

A new method to constrain the intrinsic scatter and bias of mass proxies

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Based on arxiv:1716.08353

I illustrate the idea, skipping all technical details (and we take the lunch earlier).

If you are a fan of technical details (as I am), read papers.

$z=3$

$z=1$

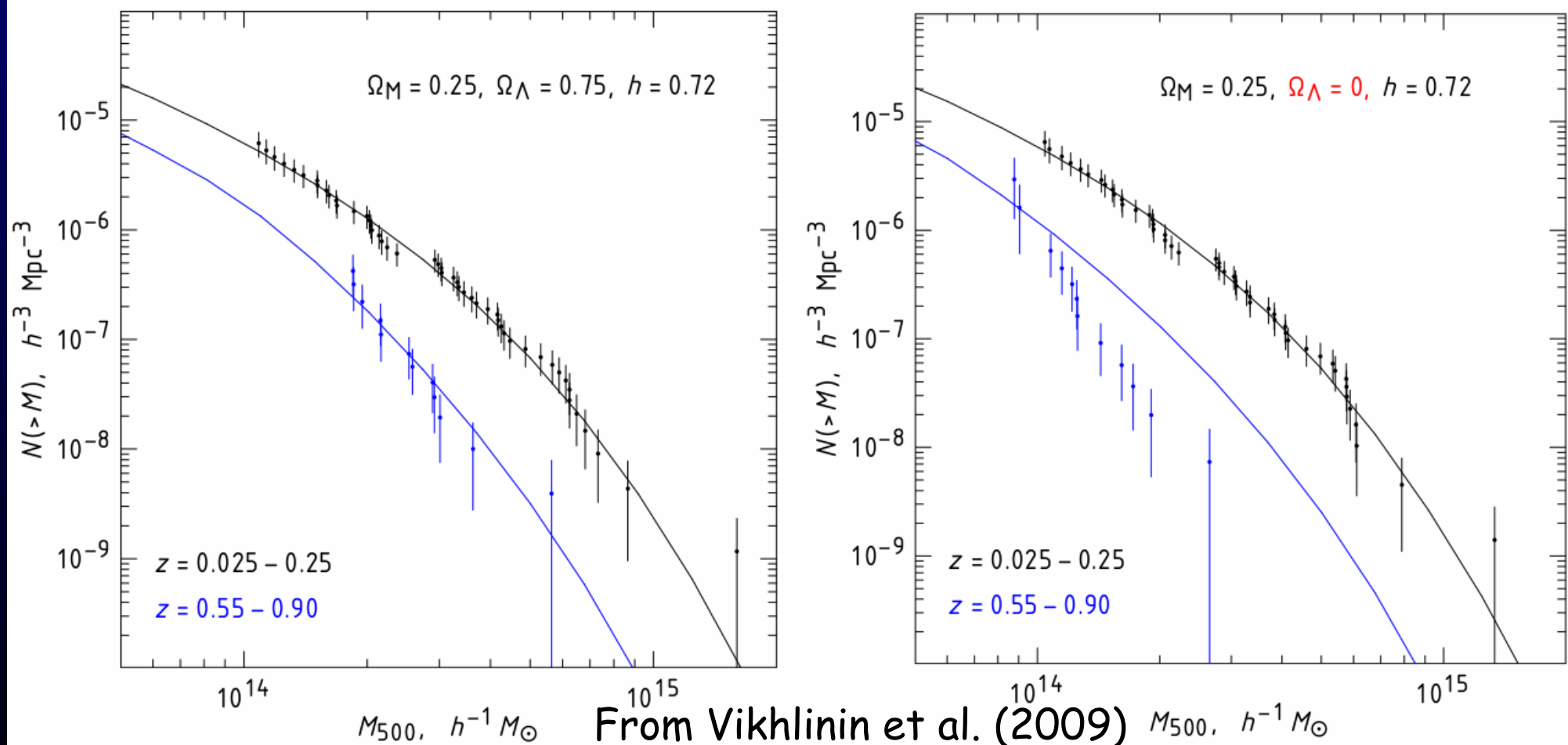
$z=0.5$

$z=0$

Clusters
emerge
from an
almost ...

From Kravtsov &
Borgani (2012)

... by amounts that depends on
cosmological parameters
(or theory of gravity)



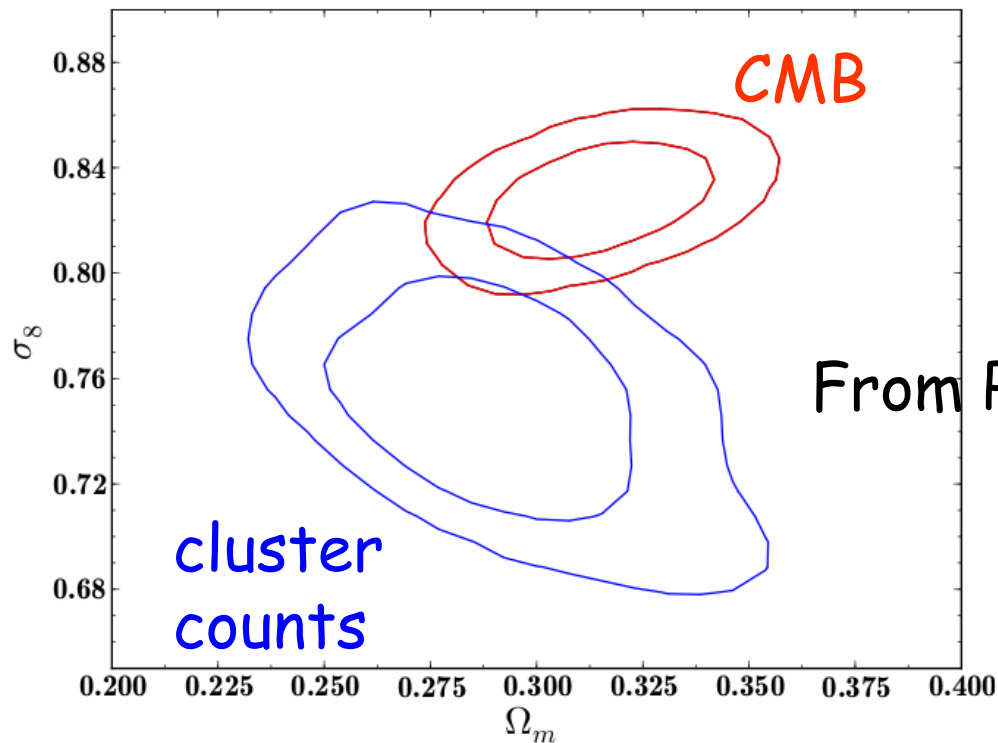
Critical issue: mass-observable relation ...

we don't measure mass, only a proxy
(richness, core-excised X-ray luminosity, Y_x ,
 Y_{SZ} , T , M_{gas} , etc.)
with some scatter and, perhaps, some bias
with mass.

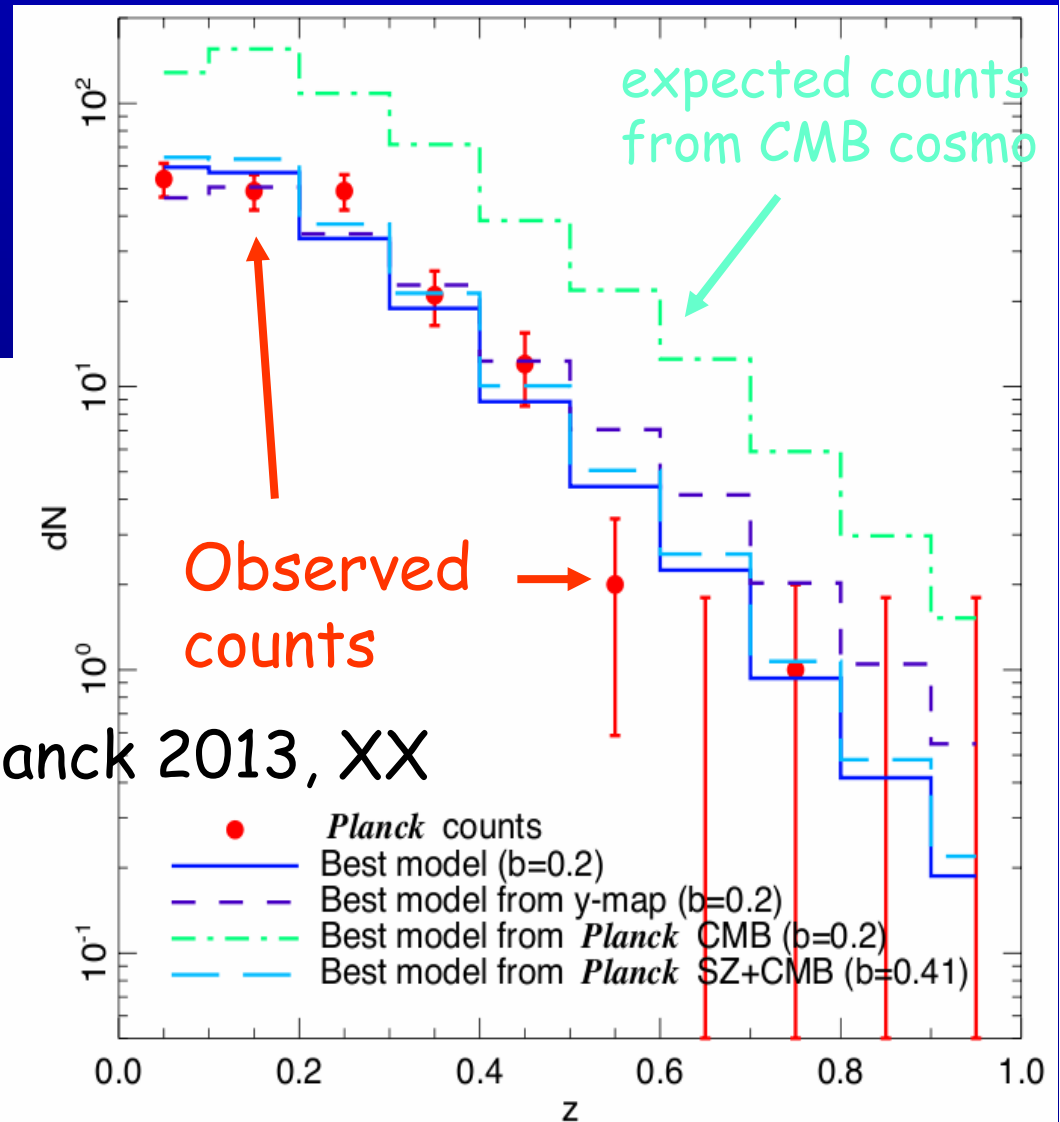
(talks by Gus, Sebastian, etc.)

A bias in mass induces a mass on cosmological parameters

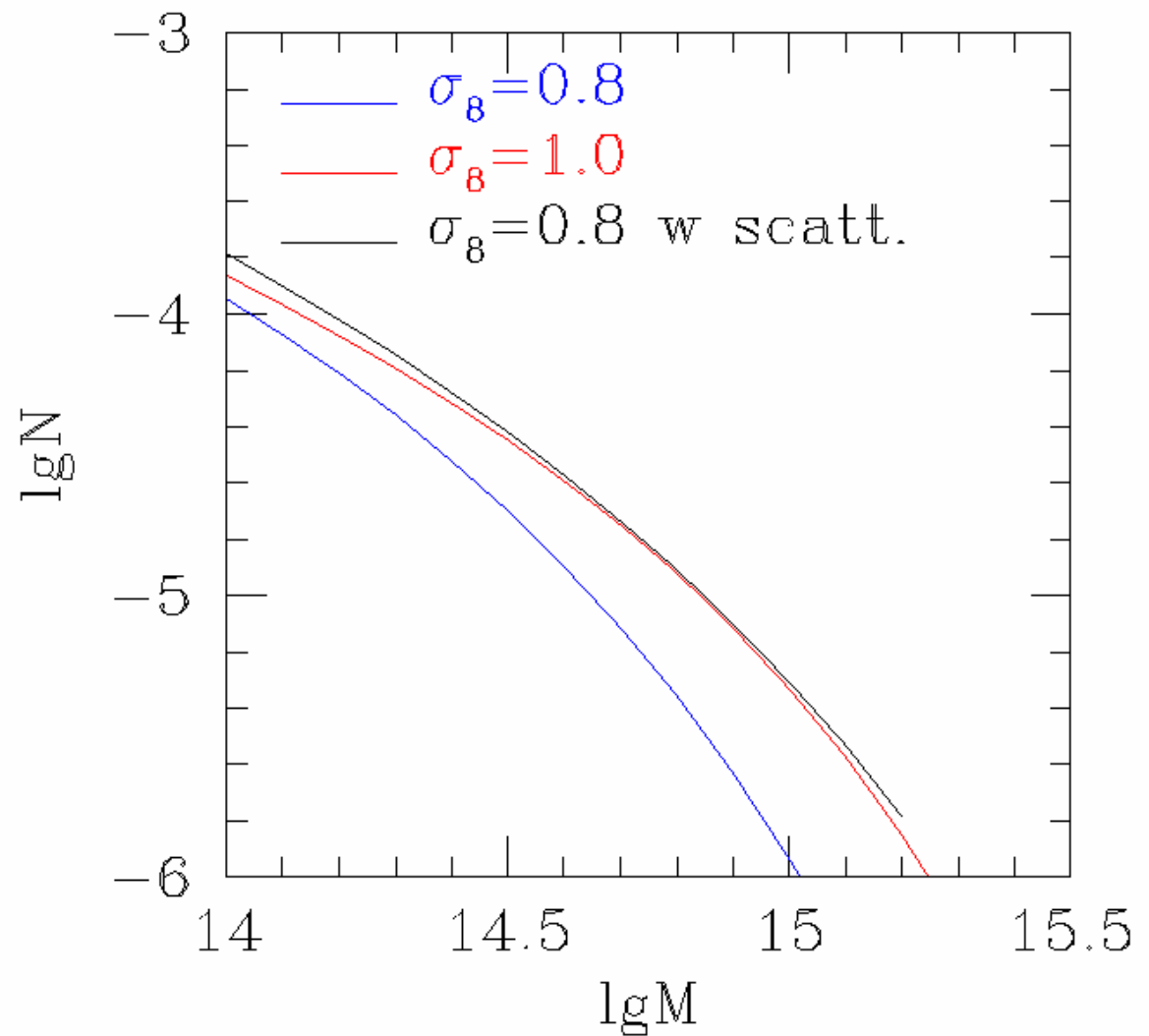
Figures only to illustrate the idea, not to state about what is going on with Planck data



From Planck 2013, XX

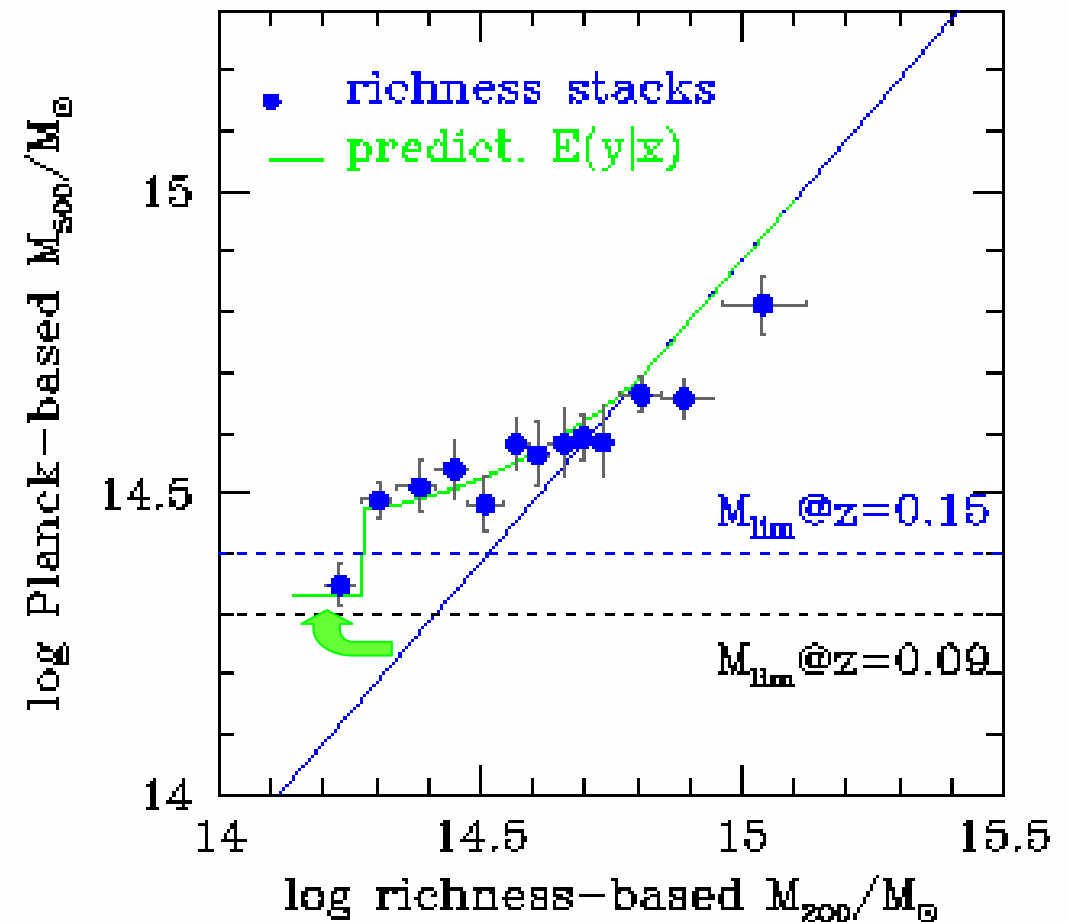


A wrong estimate of the scatter induces a bias on cosmological parameters too.



How to constraint the relative bias: I

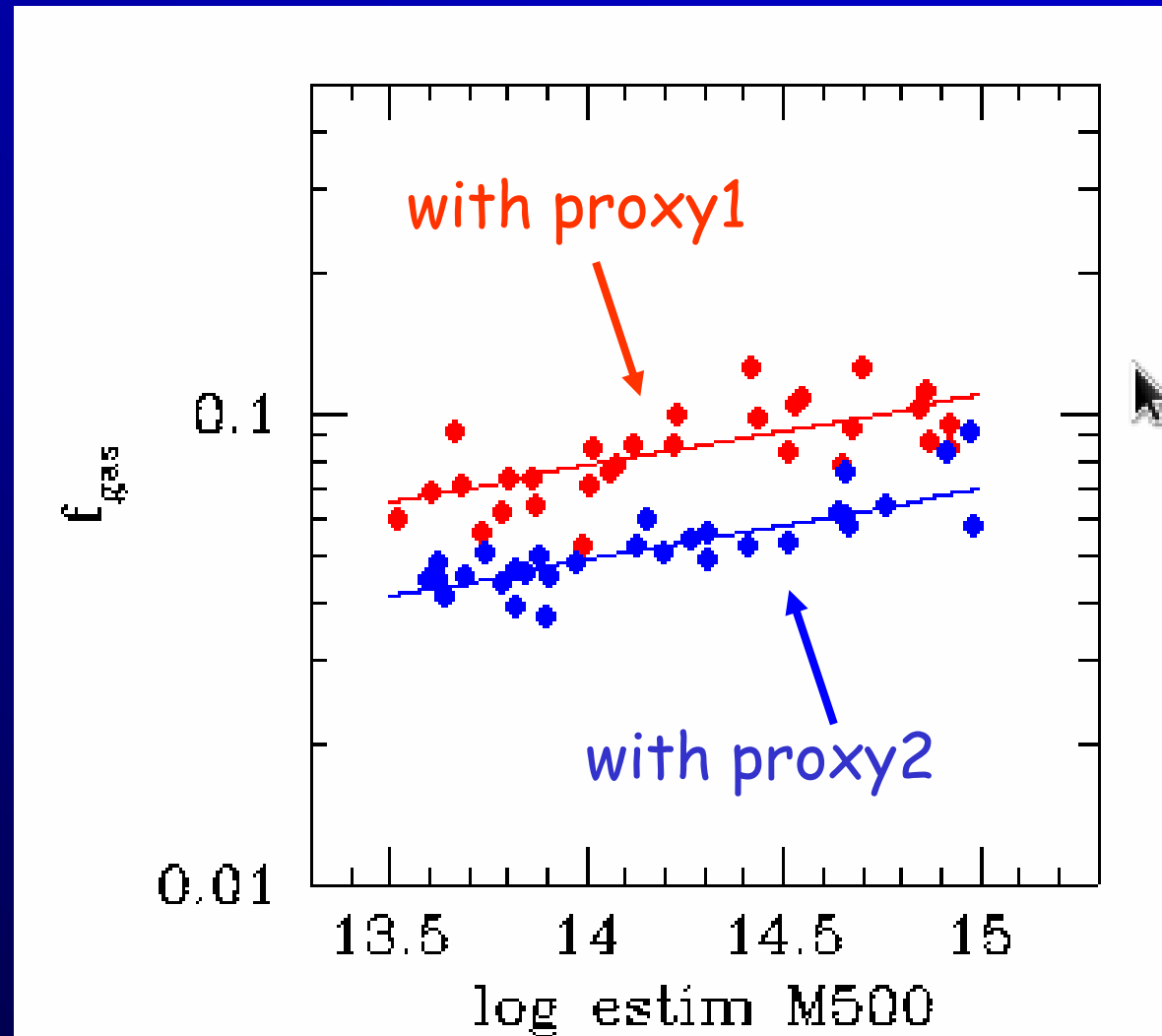
if you are lucky: it exists an overlap sample having two mass proxies with known selection function. Compare M_{proxy1} vs M_{proxy2} , accounting for selection effects (tilting the relation away from 1-to-1).



From SA 2016 "Famous cluster..." paper.

How to constraint the relative bias: II

Little or no overlap? Compute an observable mass-dependent quantity, such as gas fraction. In presence of a relative bias, gas fraction should be different at the same nominal mass.



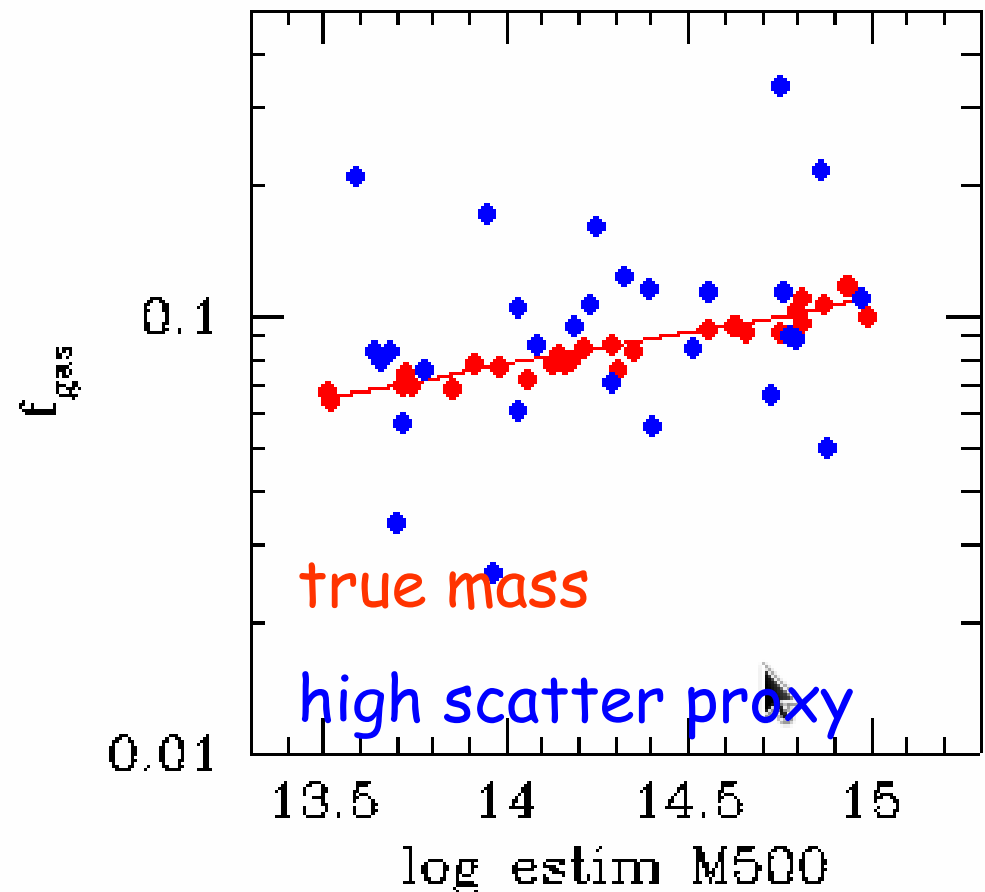
How to constraint scatter: I

If you are lucky, your sample overlaps with another having a second mass proxy believed to have a lower scatter with mass. Use it. But how to be sure about our belief on the lower-scatter proxy (we don't measure masses!)?

How to constraint scatter: II

Little or no overlap? Use a mass-related quantity.
Noisier masses will return more scattered gas fractions

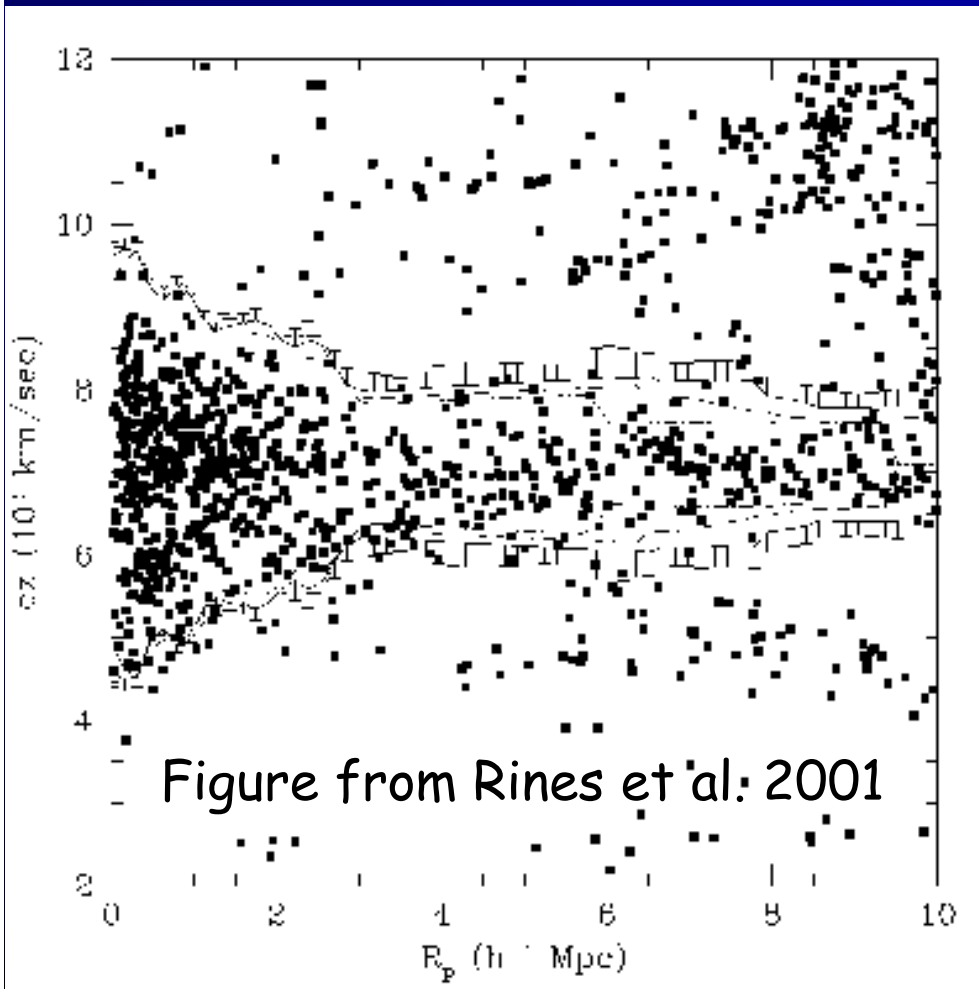
Since the true value of the scatter of the gas fraction is unknown, this method only return an upper limit to the proxy scatter.



Application to caustic masses

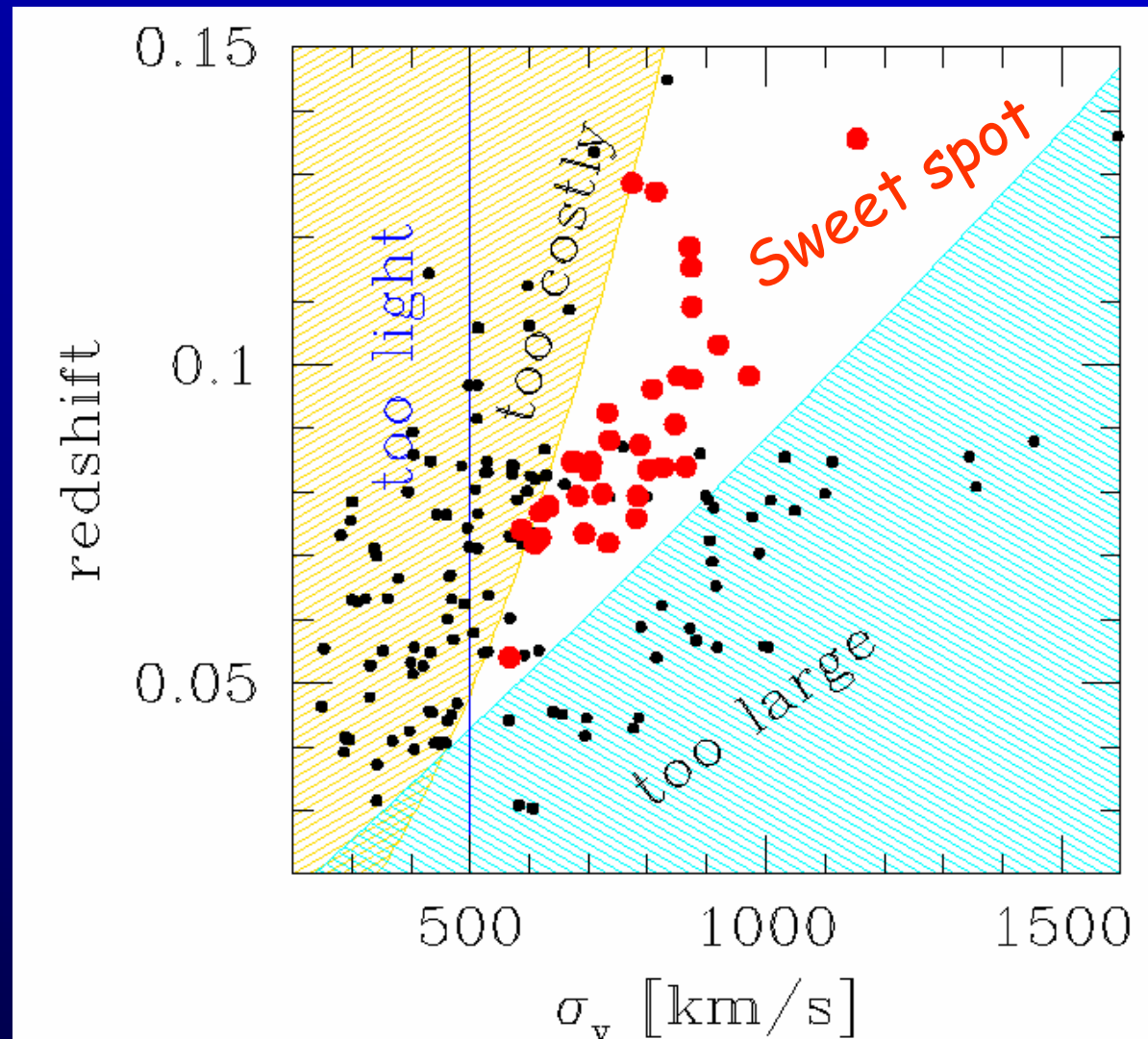
Caustic masses

Caustic masses (=escape velocity). Not requiring the object to be in dynamical, hydrostatical (or whatever) equilibrium. 116 member galaxies per cluster on average. See Ken talk.



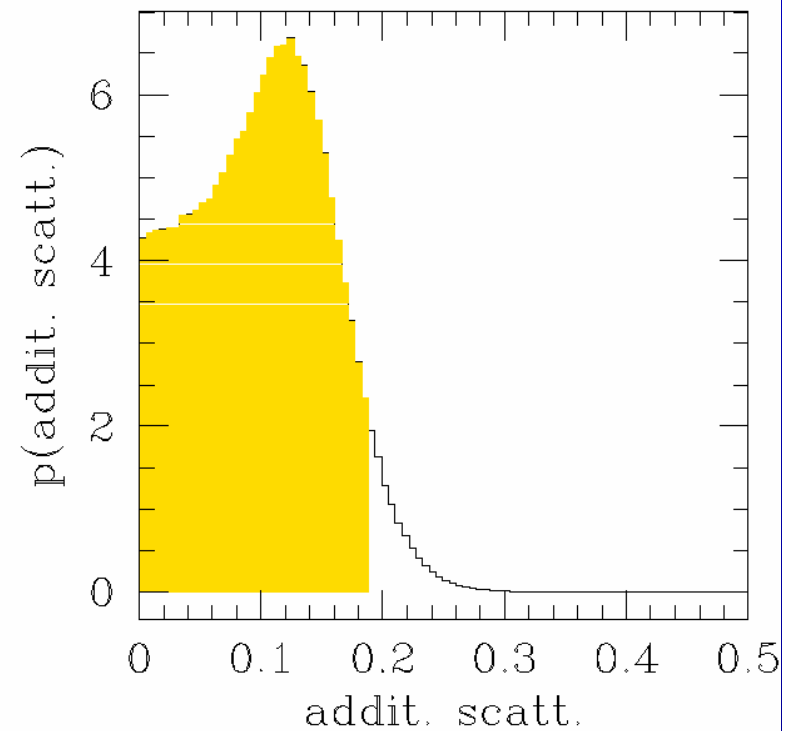
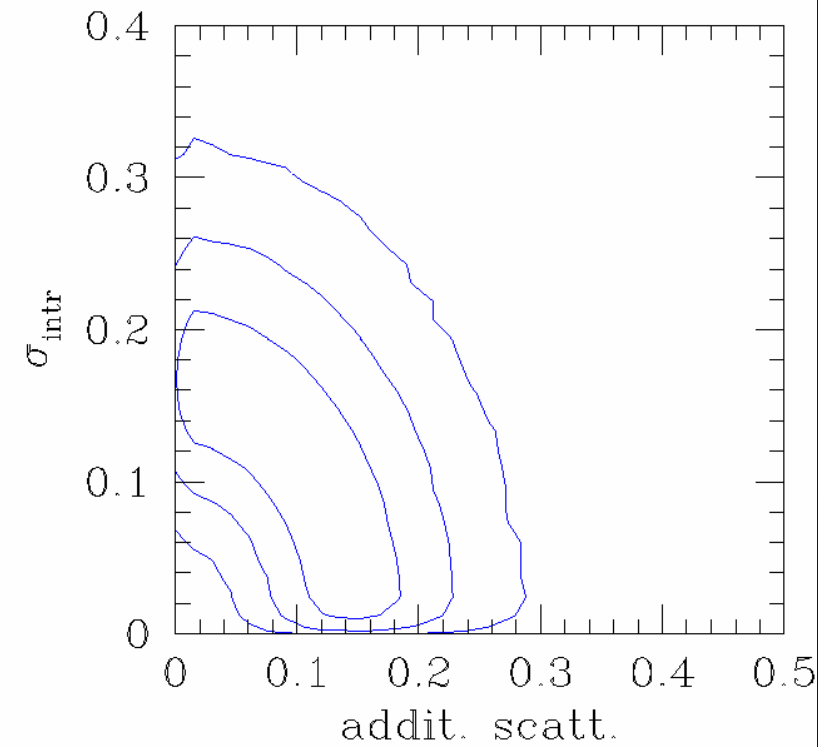
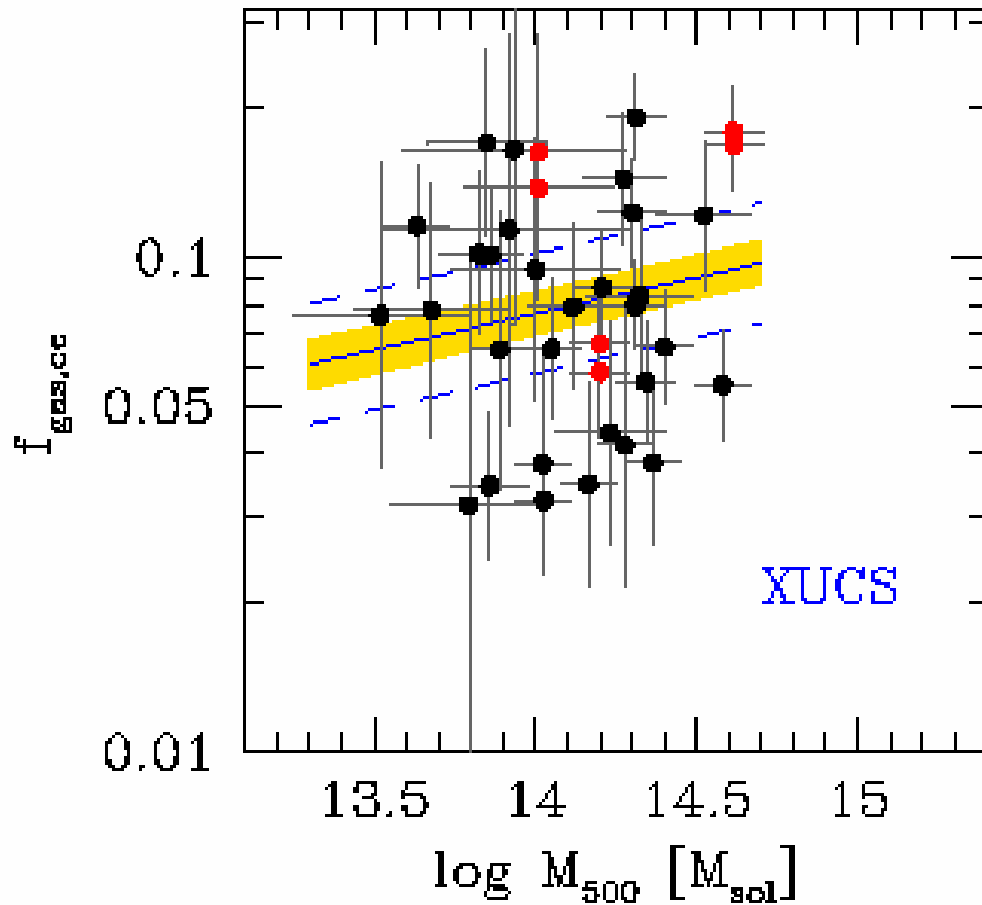
Cluster Selection Function

Followed up in X-ray all clusters with >50 spec- z members in a 3D (ra,dec,z) SDSS search (Miller et al. 2005)

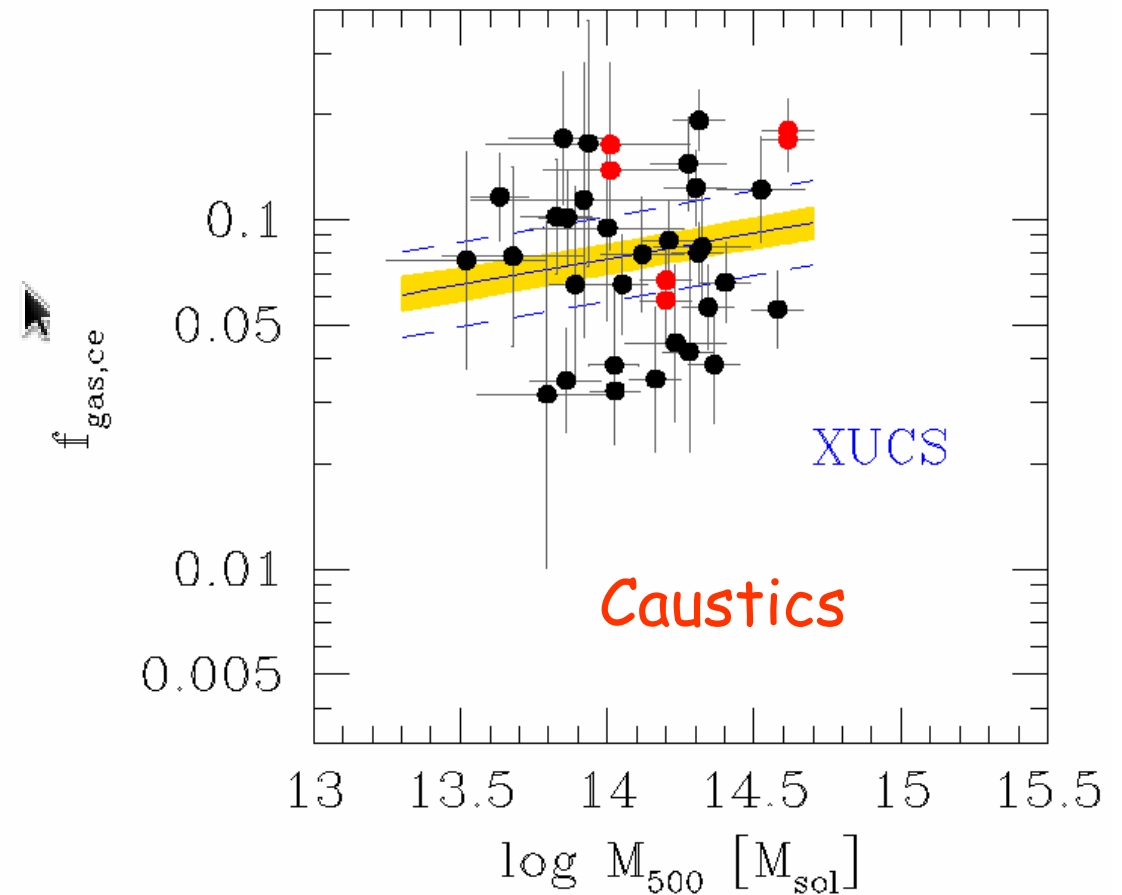
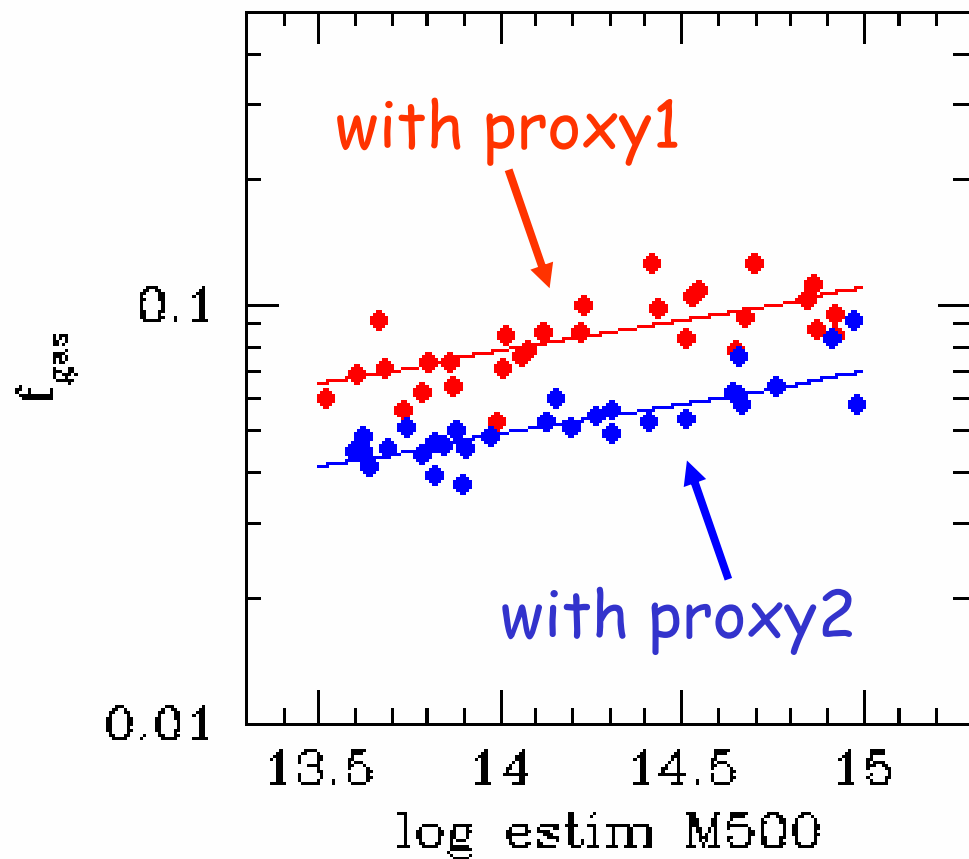


Proxy scatter

35 % scatter (<0.19 dex at 95% c.l.)

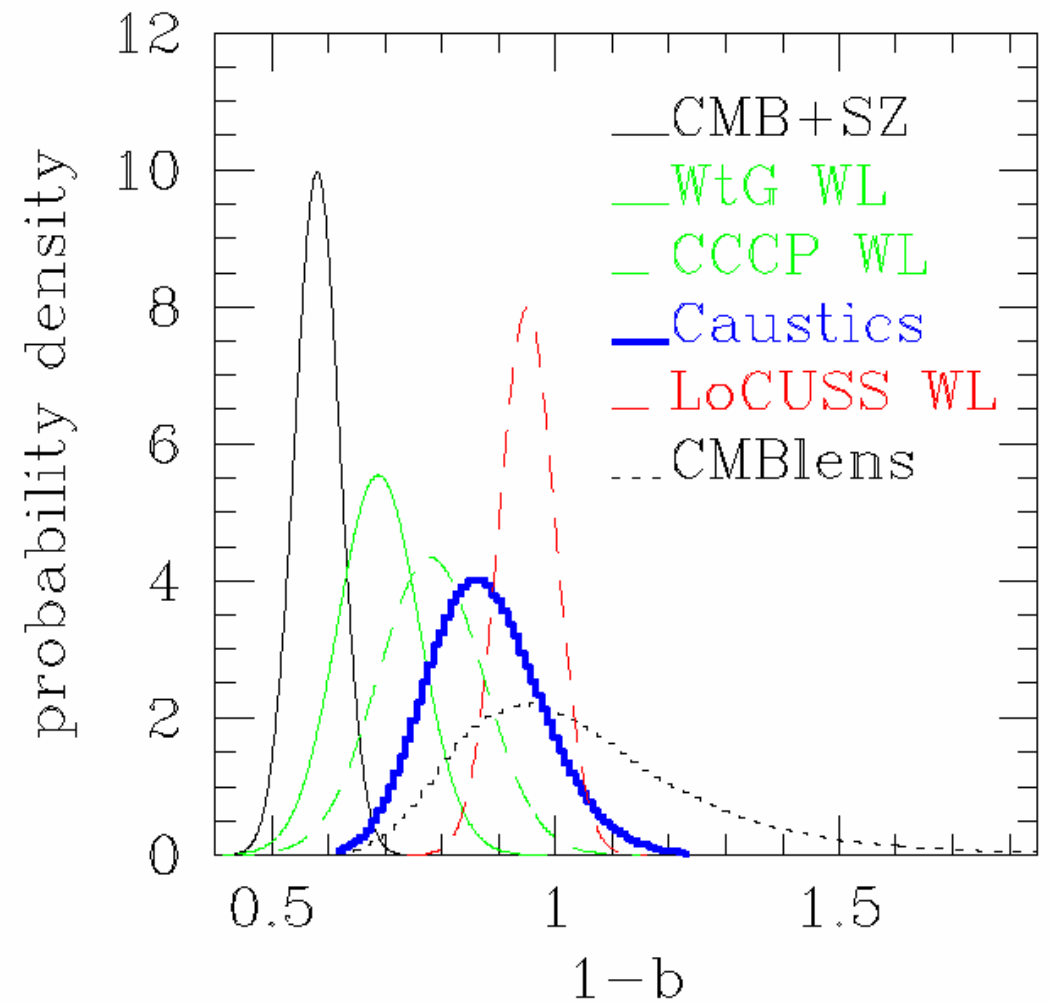
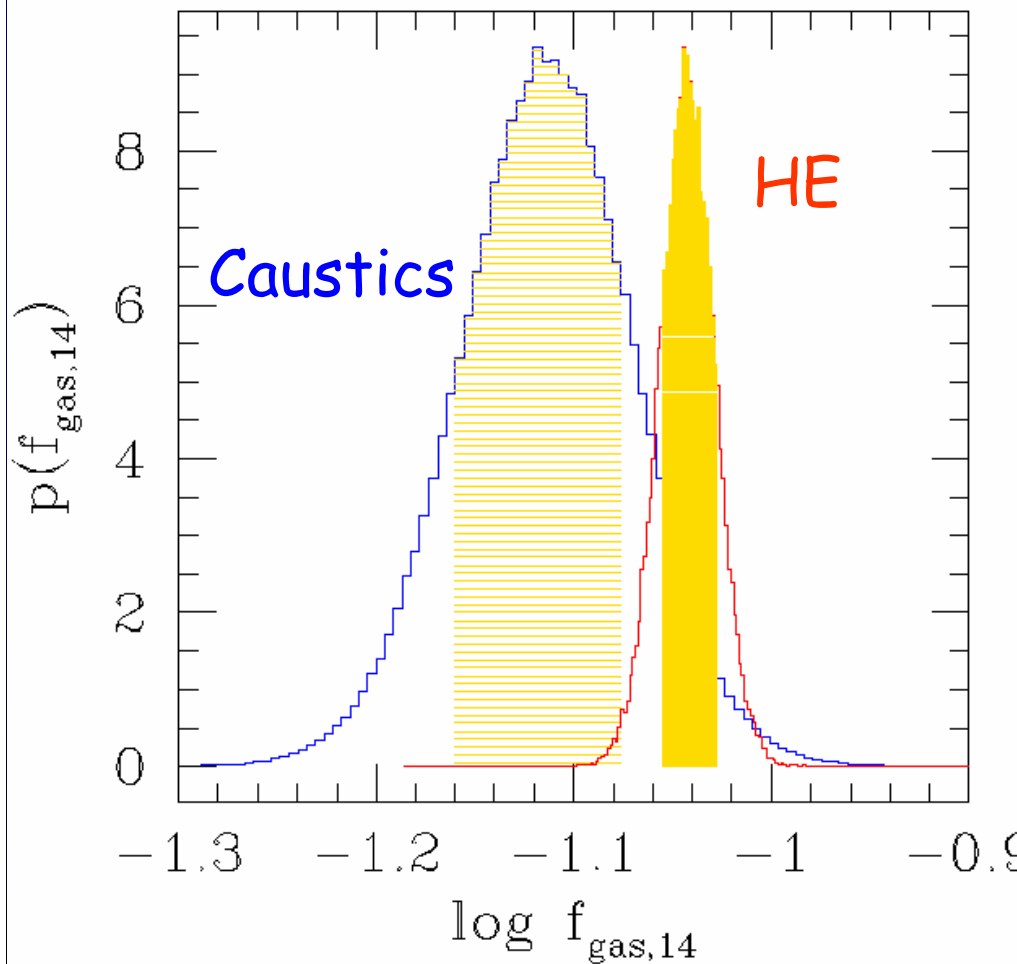


HE vs Caustics bias



Bias

Bias: 0.06 ± 0.05 dex



Summary

- 1) Introduced a new method to estimate scatter and relative bias of mass proxies.
- 2) Applied to caustic masses: 35% intrinsic scatter, 0.06 ± 0.05 dex HE bias
- 3) If you have an X-ray selected sample, or an uncontrolled sample, or you like hair-splitting (as I also like) see :
 - SA 2016, A&A 587, A158 (in part. the appendix)
 - SA et al. 2016, A&A 585, A147
 - SA et al. 2017, [arXiv:1706.08356](https://arxiv.org/abs/1706.08356)
 - SA et al. 2017, [arXiv:1706.08353](https://arxiv.org/abs/1706.08353)