Consistent lensing and clustering in a low-S8 Universe

with BOSS, DES Year 3, HSC Year 1 and KiDS-1000

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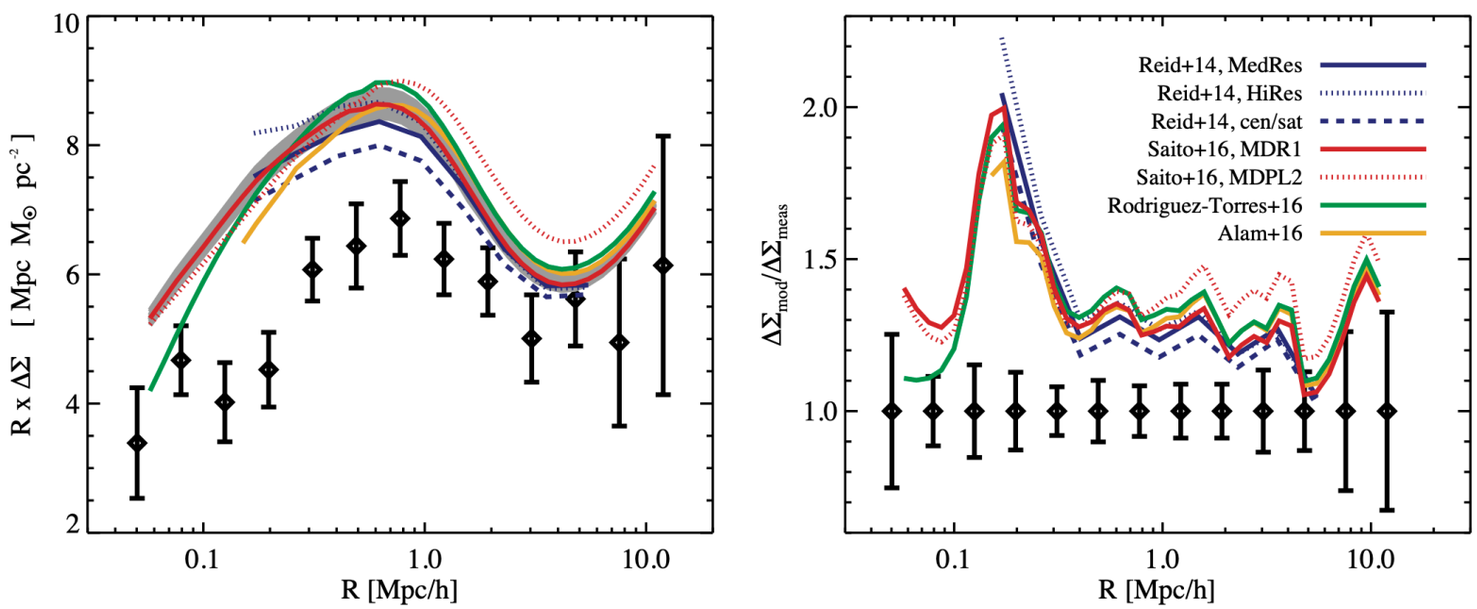
+ DES, KiDS, HSC collaborations

Tensions in Cosmology Corfu 2022

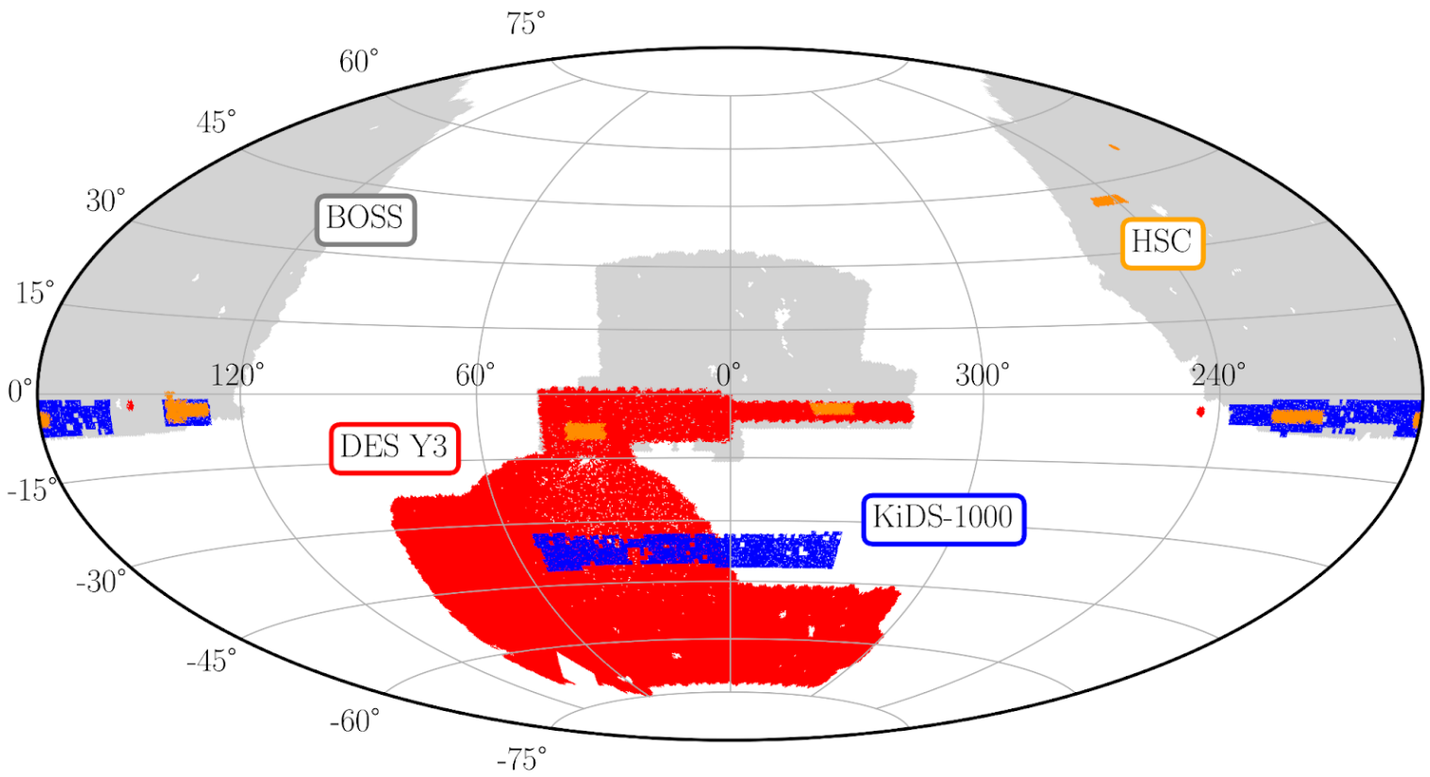
Are GGL and clustering consistent?

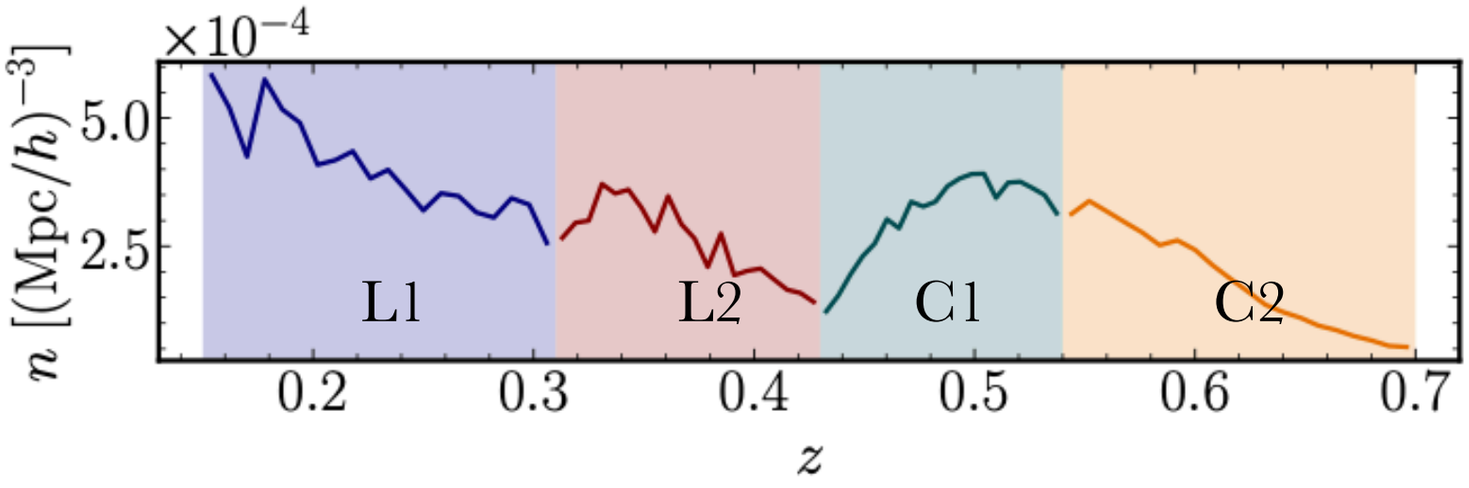
- Fit model to clustering and use to this model to predict lensing; do they agree?
- Previous work has shown differences between clustering and galaxy-galaxy lensing are up to 40% assuming a Planck cosmology.
- Potential causes: small-scale systematics, same low-S8 tension, complex galaxy selections.
- Can our improved understanding of lensing systematics or a combination of effects resolve this?

Leauthaud et al. 2017



Data

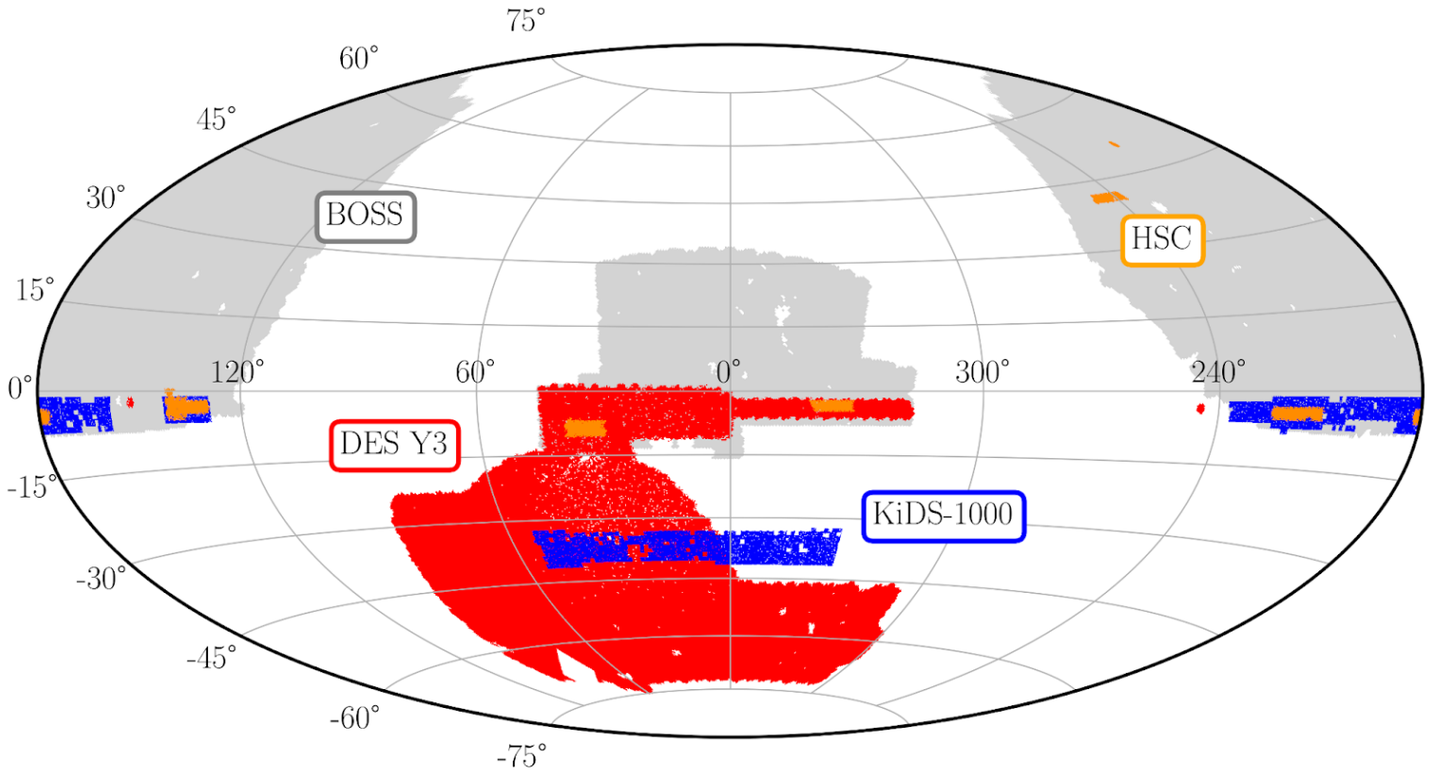


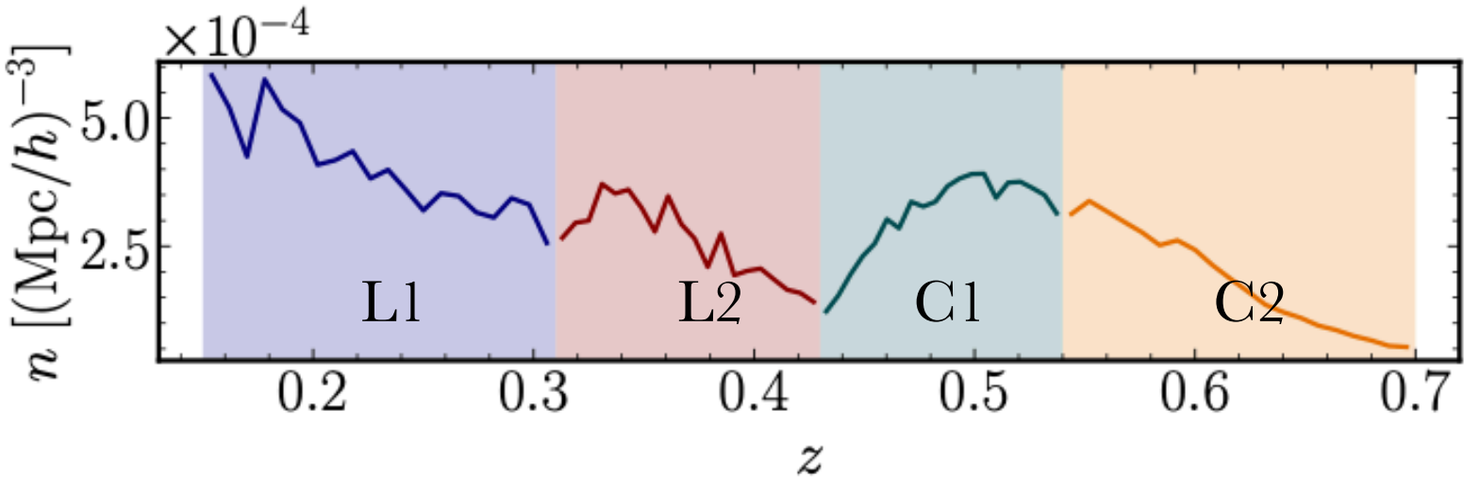


- We use the LOWZ and CMASS LRG samples for clustering measurements and as foreground lens samples.

- Split samples by redshift to get four lens bins.

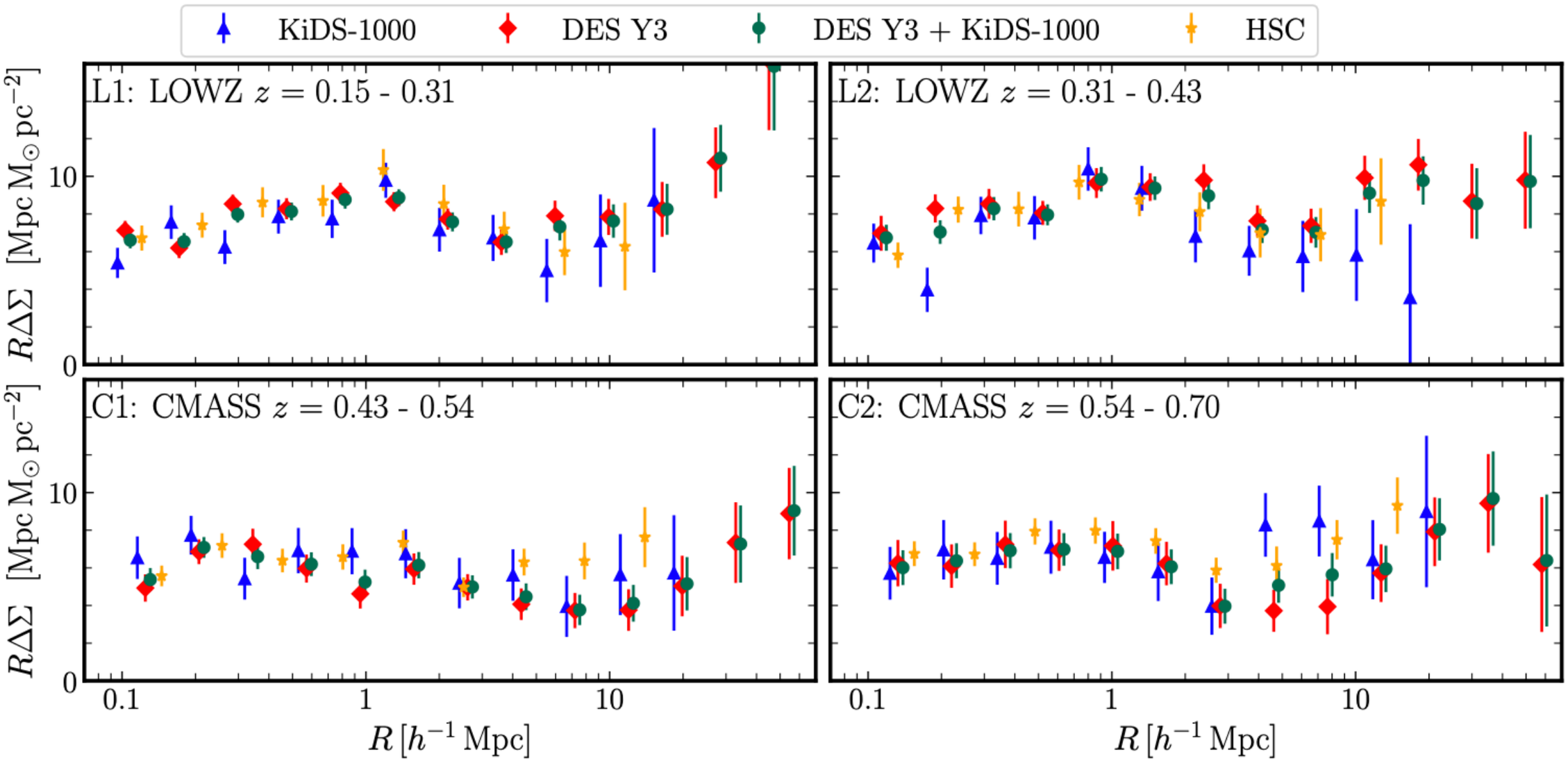
Data





- LOWZ and CMASS LRG sample are colour selected.
- Colour cuts remove star-forming galaxies in the lower redshift parts of the sample L1 and C1.
- Higher redshift sub-samples, L2 and C2, are closer to being flux limited.

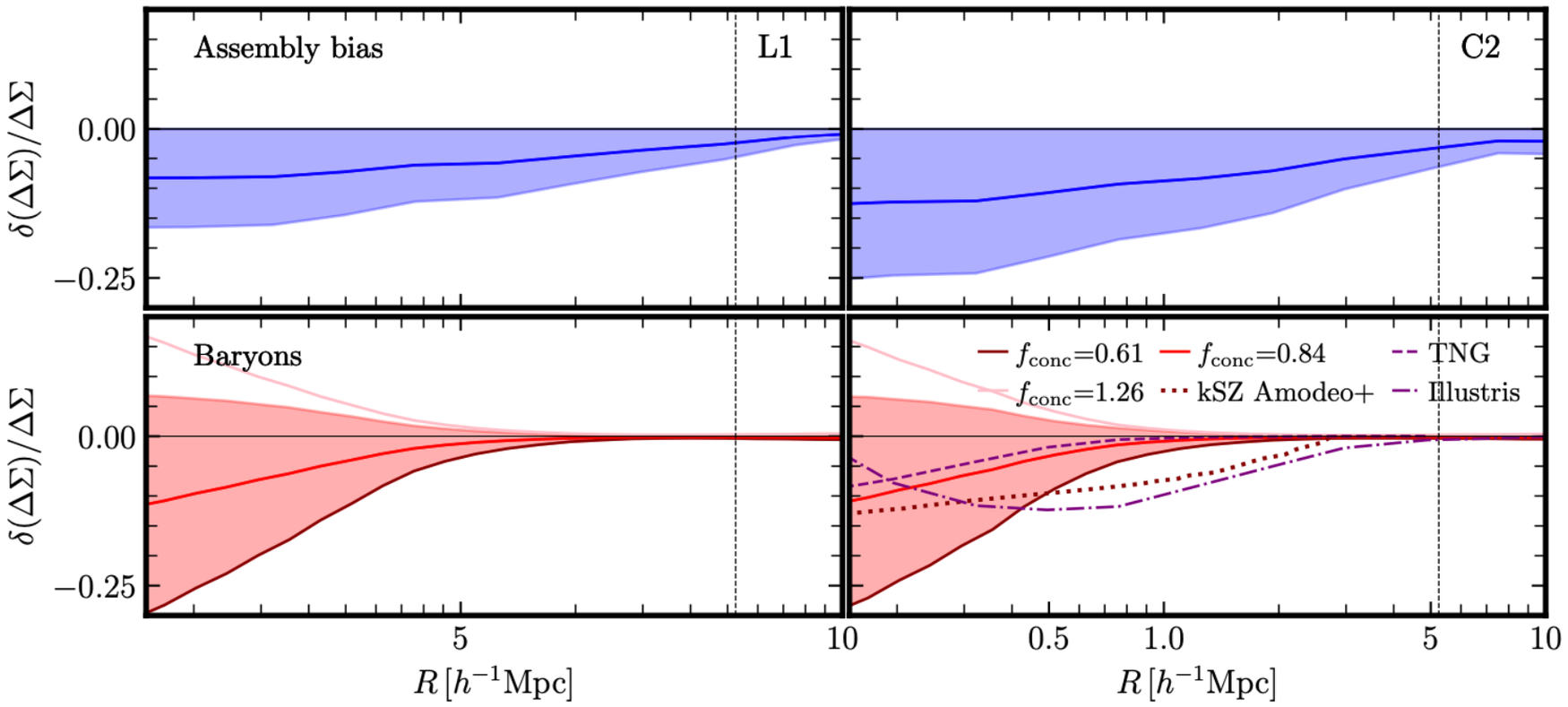
Lensing Measurements



Data	Stat	L1	L2	C1	C2
KiDS vs. DES	χ^2/DoF	1.03	1.41	0.70	0.86
	p-value	0.49	0.20	0.82	0.66
KiDS+DES vs. HSC	χ^2/DoF	0.28	0.76	1.61	0.74
	p-value	0.98	0.73	0.17	0.75

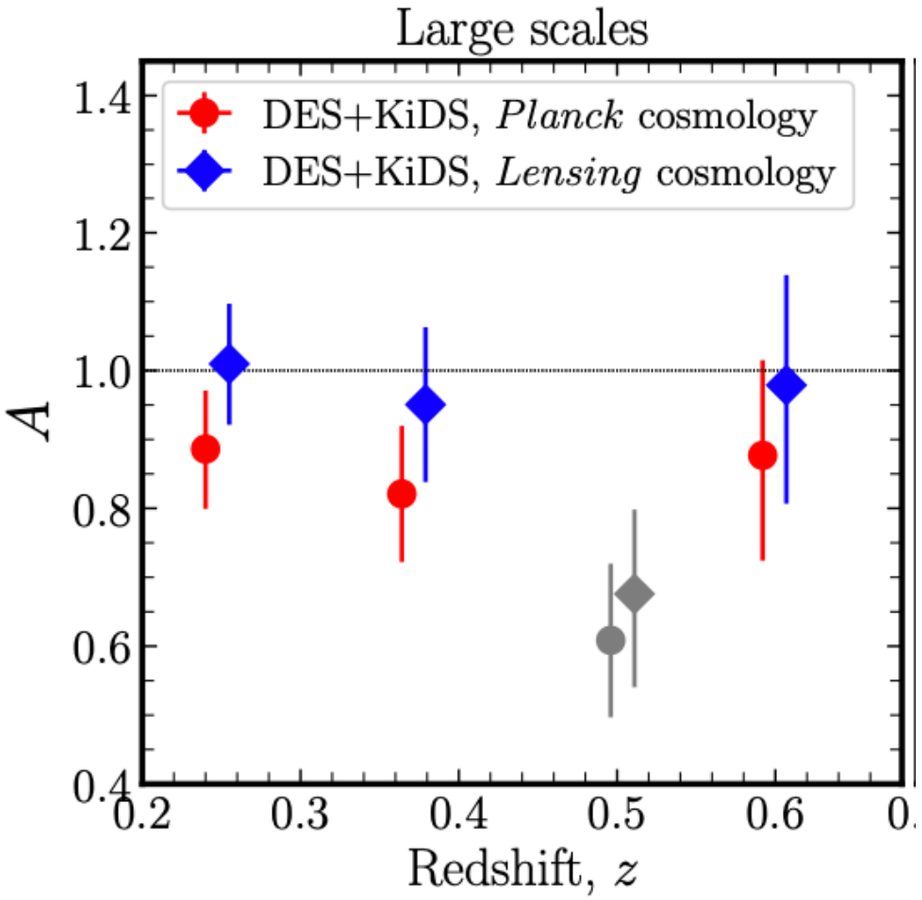
- Systematic error budget: ~2% DES and KiDS and ~5% HSC.
- Measurements consistent between surveys.

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:

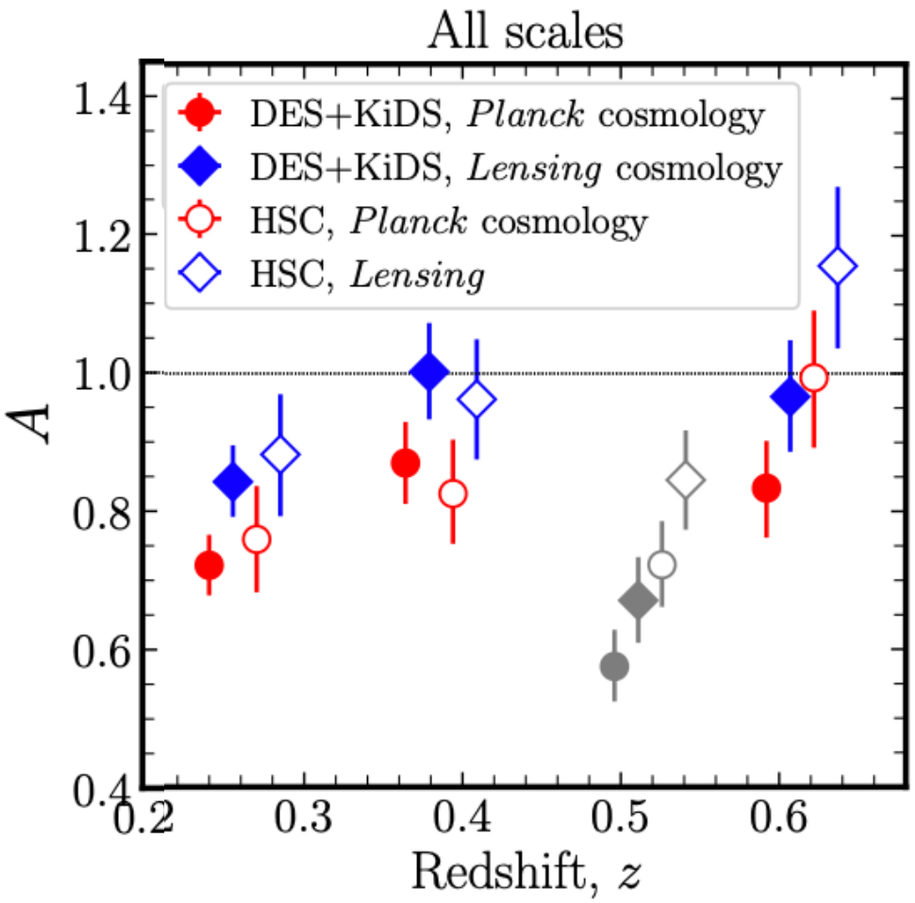
$$\Delta\Sigma \rightarrow A\Delta\Sigma(R)$$

- 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.

- Limiting the analysis to the bins for which the impact of the selection of the lens sample is negligible, indeed, we find no evidence of inconsistency on large scales.

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

- 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.