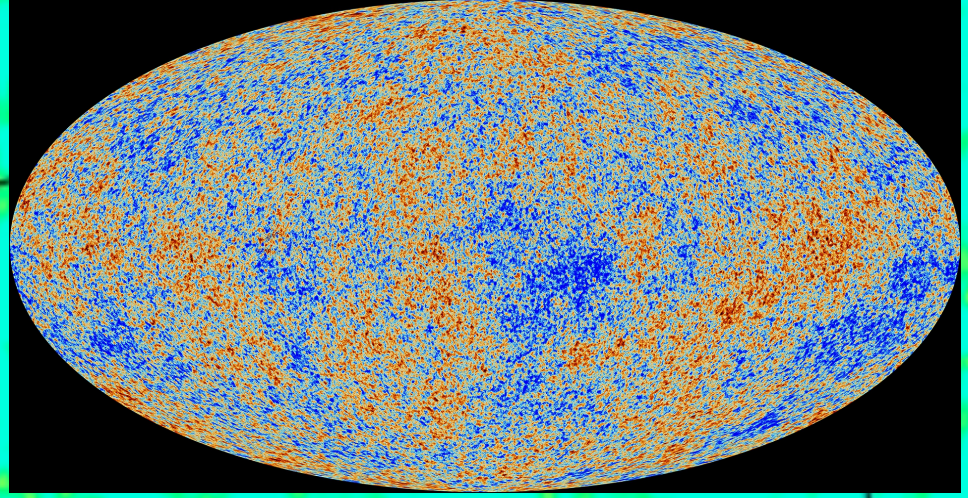


CIFAR16
Whistler
March 2016

A lensing recalibration of the gas content of dark halos

Simon White
Max Planck Institute for Astrophysics

Locally brightest galaxies as halo proxies

SDSS/DR7: $r < 17.7$, $z > 0.03$

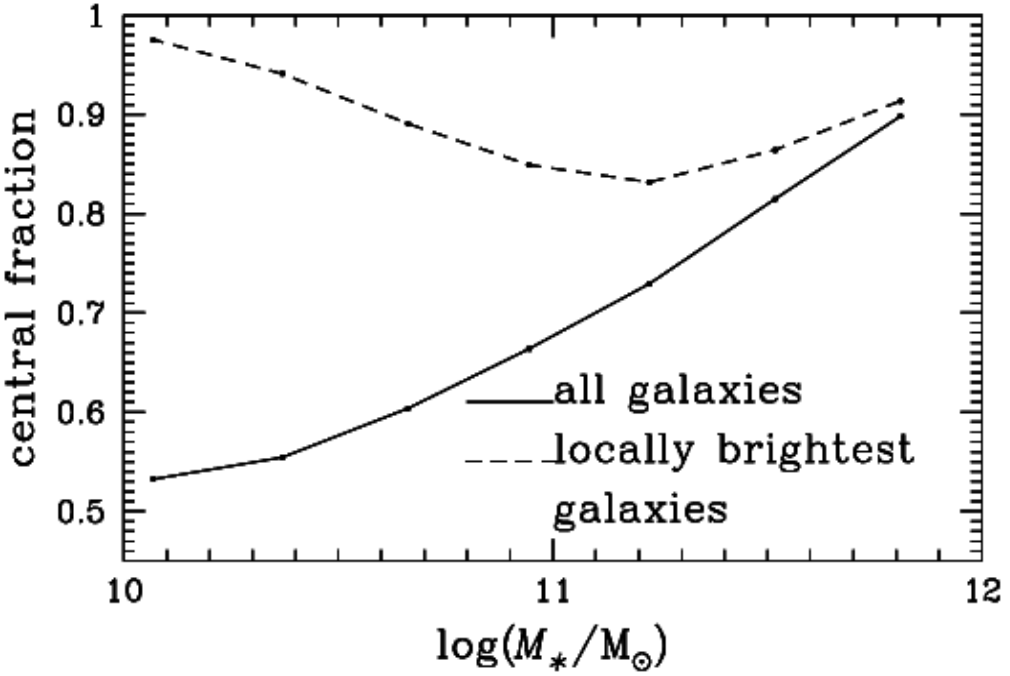
Brighter than all neighbours with $r_p < 1.0$ Mpc, $\Delta z < 1{,}000$ km/s

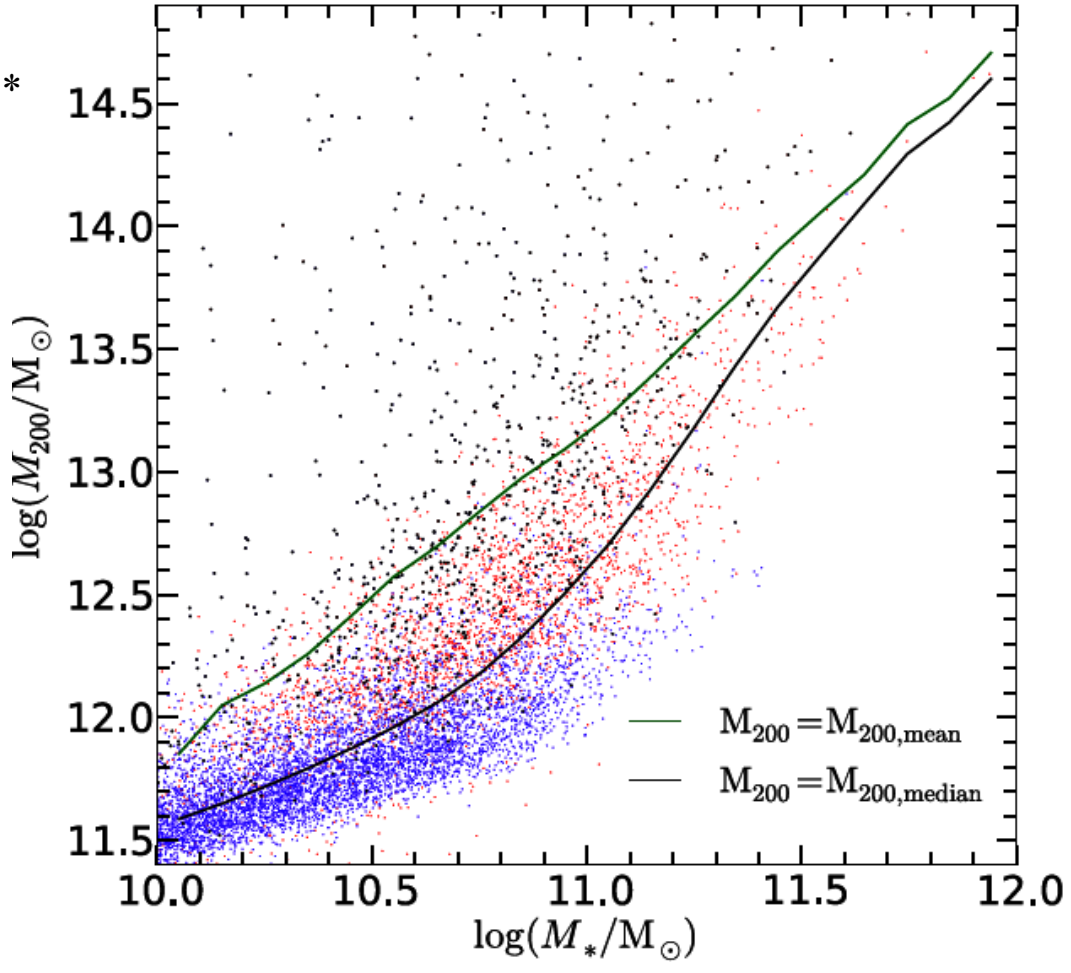
Mock light-cone: Guo et al (2013) simulation in the WMAP7 cosmology

>83% of LBGs are halo centrals

Large spread in M_{200} at given M_*

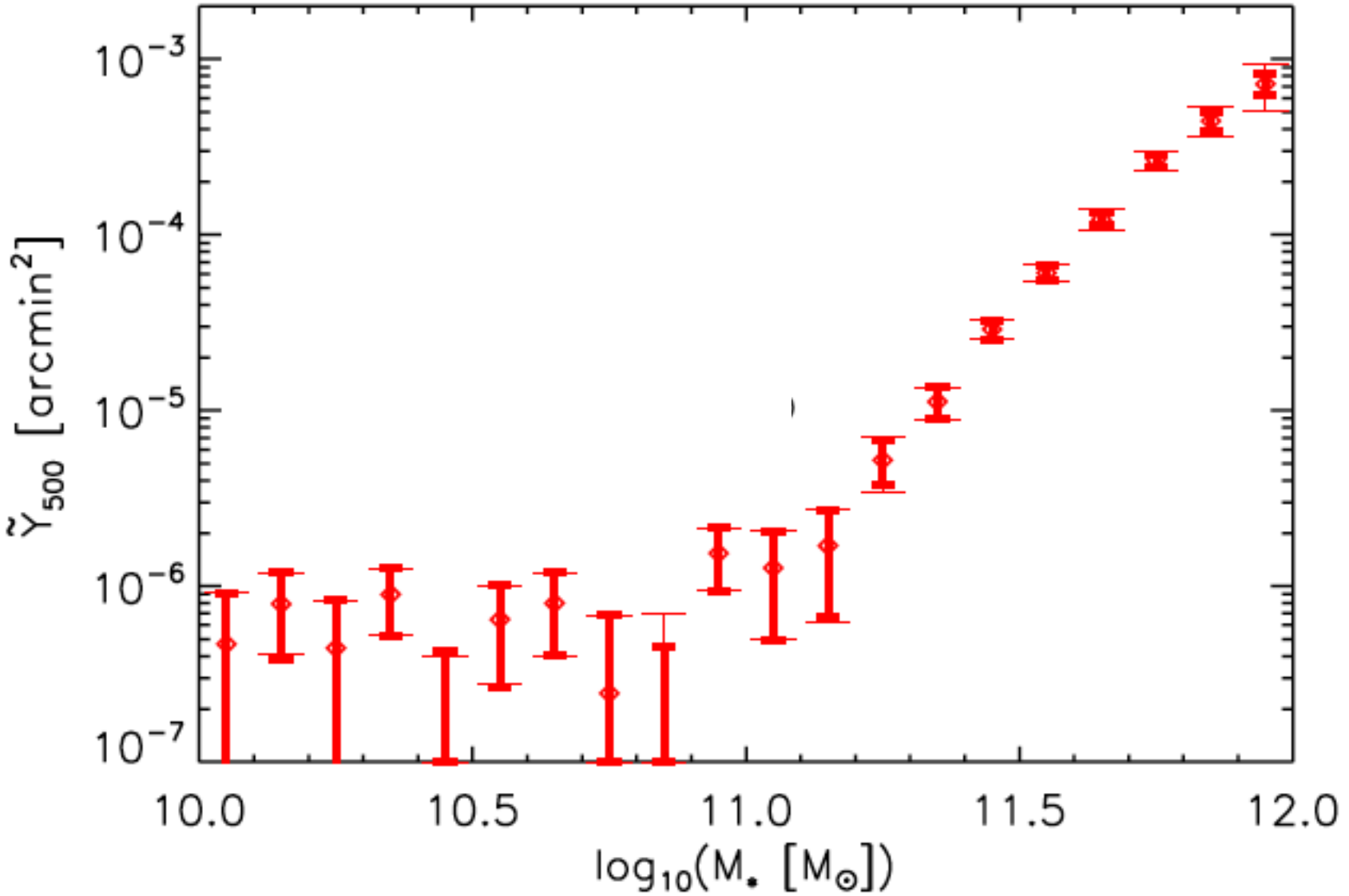
Planck Collaboration 2013





Stacked Planck SZ signal from LBGs

Planck Collaboration 2013



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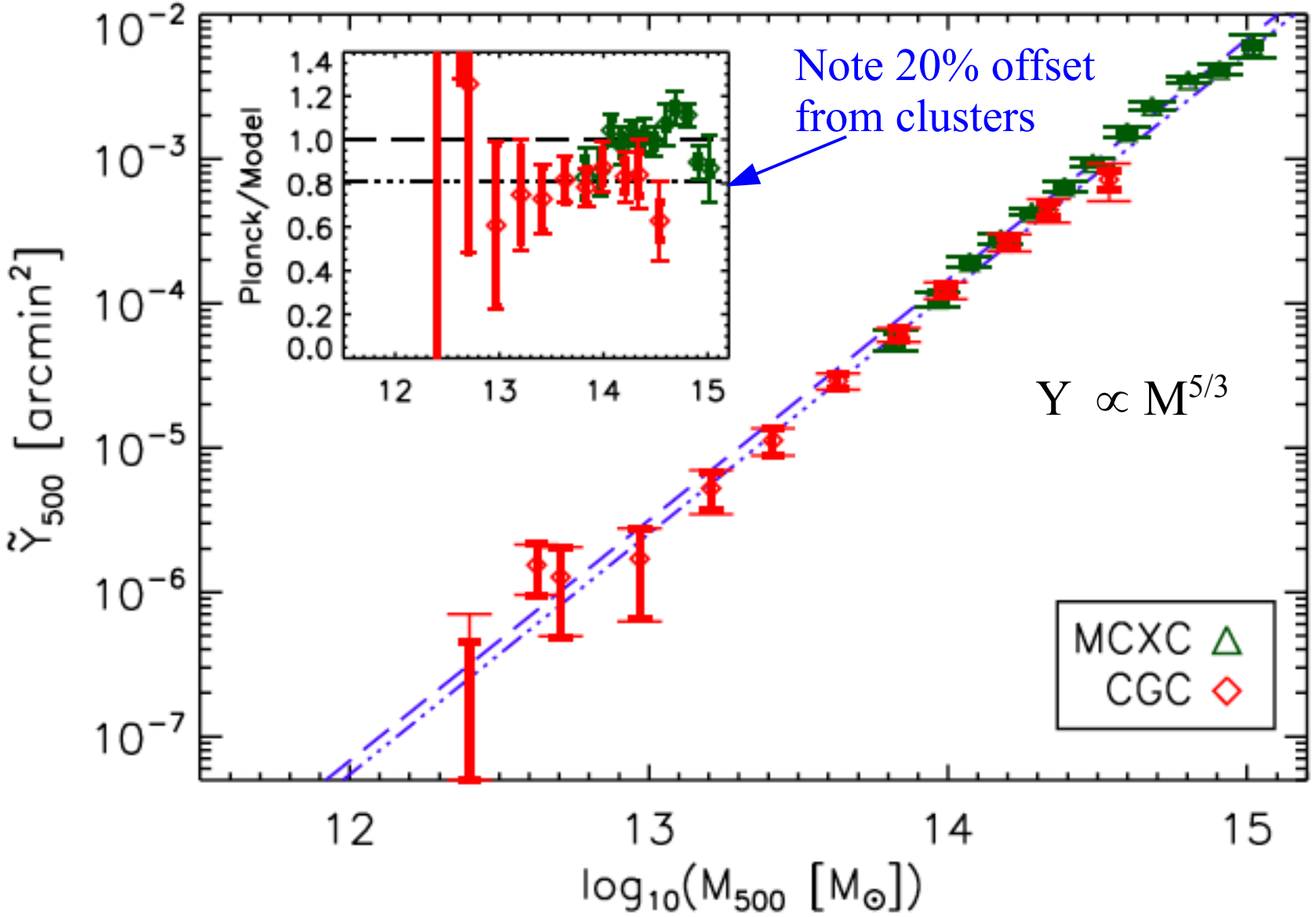

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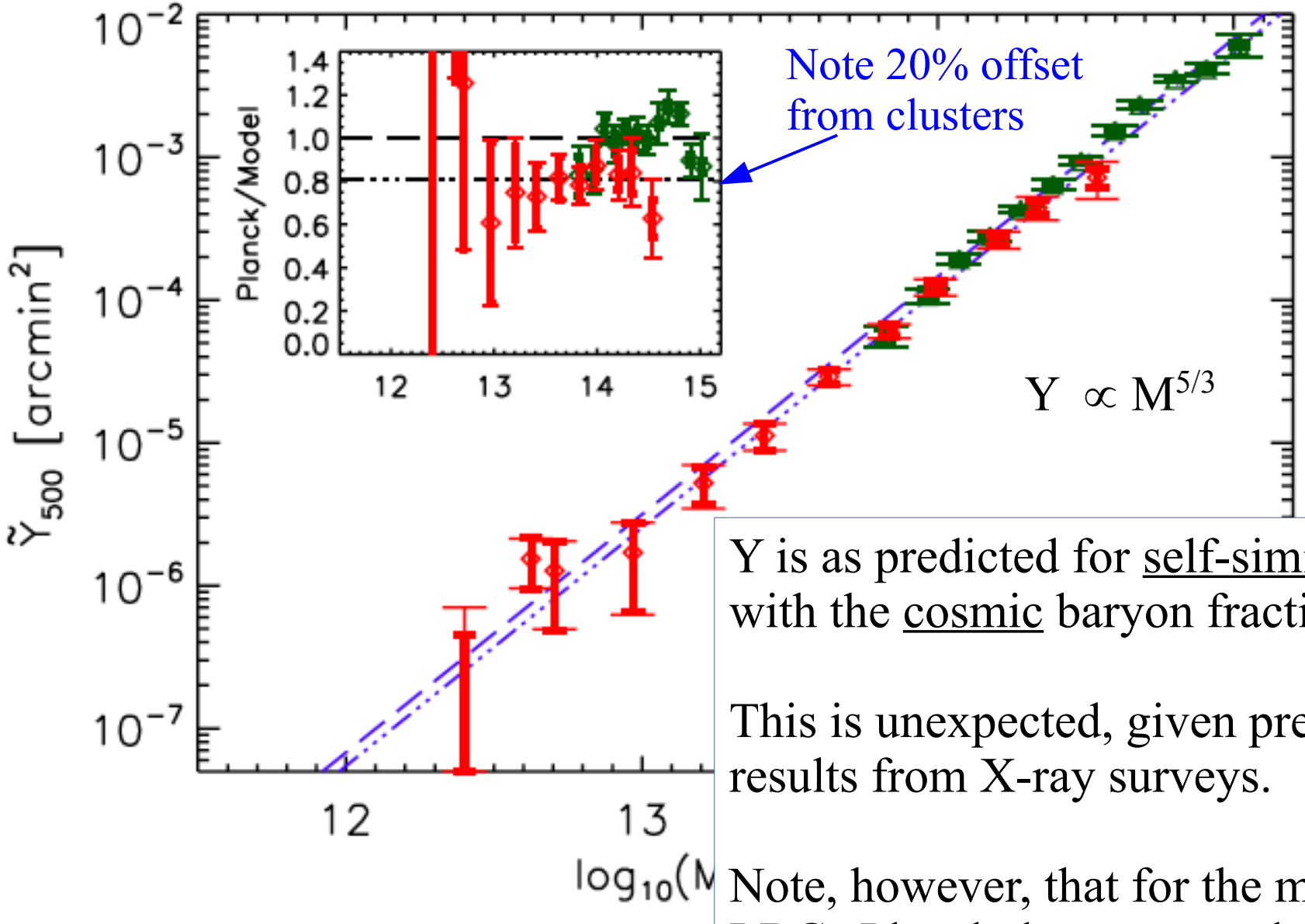


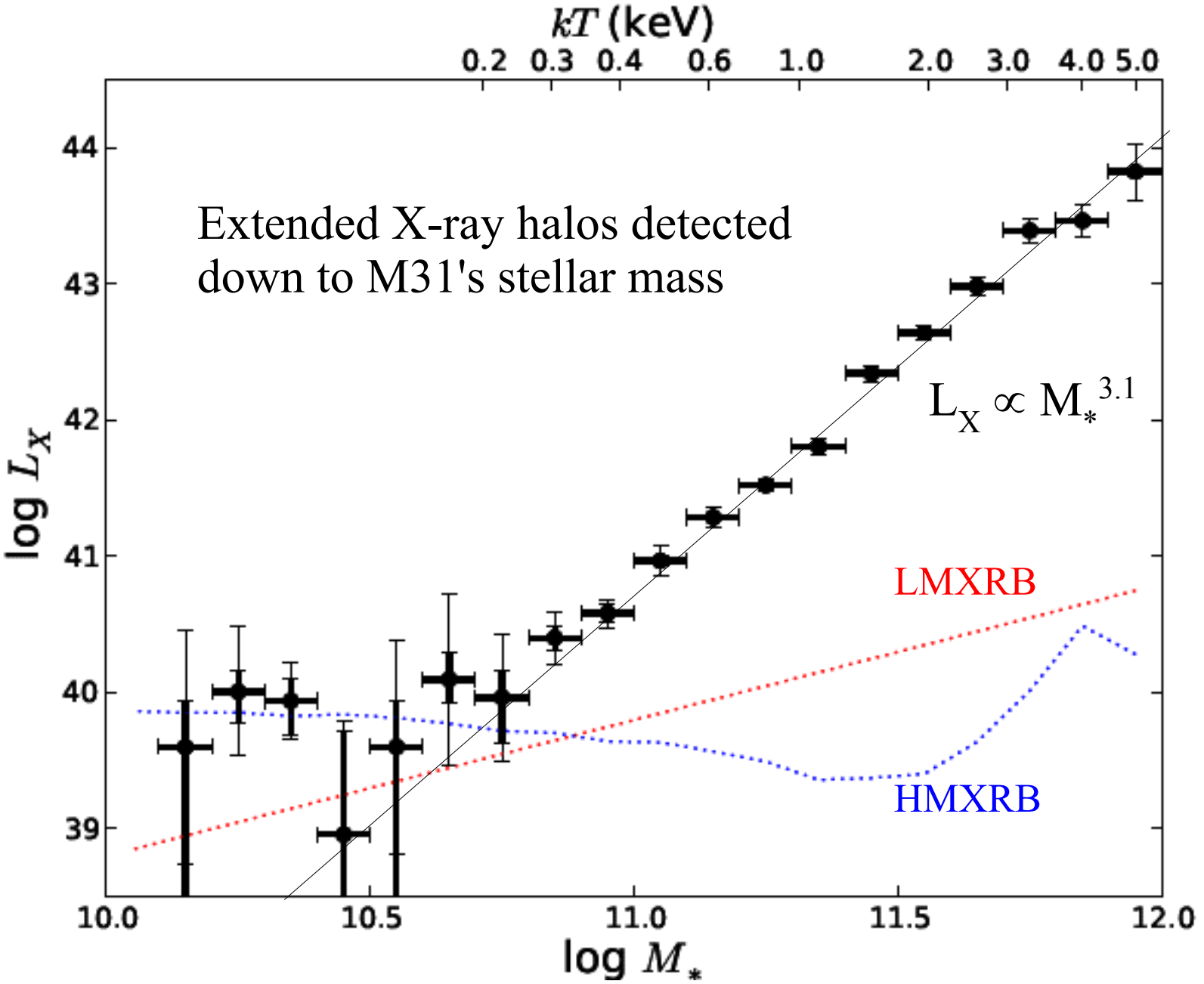
Y is as predicted for self-similar halos with the cosmic baryon fraction

This is unexpected, given previous results from X-ray surveys.

Note, however, that for the majority of LBGs Planck does not resolve R_{500}

Stacked Rosat X-ray signal from LBGs

Anderson et al 2015



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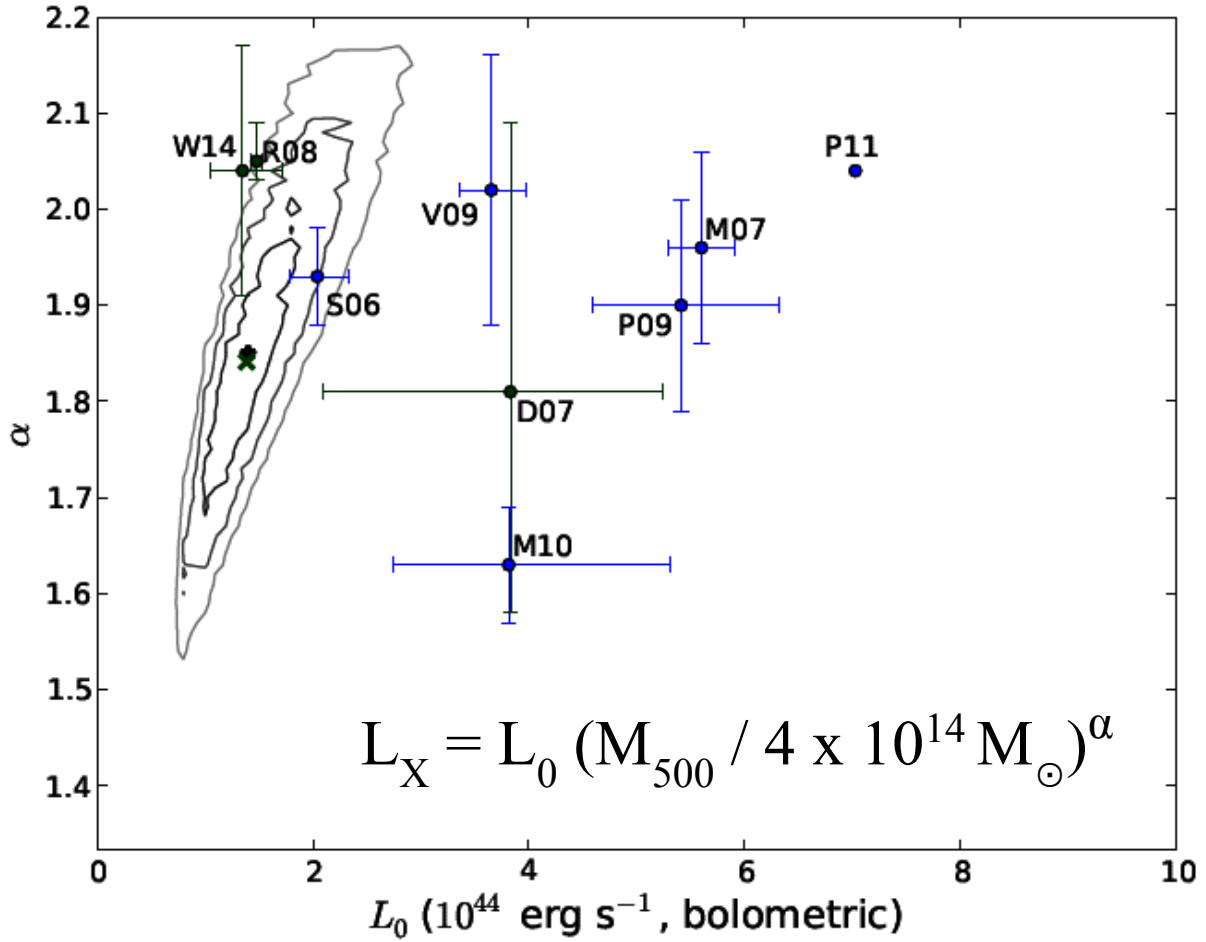


Anderson et al 2015

$\alpha = 4/3$ is expected for self-similar halos with constant baryon fraction

X-ray luminosity grows much faster with mass than this

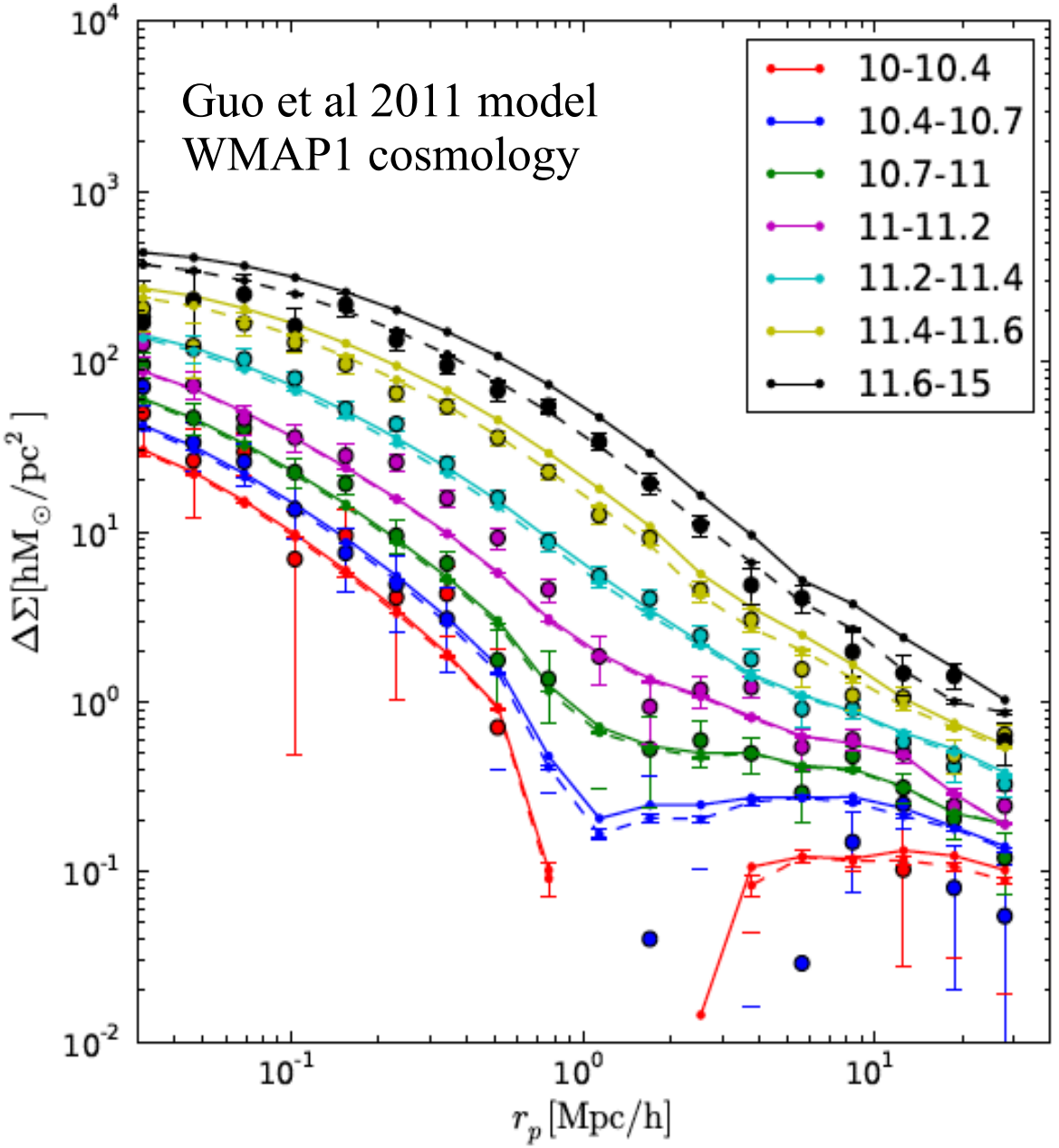
Forward modelling using the Guo13 mock LBG catalogue gives 1, 2 and 3σ ranges for the parameters of the $L_X - M_{500}$ relation

rough agreement with results for optically selected clusters

→ <u>disagreement</u> in normalisation with results for X-ray selected clusters

new normalisation eliminates conflict with primary CMB parameters

Stacked weak lensing signal from LBGs



Wang, Mandelbaum et al (2015)

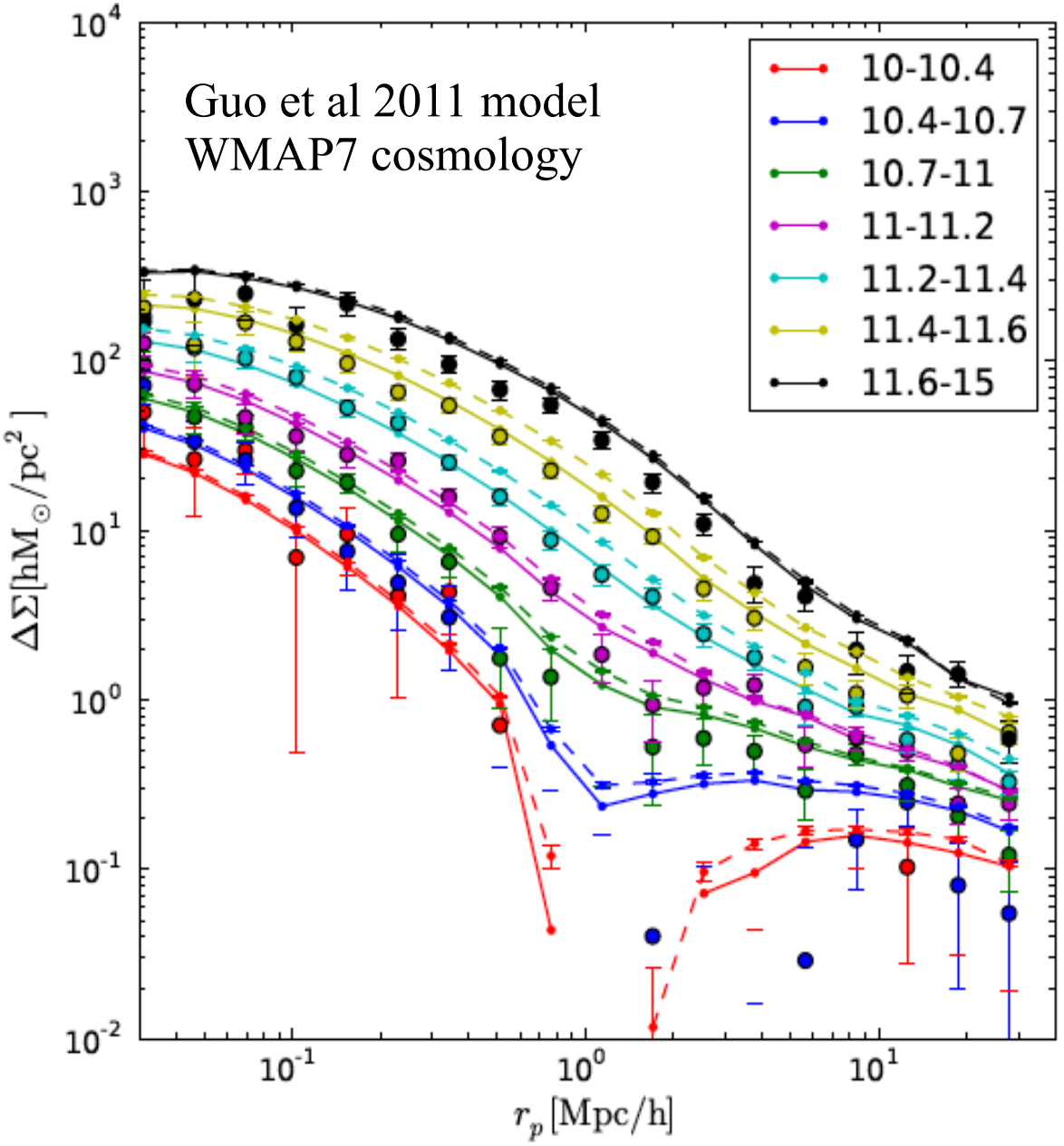
Points are results for SDSS/DR7

Dashed lines are results for the original published simulation

Solid lines are results when stellar mass is corrected by $\Delta M_*(M_*)$ chosen so that the simulated stellar mass function agrees exactly with SDSS

Typically $\Delta M_* < 0.1$ dex

Stacked weak lensing signal from LBGs



Wang, Mandelbaum et al (2015)

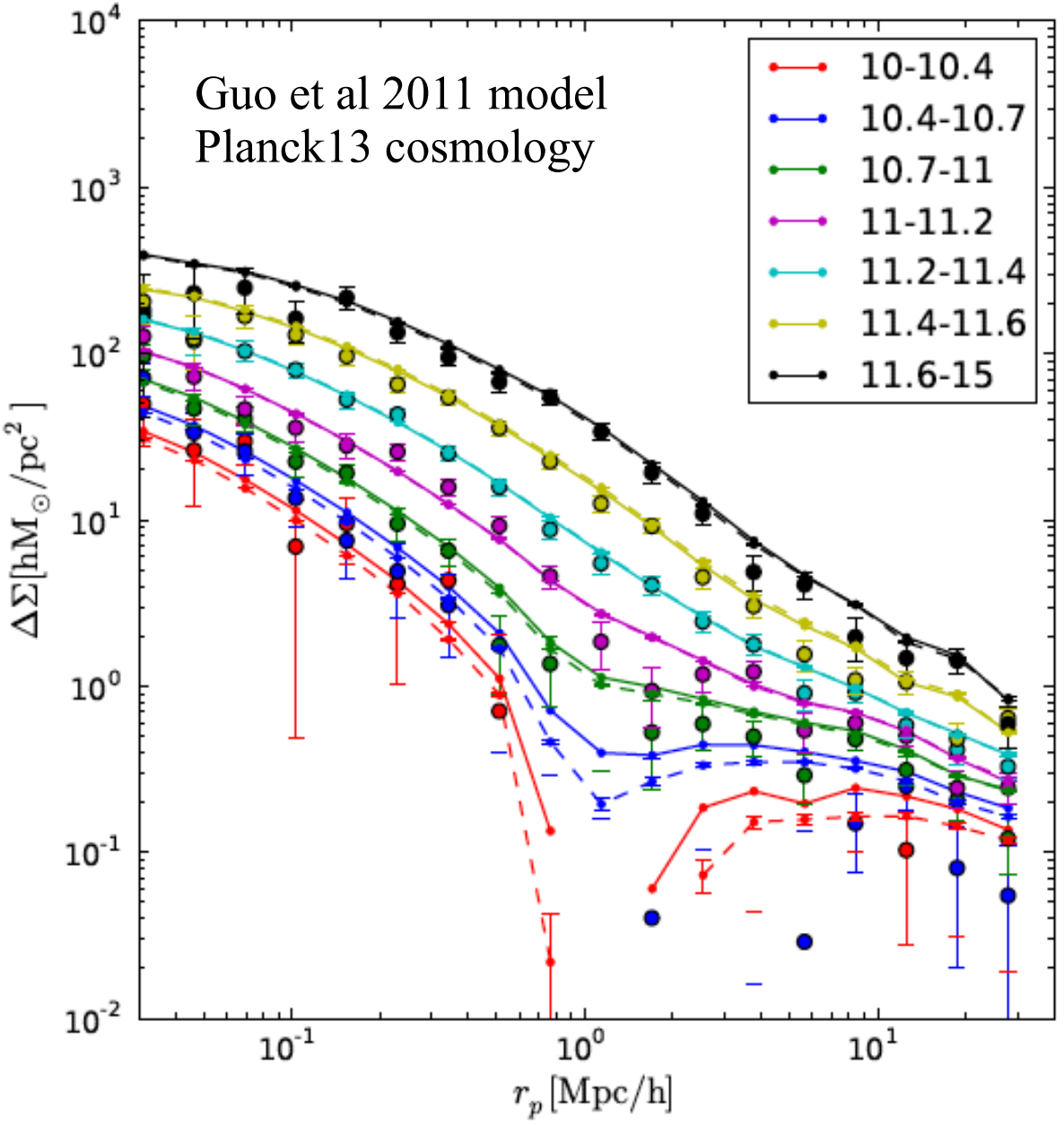
Points are results for SDSS/DR7

Dashed lines are results after scaling the N-body simulation

Solid lines are results when stellar mass is corrected by $\Delta M_*(M_*)$ chosen so that the simulated stellar mass function agrees <u>exactly</u> with SDSS

Typically $\Delta M_* < 0.1$ dex

Stacked weak lensing signal from LBGs



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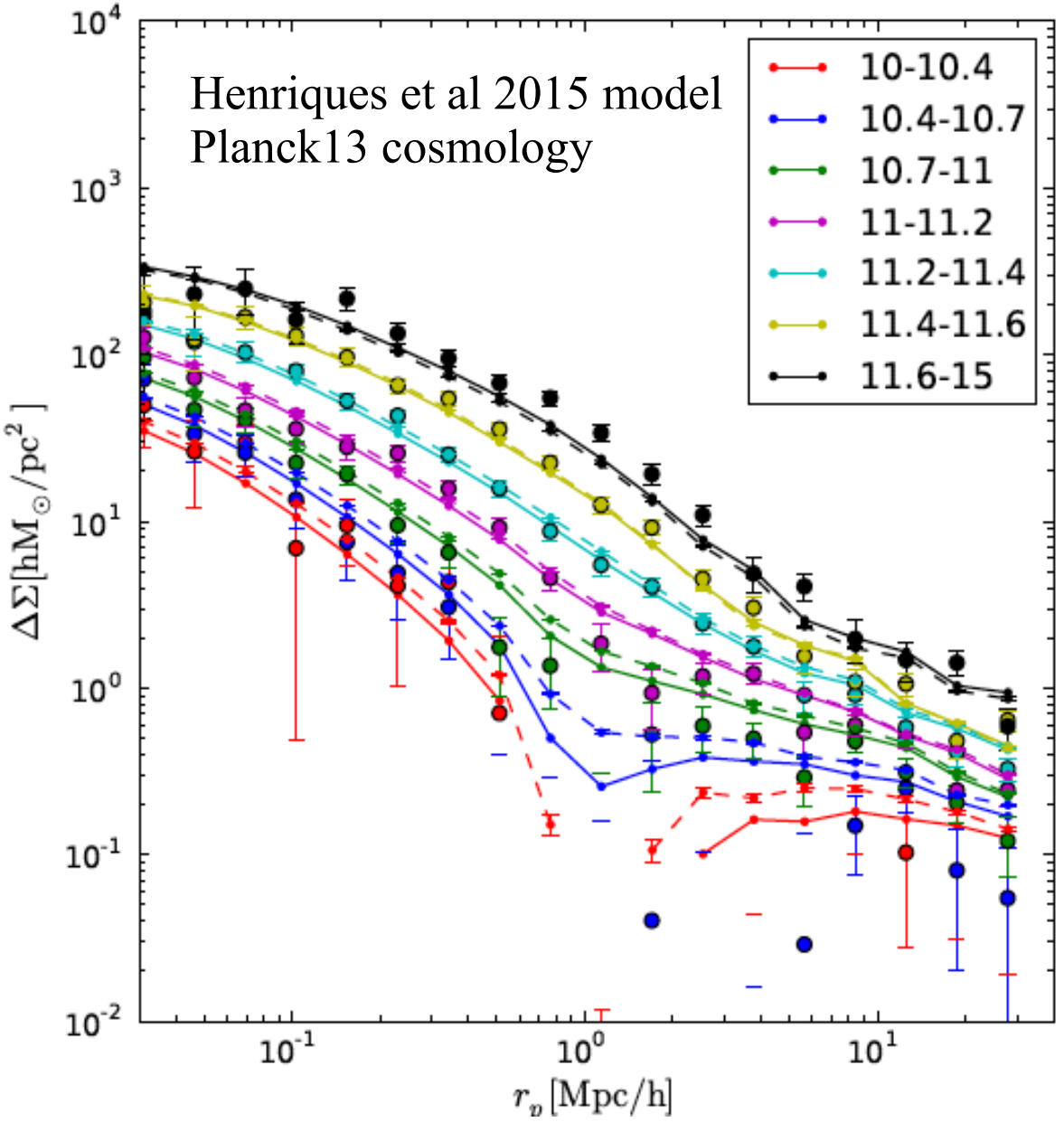
The lensing prediction is sensitive to cosmology!

Stacked weak lensing signal from LBGs



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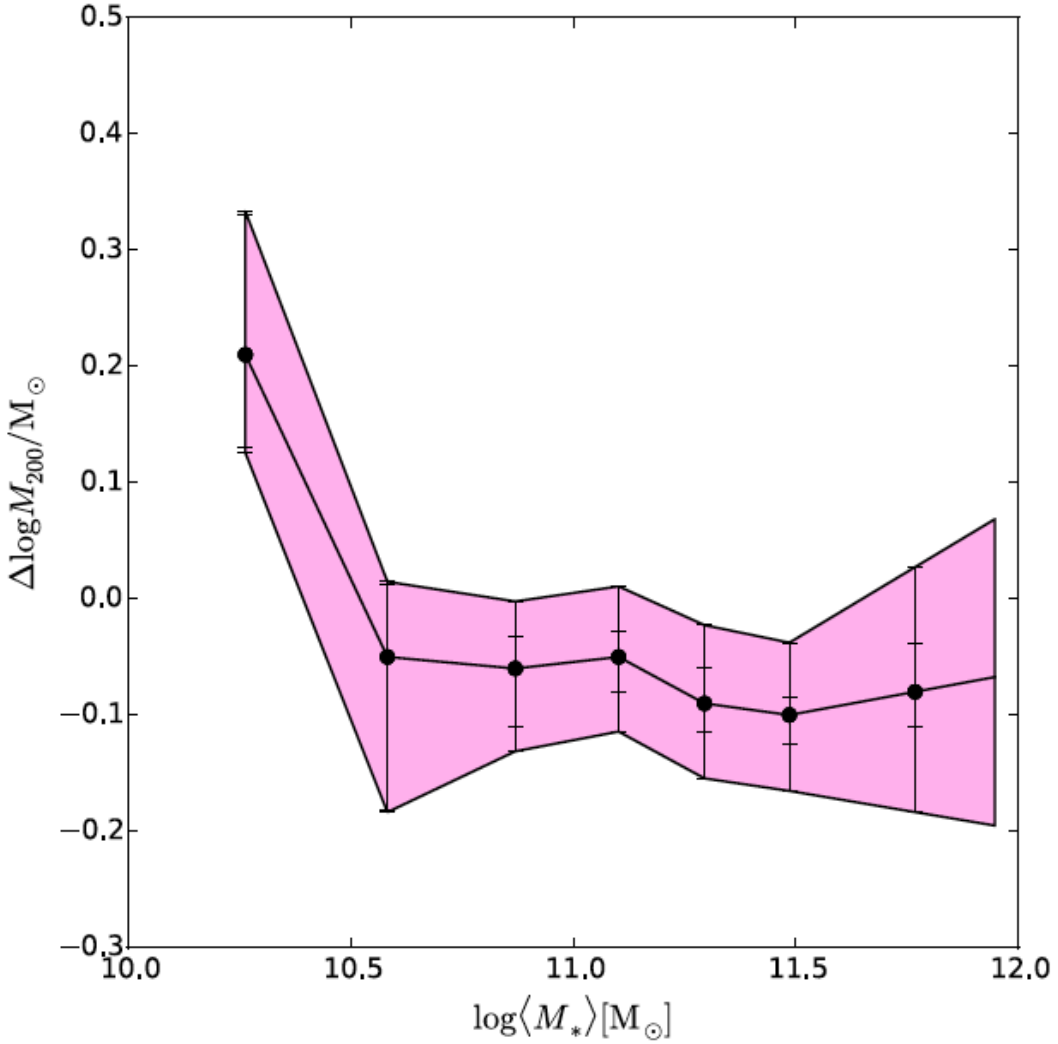
Typically $\Delta M_* < 0.1$ dex

...but it is also sensitive to galaxy formation model, even for fixed stellar mass function

Uncertainties in effective halo mass

Wang et al (2016)



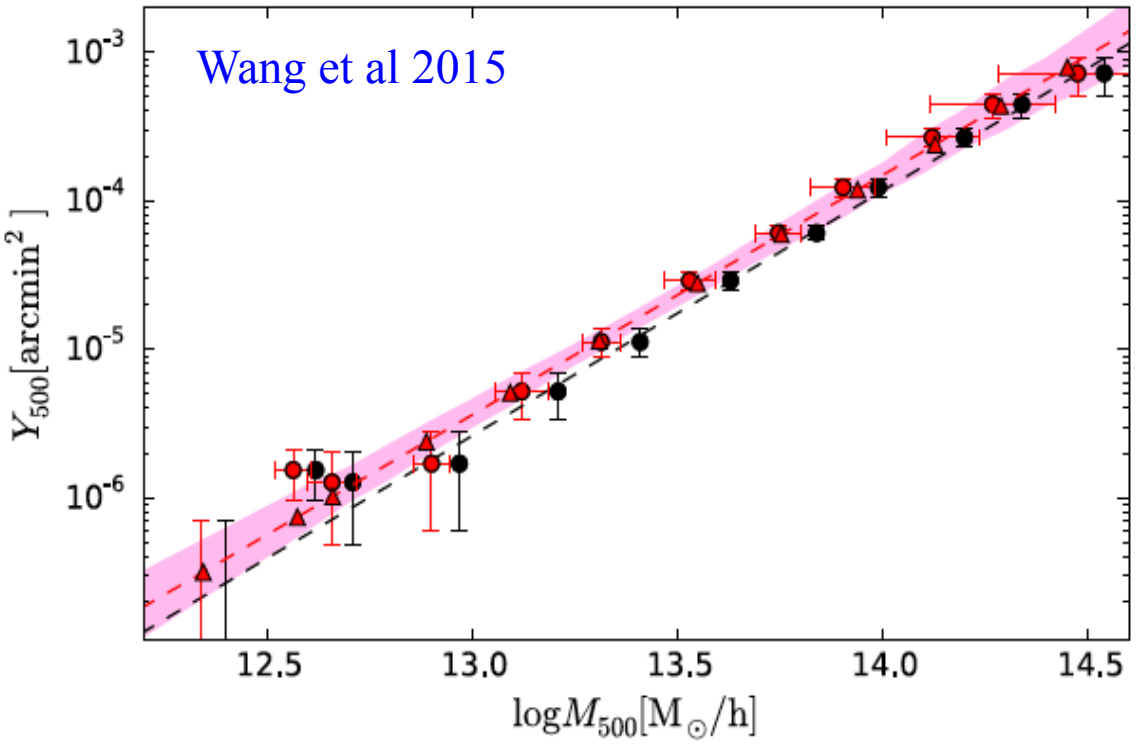
There are two types of uncertainty in the lensing calibration of $M_{halo}(M_*)$

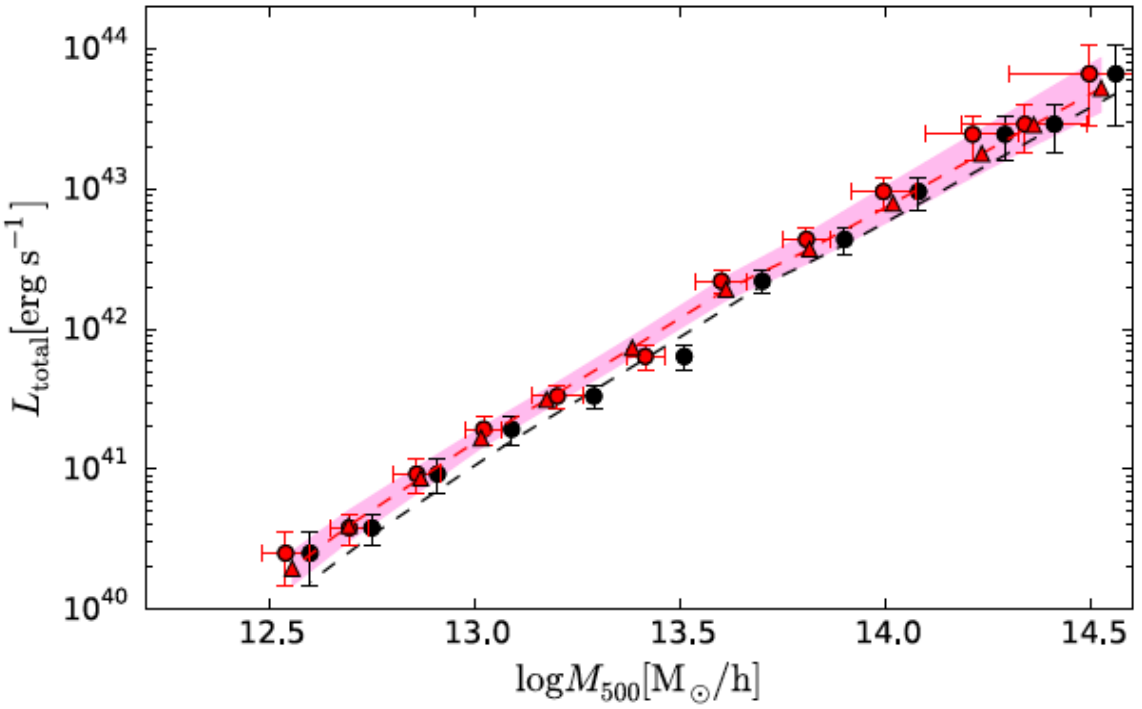
– observational uncertainties from the lensing measurements

– model uncertainties from variations in the *shape* of the distribution of halo mass at given M_*

The first is dominant at small M_*

The second at large M_*

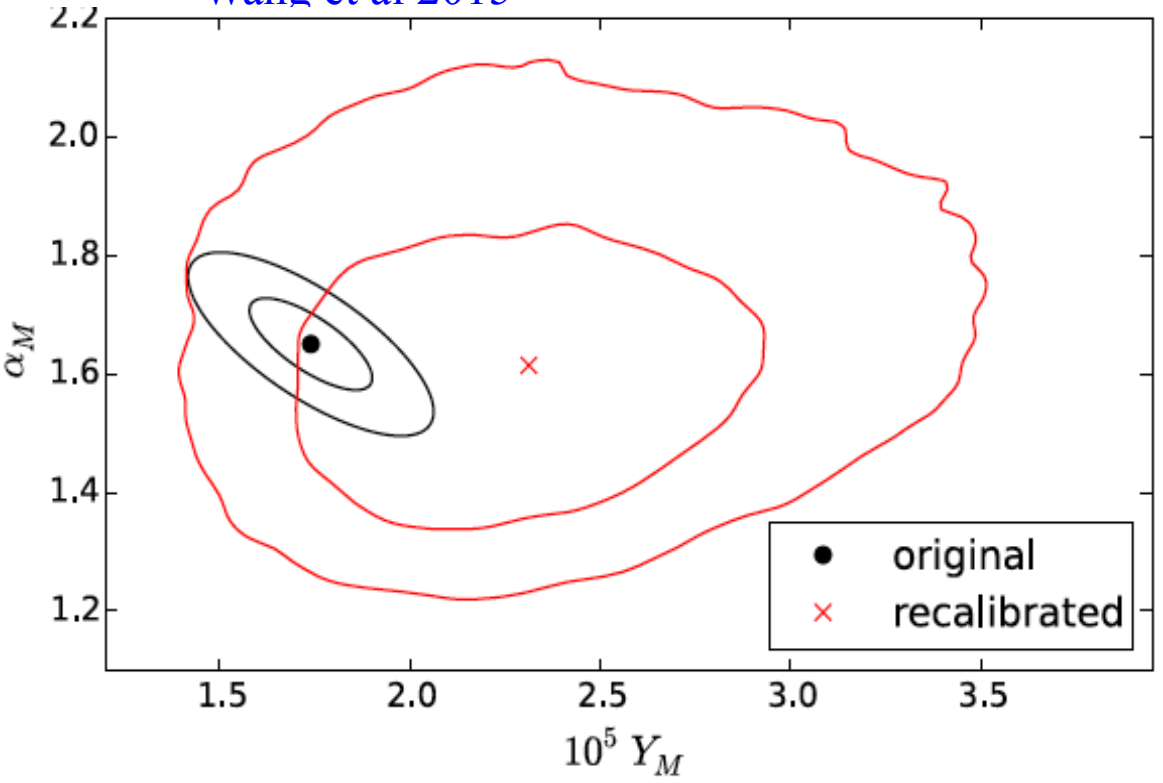


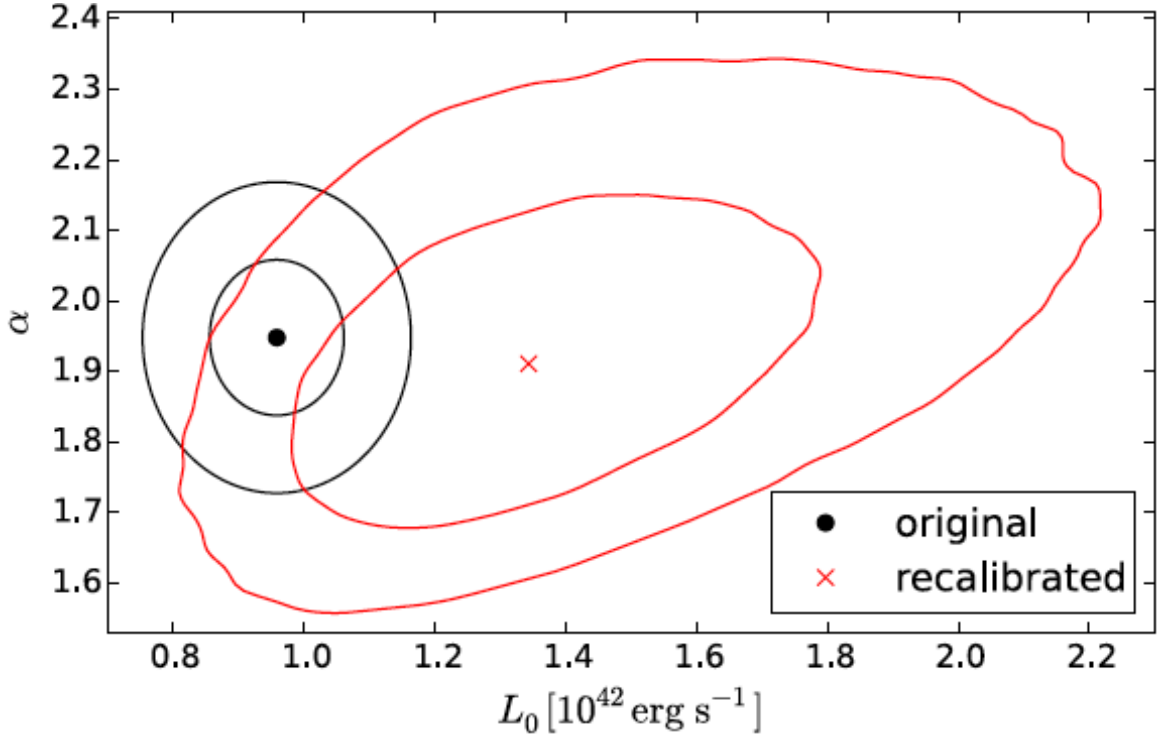


Recalibrated scaling relations

- Much less dependent on modelling assumptions
- Full treatment of errors in both masses and SZ/X-ray signals
- Mean values for a representative population of halos
- Covering the halo mass range $10^{12.5}\,\mathrm{M}_\odot < \mathrm{M}_{\mathrm{halo}} < 10^{14.5}\,\mathrm{M}_\odot$ which accounts for ~25% of all the expected baryons

Wang et al 2015





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- High-mass agreement with X-ray clusters only slightly improved but now has large uncertainty

Conclusions from Locally Brightest Galaxies in SDSS/DR7

- The gas properties of DM halos scale as power laws of mass which are consistent with self-similarity for total SZ signal, but NOT for L_X

  → feedback "puffs up" the gas in low mass halos

- Differently selected cluster samples give different $L_X - M_{halo}$ normalisations

  → selection effects bias scaling relations

- The ratio of effective lensing mass to effective SZ mass for stacks of halos depends on the <u>details</u> of how galaxies of given mass populate halos

Scatter matters – precision cosmology with clusters will only become possible when the correlated scatter between mass and all relevant observables is fully characterised