Cluster scaling relation and baryon fraction

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Main collaborators:

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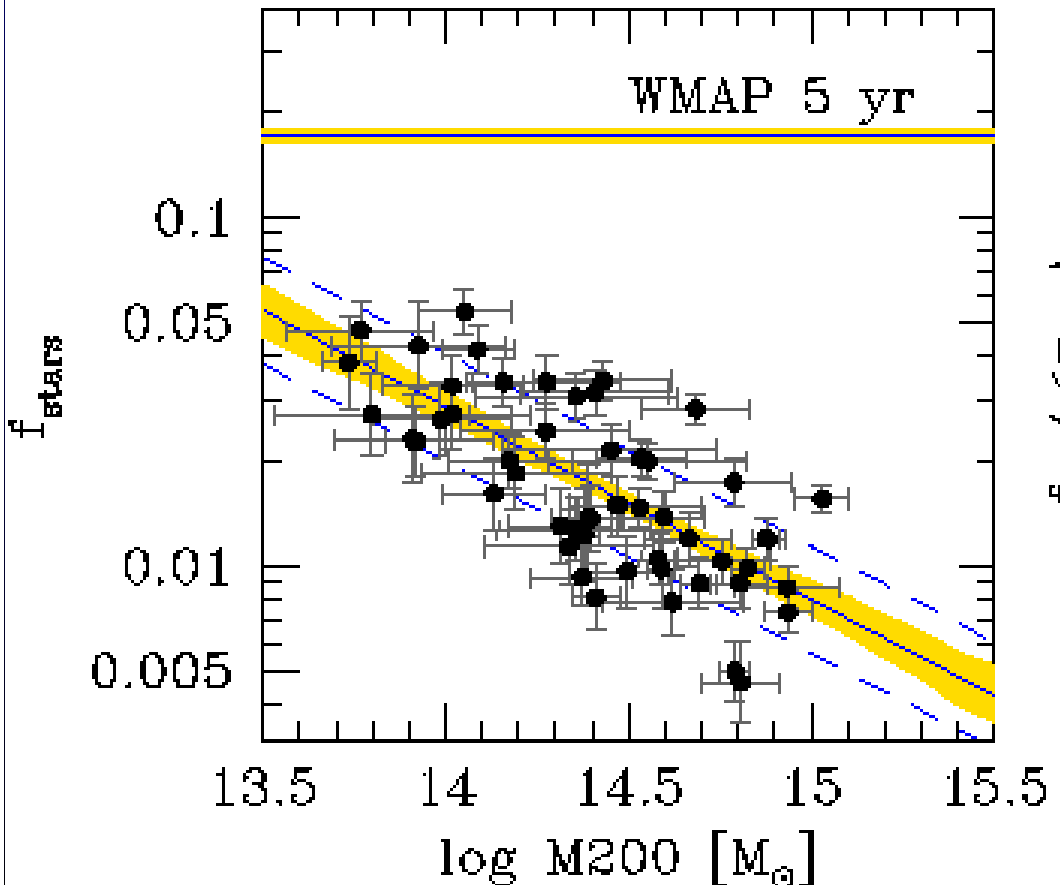
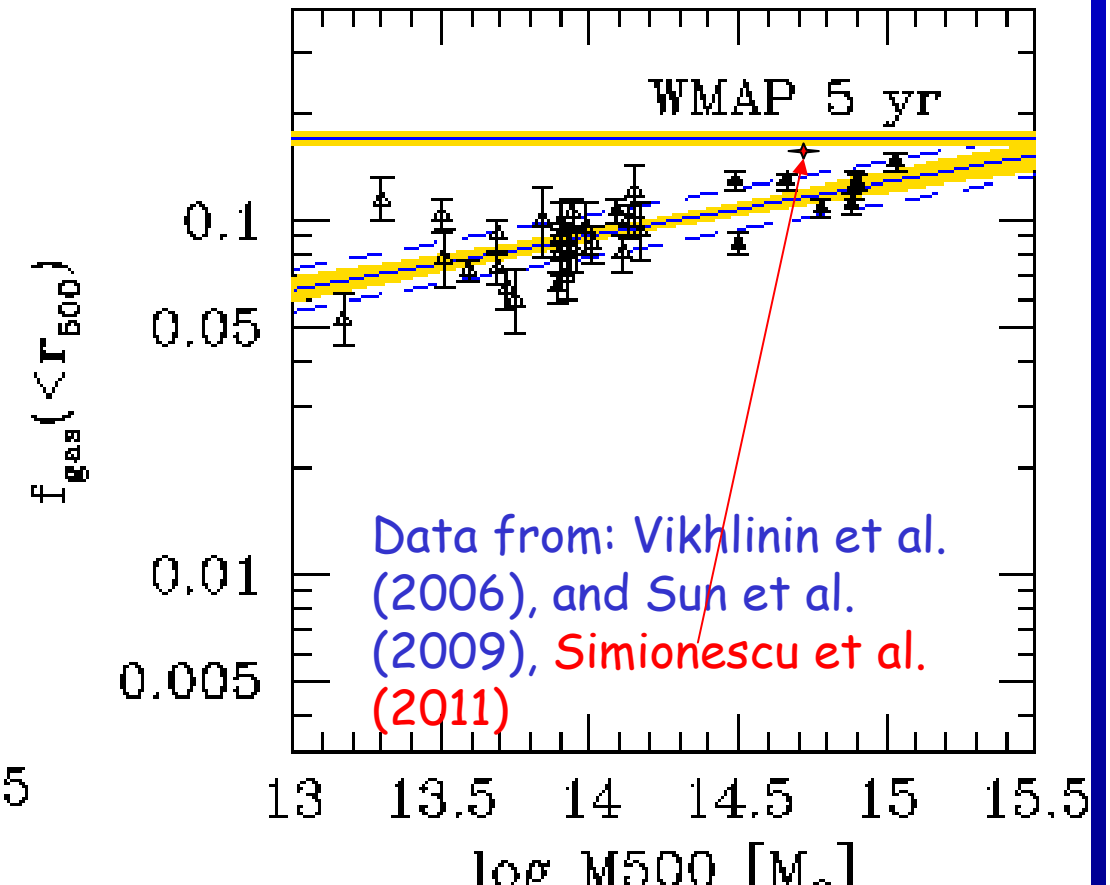
Plan

- -Clusters are a heterogeneous family, even at a given mass. Source of potential systematic errors.
- -Lx and n200 proxies for cosmology.
- -Do we understand them astrophysically?

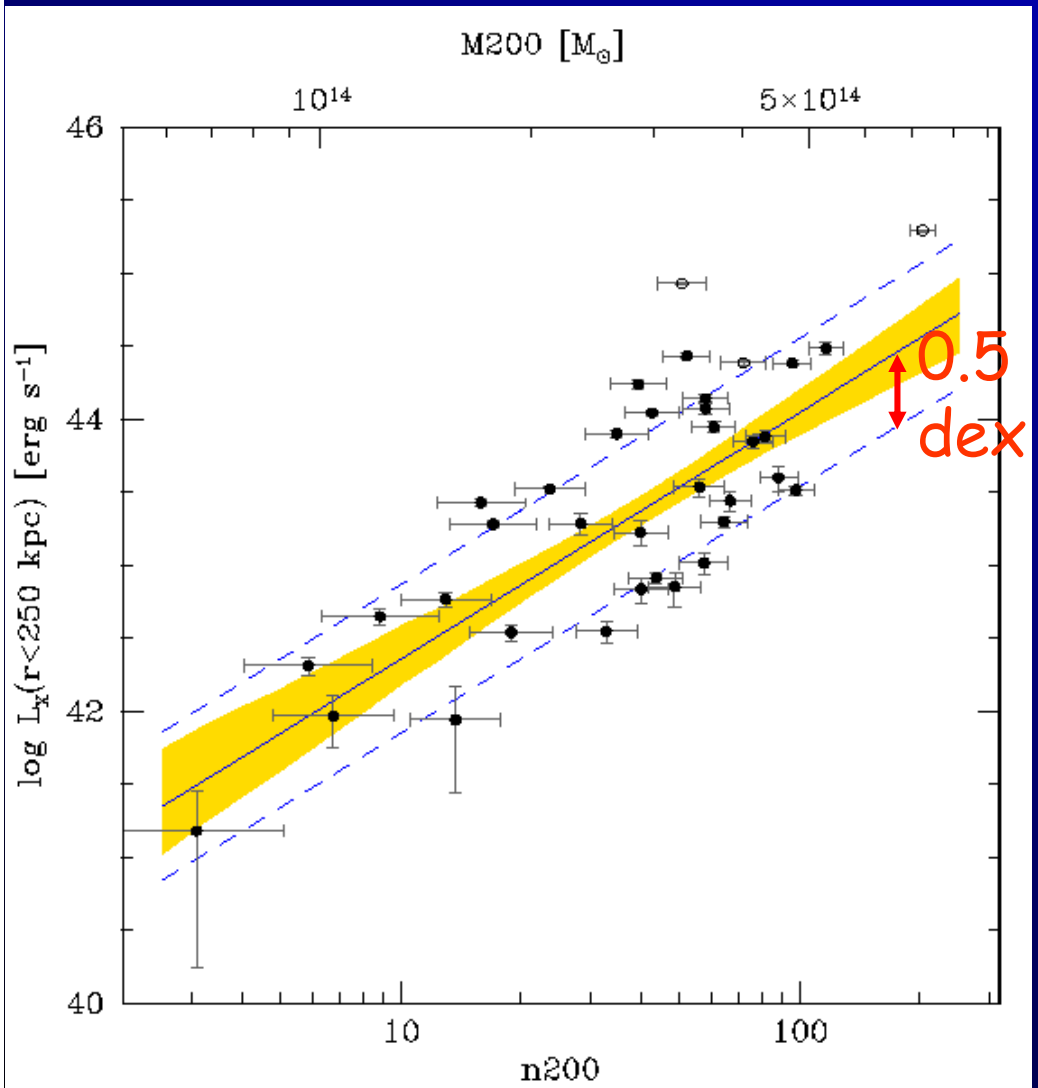
Clusters are an heterogeneous family, even at a given mass

In the optical, better data and larger sample. More source of errors accounted for. First robust determination of f_star (0.15 dex) and of f_gas (0.06 dex) spread at a given mass (SA 2010, MNRAS, 407, 263). Scatter implies we have still not reached the scale of homogeneity. Perseus (Simionescu et al) in agreement with the remaining sample (which shows a deficit!).





Heterogeneity implies a particular attention to selection effects: Lx brighter-than-average clusters are over-represented in X-ray selected samples, fainter-than-average are under-represented, and therefore the intercept of Lx vs whatever is overestimated. Scatter is underestimated for the same reason.



Don't confuse an un-accounted selection effect with a cluster properties (e.g. "optical clusters are unrelaxed" because their lower mean Lx|whatever).

If a scatter is there, be prepared to a bias, see Gus talk or any Bayesian book of stats.

SA & Moretti 2011, A&A, submitted

Critical step in cluster cosmology comes from a 6 parameter mass scaling

Cosmological parameters estimation requires conversion from mass into observables, i.e. we need to known the mass vs mass proxy (richness, Lx, etc.) scaling (6 parameters: slope, intercept, intrinsic scatter, and their evolutions) without *prior* knowledge of mass, or size!

Local (0.03<z<0.1) clusters mass-richness relation

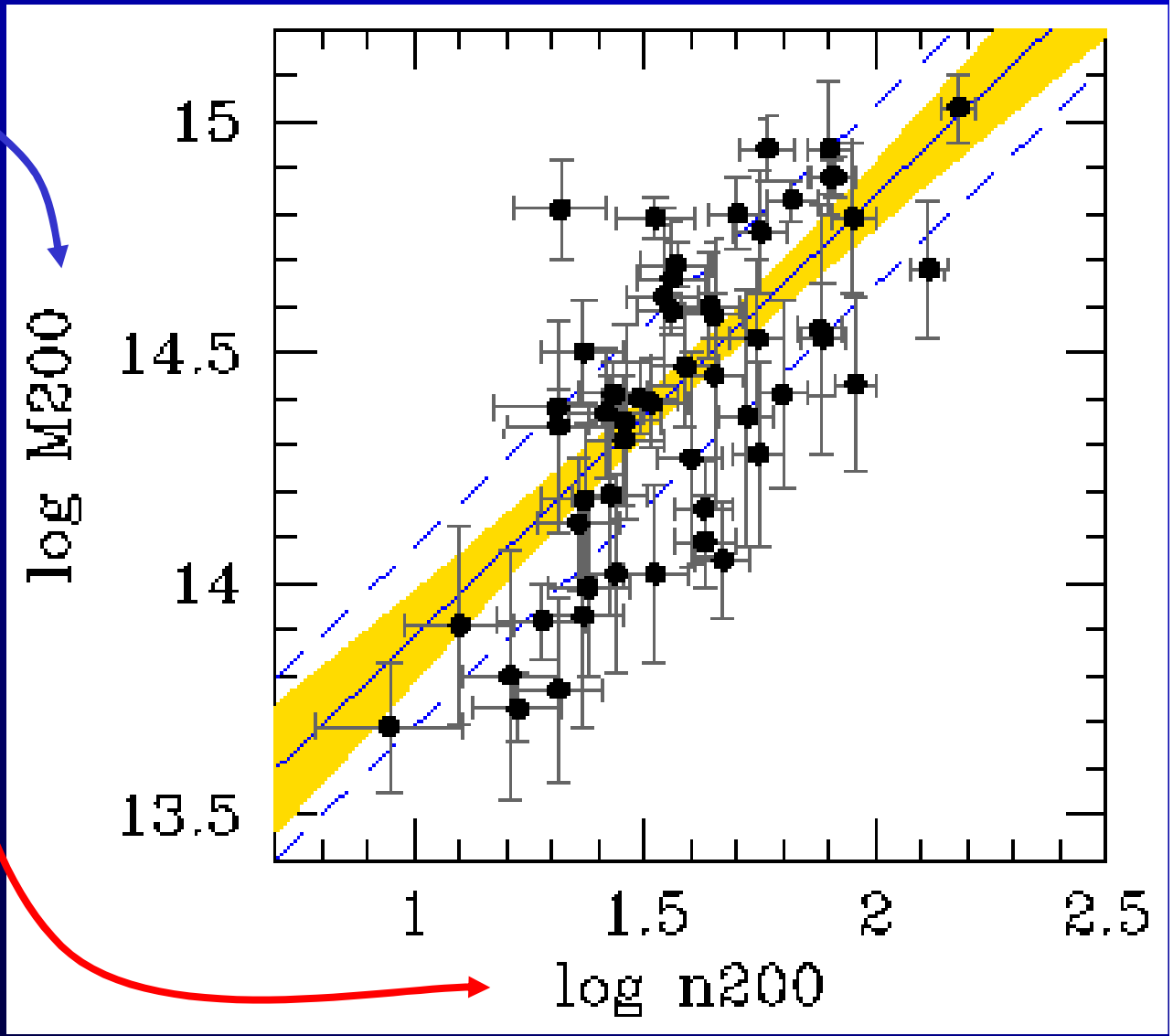
Caustic masses

Richness

slope: 0.96+/-0.15

intrinsic scatter: 0.19+/-0.03 dex.

SA & Hurn, 2010, MNRAS, 404, 1922



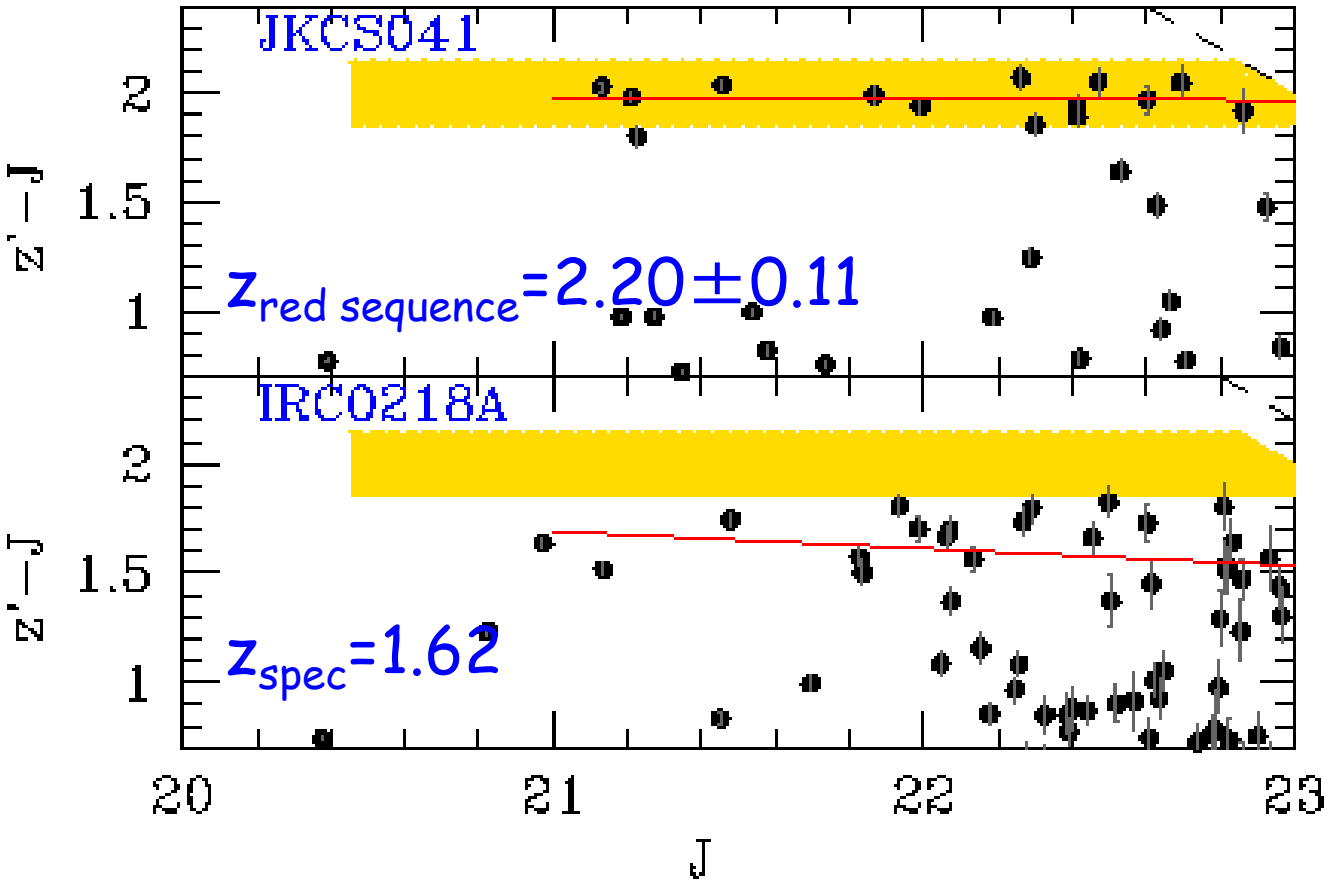
-mass performance of n200: 0.29 dex (posterior predictive) mass uncertainty.

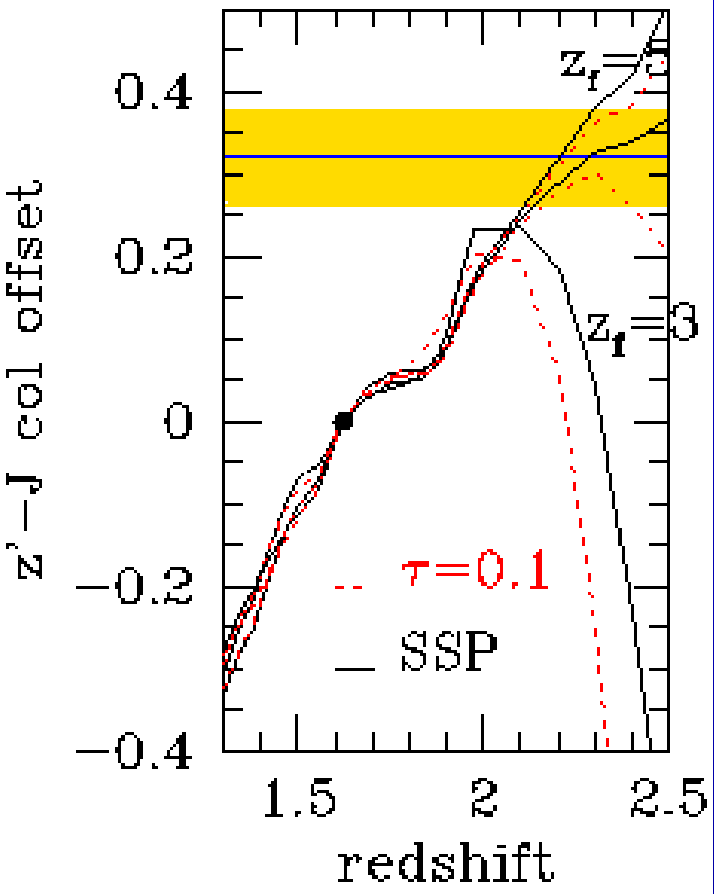
- same results using velocity-dispersion based masses.

- slope different from Johnson et al. (2007), but in agreement after correction for their neglected Malmquist bias. Obvious implication for Planck SZ lower normalization of optically selected clusters.

- same performance as Lx, for the very same sample.

Cluster searches using galaxy colours go farther away: the two most distant clusters known are color selected, not X-ray, SZ or lensing selected

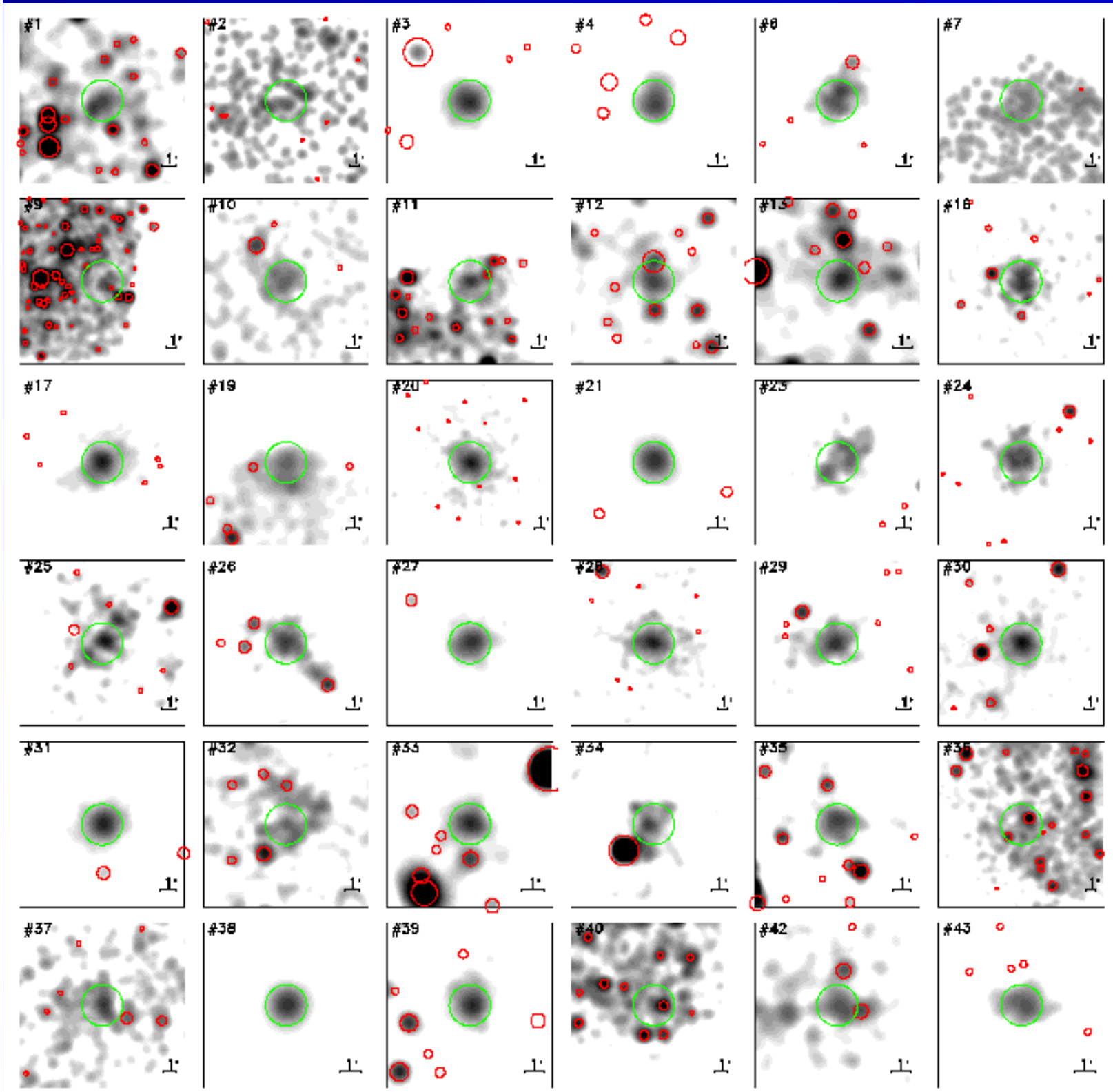




From SA & Huertas-Company, 2011, A&A 526, A11

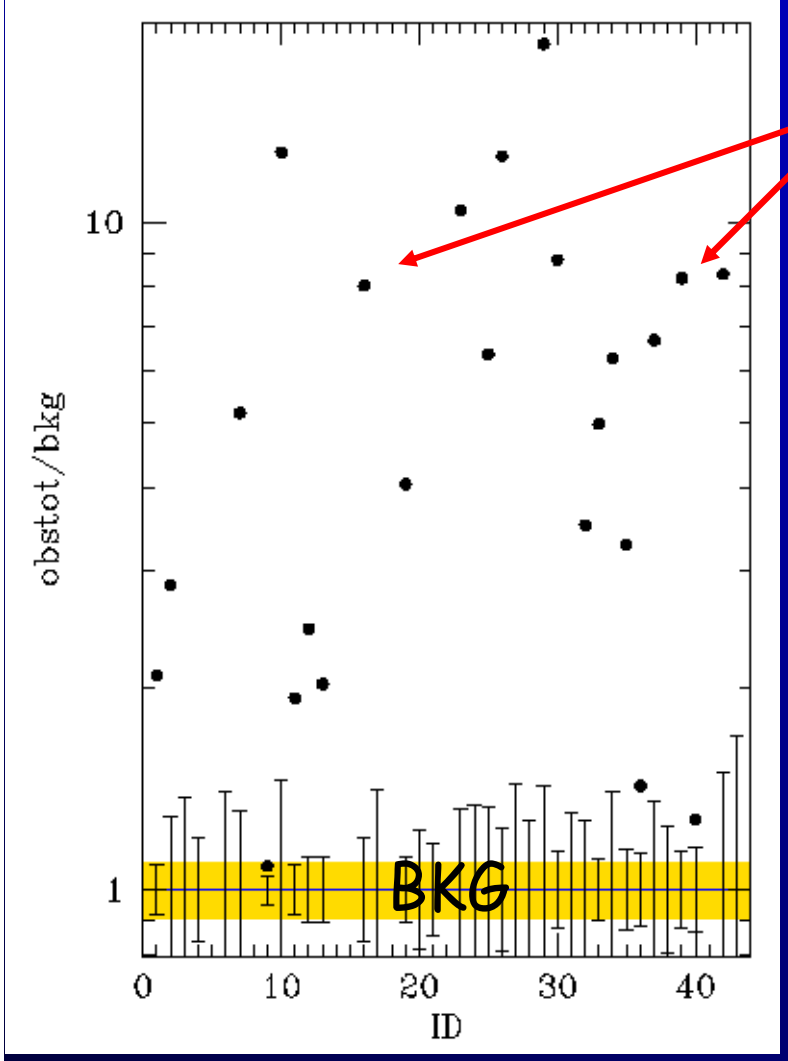
Contamination ?

colour-selected clusters are not more contaminated than X-ray detected clusters: SA & Moretti (2011, A&A submitted) look for ICM emission from a random sampling of colour-selected (maxBCG) cluster sample, and find for all!

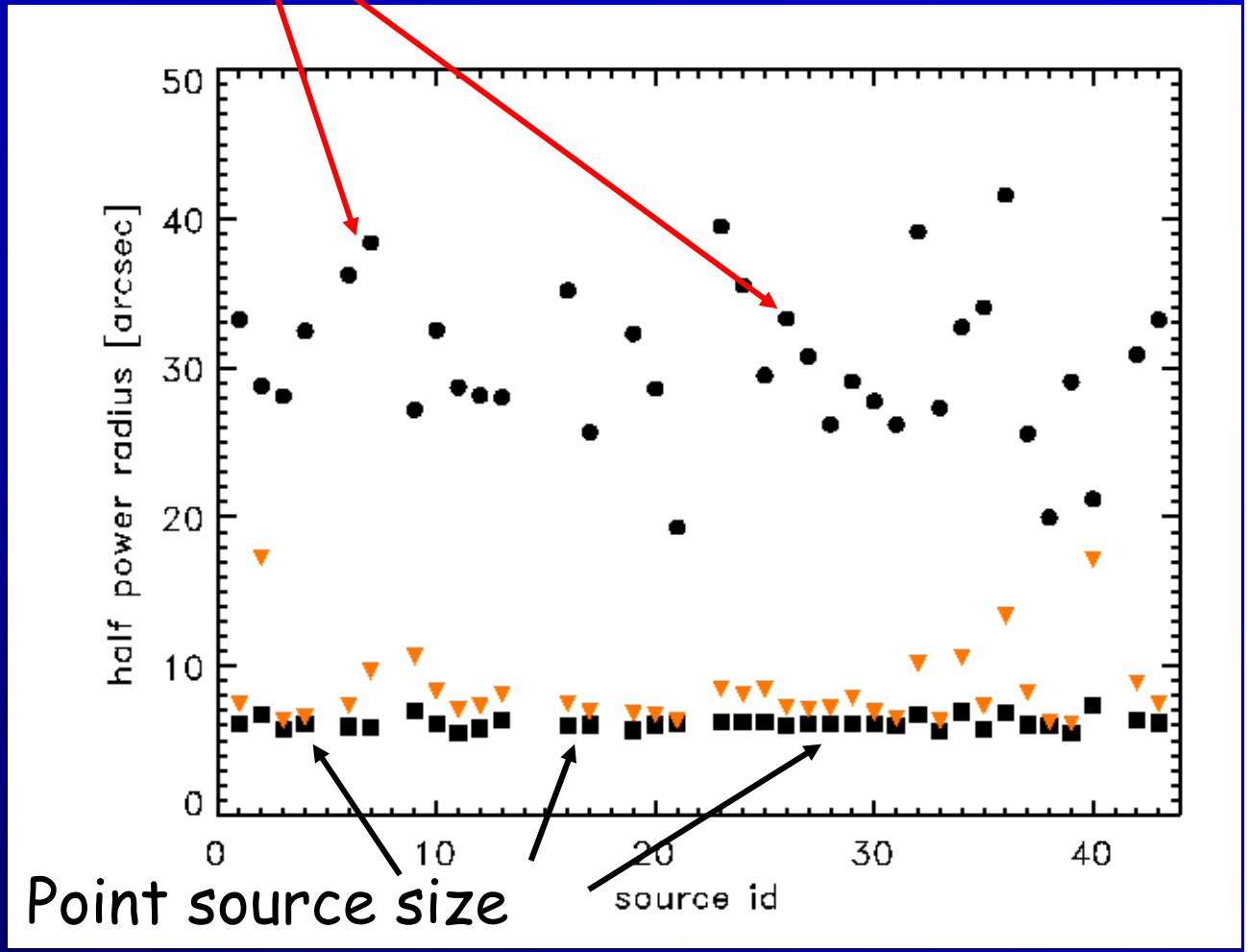


X-ray from ICM of 33 out 33 colour-selected clusters. X-ray emission from one system is not 100 % sure.

+3 X-ray selected clusters, not belonging to the statistical sample.



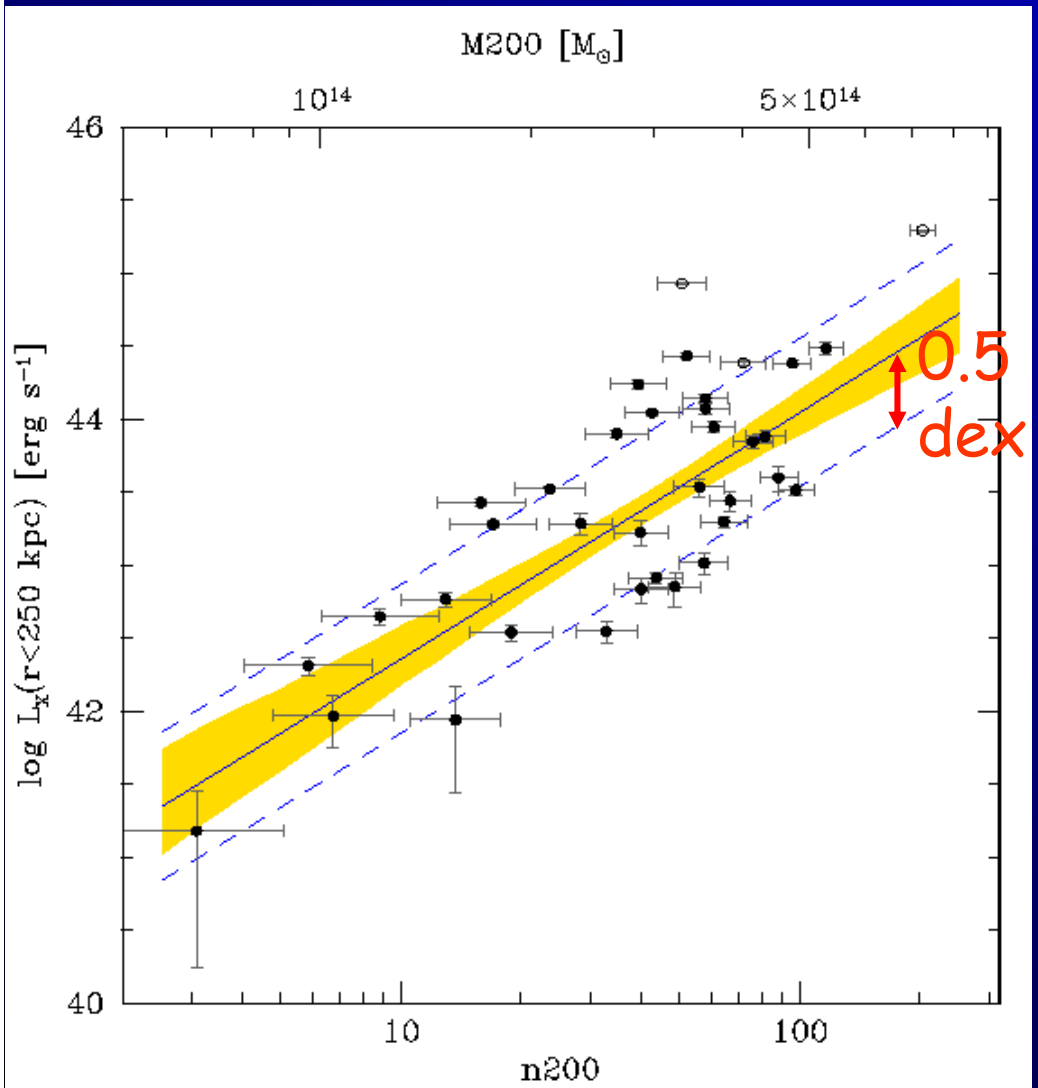
Clusters



Point source size

From 0 out 33 fakes, fake colour selected clusters upper limits is 6.5 % at 90 % confidence. Of obvious relevance for Planck SZ lower normalization of optically selected clusters. Good news also for X-ray selected clusters samples no X-ray dark cluster still known (current upper limit: 11 % at 90 % confidence).

Found Lx-n200 scaling:

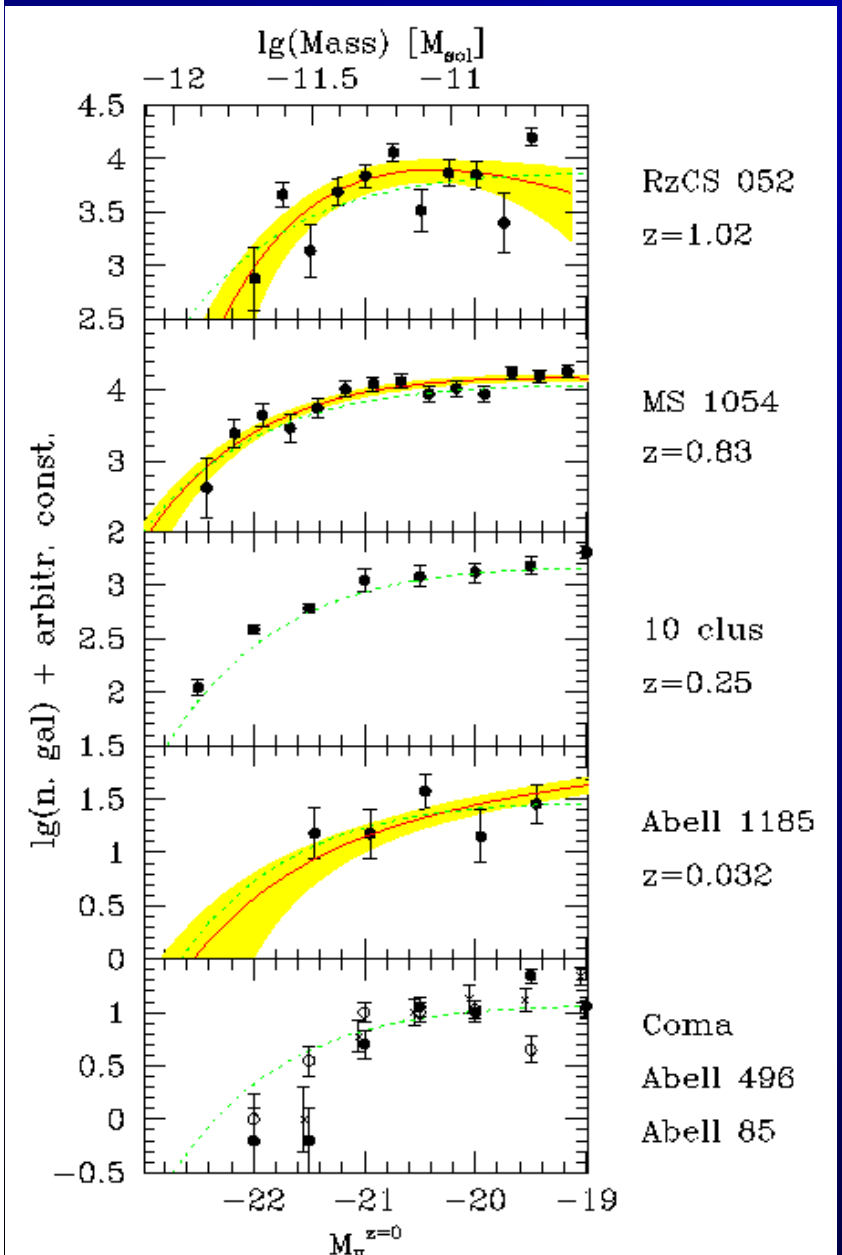


Slope and intercept in agreement with Rykoff et al (after conversions), scatter much larger

SA & Moretti 2011, A&A, submitted

Evolution of the probes

Galaxies: no evolution (beside passive)



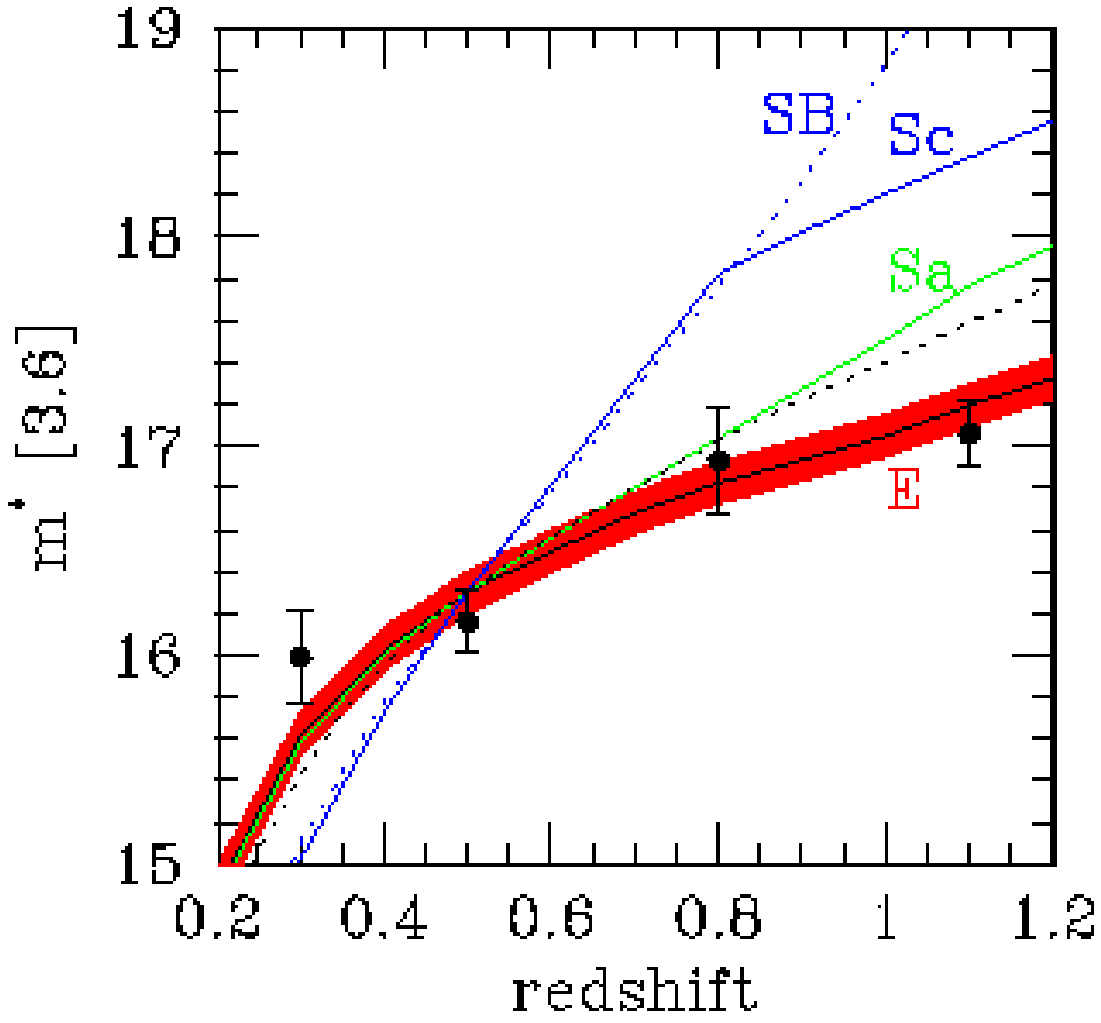
Passively evolved LF in green.

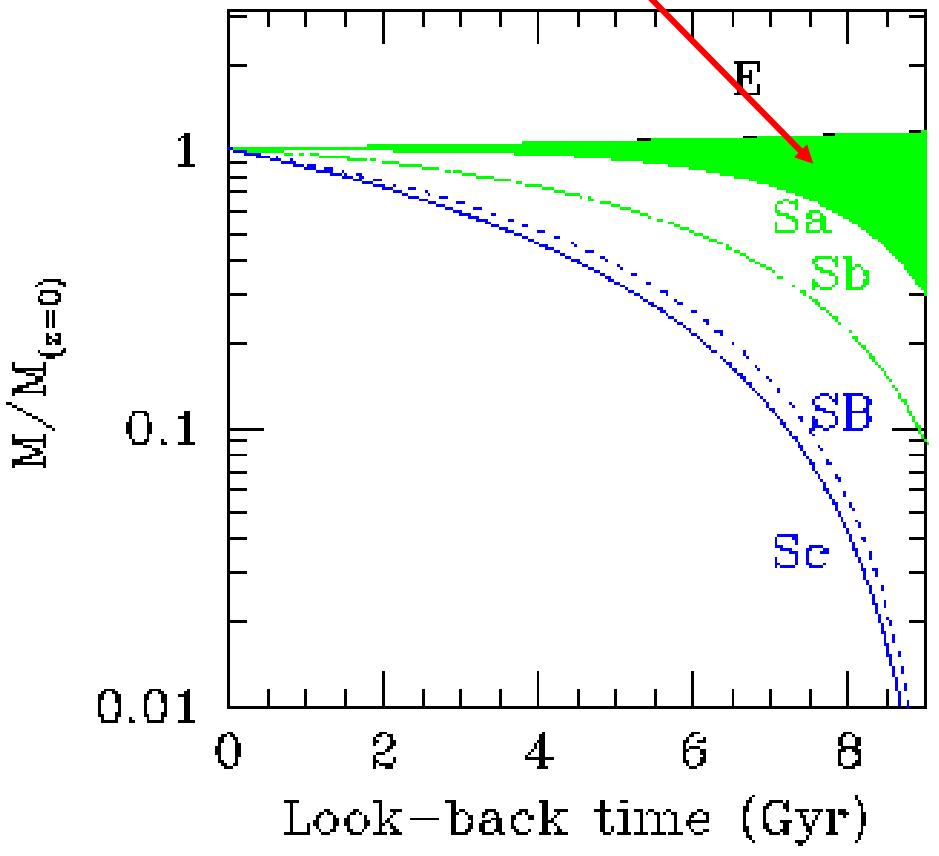
16 clusters.

SA et al. 2008, MNRAS, 385, 979

31 (more) clusters, up to z=1.22

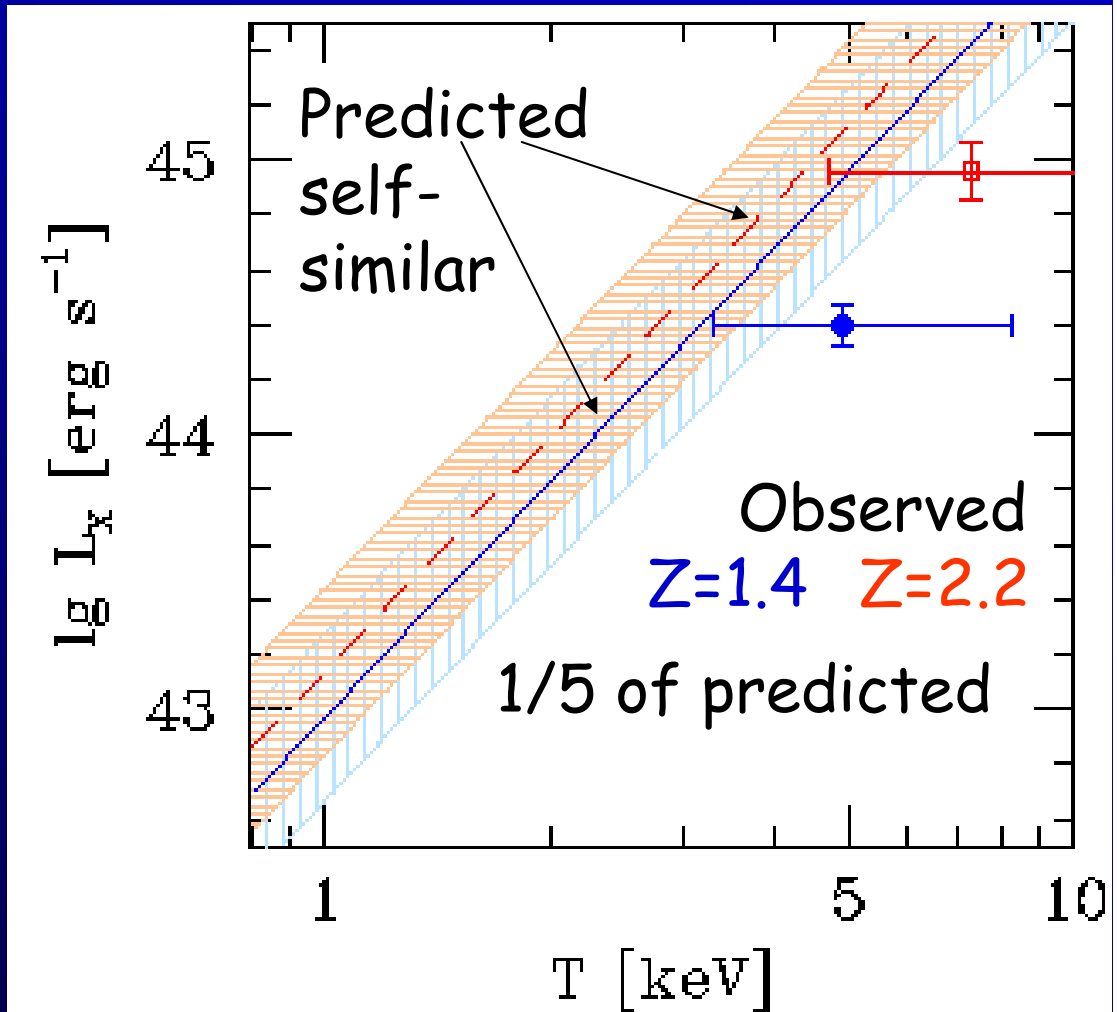
Only model compatible with the data: no mass growth. >5 % per Gyr mass growth rejected (SA 2006, A&A, 369, 969)





ICM: poorly known, likely not self-similar, evolution of Lx-T

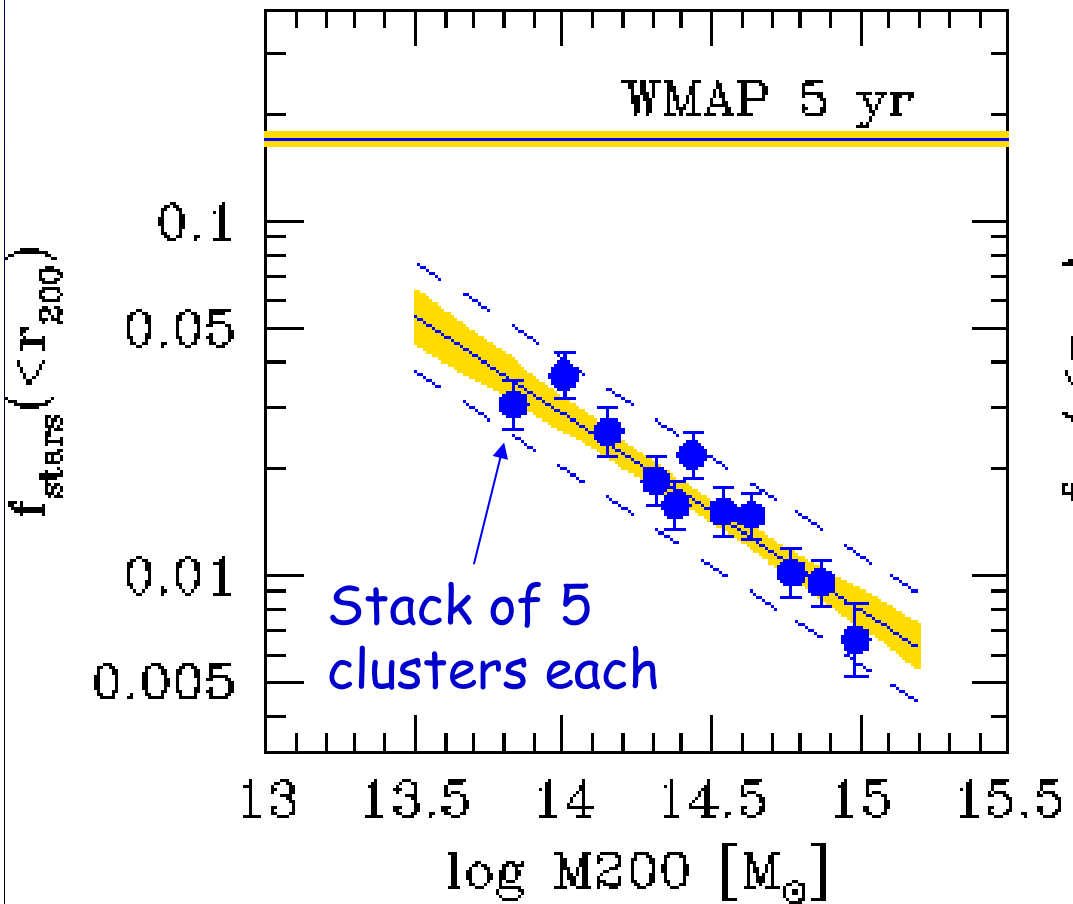
- Selection effects are difficult to correct for in X-ray selected sampes -> follow up in X-ray two very high redshift clusters.
- Lower than self-similar evolution, in agreement with previous indications (e.g. Pacaud et al. 2007) at lower redshift, when corrected for the bias of X-ray selected samples.
- Warning: two points only, 95 % significant.
- SA, Trinchieri & Pizzolato, 2011, MNRAS, in press (arXiv:1012.3034)

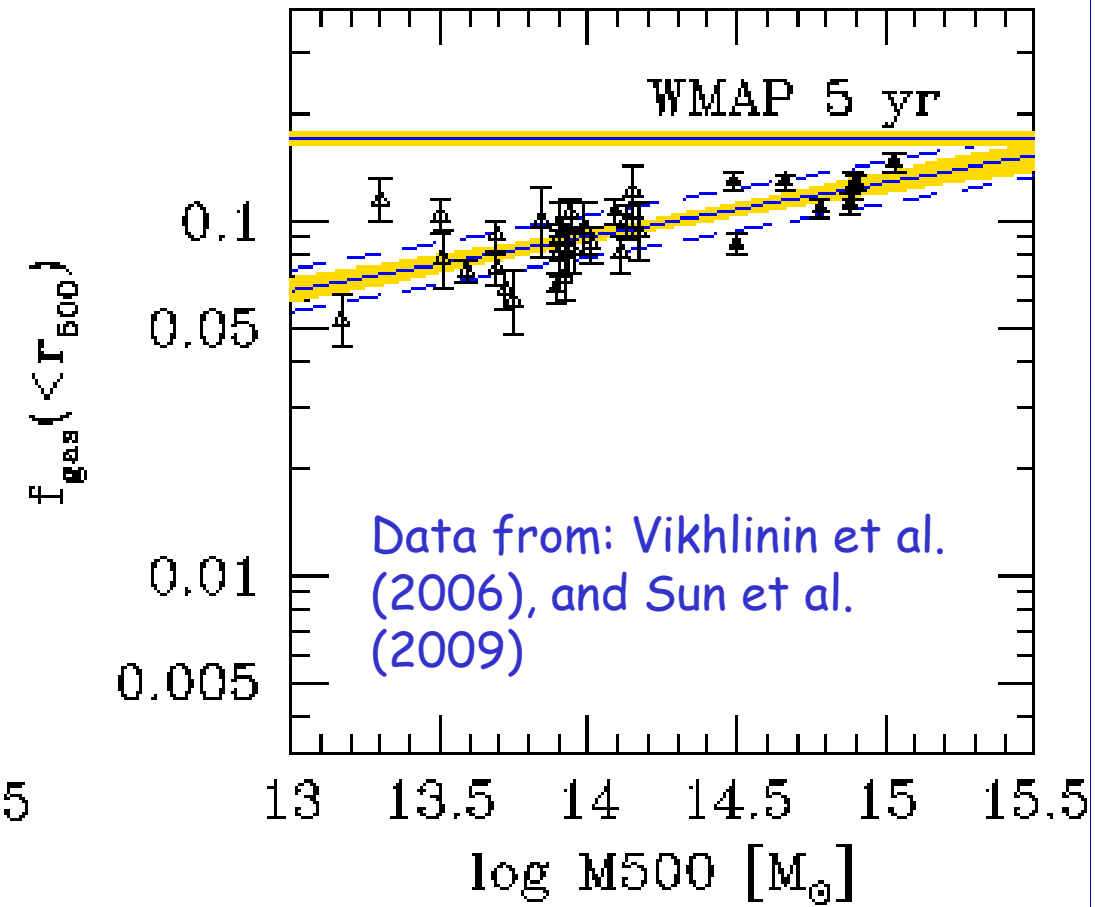


Do we understand the astrophysics related to the probes?

Stellar and gas fraction

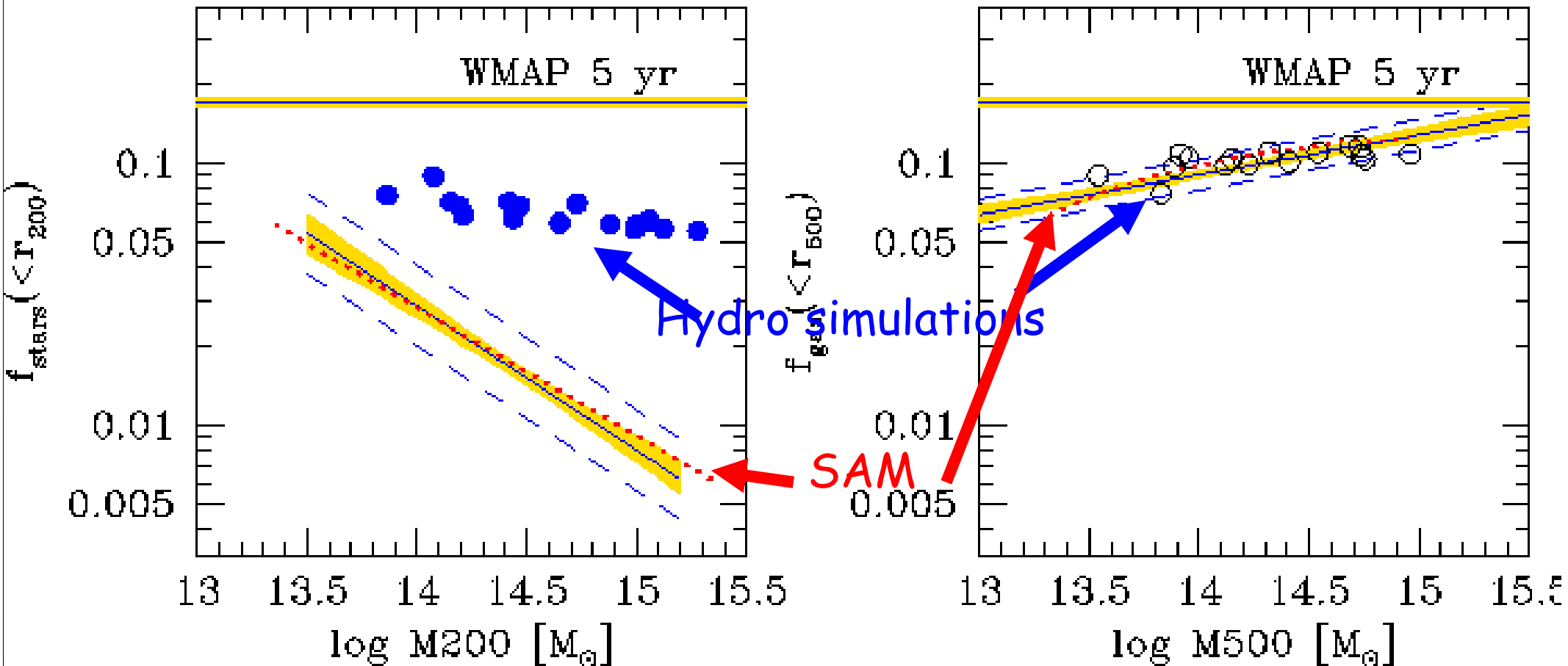
The lines fit the data, memorize them.



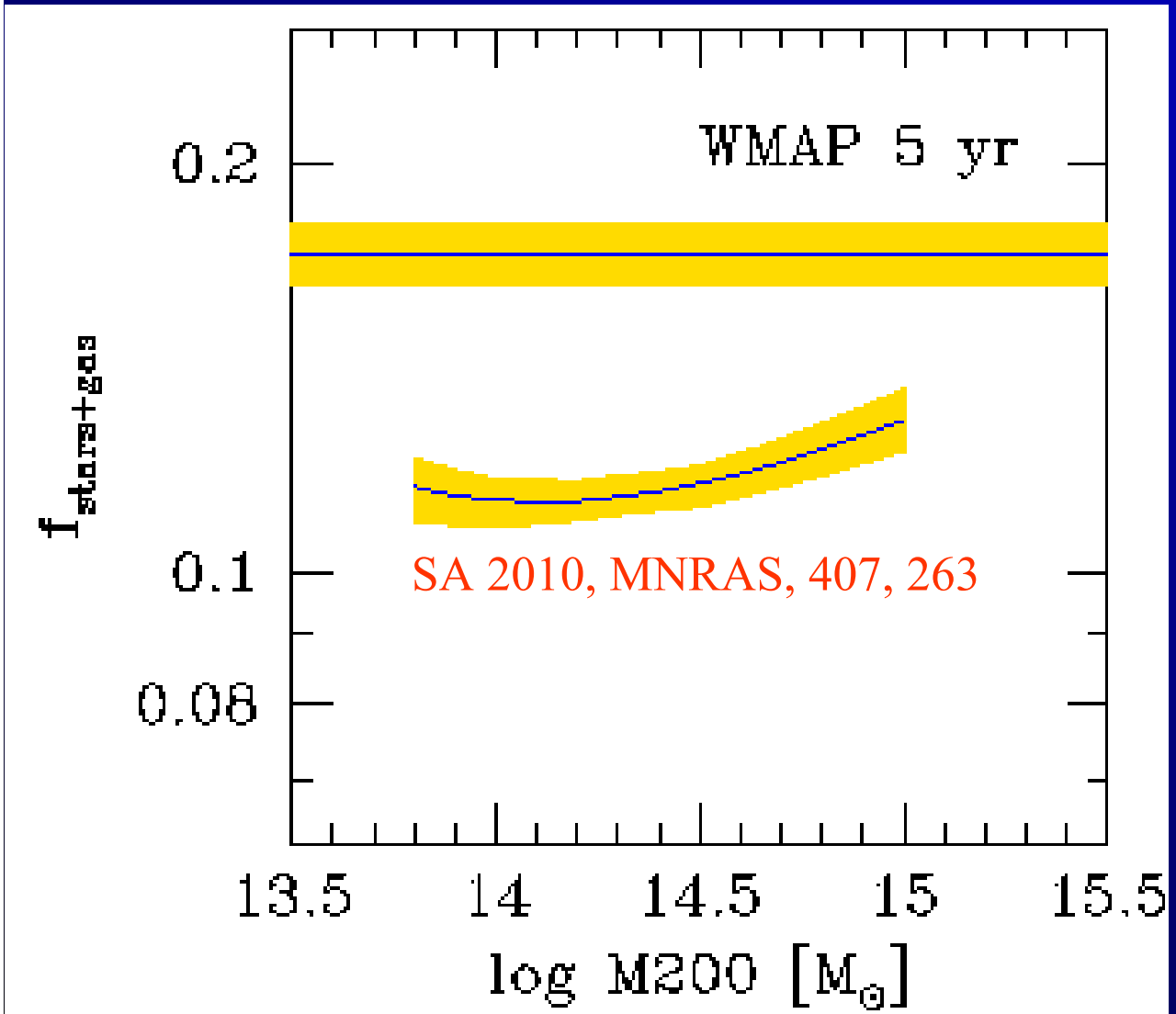


Theory (points and red line) vs data

SAM (Bode et al. 2009) models make a single prediction, the slope of f_stars, everything else is matched to observations. Low preditive power. Hydro simulation requires too feedback (=stars) to produce scaling relations that match the X-ray side. Disagreement has profound implications (SA 2010, MNRAS, 407, 263).



Mismatch also with WMAP



In agreement with previous works, but disagreement (6 sigma's), more significant here than in previous works, in spite that my analysis includes sources of errors ignored in other people analysis.

Conclusions

Go:

-Little or not X-ray dark clusters

-Little or not fake colour-selected clusters

-Another n200-M calibration (using dynamic masses)

-Likely know evolution of n200.

Pay attention:

-A lot of scatter in survey-based mass proxy makes astronomer life difficult (and interesting).

-Uncertain evolution of ICM (Lx-T), likely not self-similar.

Dangerous?

Models does not reproduce observations (fstar AND fgas AND fbaryon (<r500))

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