ETH zürich

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Impact of redshift systematics and intrinsic alignment modelling on the S_8-tension

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Corfu22: Workshop on Tensions in Cosmology

In collaboration with: T. Kacprzak, J. Blazek, A. Refregier
Redshift requirements for cosmic shear with intrinsic alignment

arXiv:2207.01627

Weak gravitational lensing and the S_8-tension

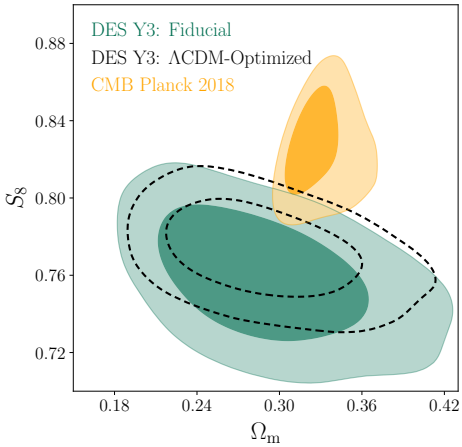
- Shapes of galaxies get distorted by the underlying matter distribution
- Measuring the shape correlations can constrain cosmological parameters
- Main constrained parameter $S_8 = \sigma_8 \sqrt{\Omega_m / 0.3}$
- Recent measurements of S_8 are in a $\sim 2\sigma$ tension with high-redshift measurements

Goal

We study two systematics

- intrinsic alignment (IA)
- redshift estimation

and their interplay

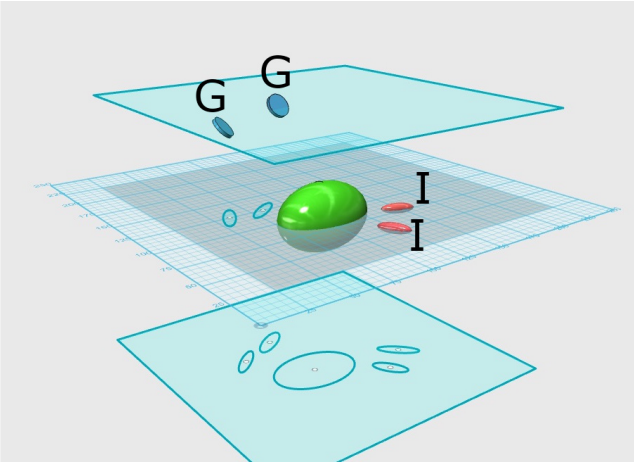


Amon et al. (2021)

Intrinsic alignment (IA)

- Cosmic shear signal: GG
- IA signal: II and GI
- How can we disentangle cosmic shear and IA?
- IA and cosmic shear have different redshift kernels
  - galaxy number density $n(z)$ for IA
  - lensing kernel $g(z)$ for cosmic shear

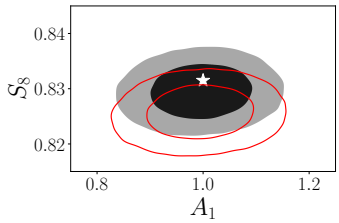
$\rightarrow$ use more than one redshift bin

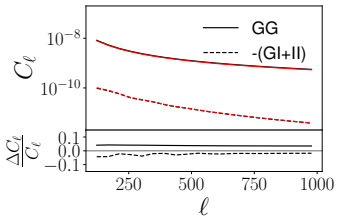


Joachimi et al. (2015)

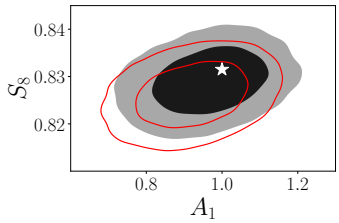
How redshift systematics and IA impact cosmological constraints

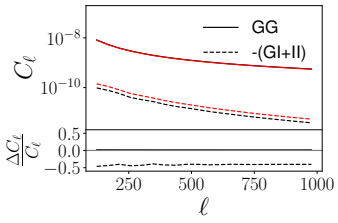
errors on the mean δ_z





errors on the width σ_z

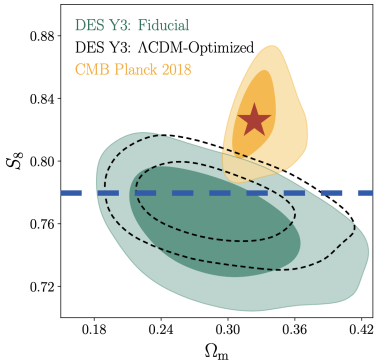




→ **Potential coupling between IA and redshift systematics**

Analysis pipeline

- Create mock observations with
  - cosmological parameters fixed at Planck ($S_8 = 0.8325$)
  - varying IA and redshift parameters δ_z and σ_z
- Analysis of mock observation using a Stage-III-like setup
  - 5 cosmological parameters
  - IA models: NLA, TATT
  - redshift uncertainty δ_z
- Fast C_ℓ emulator trained on `PyCosmo` predictions
- Determine best-fits of S_8
- Search for scenarios where S_8 is low ($S_8 < 0.78$)

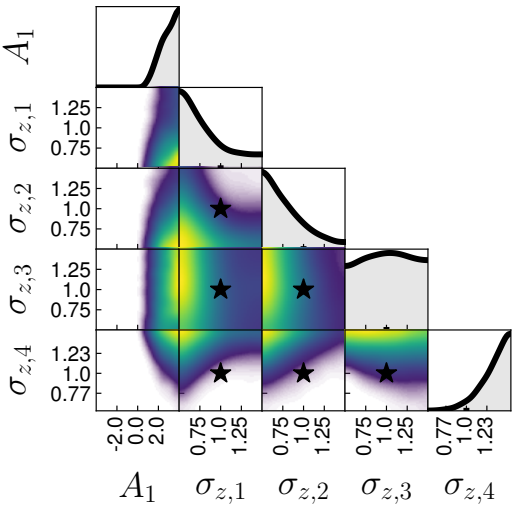


Amon et al. (2021)

Scenarios with $S_8 < 0.78$

- We find many scenarios with low S_8 in the analyzed parameters space
- Histogram of such low S_8 scenario with NLA and varied σ_z shows
  - stretched last bin and compressed first two bins leads to low S_8
  - high IA amplitude amplifies these redshift errors

  $\rightarrow$ **IA and redshift systematics are coupled**
- Similar results if extending the parameter space with δ_z or using TATT as IA model
- Some of the scenarios are in a realistic range of $A_1, \delta_{z,i}, \sigma_{z,i}$



Can this be the cause of the S_8-tension?

- Looking only at realistic scenarios, we find a $S_8 < 0.78$ in
  - 7.4 % for NLA (including IA underfitting)
  - 1.3 % for TATT

Key points

Redshift systematics and IA
- are a **possible, but unlikely** explanation of the S_8-tension
- can **bias cosmological constraints** significantly

→ What are the redshift requirements for current and upcoming surveys such that these biases do not dominate?

Survey requirements

Key points

Stage-III surveys:

- Statistical uncertainty is high

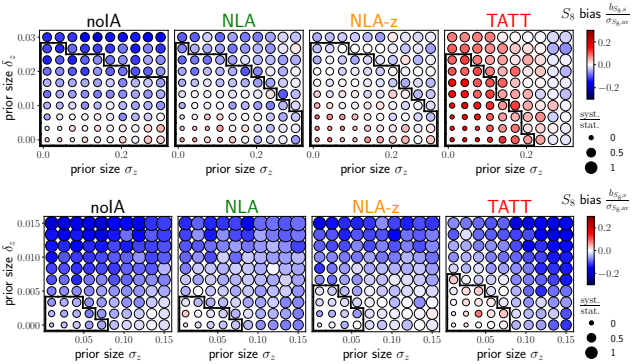
→ Redshift systematics are subdominant to statistical uncertainty

Stage-IV surveys:

- Increased statistical power

→ Challenge to reach the required precision

For more information, read the paper:
arXiv:2207.01627



Requirements for Stage-III (top) and Stage-IV surveys (bottom)

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Fischbacher et al., 2022,
arXiv:2207.01627