The Abdus Salam
International Centre for Theoretical Physics

United Nations
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2419-9

Workshop on Large Scale Structure

30 July - 2 August, 2012

On the importance of feedback modelling for weak lensing precision cosmology

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On the importance of baryonic Feedback Modelling for Weak lensing precision cosmology

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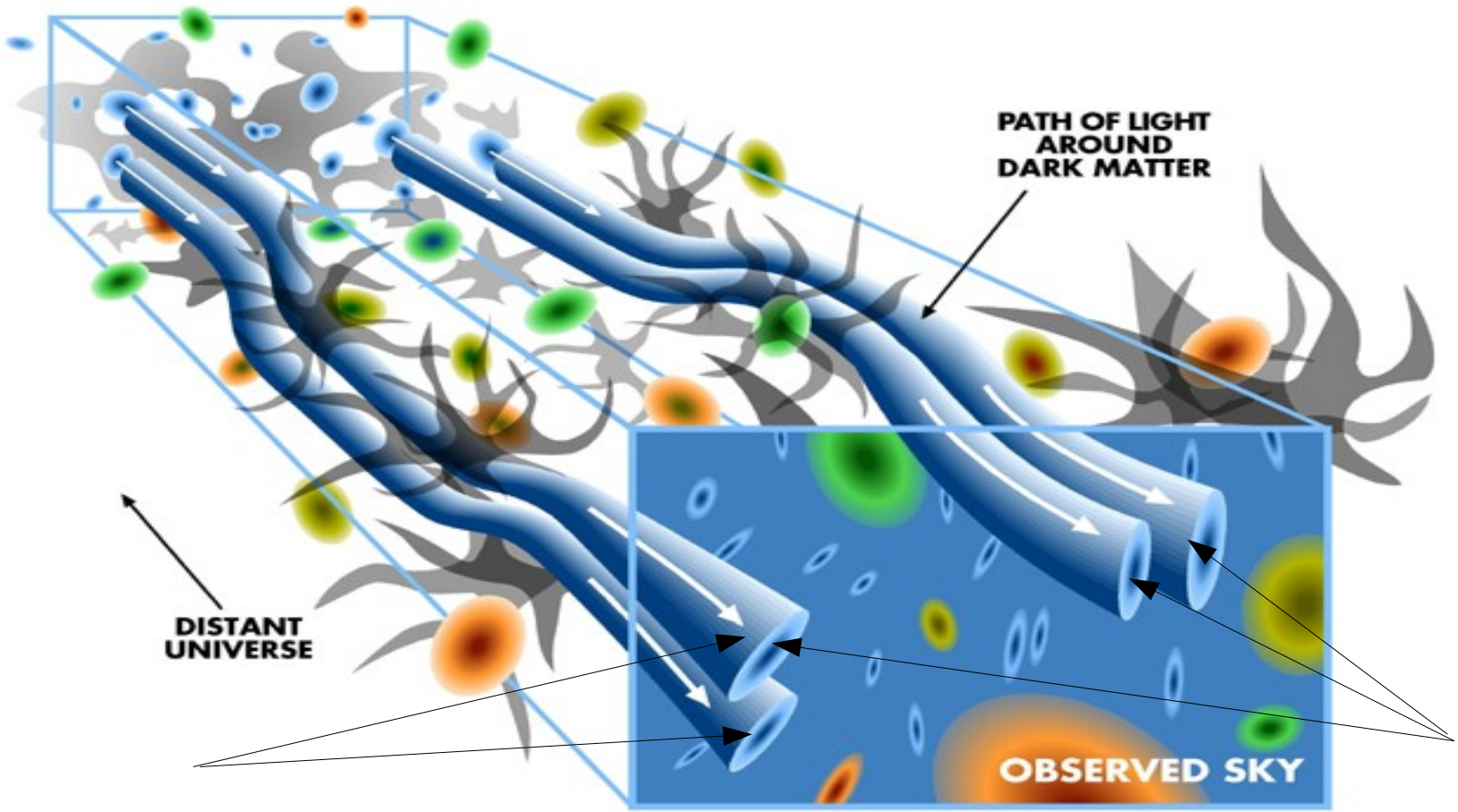
Cosmic Shear statistics



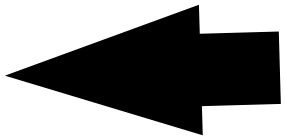
2pt correlation functions

Credit: LSST collaboration

3pt correlation functions

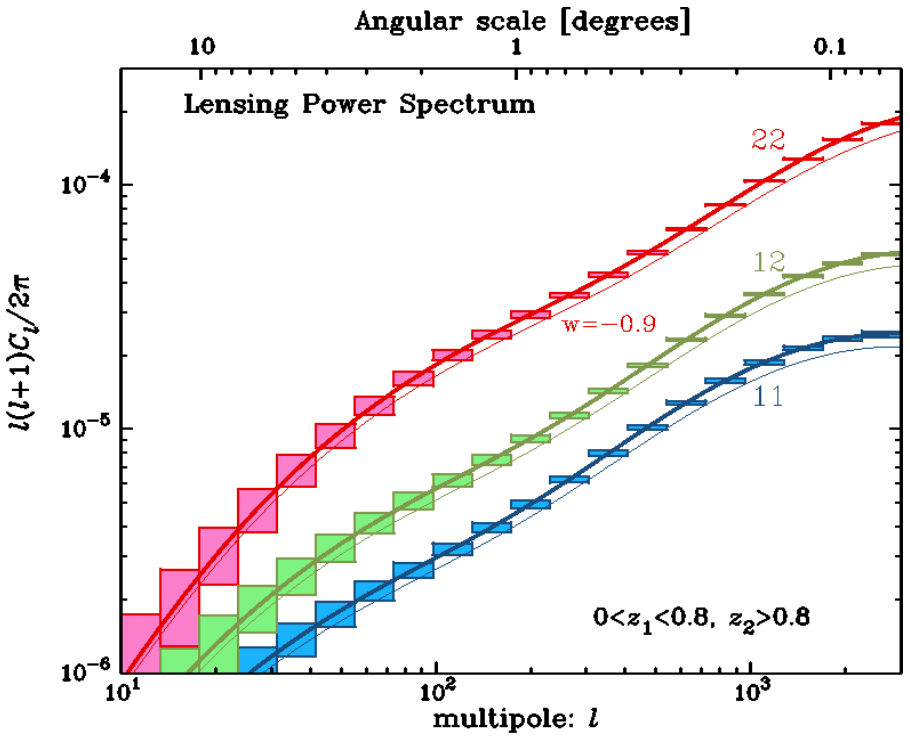
The nature of the accelerated expansion

Expansion history
Growth of structures



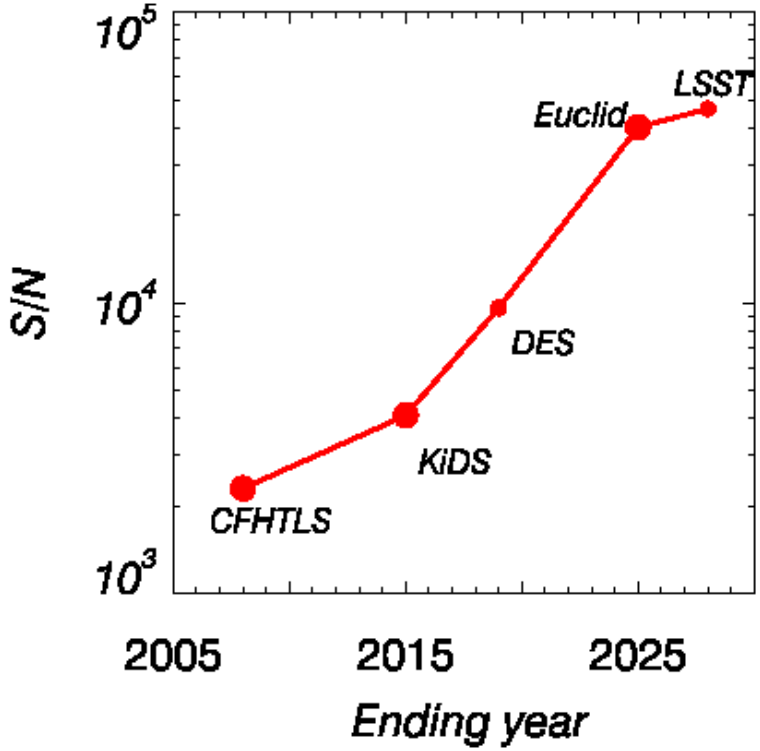
Dark energy
Test of gravity

Cosmic shear tomography



Credit Hoekstra & Jain (2008)

Increasing of the statistical power with time



In order to constrain the parameters of the equation of state of the dark energy one needs to model the non linear matter power spectrum to the percent level accuracy in the range 0.1<k<10 h/Mpc

see F. Bernardeau and M.Crocce talks

See also: Hybrid PT + halo-model (Valageas & Nishimichi)

Why cosmic shear statistics?

- Sensitive to growth and geometry
- Complementary to other cosmological proofs
- Pristine measurement of the matter power spectrum... not so true that it is “easy” when you want to look at percent effects.

- **Baryons represent 17% of total matter content can we neglect them ?**

- **If not then which baryonic feedback should we be consider as the “good” one?**

OWLS: (Schaye et al 2010)

Size=120 Mpc/h M=4.06*10^8 M_sun/h (dark matter)
M=8.66*10^7 M_sun/h (baryons)
Same initial conditions.

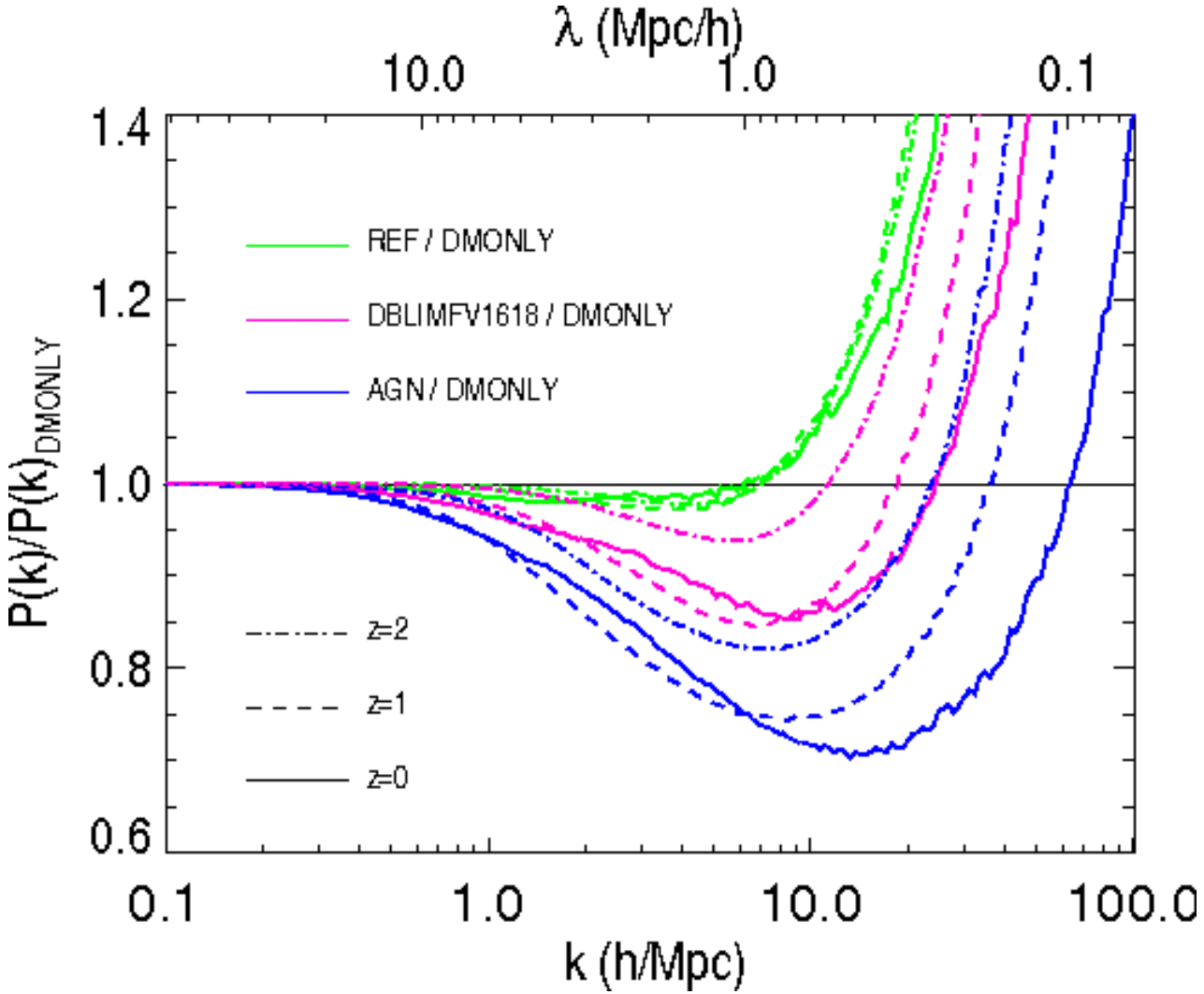
DMONLY: Dark matter only N-Body simulation

REF: Hydrodynamic simulation with star formation, radiative cooling, SN feedback

DBLIMFV1618: REF with modified IMF in high pressure regions (Baugh et al. 2005)

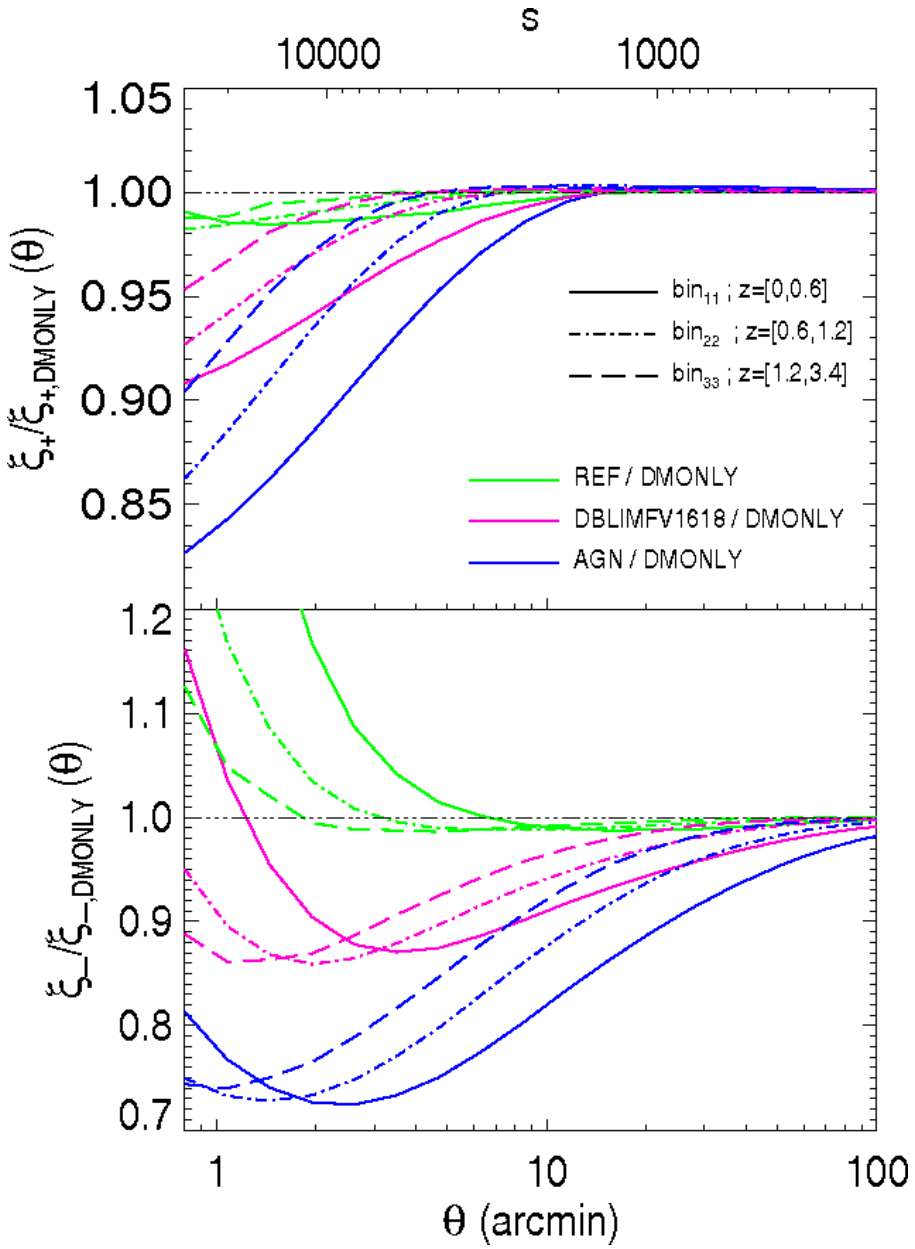
AGN: REF + AGN (Booth & Schaye 2009)

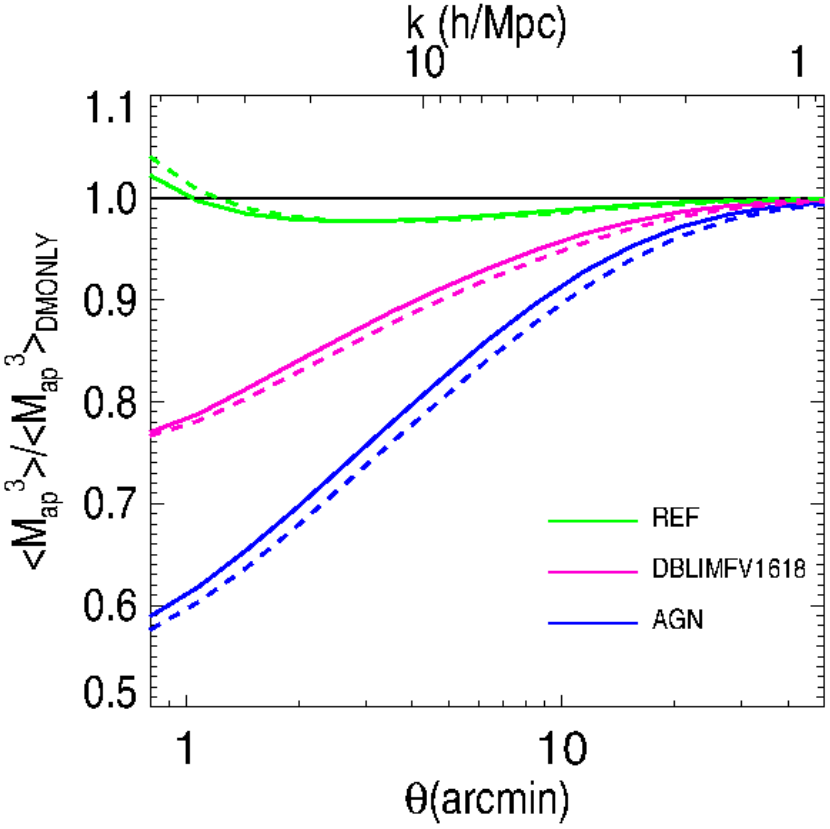
Effect of feedback on P(k)



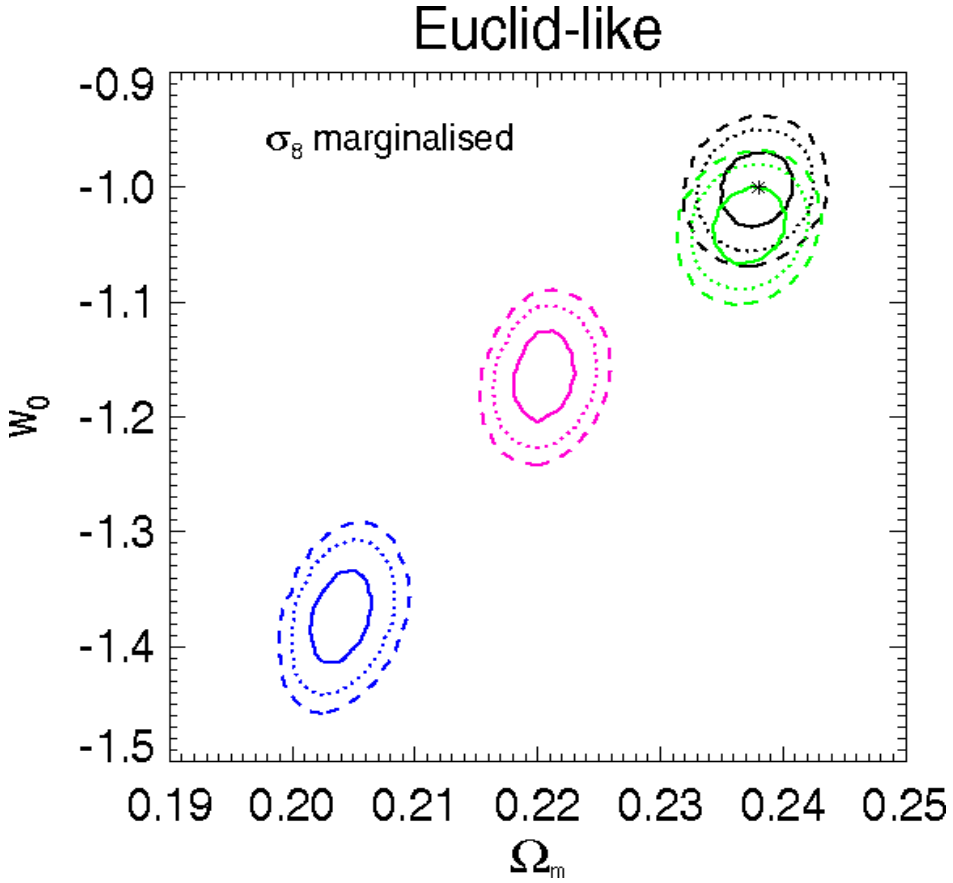
Semboloni et al. (2011)
van Daalen et al. (2011)

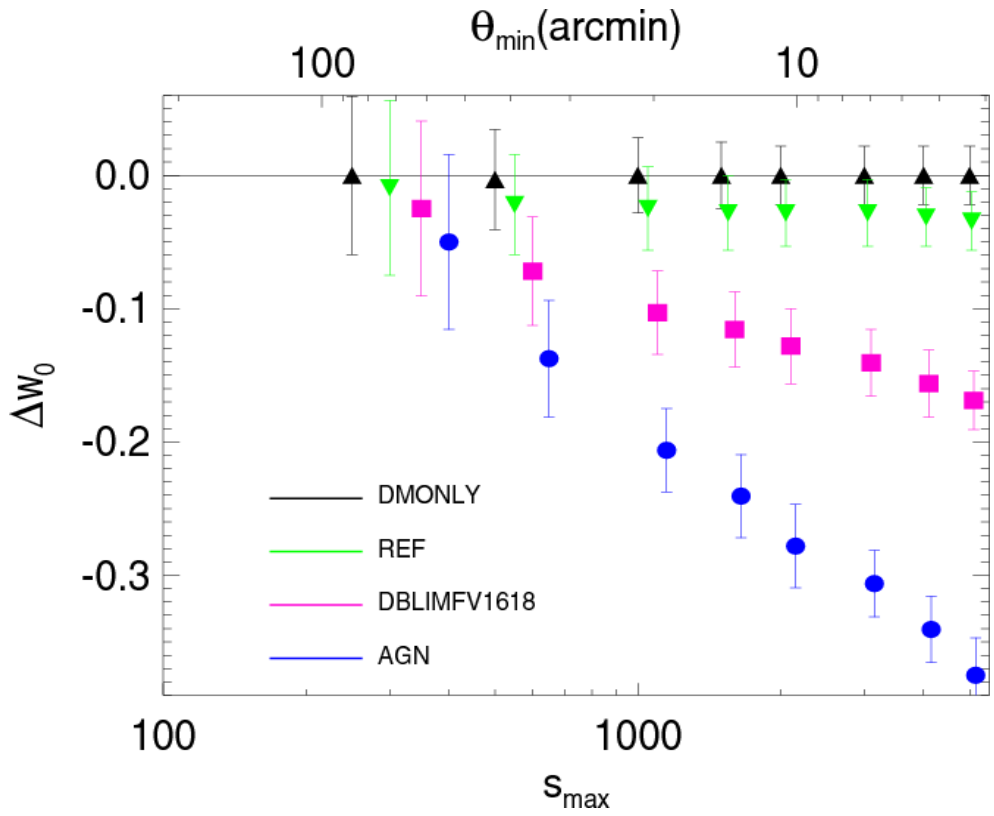
Effect on cosmic shear statistics





Ignoring the baryonic feedback





Modelling the effect of baryonic feedback
it is actually very important!

Halo model approach

The halo-model provides a quite natural way to correct for baryonic feedback (Seljak 2000)

$$P^{tot}(k) = P^{P}(k) + P^{2h}(k)$$

$$P^{p}(k) = \frac{1}{(2\pi)^3} \int d\nu\, M(\nu)\, f(\nu) \frac{M(\nu)}{\bar{\rho}} [y(k, M(\nu))]^2$$

$$P^{2h}(k) = P_{lin}(k) \left\{ \int d\nu\, M(\nu)\, f(\nu)\, b(\nu) [y(k, M(\nu))] \right\}^2$$

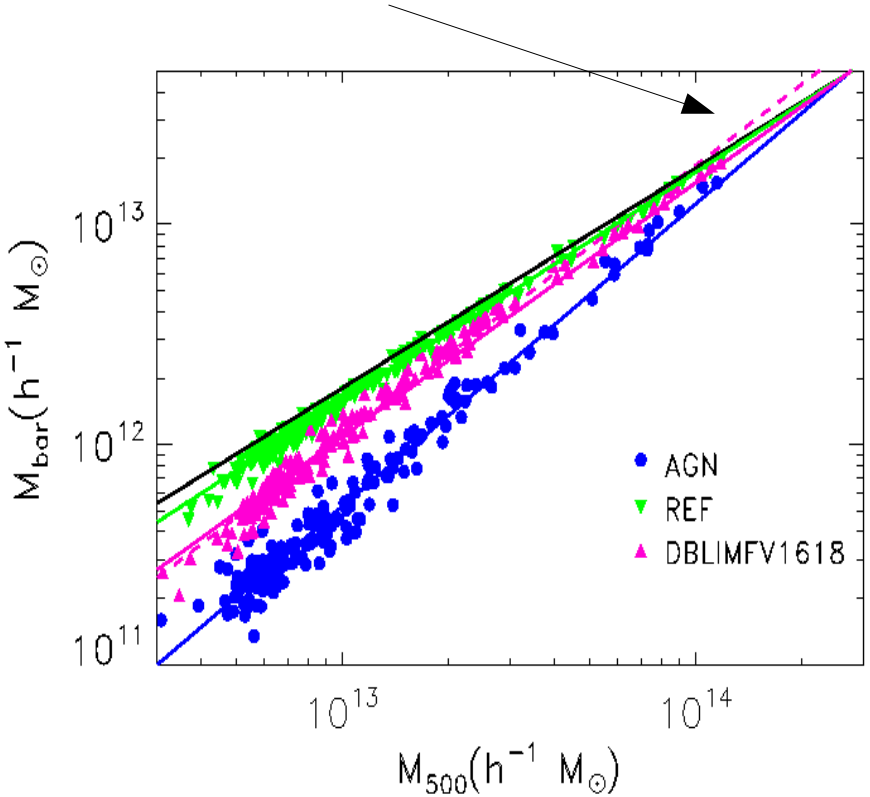
$[y(k, M(\nu))]$ is the Fourier transformed of the halo profile

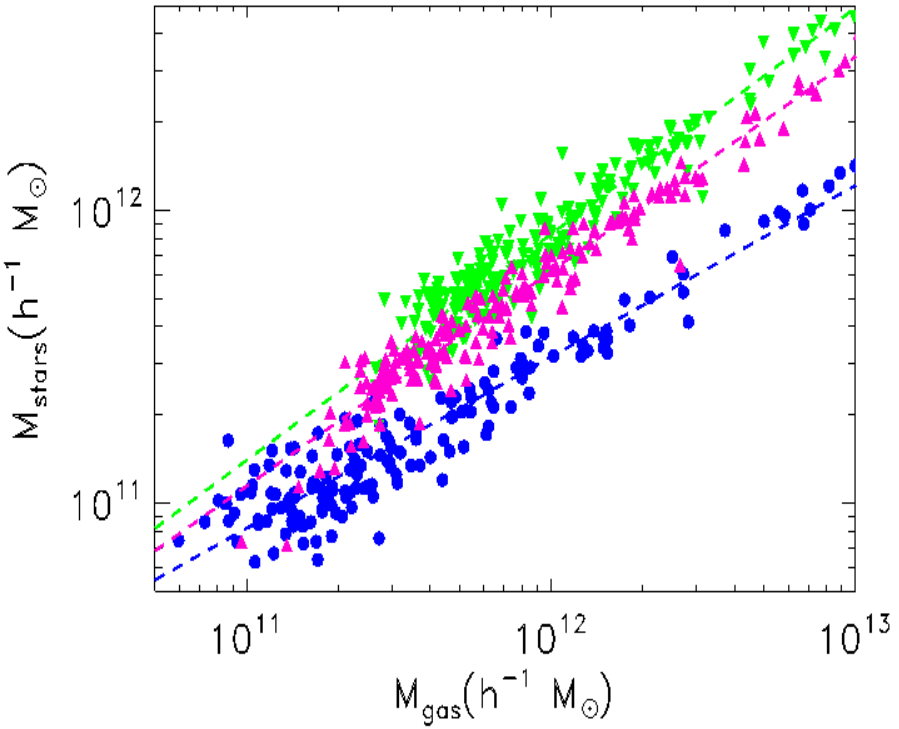
Can we change this profile to account of feedback ?

The correct framework

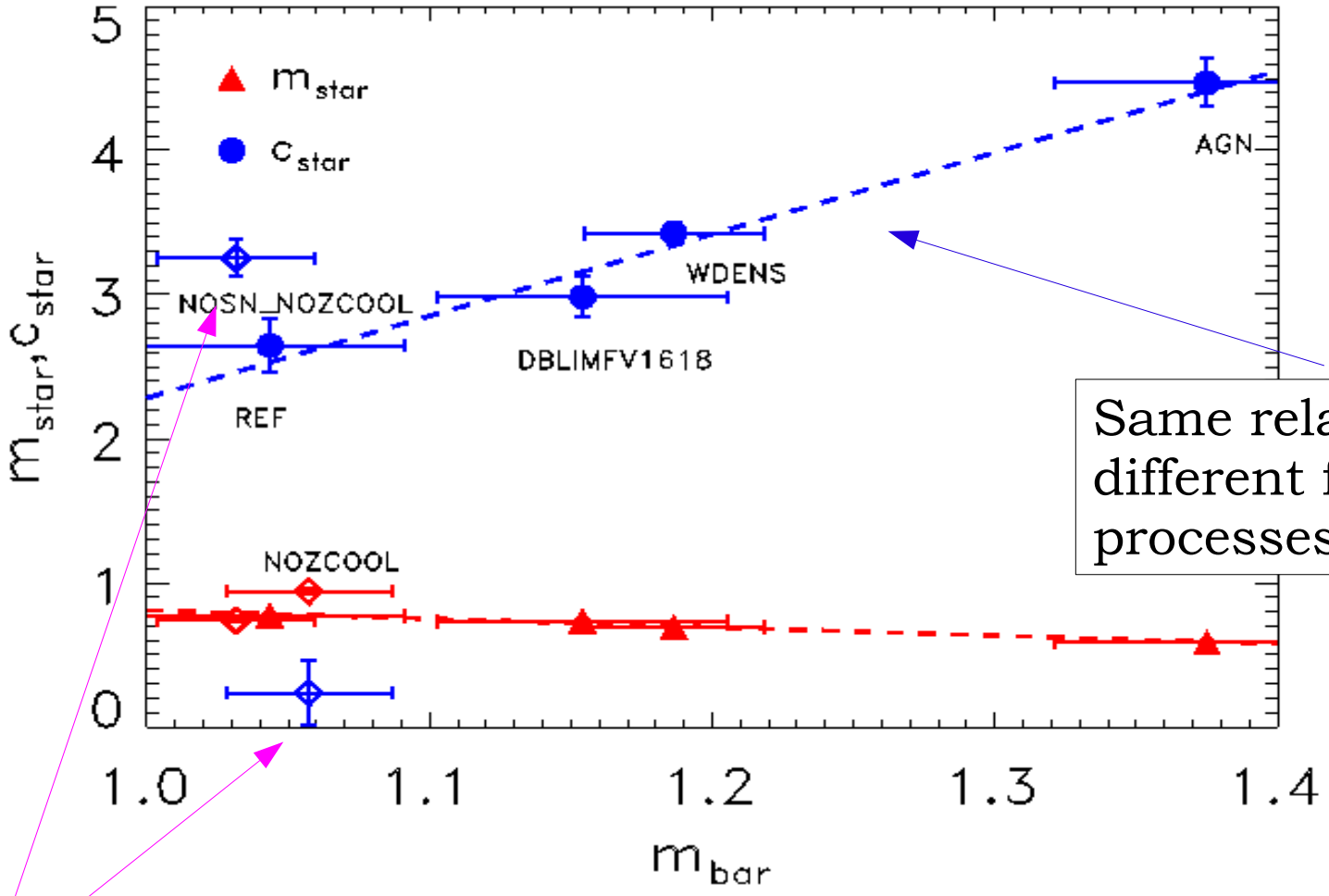
If we are not certain of which simulations are good representations of reality we can try to build a model we can (partially) contrain with real observations?

M(500)=2 *10^4 M_sun/h universal fraction reached





Baryonic fraction-stellar mass relation

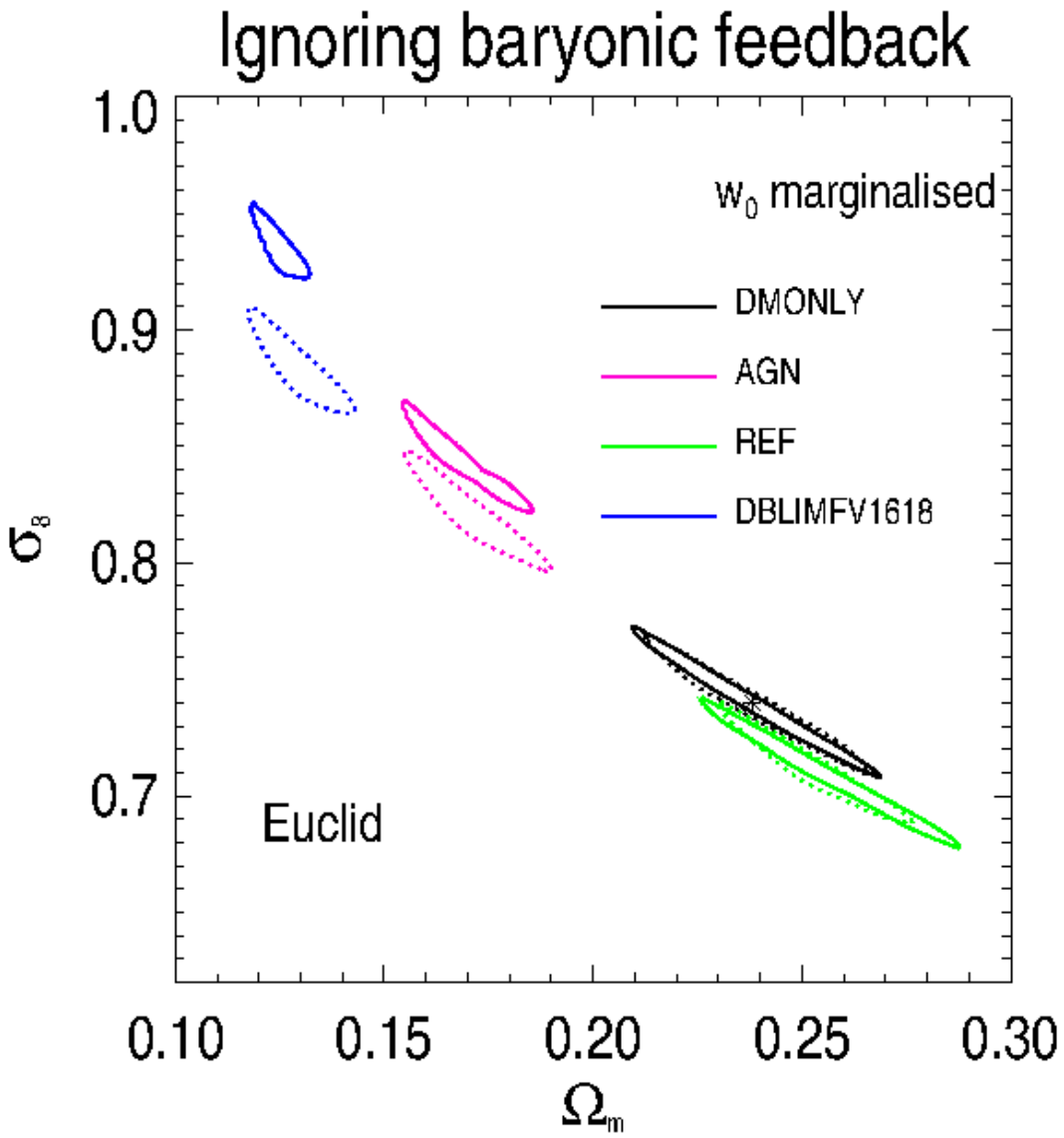


Same relation from different feedback processes.

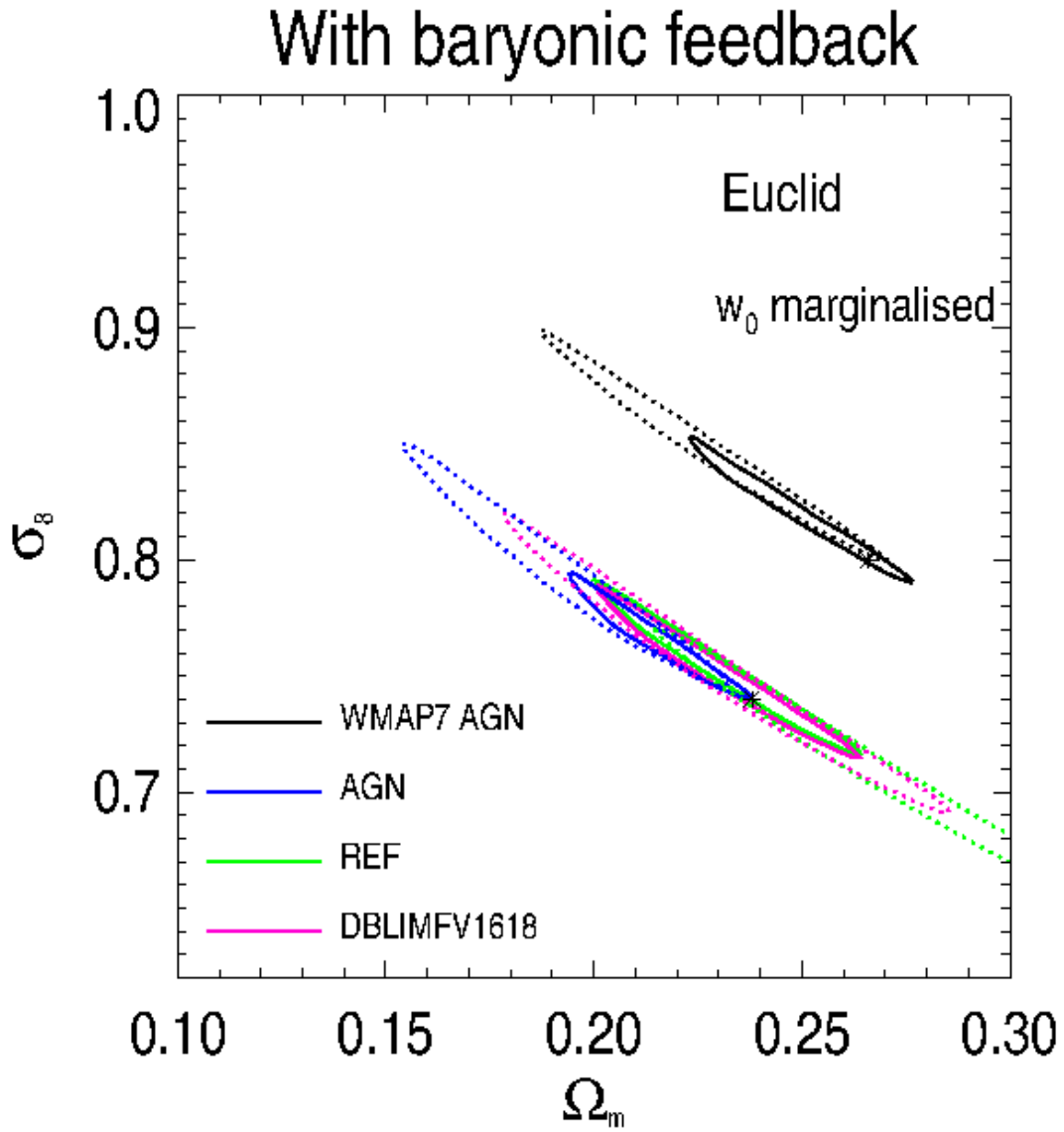
Increasing energy injected to the sorrounding

Models with no metal line cooling: very different IMF

Can cosmic shear tell us about baryonic feedback?

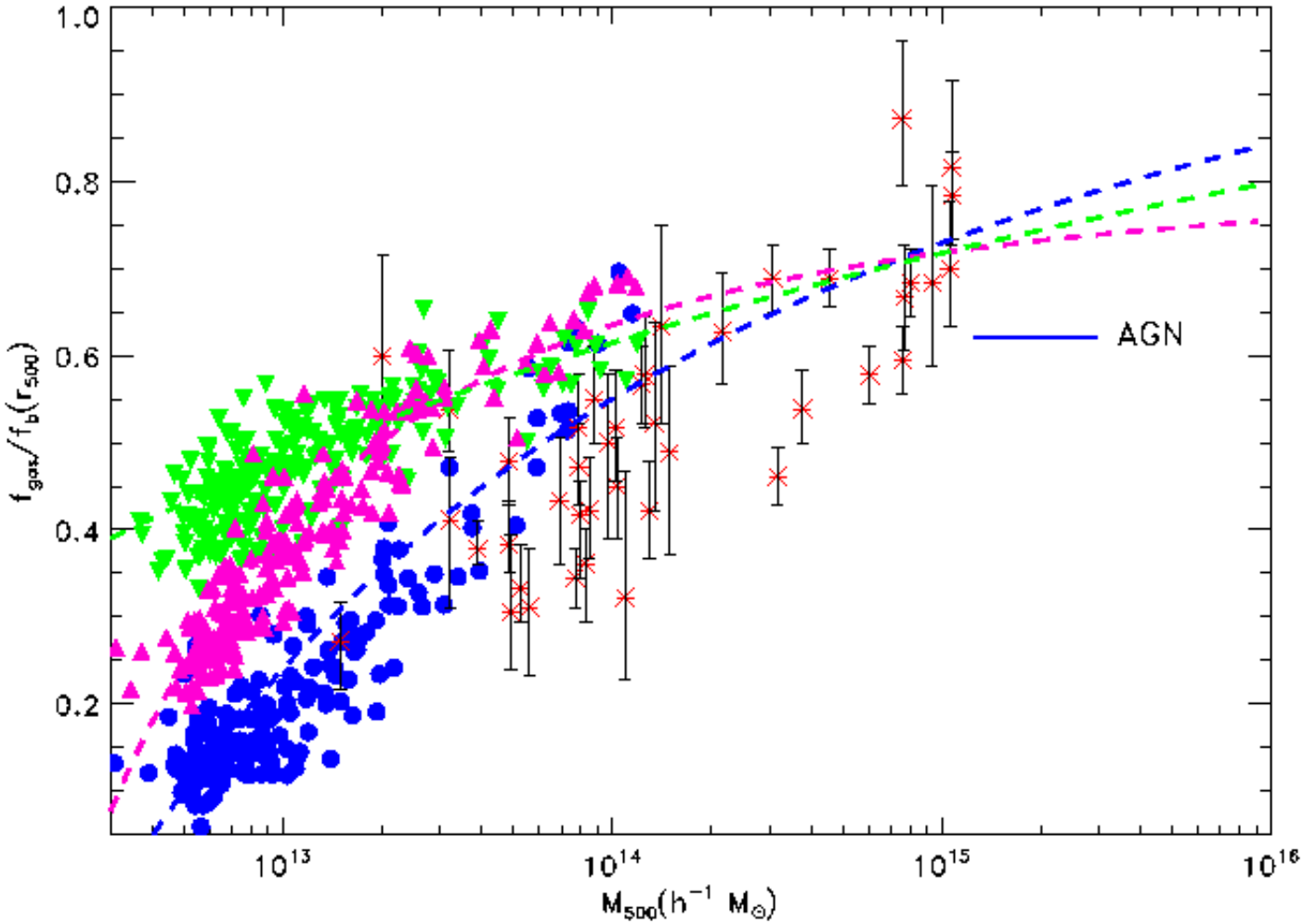


Calibration of baryonic feedback



Conclusions and outlook

- Ignoring the fact that baryons do not follow the DM can be a source of significant bias
- Constructing a model that capture the modification to DM-only models introduced by baryonic physics is maybe possible
- It is important to put as much as physical insight we can so that the models can be constrained with observations.
- 2pt and 3pt statistics can tell whether strong feedback models are realistic


1.0
0.8
0.6
0.4
0.2
$f_{gas}/f_b(r_{500})$
10^{13}
10^{14}
10^{15}
10^{16}
$M_{500}(h^{-1}\ M_\odot)$
AGN