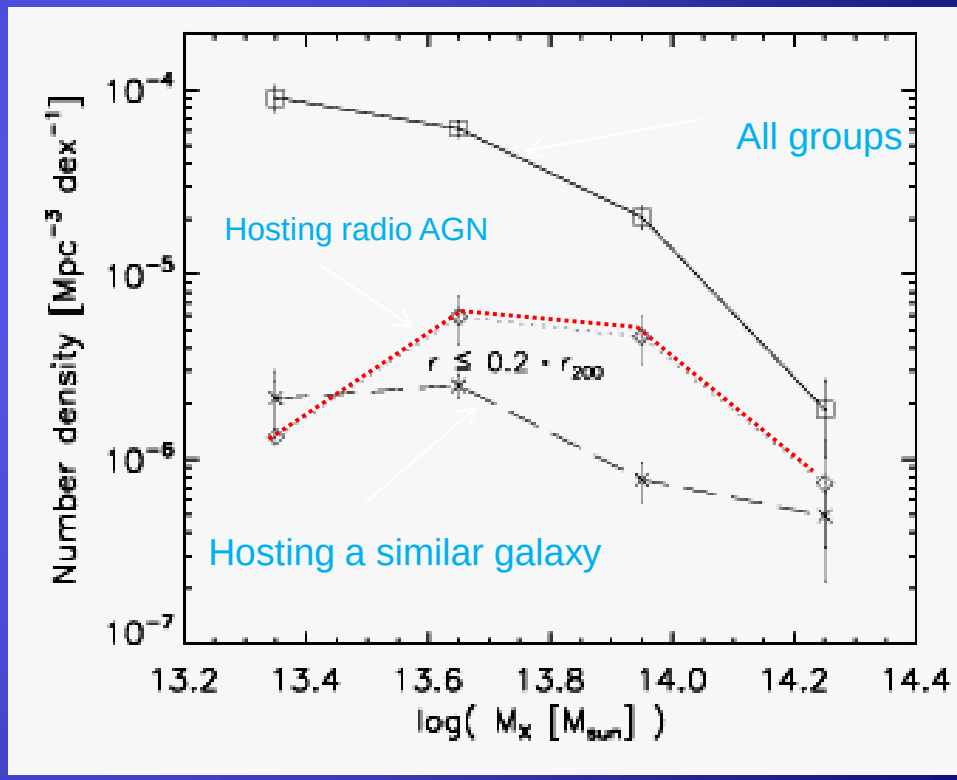
where A 0.322, a = 0.707 and p = 0.3.

Allevato, AF, et al. 2012

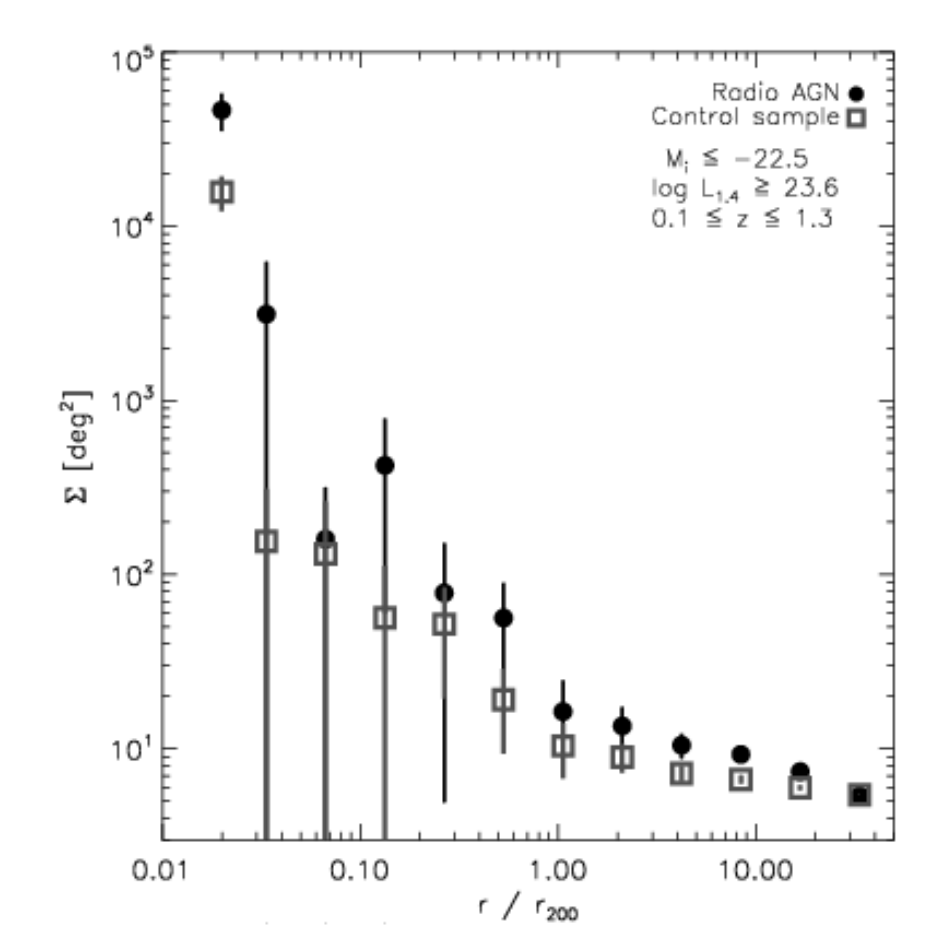


HOD of radio galaxies Smolcic, AF et al. 2011

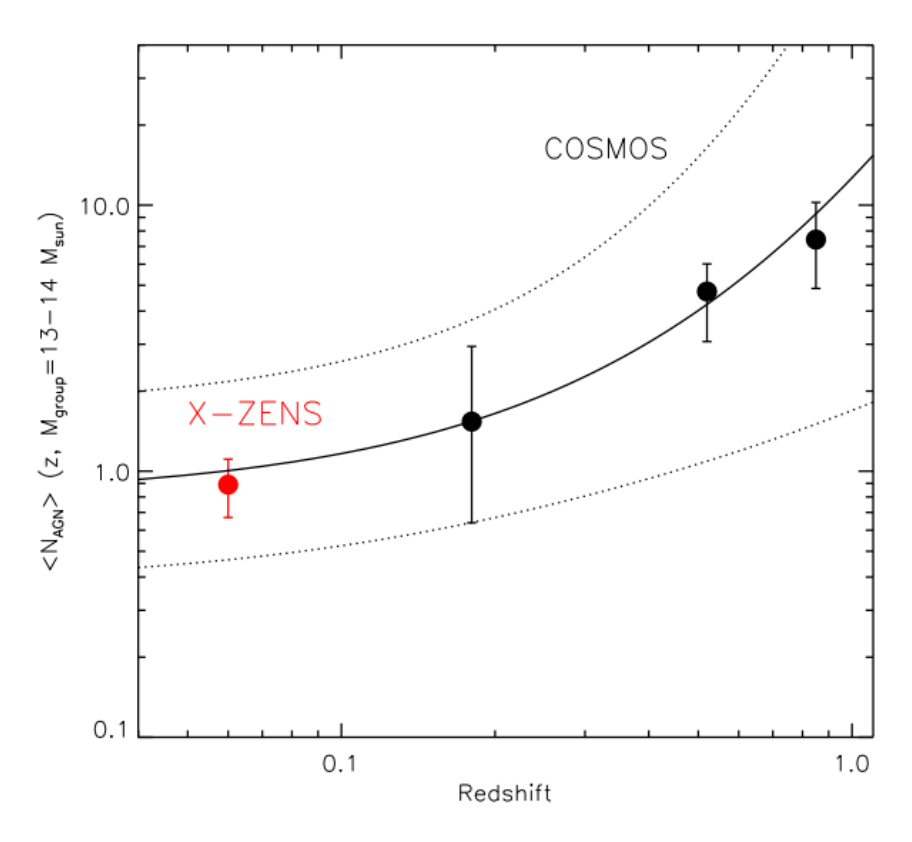


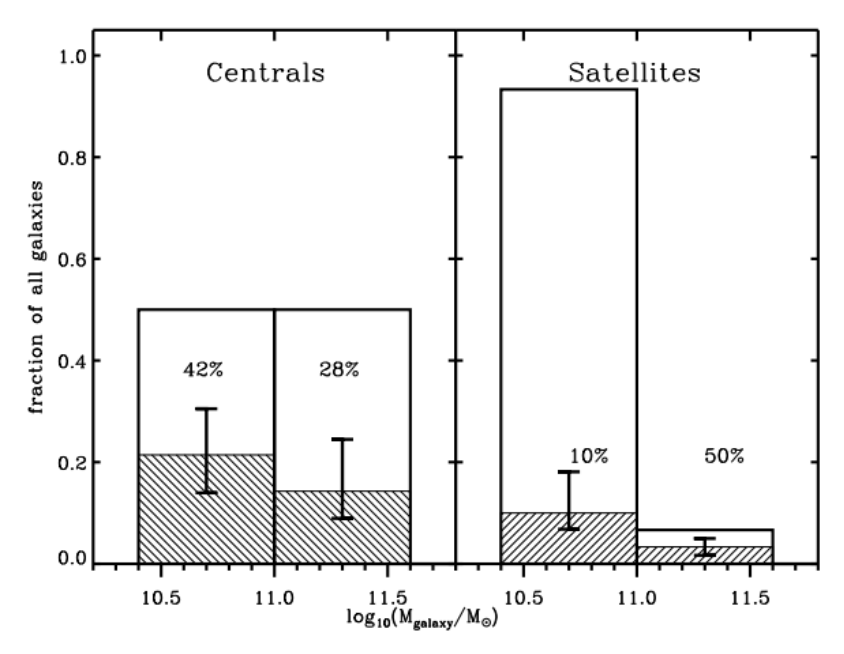


Radio distribution of Radio AGNs

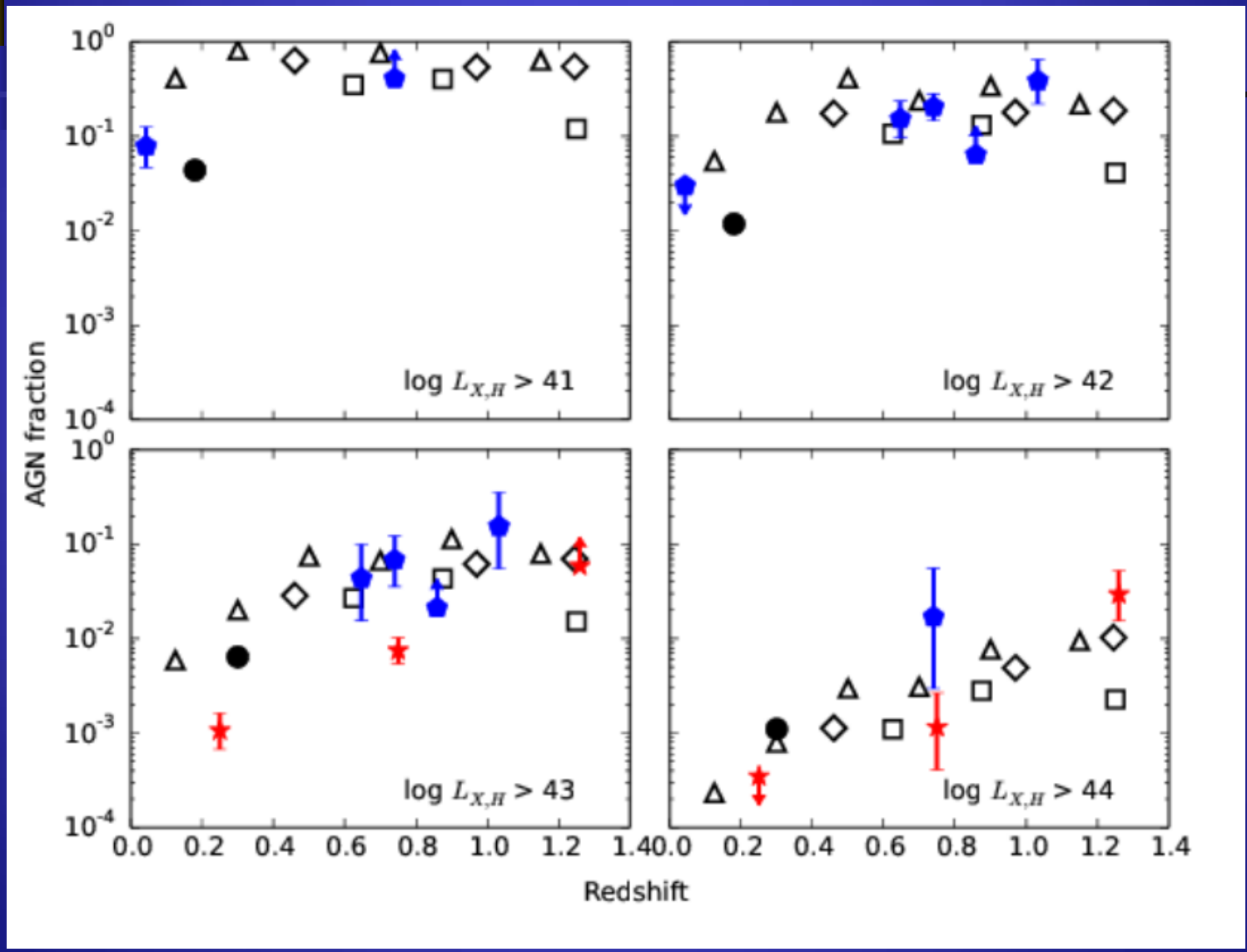


Silverman,..AF et al. 2014

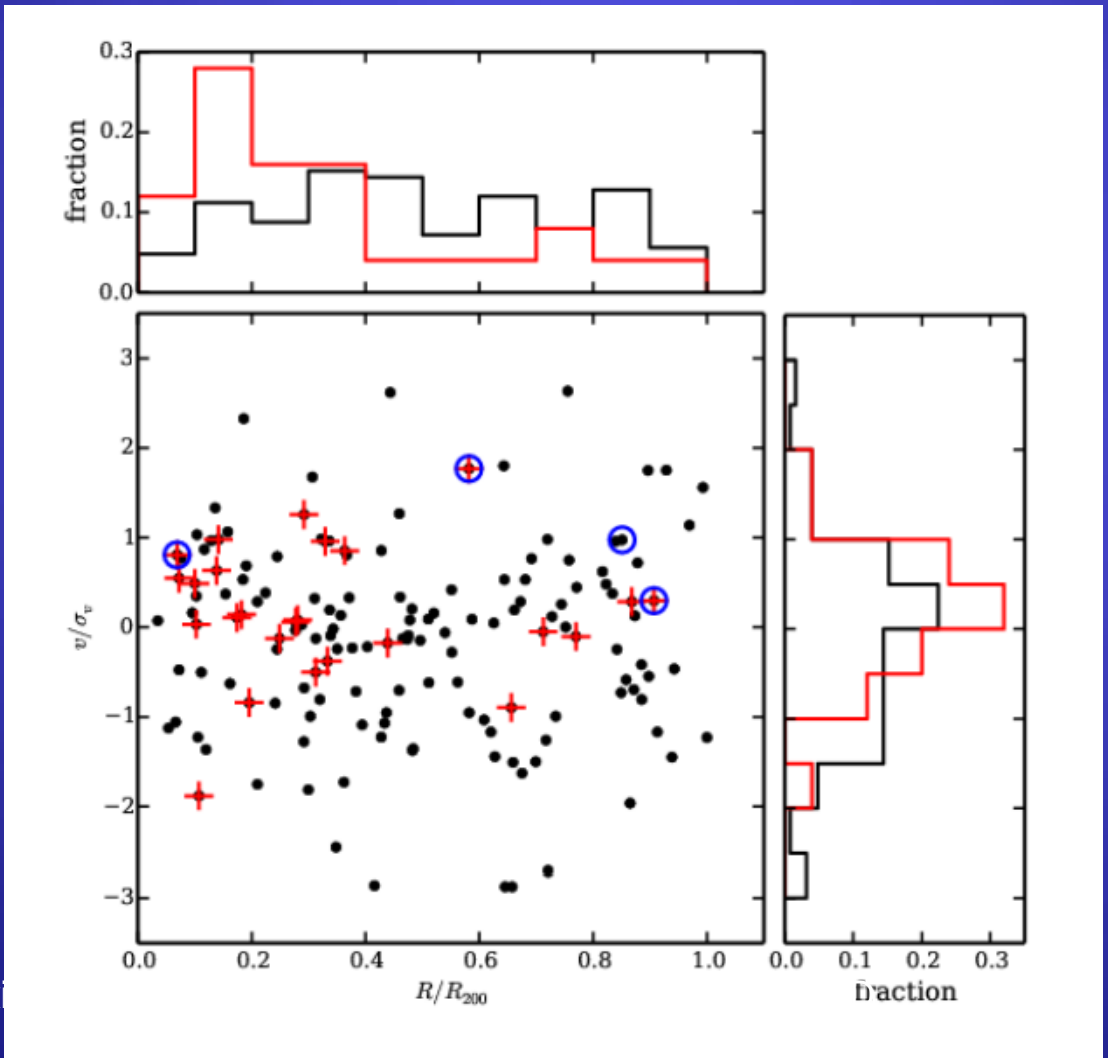




Oh, Mulchaey, AF, et al. 2014



X-ray AGNs inside CDFS galaxy groups (Oh+'14)



AGN within galaxy groups

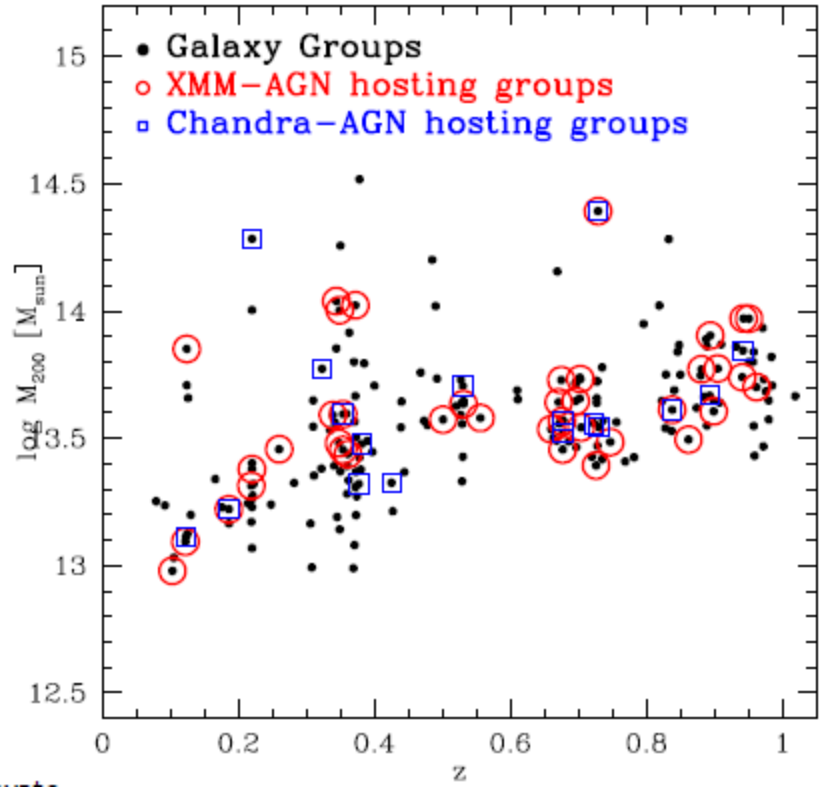
XMM-Chandra AGN

- 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

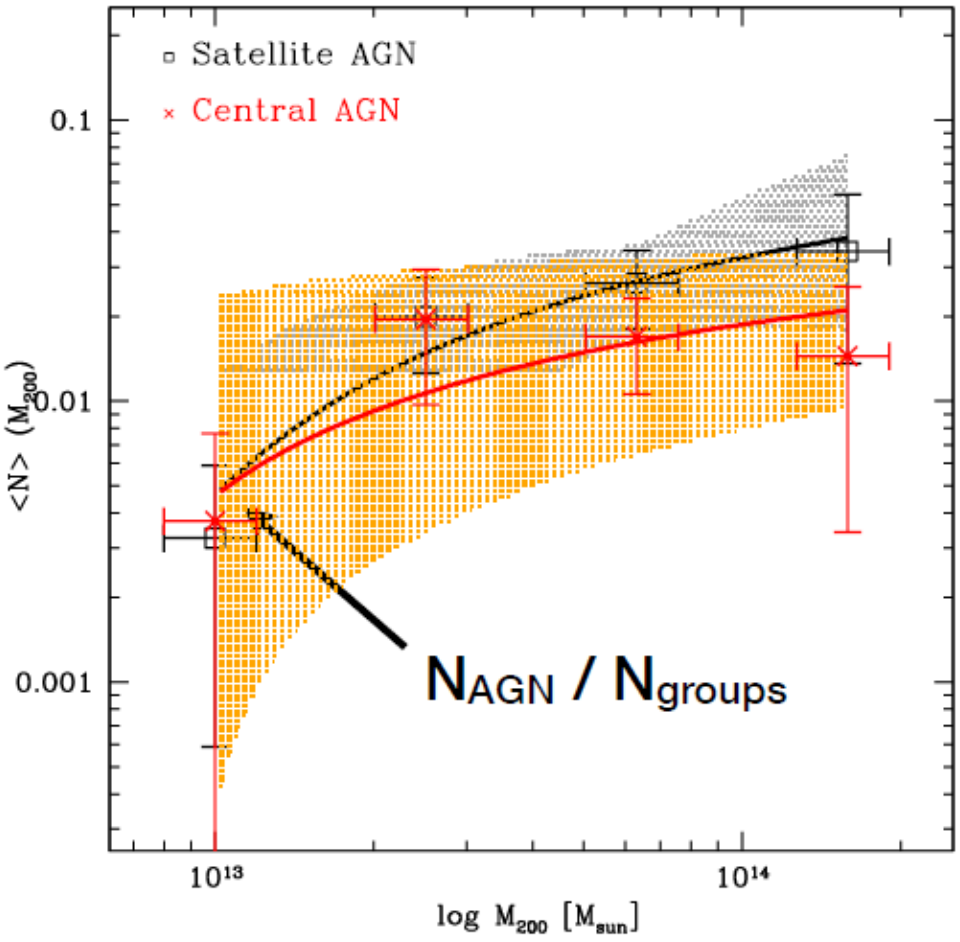
(George et al. 2011,2012)

- 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;

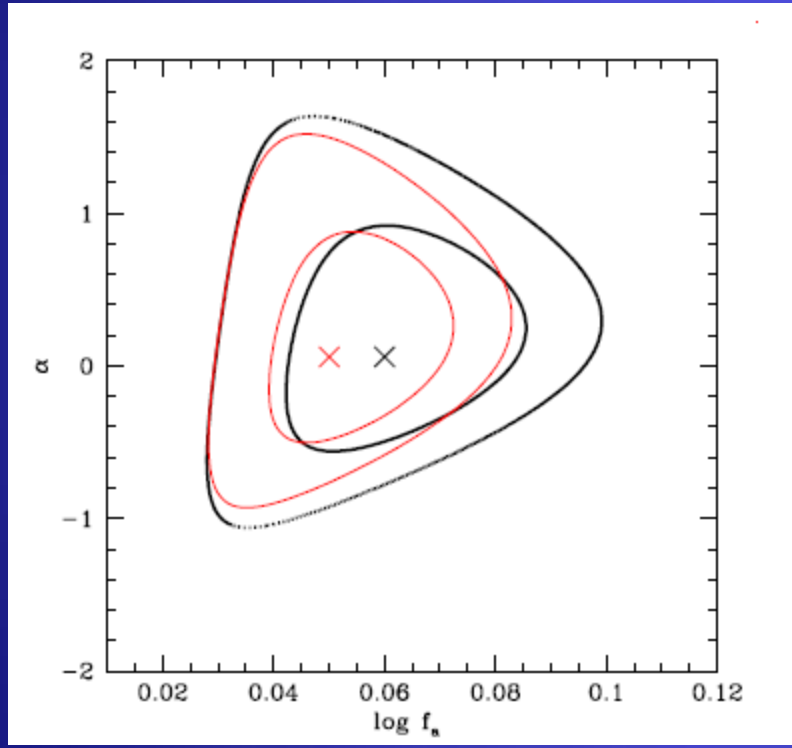
- Central AGN HOD:
  - log M_{min} [M_{sun}] = 12.7(12.1-12.9)

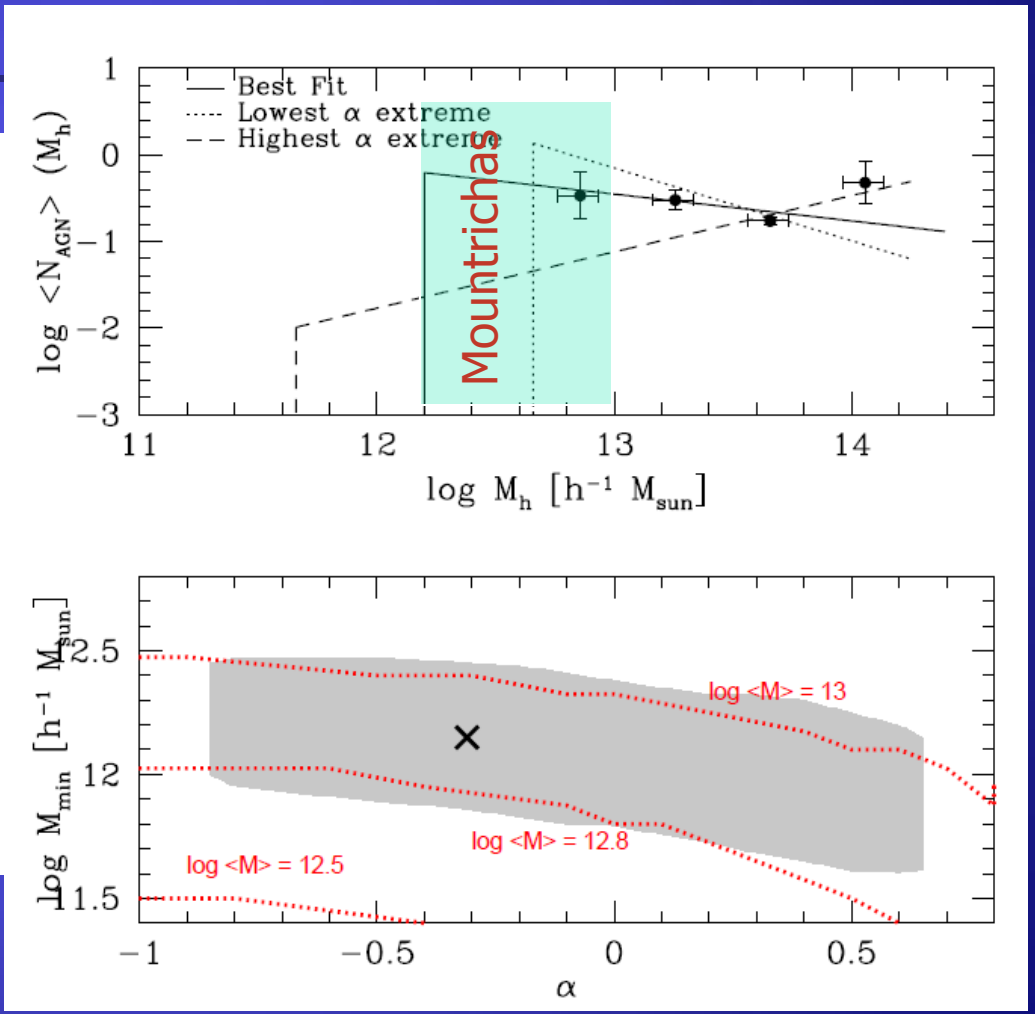
$$\langle N_{cen}\rangle(M_h) = f'_a \; erf\left(\frac{logM_h - logM_{min}}{\sigma_{logM}}\right)$$

Allevato, AF, et al. 2012

HOD model parameters

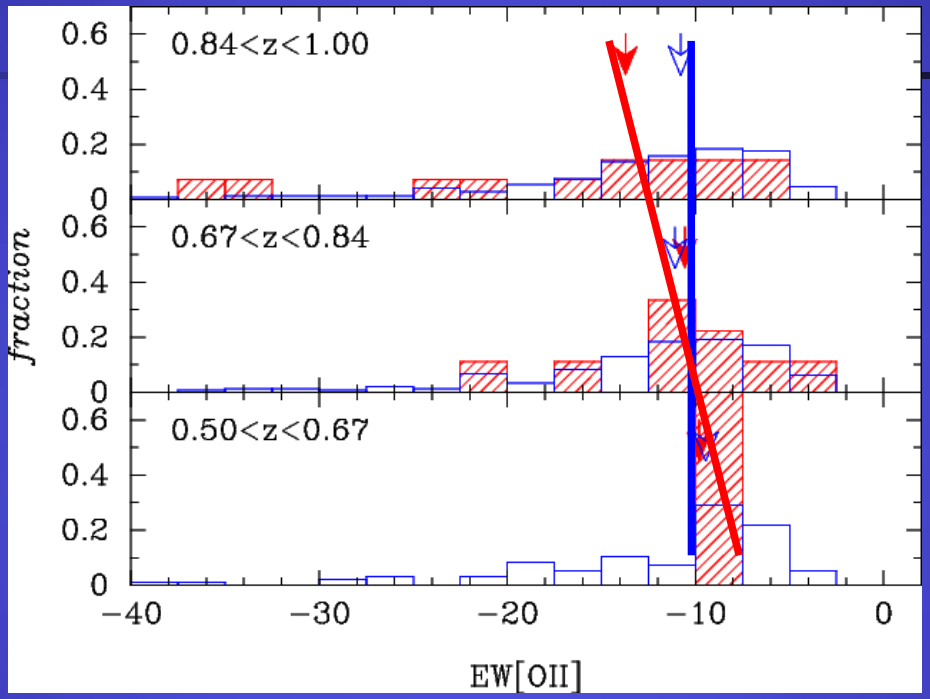
Allevato et al. 2012 (COSMOS); Mountrichas, Georgakakis, AF+ 2013 (AEGIS, COSMOS, ECDFS)





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

Increased red [OII] emitters in groups at high redshifts



groups

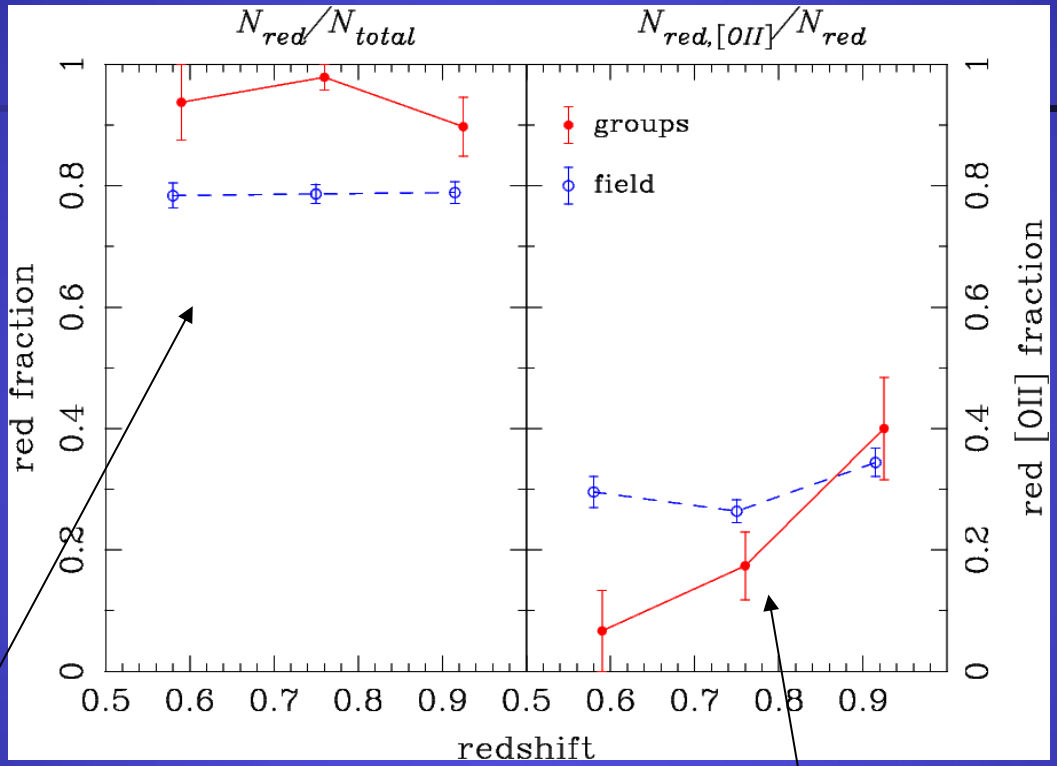
field

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

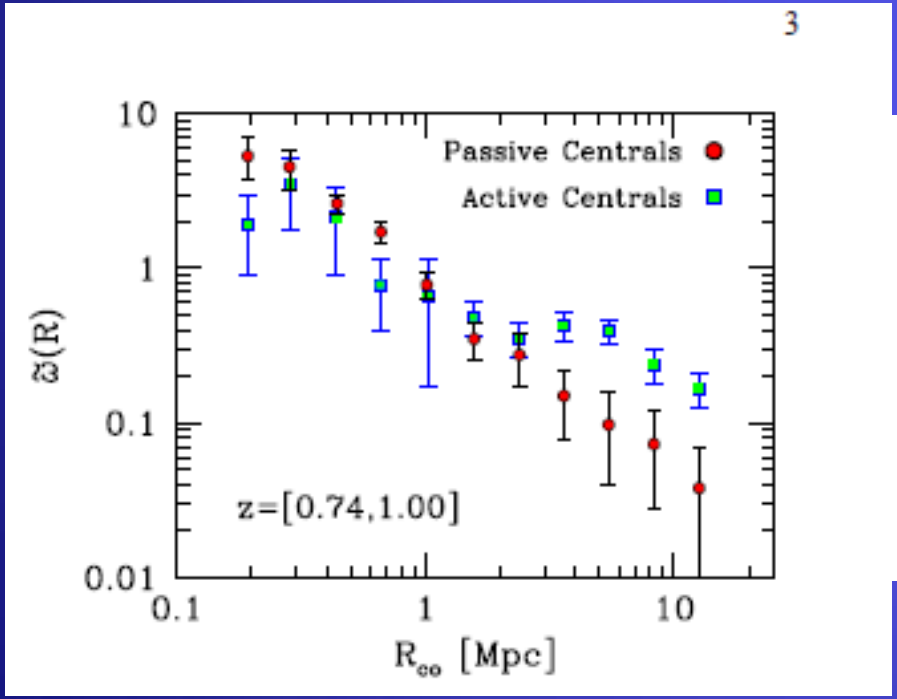
field

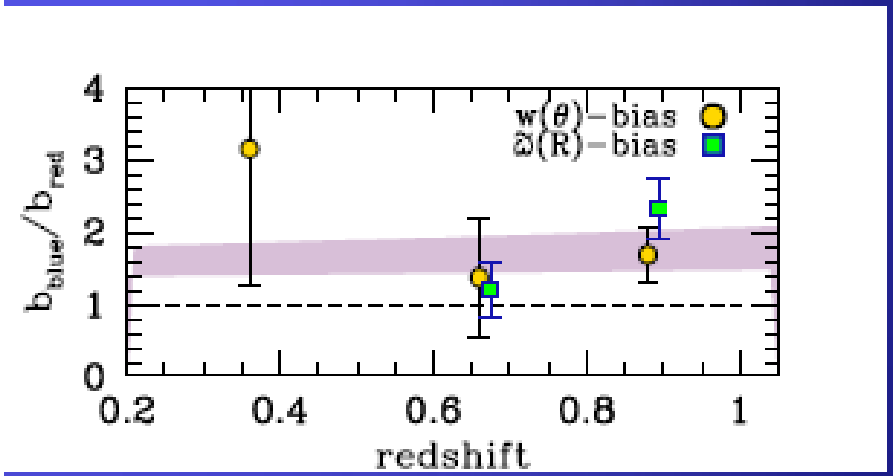
The red fraction clearly depends on environment. The red fraction does not strongly change with redshift (note that we are looking at very massive galaxies only).

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

Tanaka et al. to be submitted soon

Role of halo formation
Tinker, ..., AF et al. 2012





Conclusions

- Using galaxy groups it is possible to determine the shape of HOD of phenomena associated with the galaxies.
- We illustrate the power of the method by resolving a long-standing issue of the HOD of AGN, revealing the important role of satellite AGN in galaxy groups
- We confirm that evolution of HOD is similar to the field (type II AGNs).
- We provide the distribution of AGN in satellites, important for the weak lensing modelling.
- We confirm the conservation of the shape of the AGN XLF in galaxy groups, but not in clusters.
- In the future, there is a possibility to discriminate between halo mass and triggering.