Constraints on cosmology and baryonic feedback
by the combined analysis of weak lensing and galaxy clustering
with the Deep Lens Survey

(arXiv:1807.09195, …)

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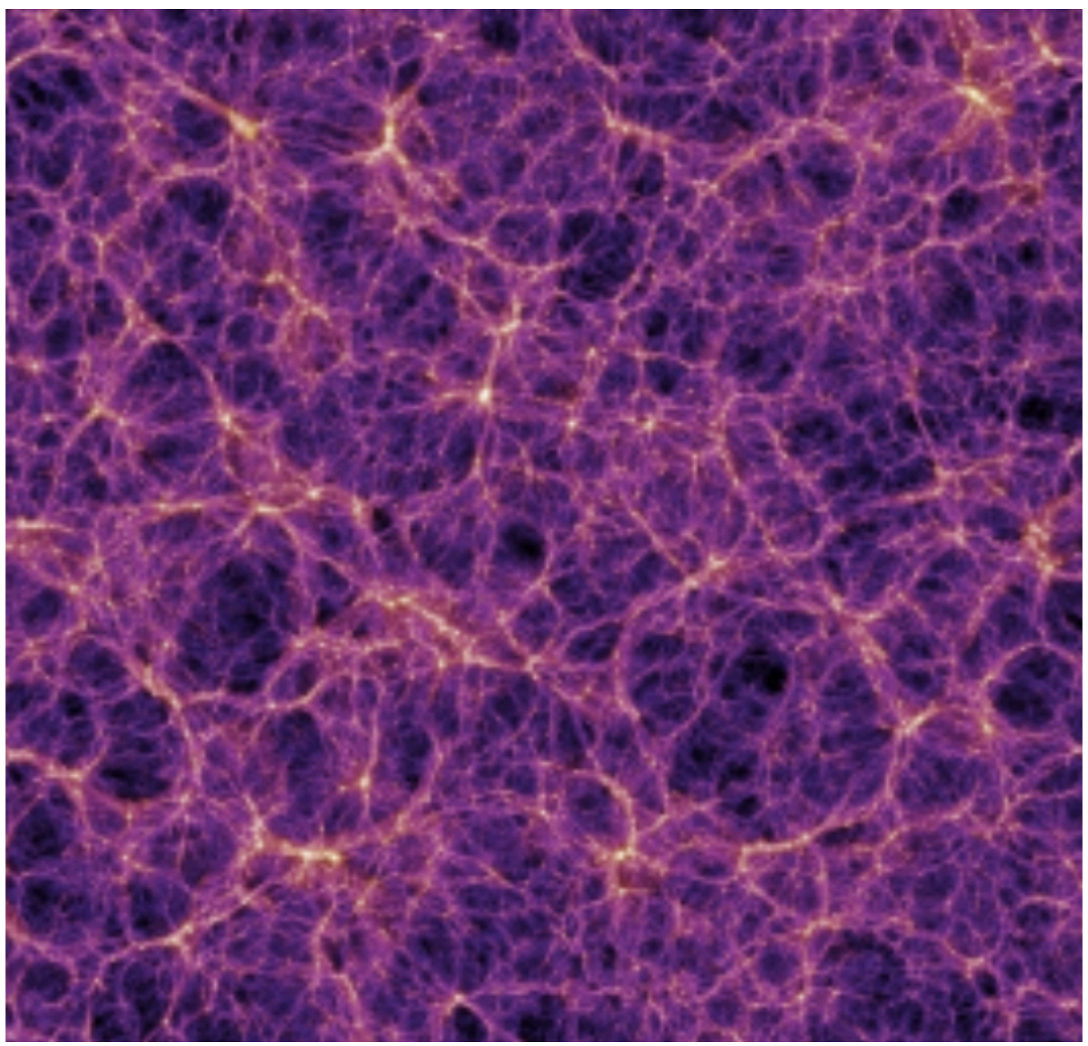
Power spectrum



- The primordial fluctuations developed into large-scale structure.
- Power spectrum is one of the summary statistics of large-scale structure in the universe.

Three Power Spectra (3×2pt)

Shear-Shear (Cosmic shear)

$$C_{\mathrm{GG}}^{ij}(\ell) = \int_0^{\chi_{\mathrm{H}}} d\chi \, \frac{q_i(\chi) q_j(\chi)}{[f_K(\chi)]^2} P_{\delta\delta}\left(\frac{\ell + 1/2}{f_K(\chi)}, \chi\right)$$

Jee et al. (2013, 2016)

+

Galaxy-Galaxy

$$C_{gg}^{ii} = \int_0^{\chi_H} d\chi \frac{n(\chi)^2}{[f_K(\chi)]^2} P_{\delta\delta}\left(\frac{\ell + 1/2}{f_K(\chi)}, \chi\right) \times b(k, \chi)^2$$

+

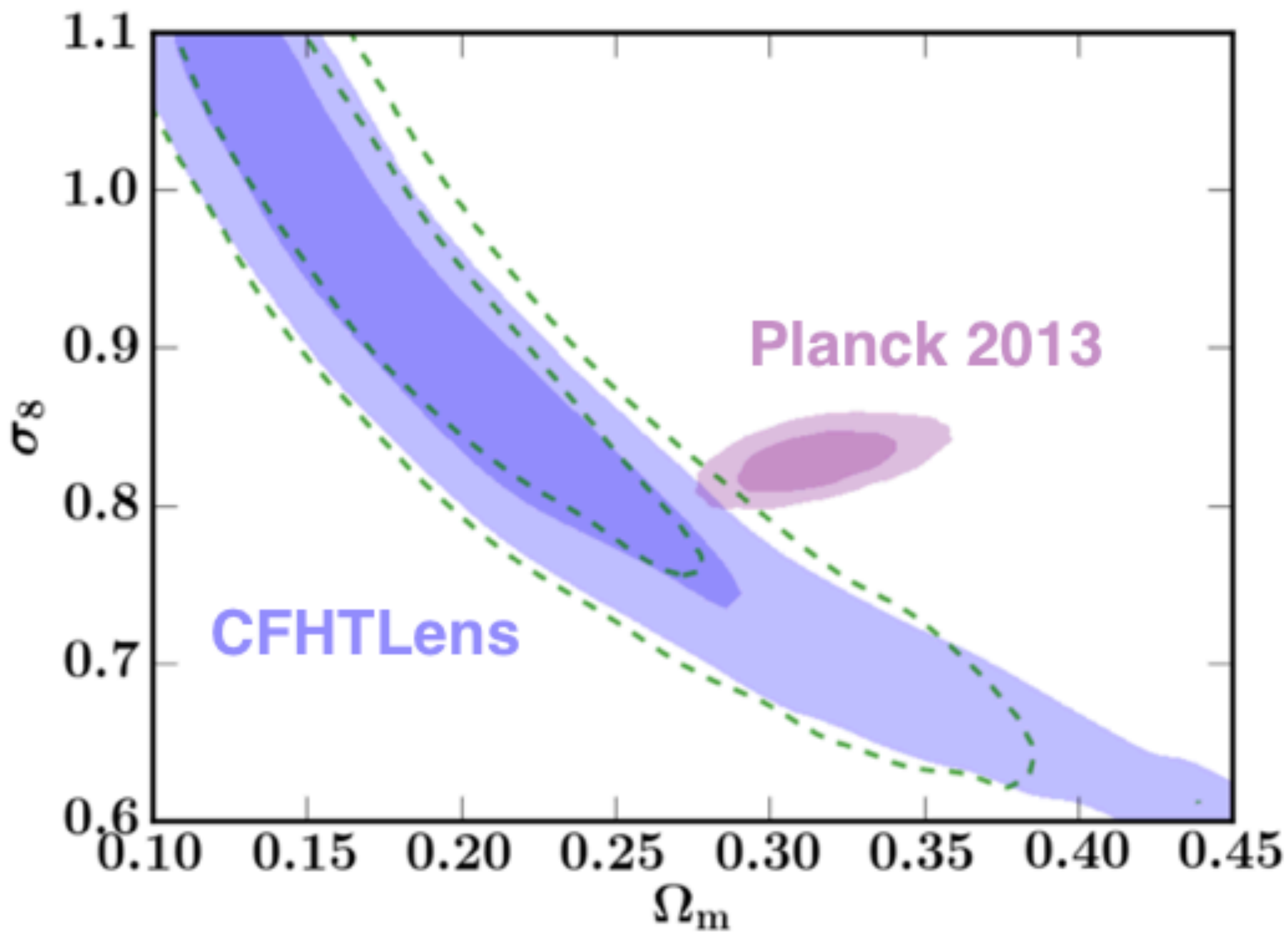
Galaxy-Mass (galaxy-galaxy lensing)

$$C_{gG}^{ij} = \int_0^{\chi_H} d\chi \frac{n_i(\chi) q_j(\chi)}{[f_K(\chi)]^2} P_{\delta\delta}\left(\frac{\ell + 1/2}{f_K(\chi)}, \chi\right) \times b(k, \chi)$$

Yoon et al. (2018a) (arXiv:1807.09195)

→ Yoon et al. (2018b)
Preliminary

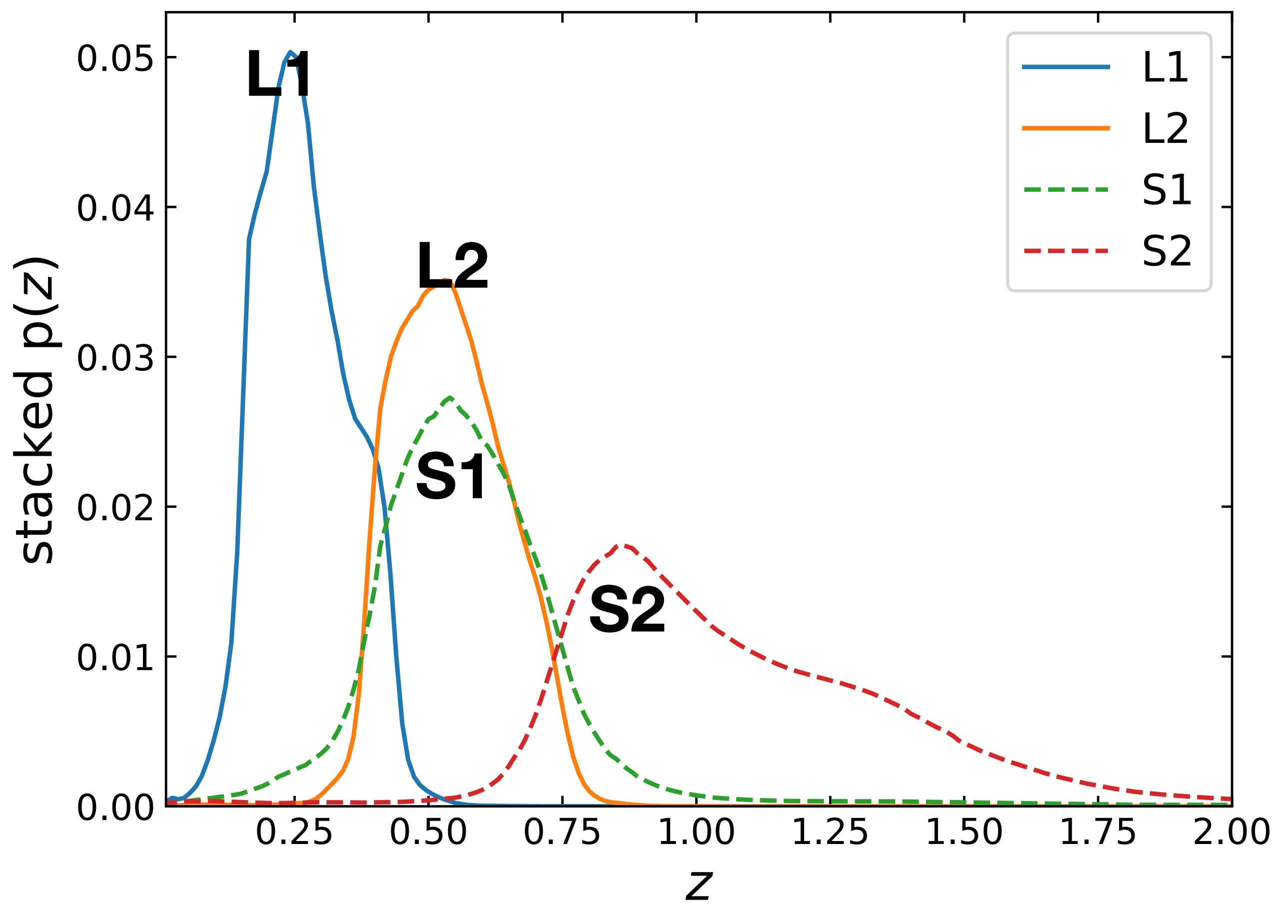
Tension between Planck and weak lensing



CMB (high redshift, early universe) and LSS (low redshift, late time universe) tension may require modification of cosmology model.

Data

DLS
Lens & source selection



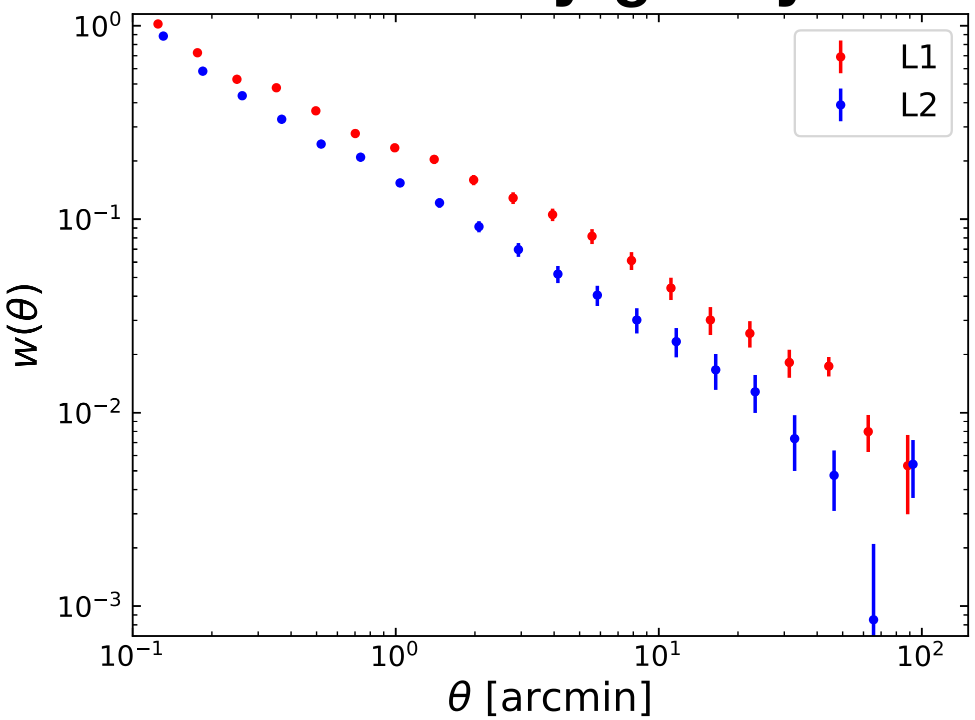
bins		z_b^-	z_b^+	$\langle z \rangle$	m_R^-	m_R^+	# of gal
Lens	L1	0.15	0.4	0.270	18	21	57,802
	L2	0.4	0.75	0.542	18	22	98,267
Source	S1	0.4	0.75	0.642	21	24.5	418,932
	S2	0.75	1.5	1.088	21	24.5	450,353

Conservative cut compared to DLS's mag limit, 27th.

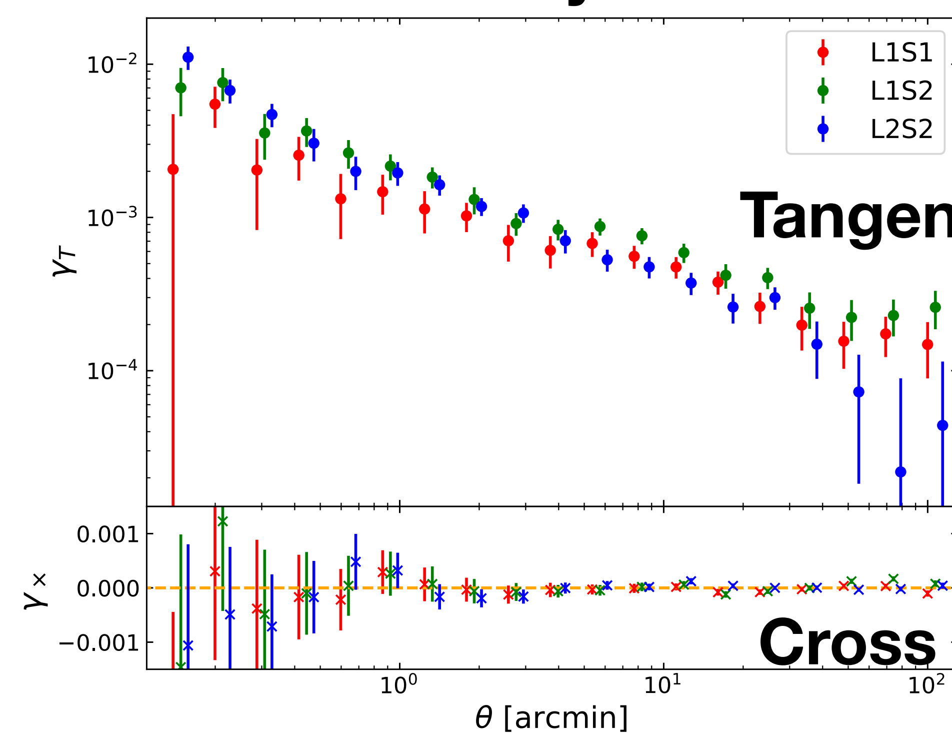
- We select lens and source bins based on their redshifts and luminosities.
- The stacked p(z) curves (the sum of p(z)s of the individual galaxy in each bin) are used to estimate the model power spectrum.
- We measure galaxy clustering from the lens bins (L1, L2).
- We measure cosmic shear signal from the source bin pairs (S1S1, S1S2, S2S2).
- We measure lensing signal from the lens-source bin pairs (L1S1, L1S2, L2S2).

Raw measurements

Galaxy-galaxy



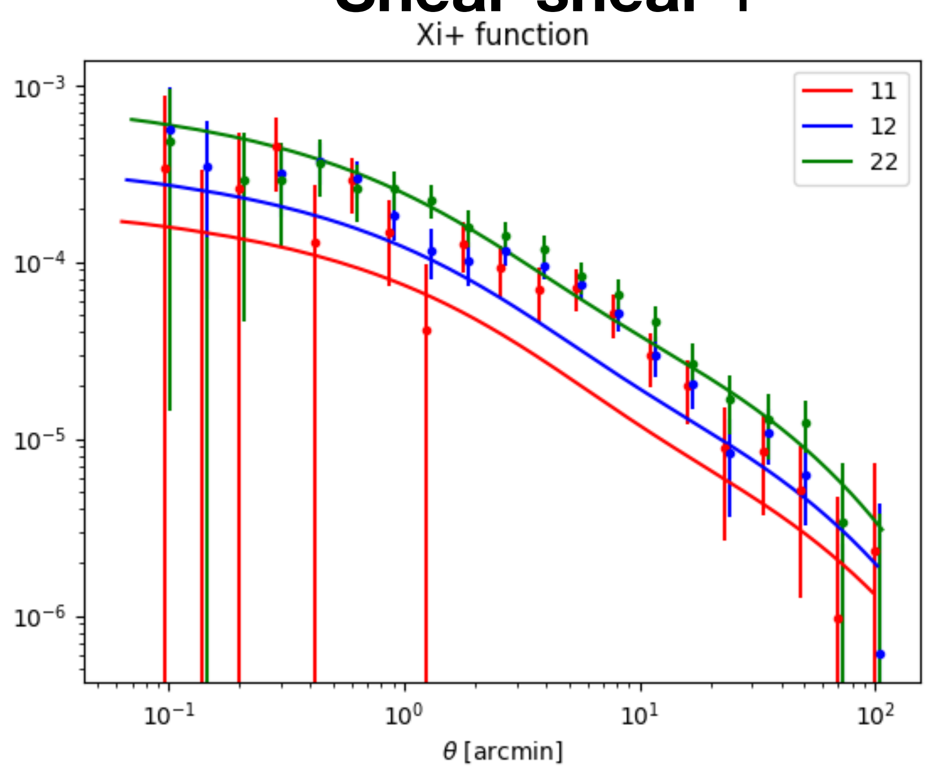
Galaxy-mass



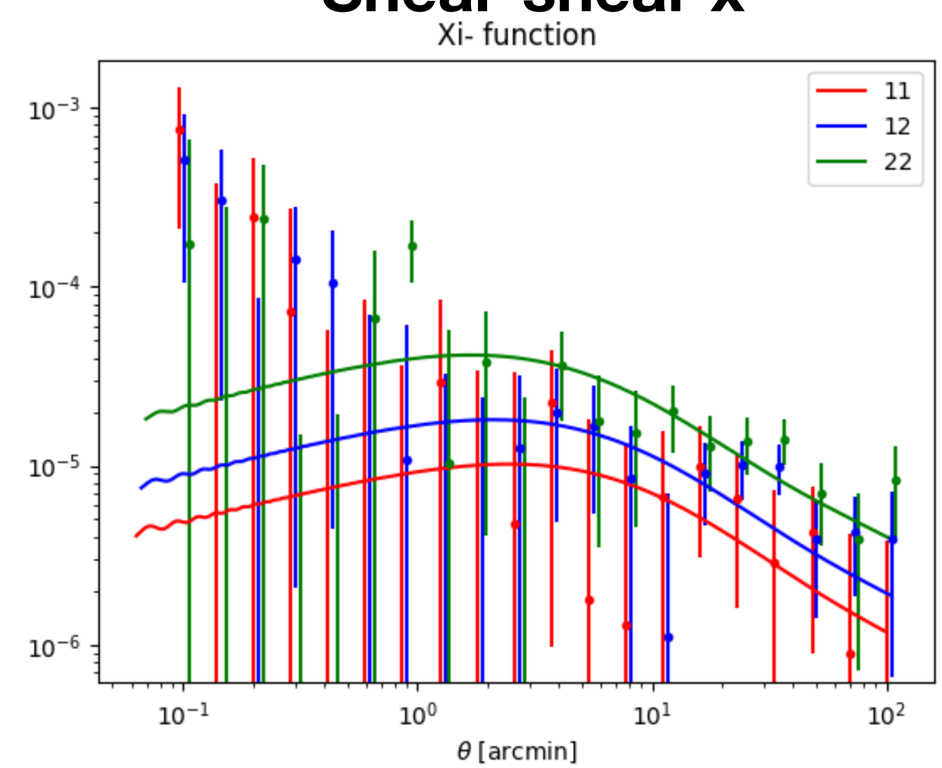
Tangential shear

Cross shear

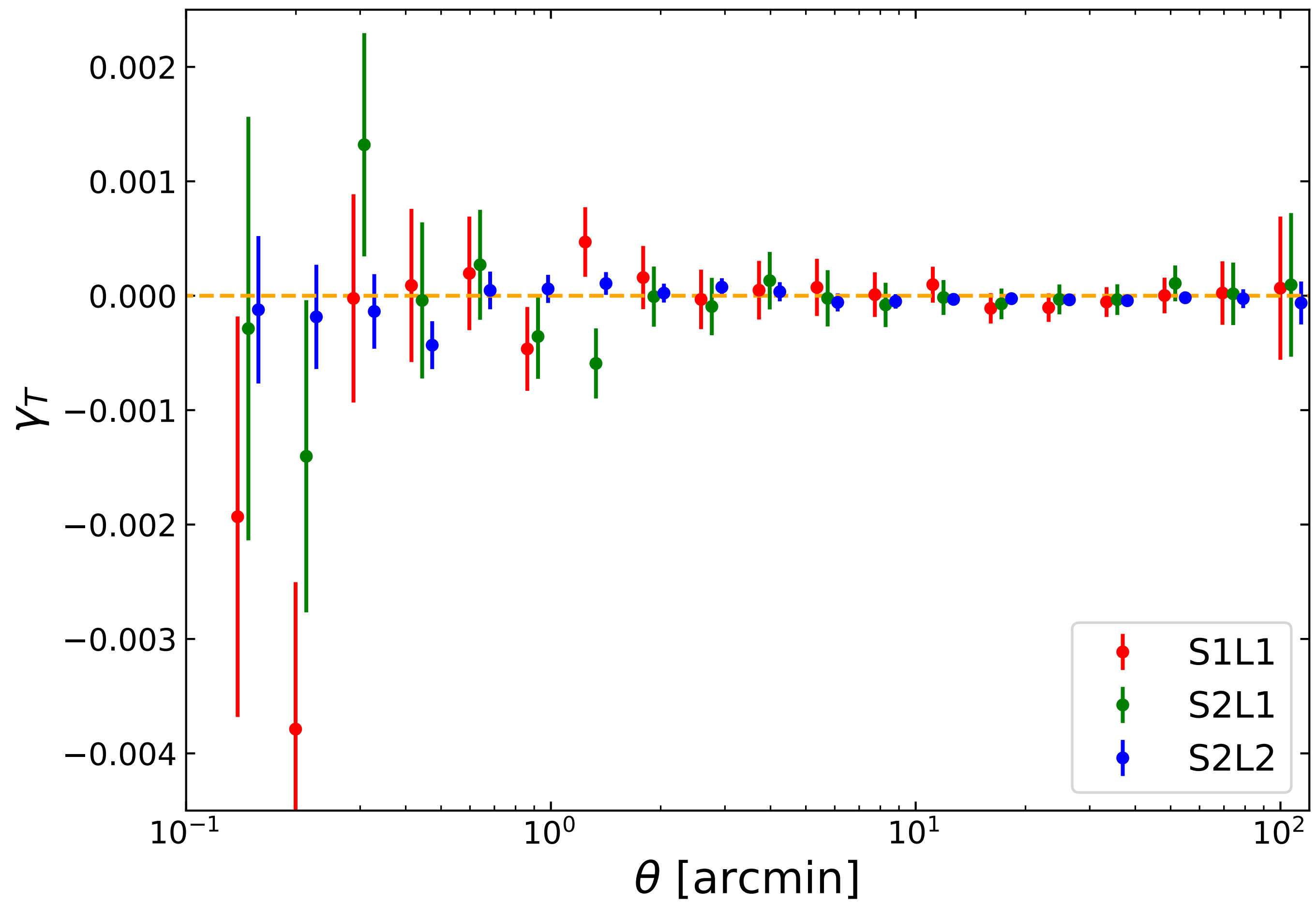
Shear-shear +



Shear-shear x



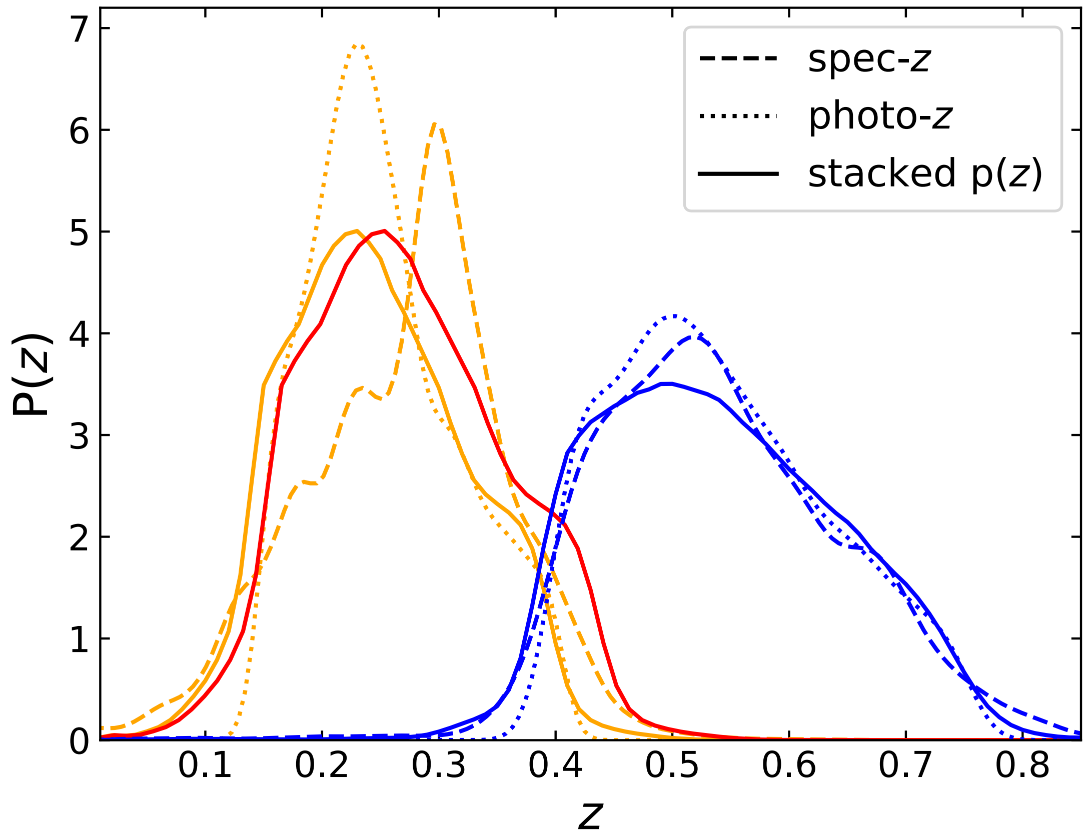
Lens-source flip test for galaxy-galaxy lensing signals

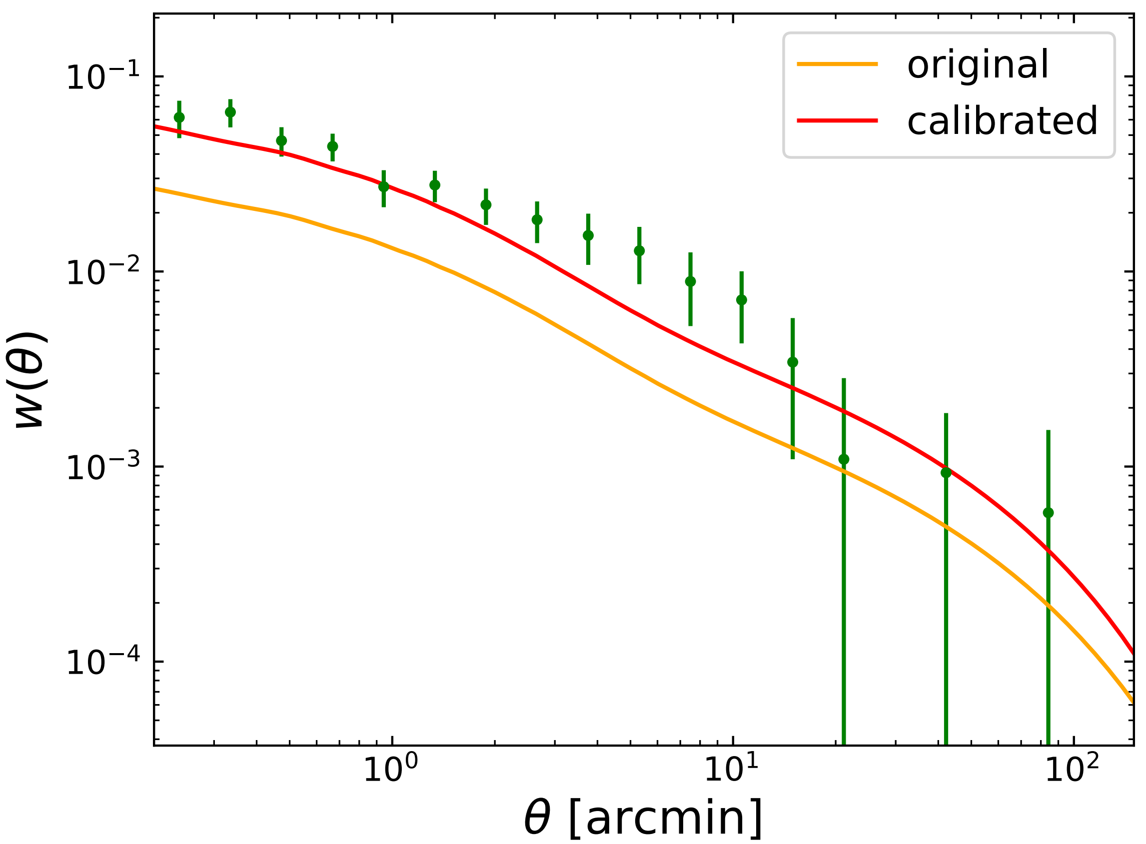


- Lens-source flip test is used to check the residual systematics mainly in photo-z estimations.

Systematic test

Photo-z calibration and cross-correlation



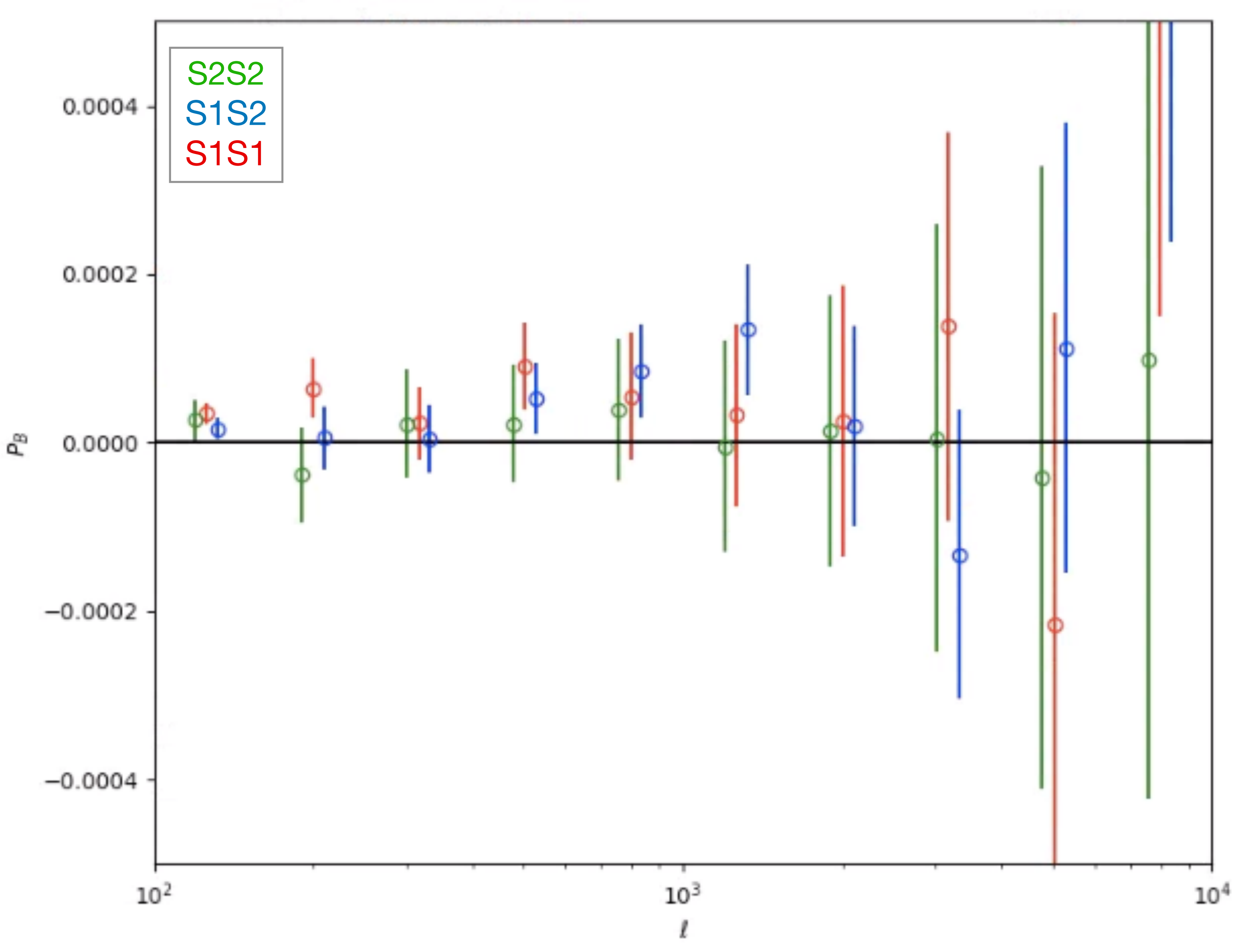


Original photo-z estimation: Schmidt & Thorman (2013)

- The stacked photo-z curves are calibrated by matching with spec-z samples (PRIMUS and SHELS).
- We found 10% photo-z shift for L1 was required, but calibration of L2 was not necessary.
- The cross-correlation measurement between L1 and L2 reconfirms the photo-z calibration was relevant to agree with the theoretical prediction.

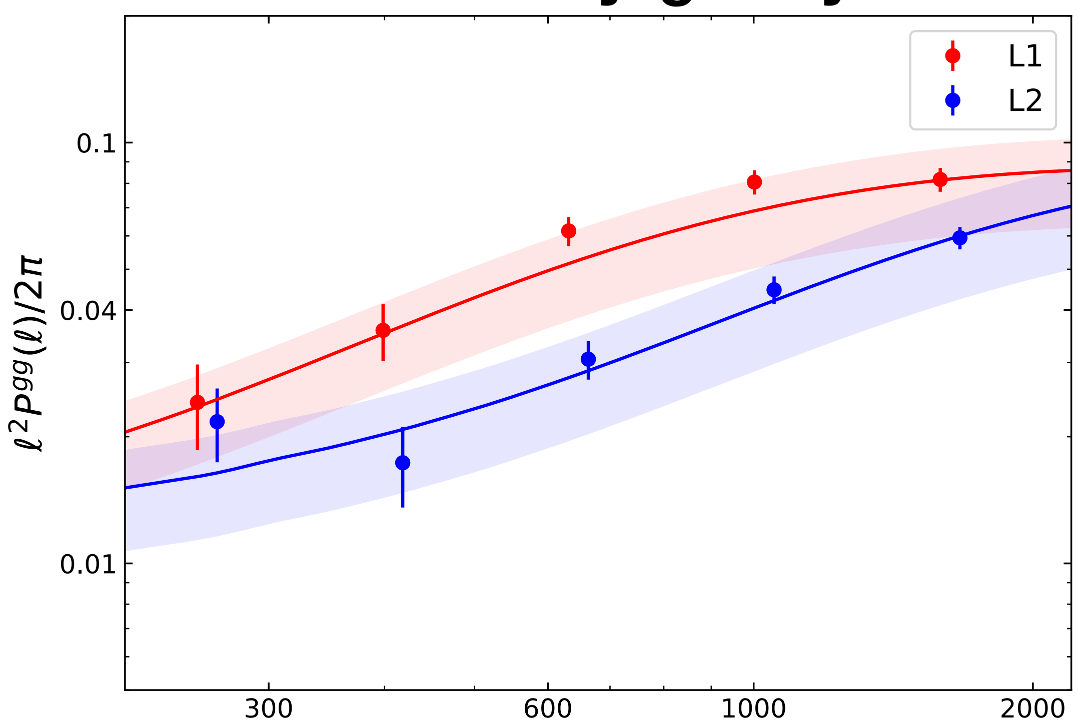
Systematic test

B-mode for cosmic shear

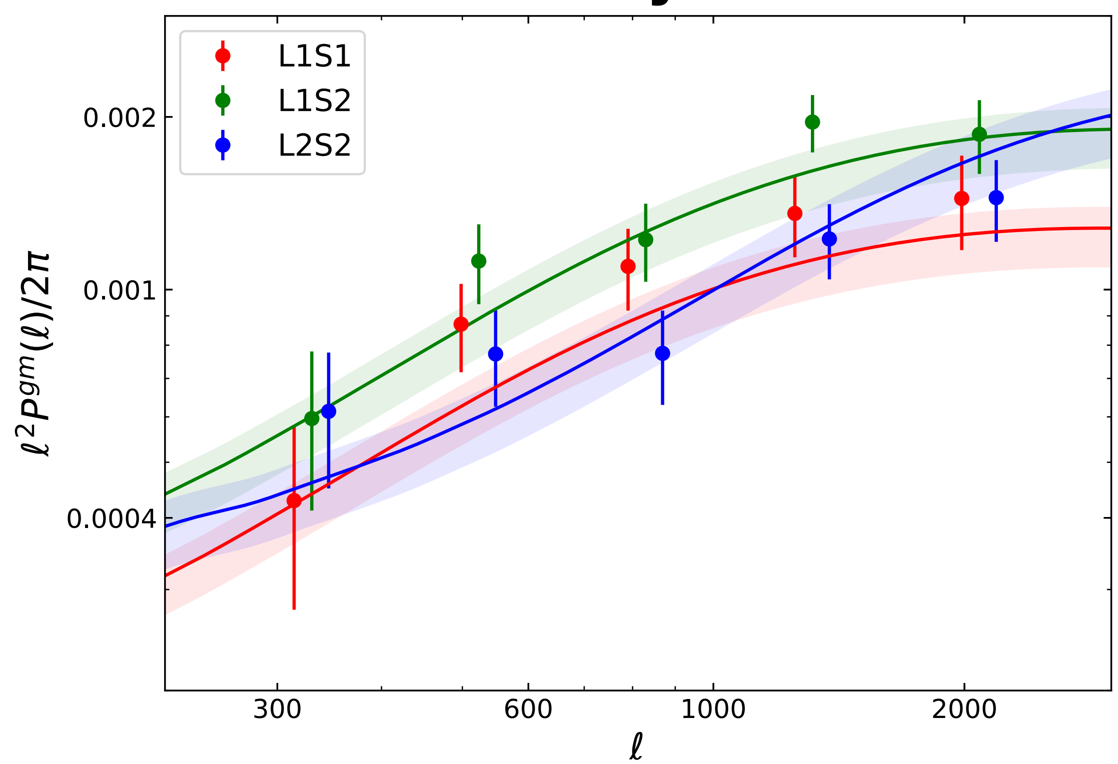


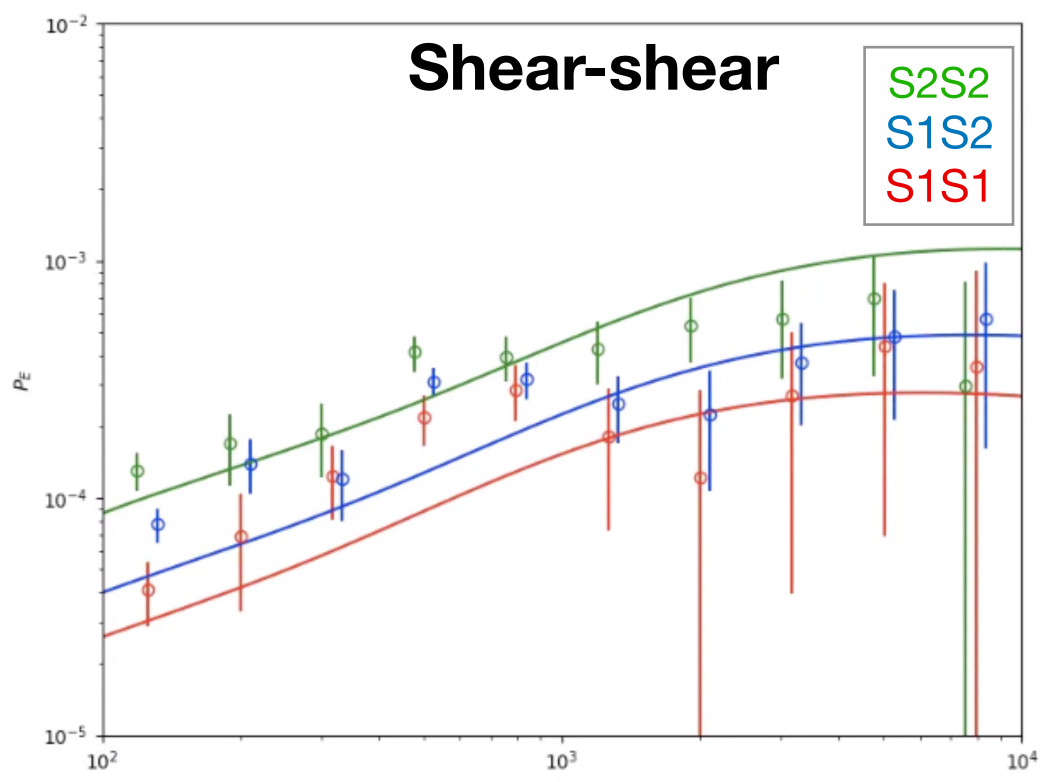
Power spectra

Galaxy-galaxy



Galaxy-mass





- Errors were estimated based on catalogs that we generated based on log-normal distribution.

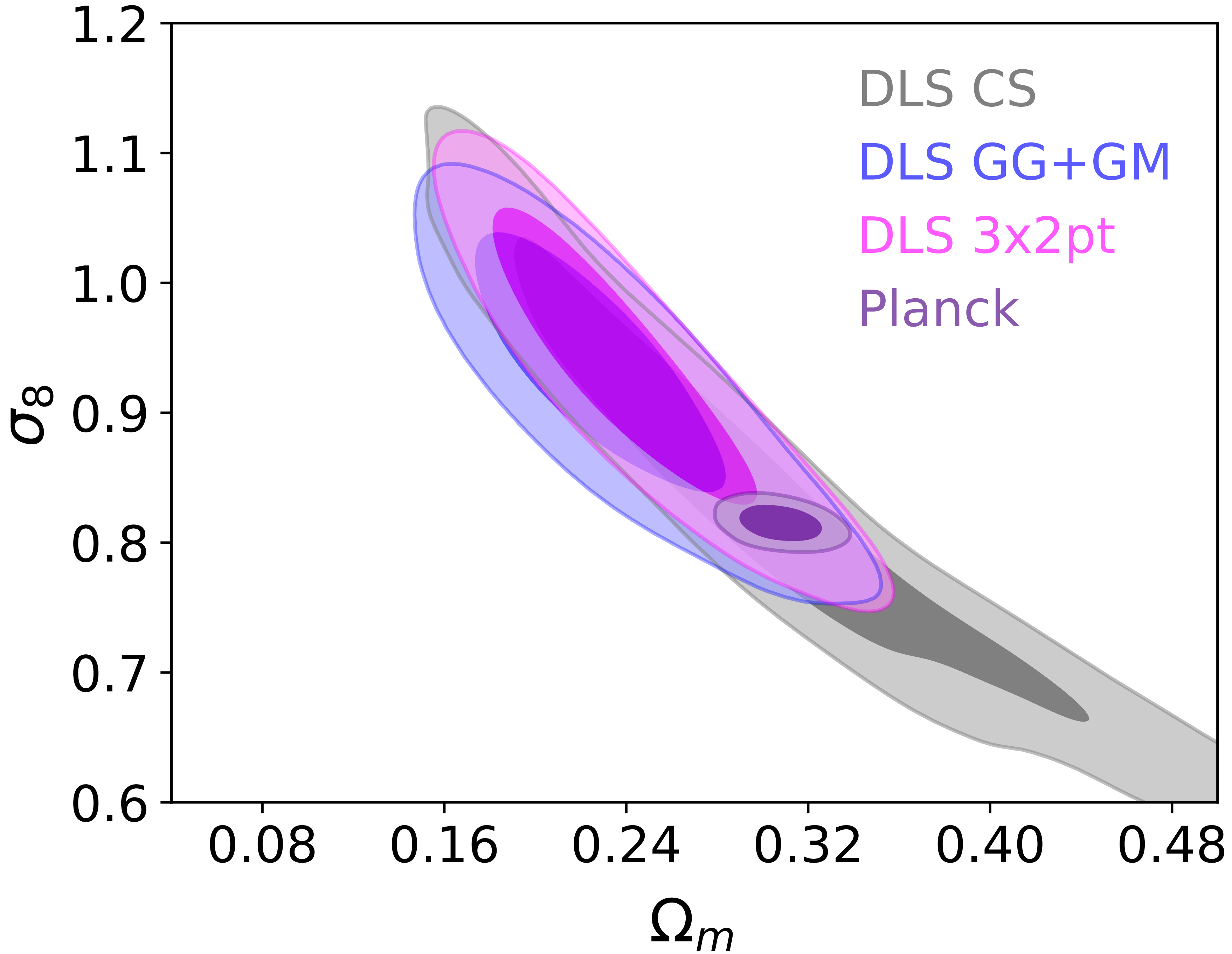
Parameter estimation

- **Prior ranges**

parameters	prior range	
Nuisance parameters		
photo-z shift in L1, L2, S1, S2 (σ_{zi}), $\mathcal{N}(0,0.02)$	-0.04	0.04
multiplicative shear error (σ_{m_γ})	-0.03	0.03
Astrophysical parameters		
galaxy bias in L1 & L2 (b_i)	0.1	2.5
baryon amplitude (A_{baryon})	2.0	4.0
intrinsic alignment amplitude (A_{IA})	-4.0	4.0
Cosmological parameters		
matter density (Ω_m)	0.06	1.0
baryon density (Ω_b)	0.03	0.06
hubble parameter (h)	0.55	0.85
power spectrum normalization (σ_8)	0.1	1.5
spectral index (n_s)	0.86	1.05
sum of neutrino masses ($\Sigma_\nu m_\nu$/eV)	0.06	0.9

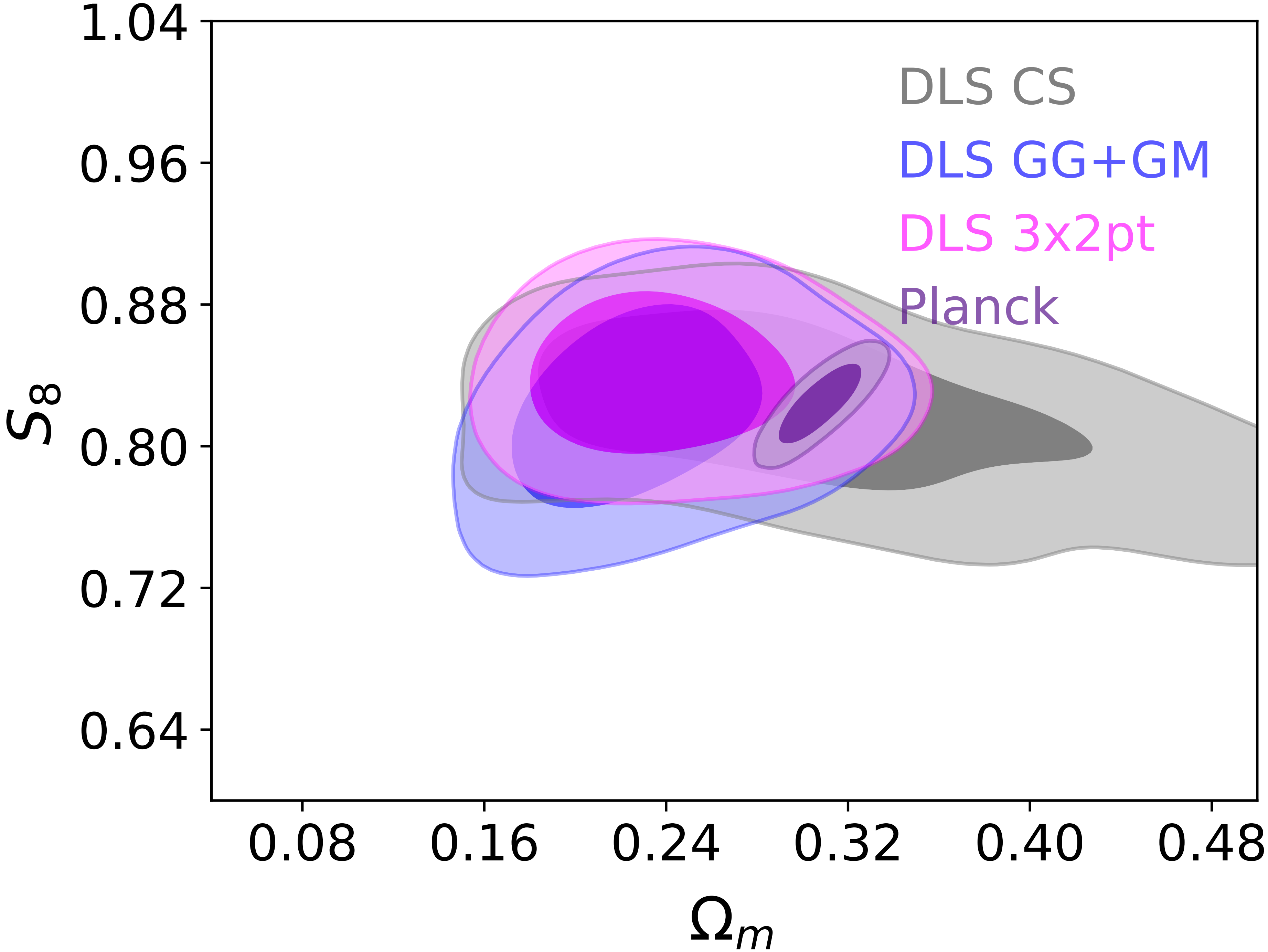
Using nested sampling algorithm (multinest), we obtain constraints on parameters.

DLS results


1.2
1.1
1.0
0.9
0.8
0.7
0.6
σ_8
0.08
0.16
0.24
0.32
0.40
0.48
Ω_m
DLS CS
DLS GG+GM
DLS 3x2pt
Planck

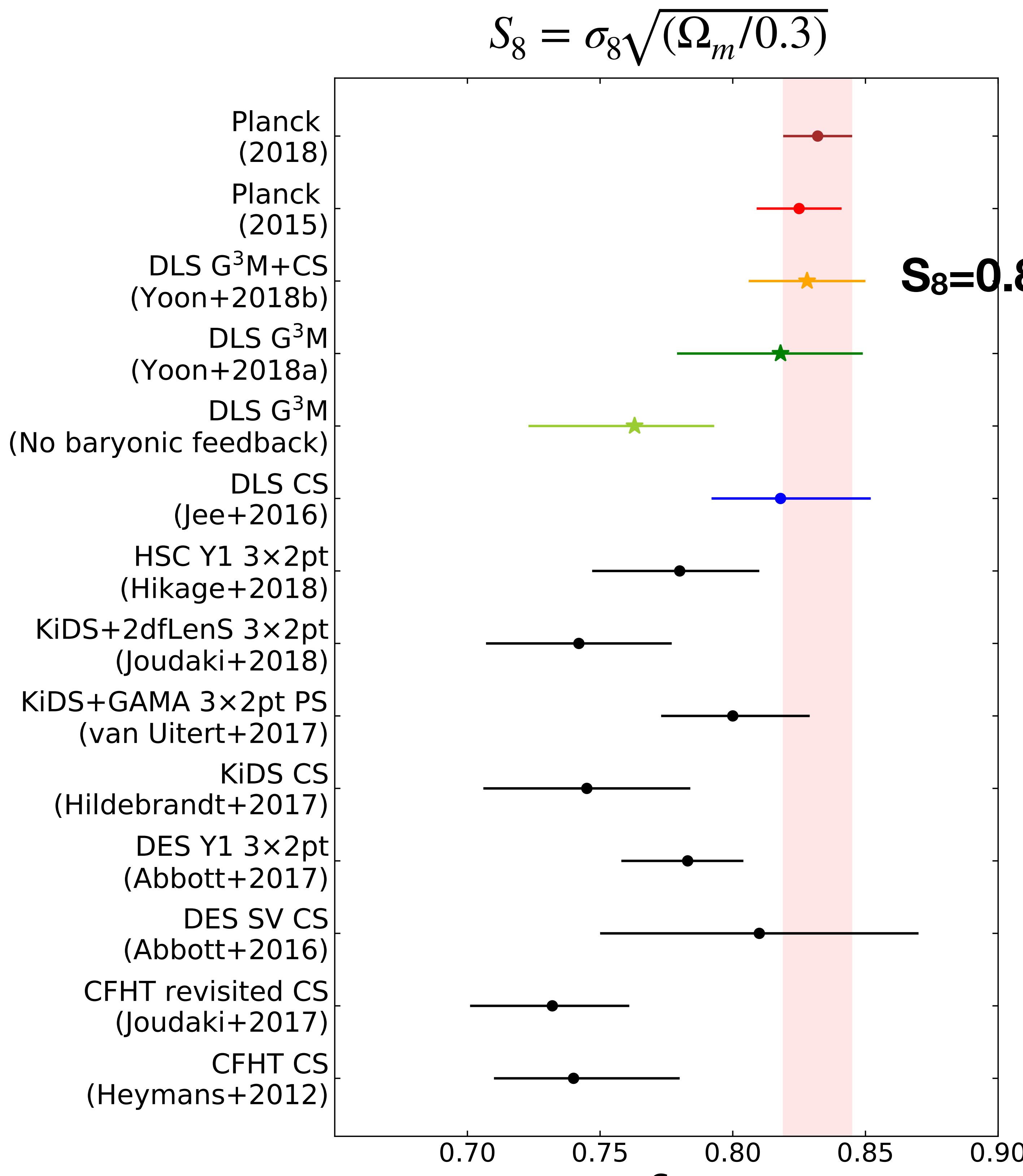
DLS constraints

$$S_8 = \Omega_m(\sigma_8/0.3)^{0.45}$$



Results

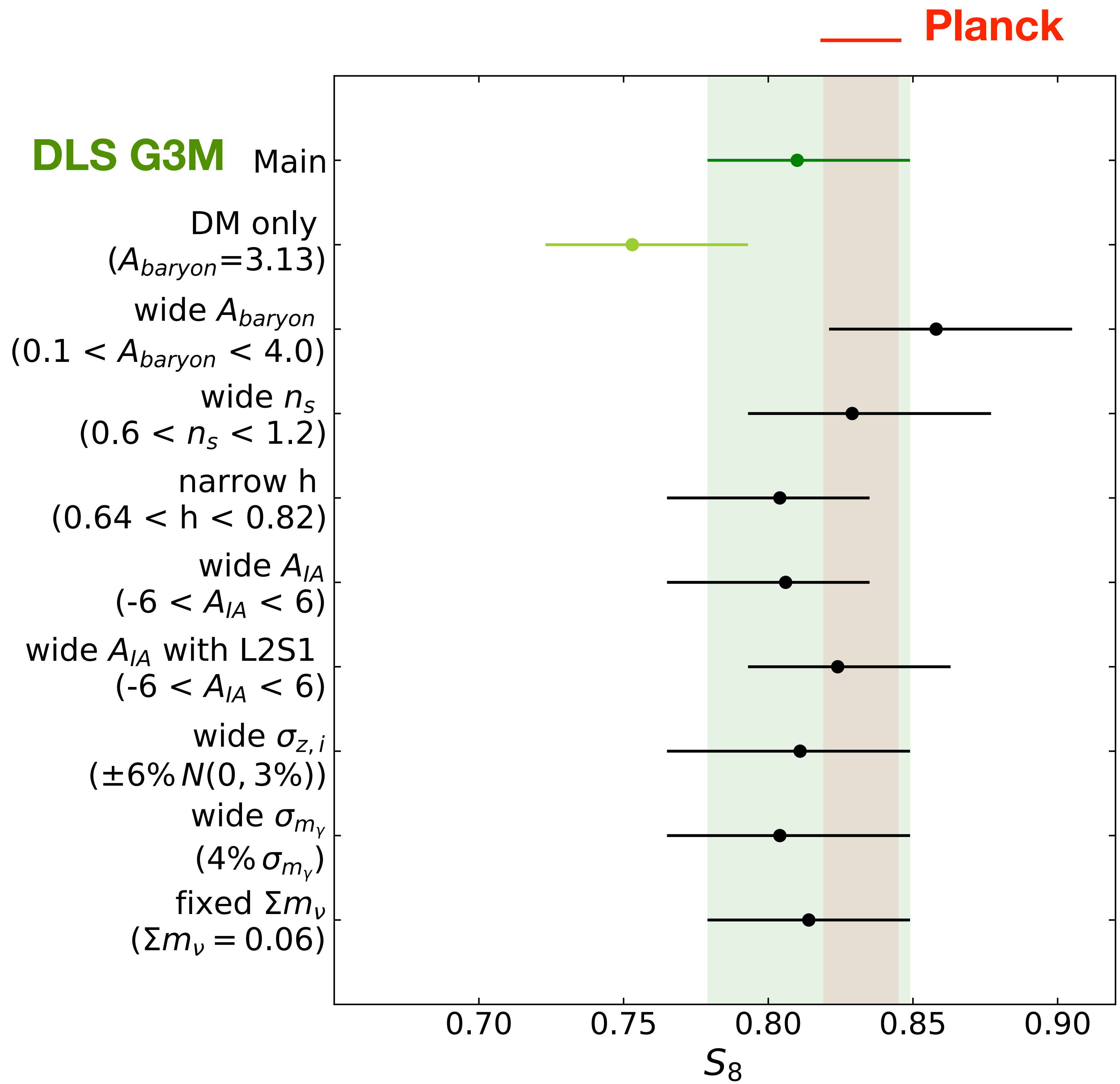
Comparison with other surveys



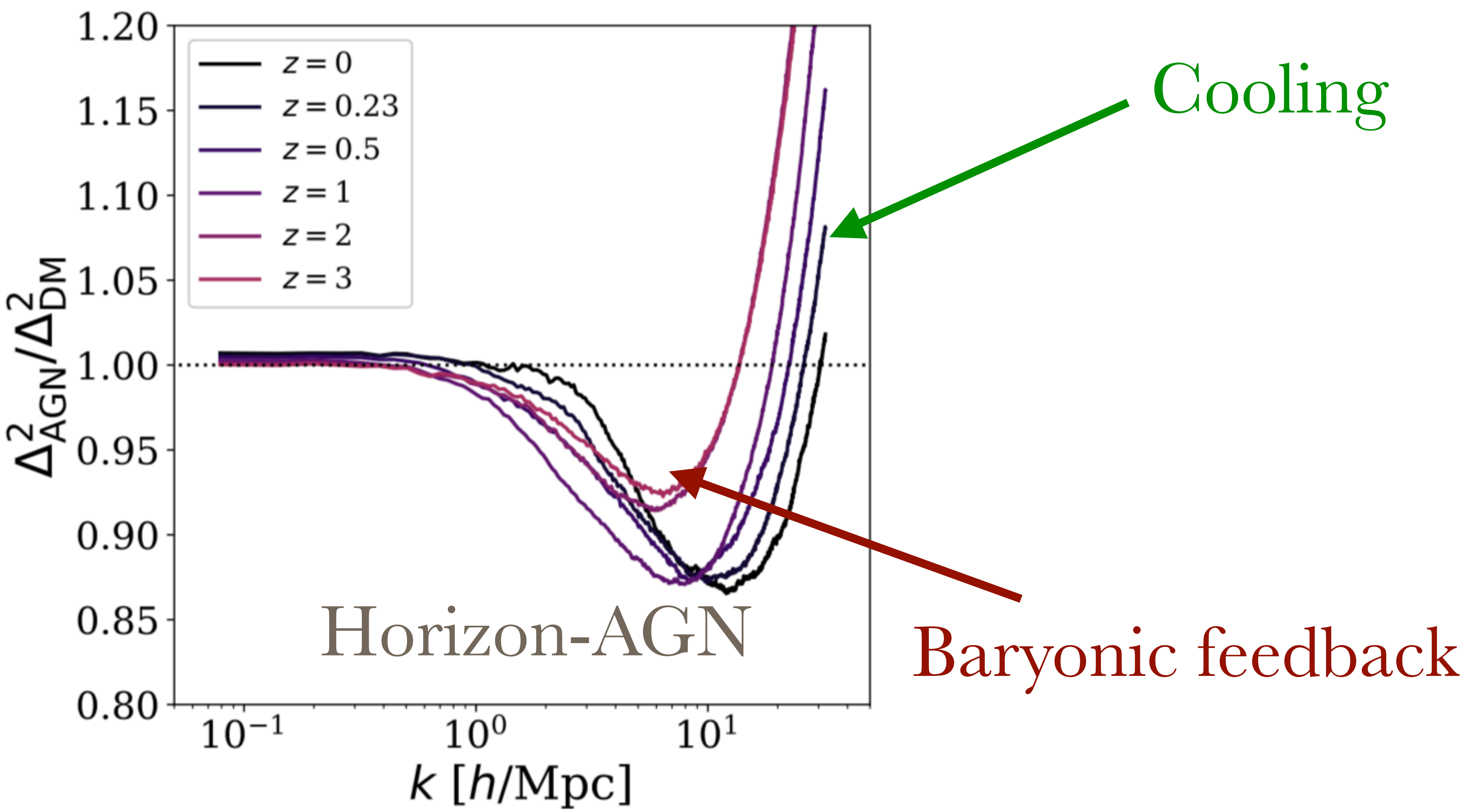
S_8=0.829 +0.034 -0.022

Preliminary

Prior tests


Planck
DLS G3M
Main
DM only
(A_{baryon}=3.13)
wide A_{baryon}
(0.1 < A_{baryon} < 4.0)
wide n_s
(0.6 < n_s < 1.2)
narrow h
(0.64 < h < 0.82)
wide A_{IA}
(-6 < A_{IA} < 6)
wide A_{IA} with L2S1
(-6 < A_{IA} < 6)
wide $\sigma_{z,i}$
($\pm 6\%\, N(0,3\%)$)
wide σ_{m_γ}
(4% σ_{m_γ})
fixed Σm_ν
($\Sigma m_\nu = 0.06$)
0.70
0.75
0.80
0.85
0.90
S_8

Baryonic effect

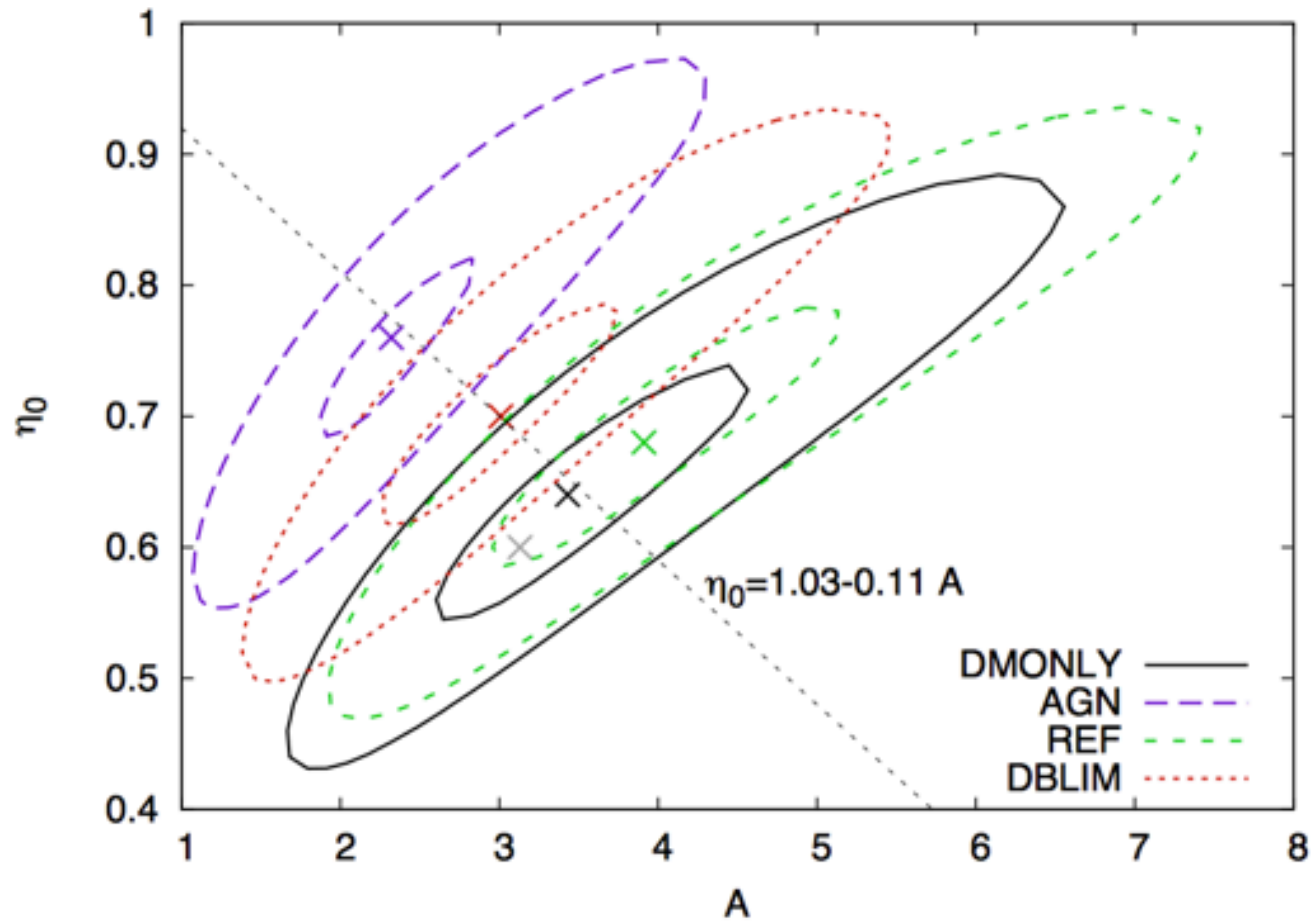


Chisari et al. (2018)

Baryonic effect

- Single parameterization determined by OWLS (OverWhelmingly Large Simulation):

$$\eta_0 = 1.03 - 0.11A\ .$$

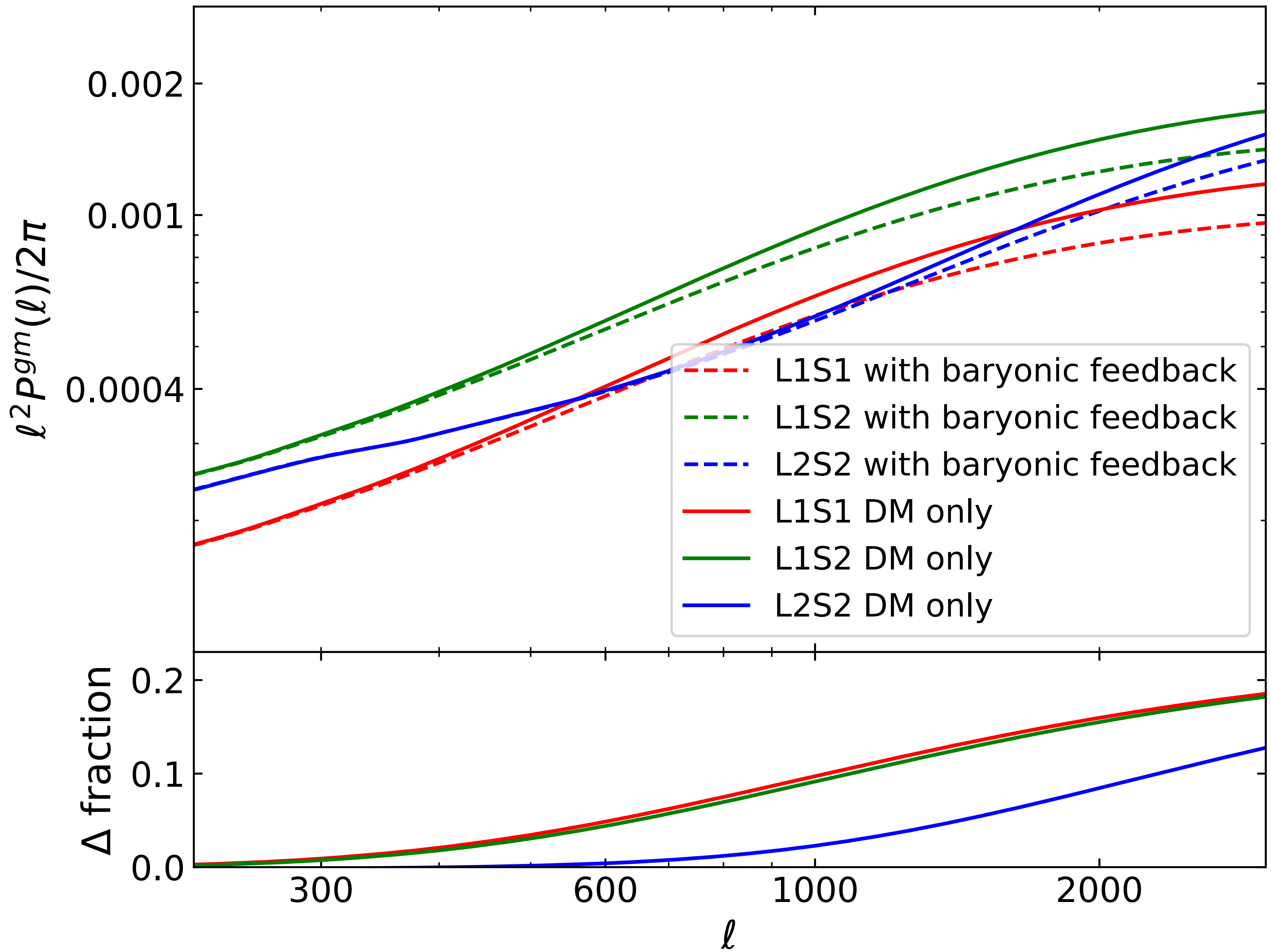


A_{baryon} : Minimum halo concentration

η_0 : halo bloating parameter

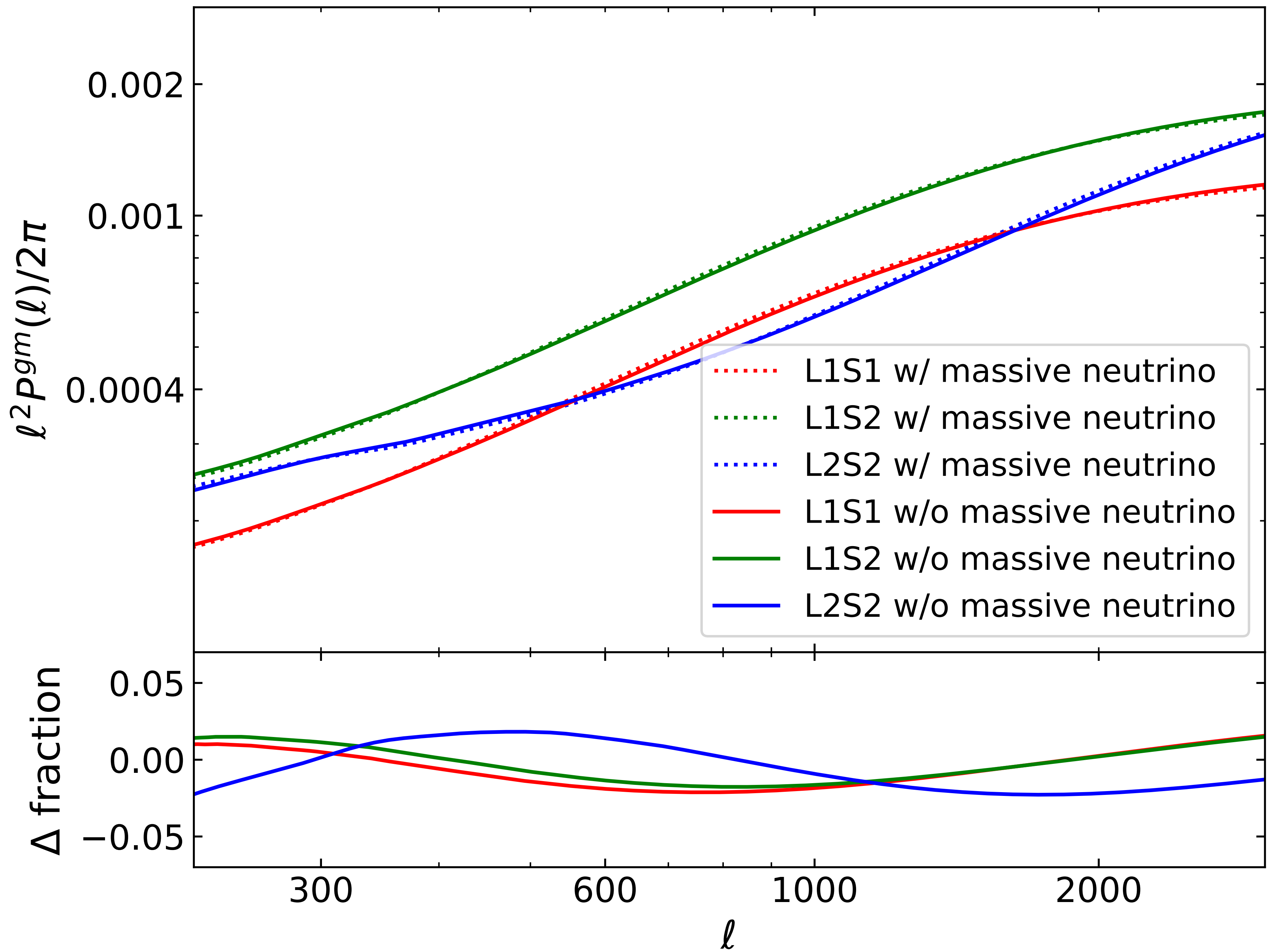
Methodology

Baryonic effect



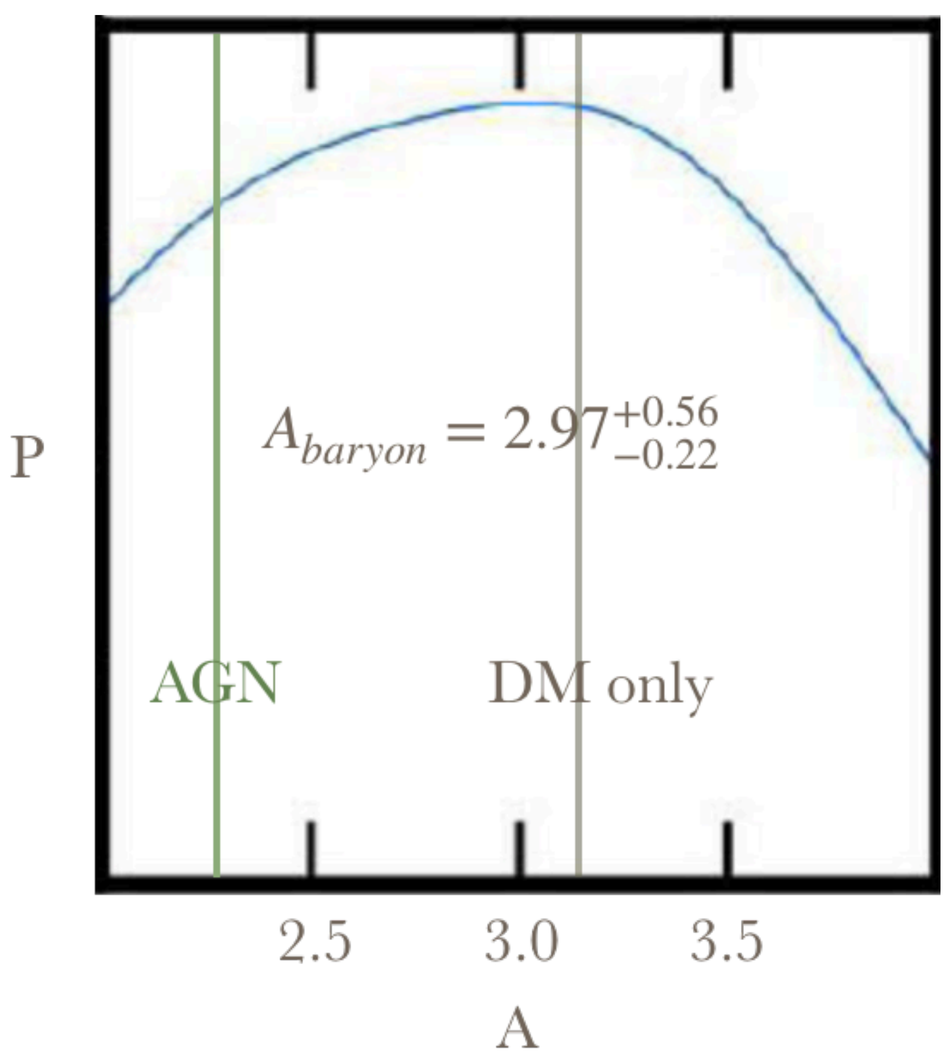
Difference between DM only and AGN feedback case

Neutrino effect



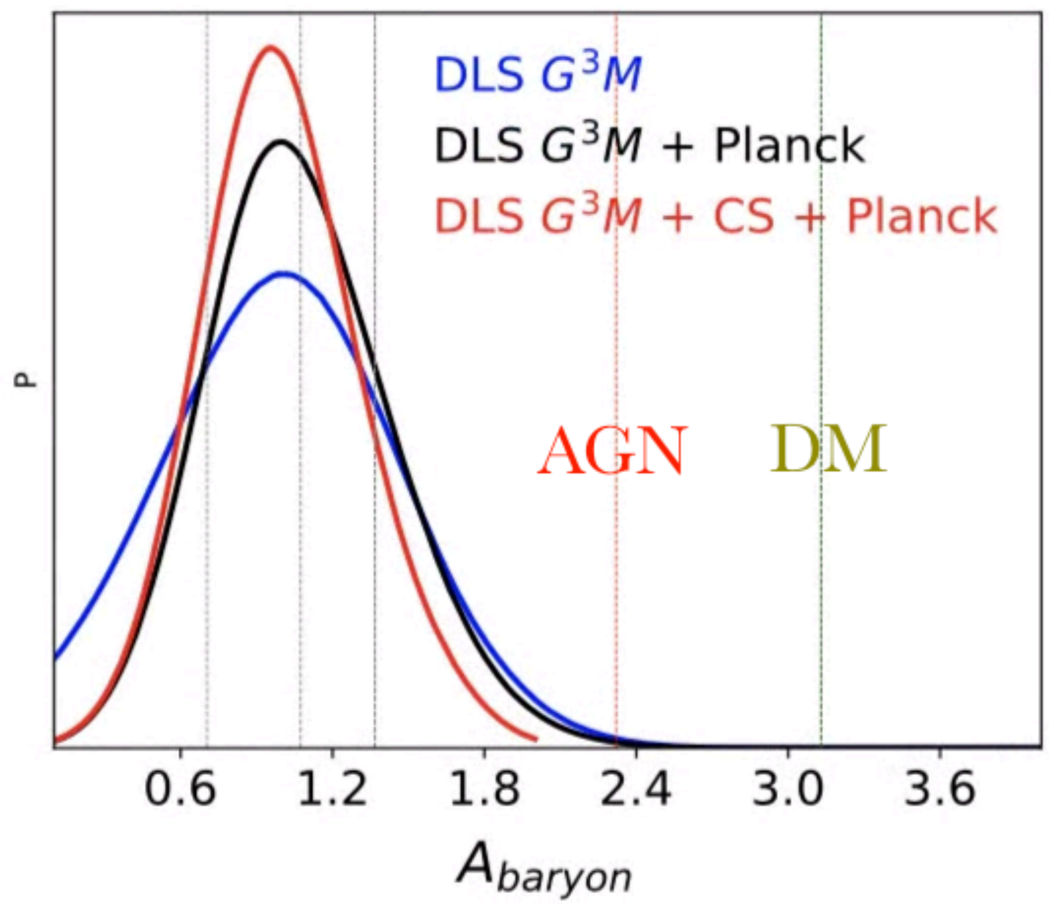
$\Sigma m_\nu = 0.6eV$

Previous attempts



Authors	Survey	Method	Results
Hildebrandt et al. (2017)	KiDS	Cosmic Shear	No constraint
Joudaki et al. (2018)	KiDS+ 2dFLenS	Cosmic Shear+GGL+GG	Upper bound
van Uitert et al. (2018)	KiDS+ GAMA	Cosmic Shear+GGL+GG	Loose constraint

Our constraint on A_{baryon}



For each case, respectively,

$$A_{baryon} = 1.28^{+0.48}_{-0.45}$$

$$A_{baryon} = 1.07^{+0.31}_{-0.39}$$

$$A_{baryon} = 1.00^{+0.31}_{-0.31}$$

- We achieved the first constraint on baryonic feedback parameter.
- Different combinations of DLS and Planck data produce consistent results.

Conclusions

- We constrained S_8 value (0.829 +0.034 -0.022) tightly from DLS which does not have any tension with Planck.
- We achieved a reliable constraint on baryonic feedback parameter (1.00 +/- 0.31).
- The constrained baryonic parameter implies that the actual baryonic feedback may be stronger than the current OWLS simulations.

Thank you.