Is lensing really low?

Consistent lensing and clustering in a low-S8 Universe with BOSS, DES Year 3, HSC Year 1 and KiDS-1000

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+ DES, KiDS, HSC collaborations

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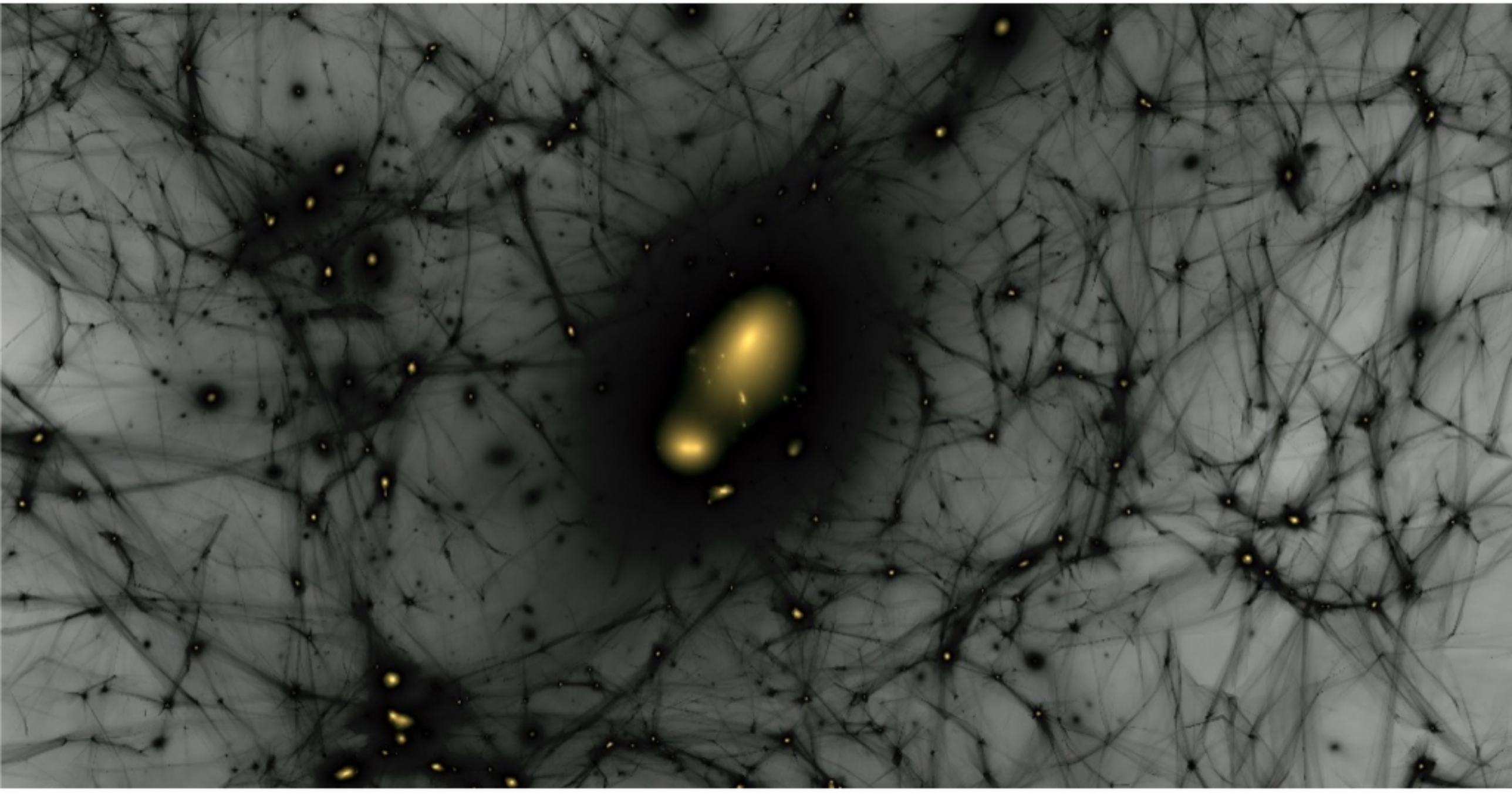
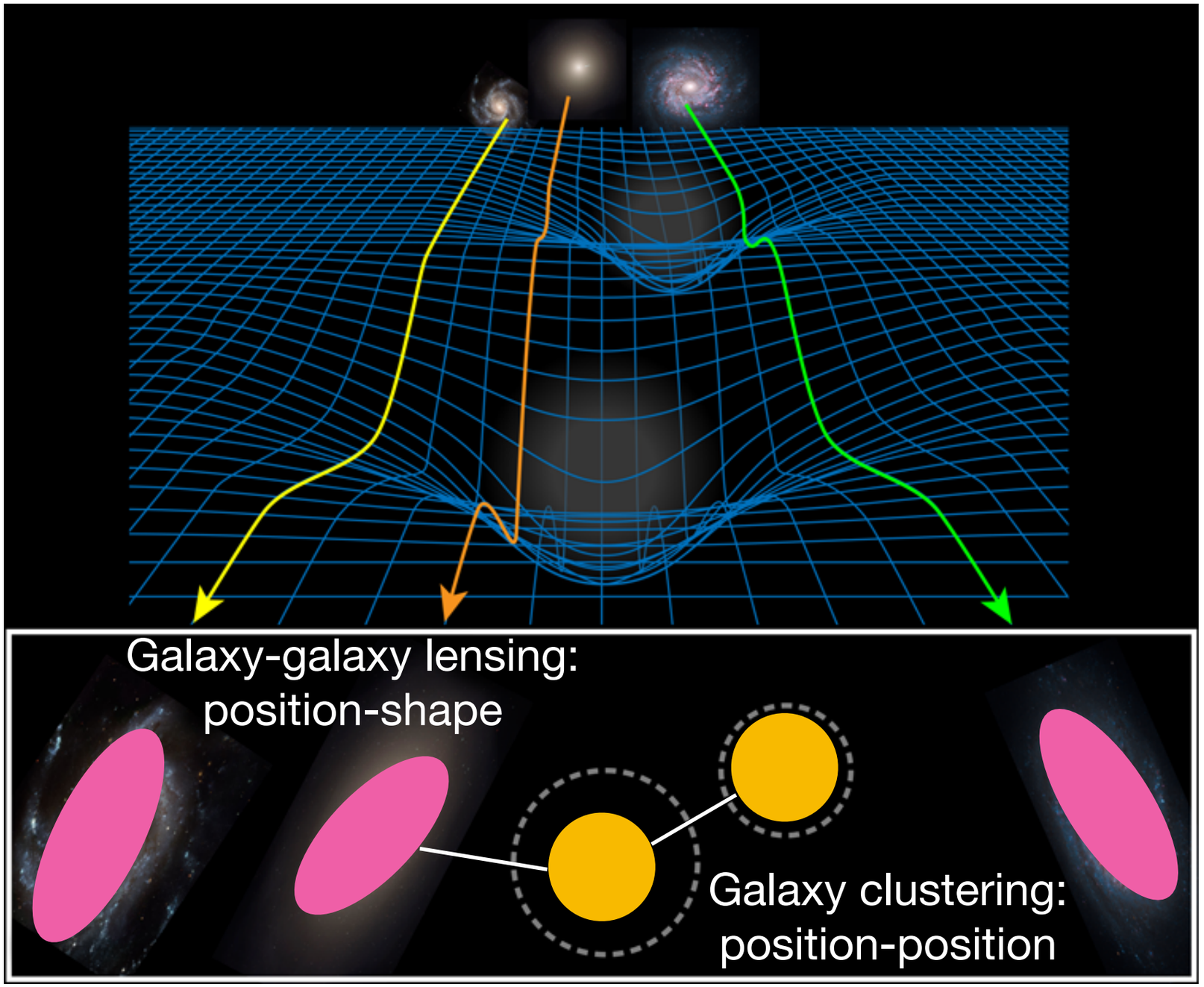
Cosmology or Galaxy Formation



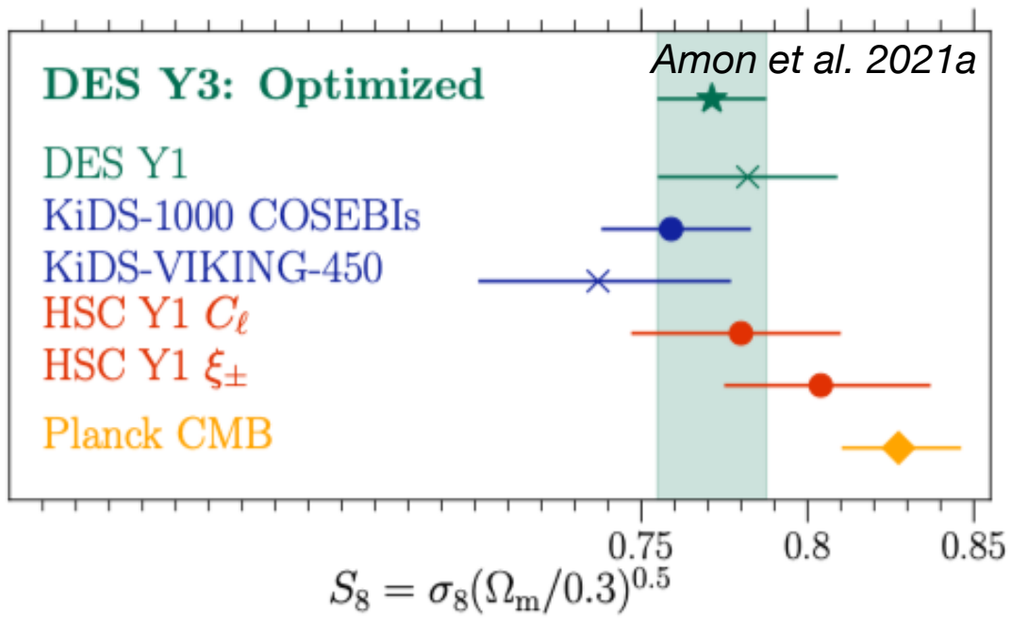
Galaxy Clustering and Galaxy-galaxy Lensing



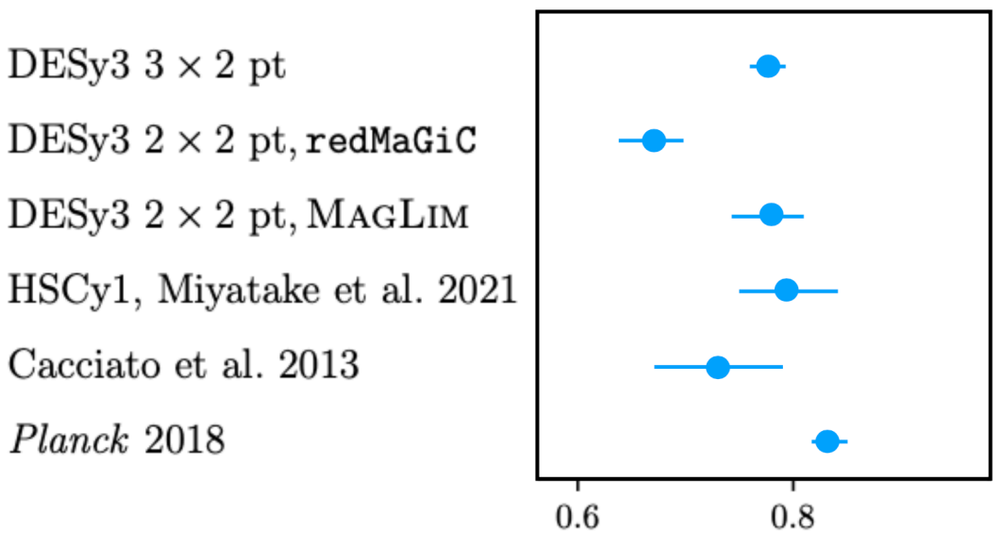
The S8 Tension

- Lensing finds S8 to be ~ 10% lower than a primary CMB analysis.
- These analyses remove the small-scales that are difficult to model.

Cosmic Shear



Galaxy-galaxy Lensing & Clustering



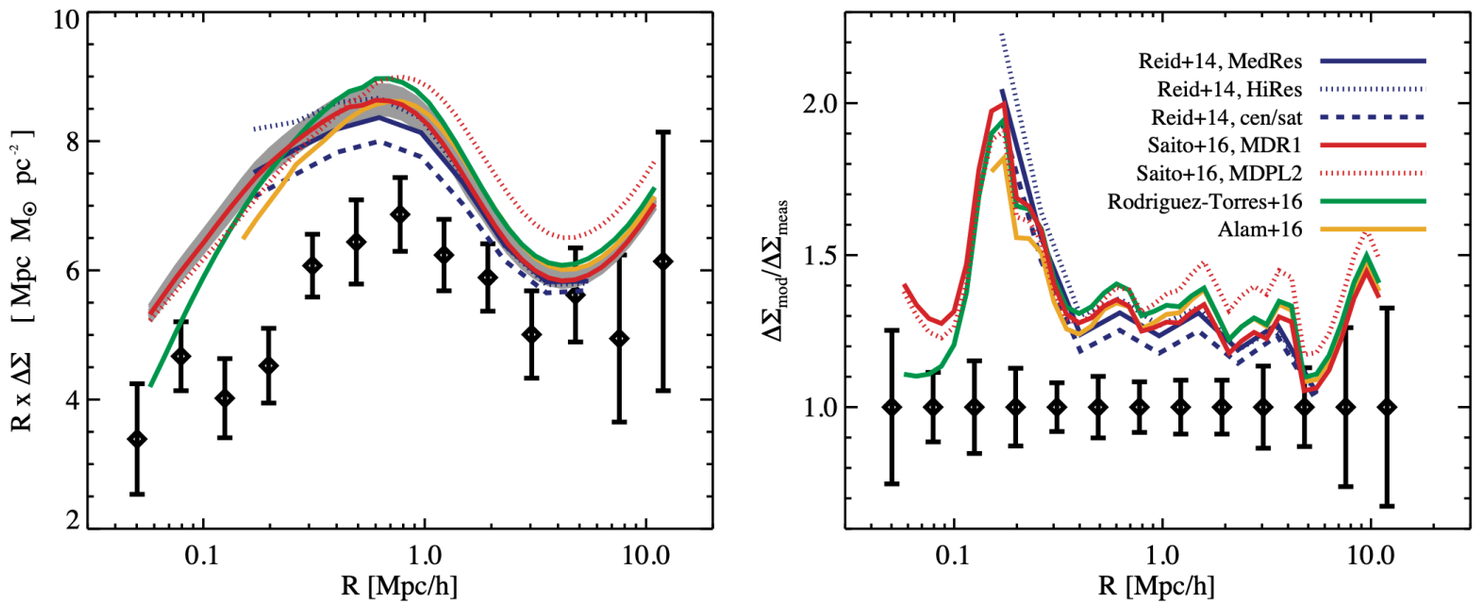
Lensing is Low

- Previous work has shown differences between clustering and galaxy-galaxy lensing, up to 40%.

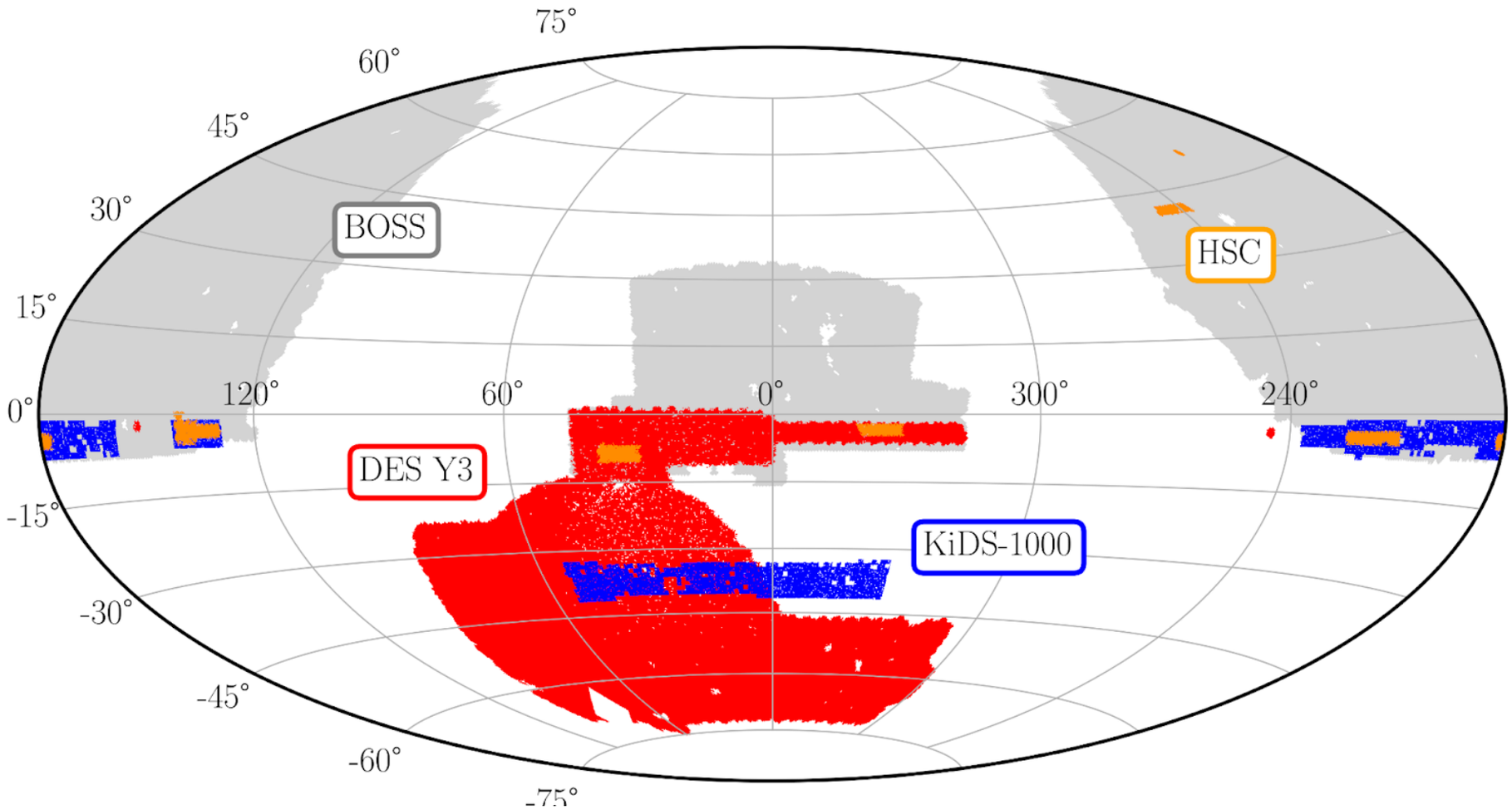
- Fit model to clustering -> predict lensing from best model, do they agree?

- Potential causes: small-scale systematics, same low-S8 tension, complex galaxy selections.

Leauthaud et al. 2017

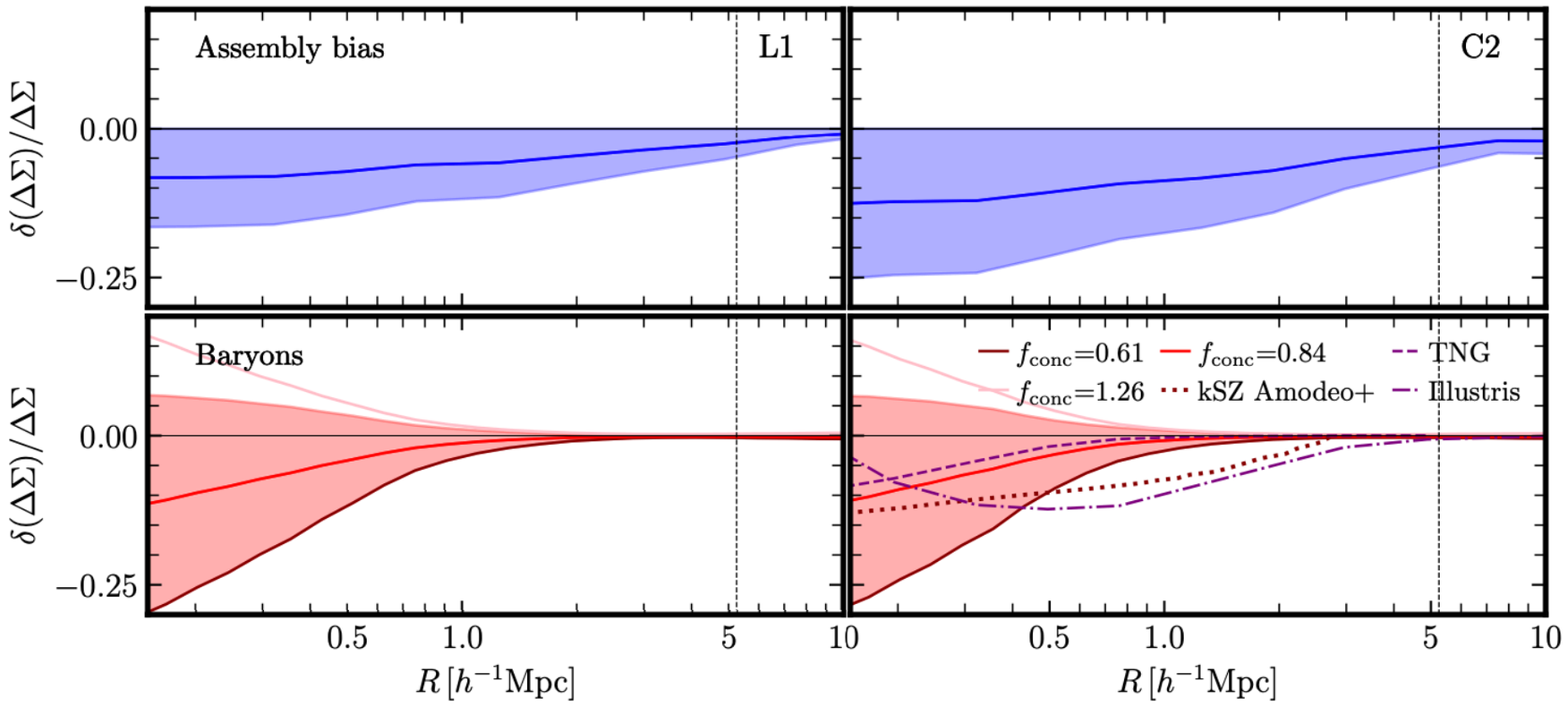


Data



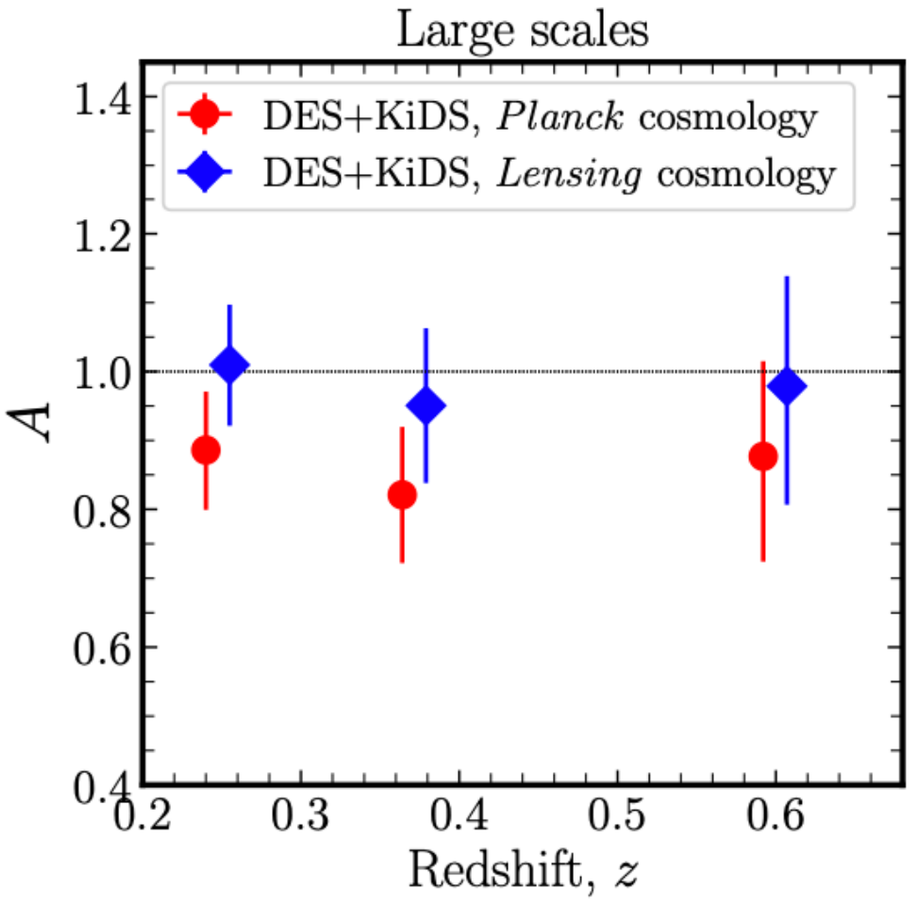
	HSC-Y1	DES-Y3	KiDS-1000
Area [deg^2]	137	4143	777
BOSS overlap area	137	771	409
Num. LOWZ (L1/L2)	3170 / 3251	16285 / 17661	4701 / 5431
Num. CMASS (C1/C2)	8409 / 8943	30613 / 34223	17501 / 18509
$z_{\rm med}$	0.80	0.63	0.67
$n_{\rm eff}$	21.8	5.59	6.22

Small-scale Systematics in GGL



- Assembly bias is the dependence of halo clustering on secondary halo properties, beyond dark matter halo mass.
- On the smallest scales, this incurs a ~10% suppression due to assembly bias, and an uncertainty of the same amplitude.
- Baryonic feedback changes the overall matter distribution which will impact the lensing model.
- We account for baryonic effects by changing the concentration-mass relation normalisation, fconc, which incurs a ~10% suppression at smallest scale, which is negligible at 1Mpc/h.

Consistency of Clustering and GGL



- Evaluate consistency using an additional parameter A such that:

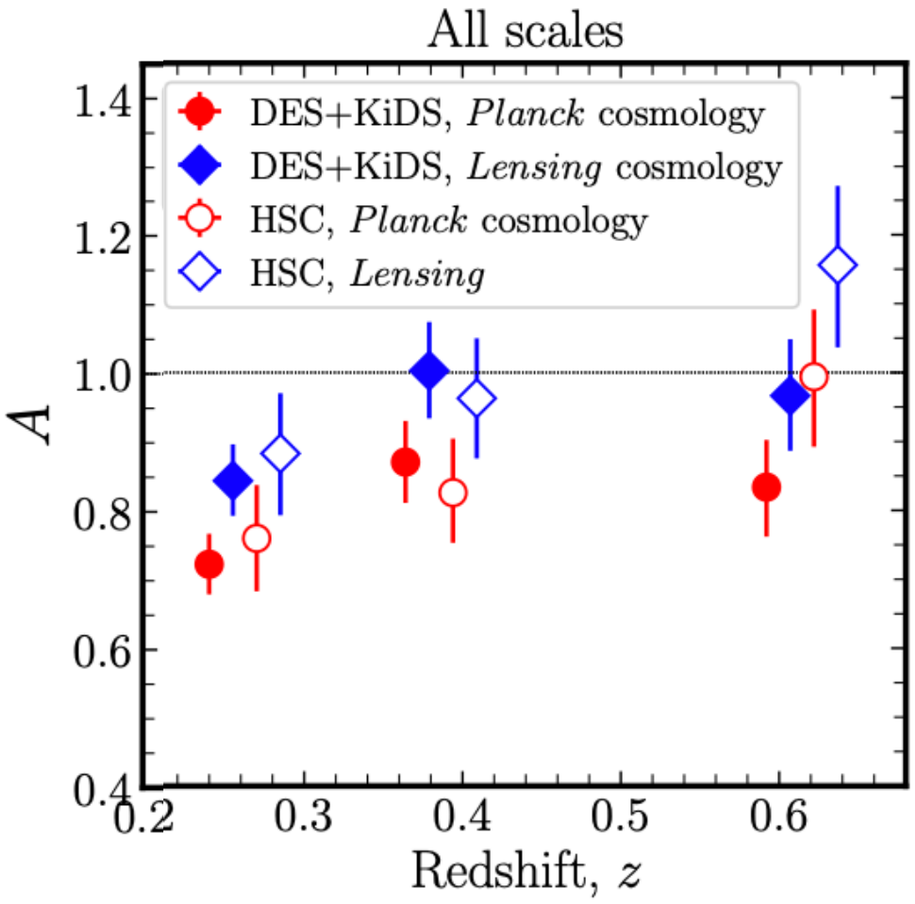
$$\Delta\Sigma \rightarrow A\Delta\Sigma(R)$$

- Large scales where baryonic effects and assembly bias are negligible and so we expect that A = 1 in ΛCDM.

- A = 0.99 ± 0.06 for the Lensing cosmology, and A = 0.86 ± 0.06 for the Planck cosmology.

- We find no evidence of inconsistency on large scales, in the bins where the selection of the lens sample is negligible.

Consistency of Clustering and GGL



- We include the systematic corrections for both baryonic effects and assembly bias.
- Assuming a Lensing cosmology: A = 0.91 ± 0.04 for DES+KiDS and A = 0.97 ± 0.06 for HSC.
- Assuming a Planck cosmology: A=0.79±0.03 for DES+KiDS and A=0.84±0.05 for HSC.
- Overall, with our theoretically–reasoned corrections for assembly bias and baryonic effects applied to the vanilla HOD model, we find that the lensing and clustering are consistent in a Lensing cosmology.

Outlook

- We find good agreement between the lensing data from DES-Y3, KiDS-1000, and HSC-Y1.

- Non-linear scales are challenging due to astrophysical effects and should be considered with caution in a cosmological analysis.

- We need to consider the implications of complex galaxy selections and account for this when modelling.

- We lose a lot of information and power by neglecting these small scales.

- DESI+lensing+SZ provides exciting opportunities for future exploration of this topic.

Summary

- We perform a joint lensing and clustering analysis using BOSS, combined with state-of-the-art lensing data from KiDS, DES and HSC.

- Considering two fixed cosmologies: Planck and a low-S8 Lensing cosmology and isolating the easier-to-model large scales, we find an acceptable fit to the data in both cases.

- Incorporating a wider range of scales and accounting for assembly bias and baryonic effects, we find a preference for the Lensing cosmology: lensing and clustering are consistent in a low-S8 Universe.

- But small-scale modelling is still a challenge.

- We find good agreement between the lensing data from DES-Y3, KiDS-1000, and HSC-Y1.