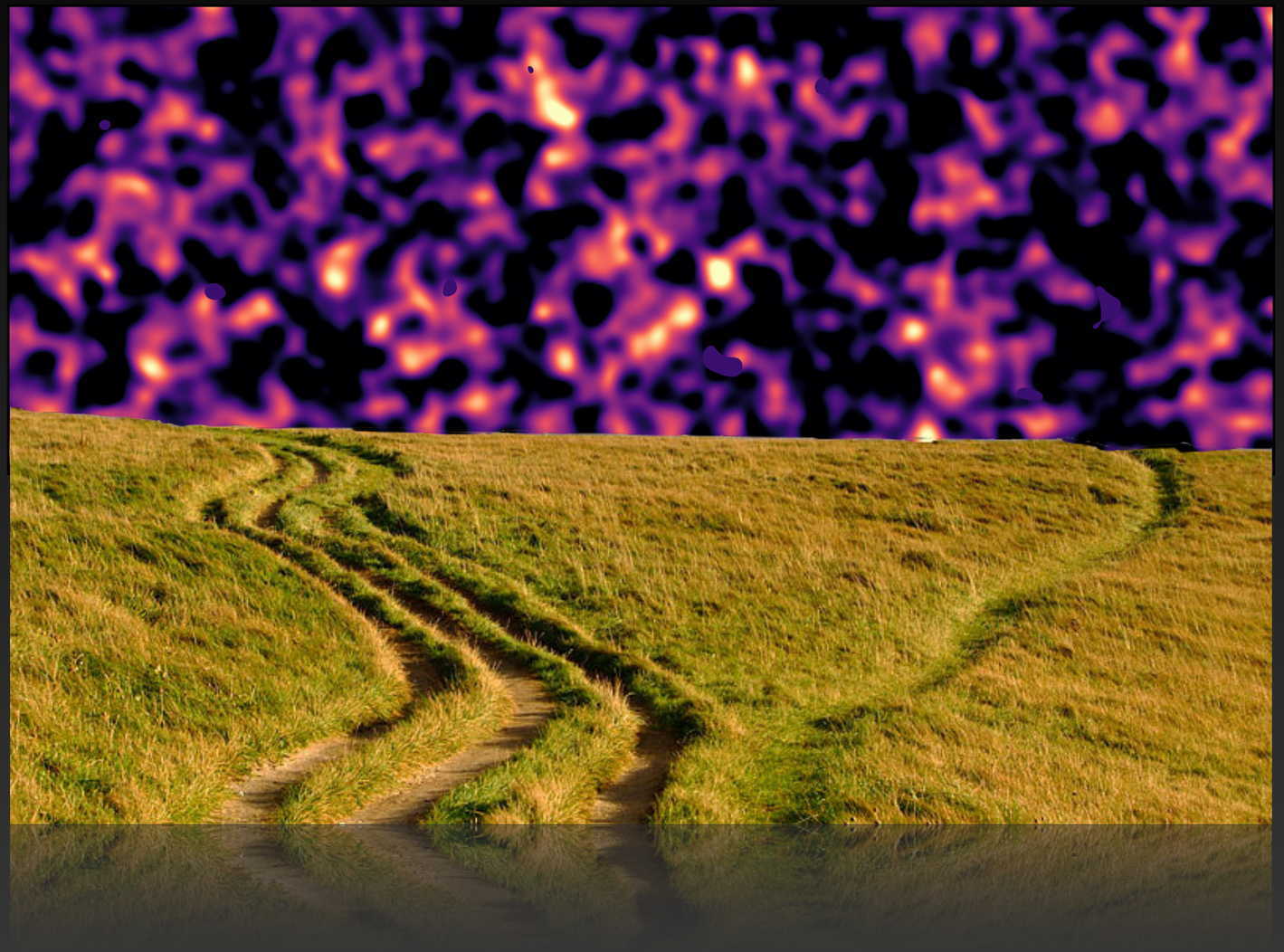


Enhancing cosmic shear with the multi-scale lensing PDF

Benjamin Giblin,
Yanchuan Cai,
Joachim Harnois-Déraps
(arXiv: 2211.05708)

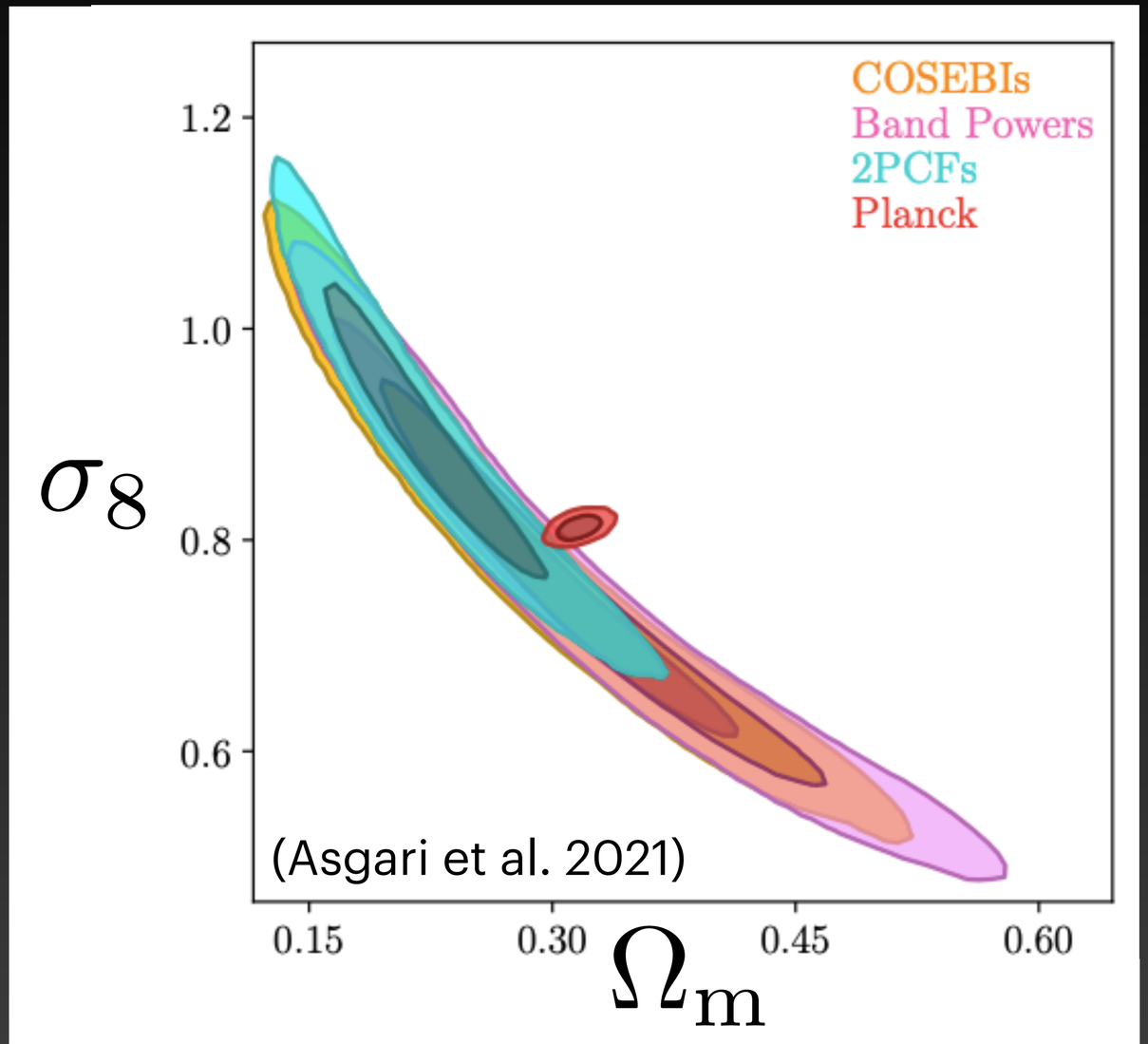
GCCL Seminar
24th Feb 2023

RSE The Royal Society of Edinburgh
KNOWLEDGE MADE USEFUL

Universitat de Barcelona

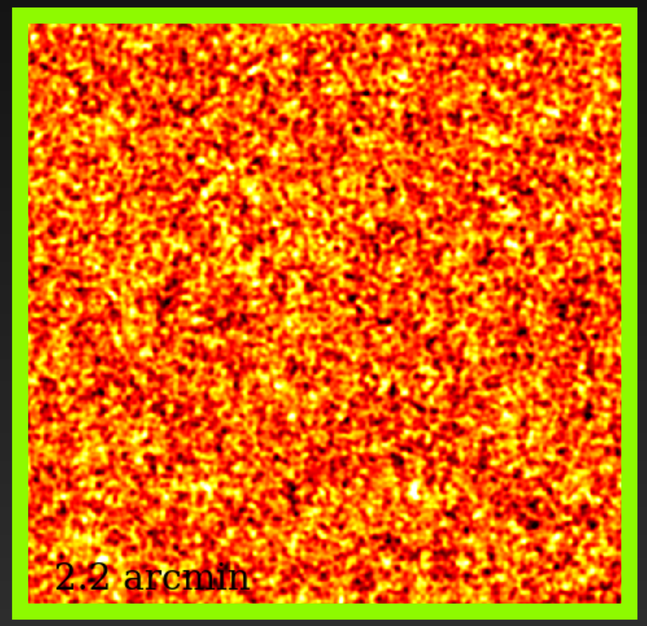
The University of Edinburgh

Weak lensing:
A powerful cosmological probe

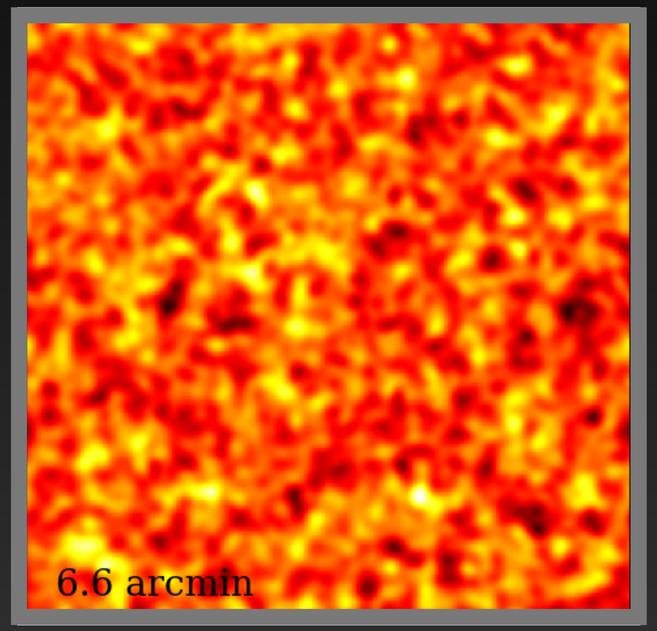


Beyond two-point statistics:

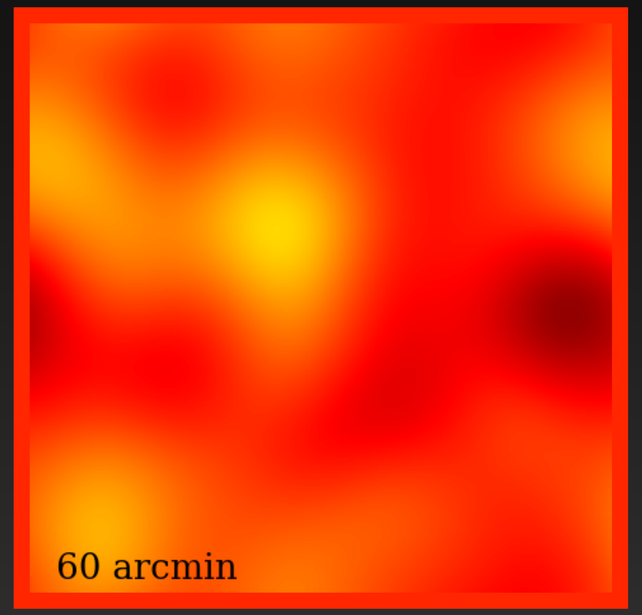
what can the convergence tell us?



Low smoothing
(2 arcmin)



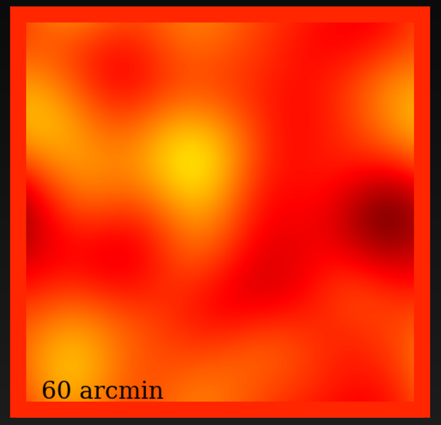
Medium smoothing
(6 arcmin)

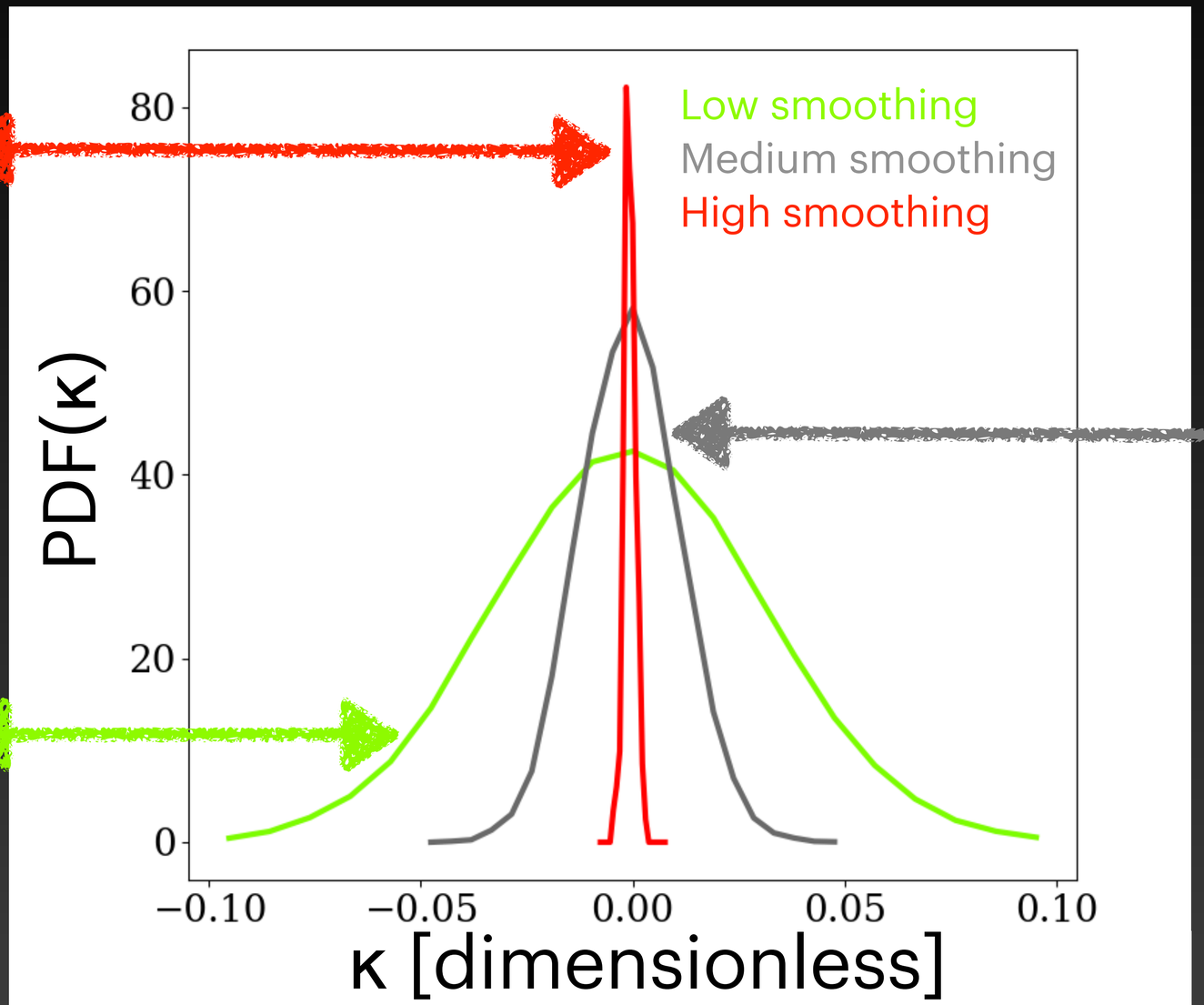


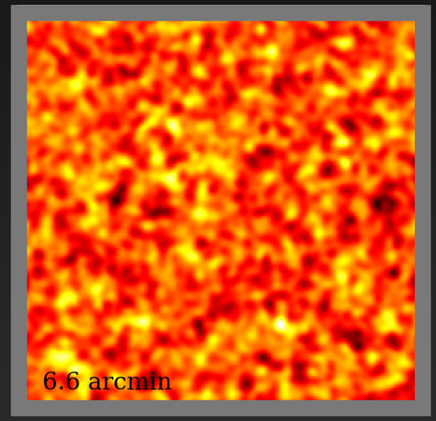
High smoothing
(60 arcmin)

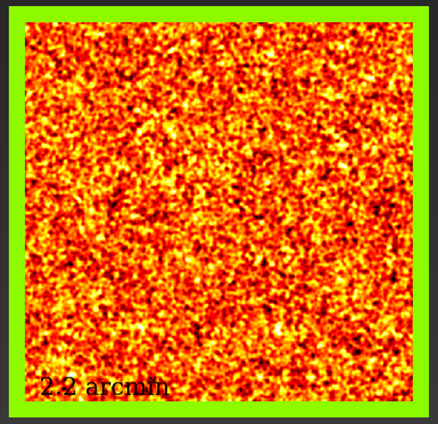
Beyond two-point statistics:

"The lensing PDF"



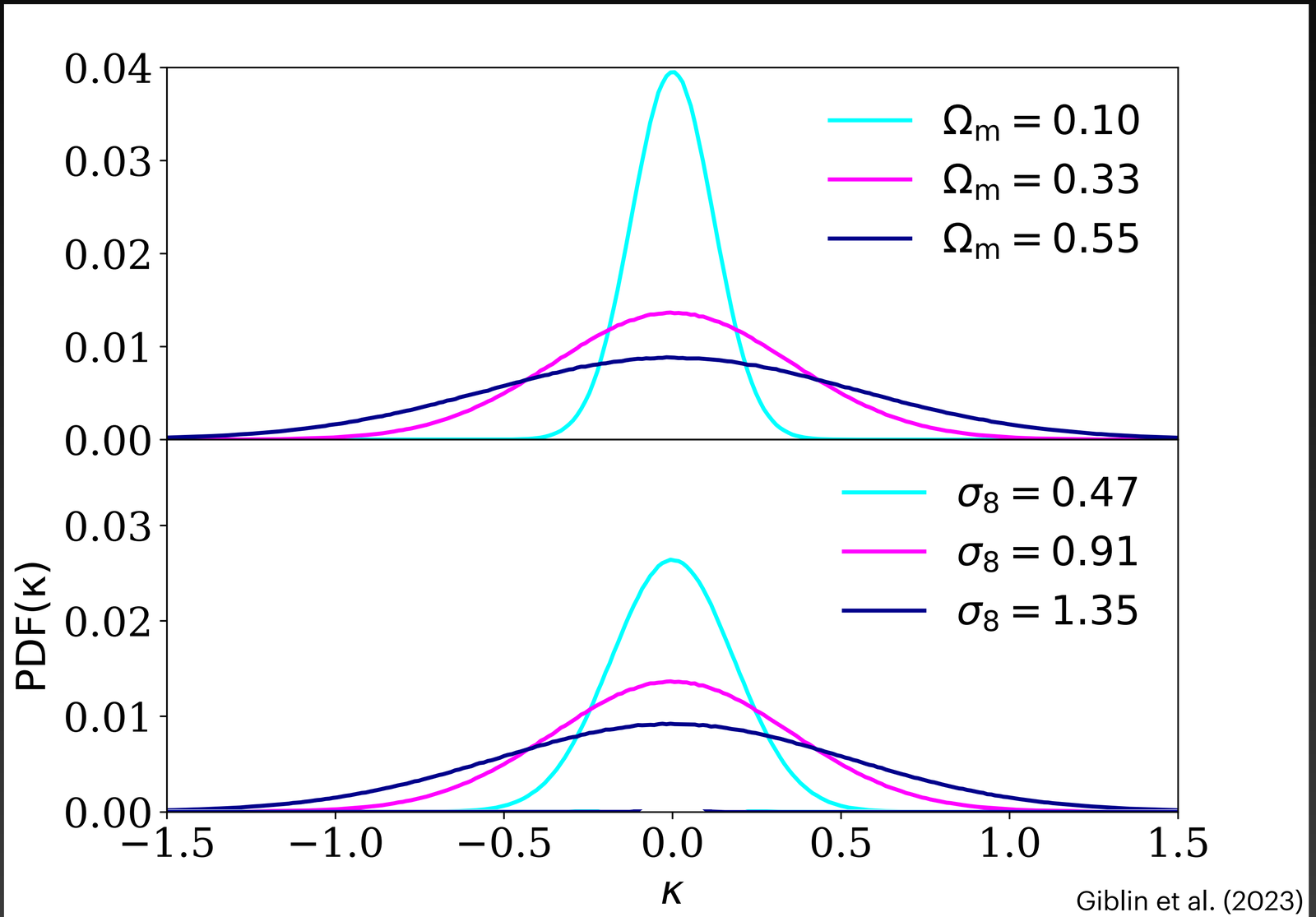






Beyond two-point statistics:

"The lensing PDF"

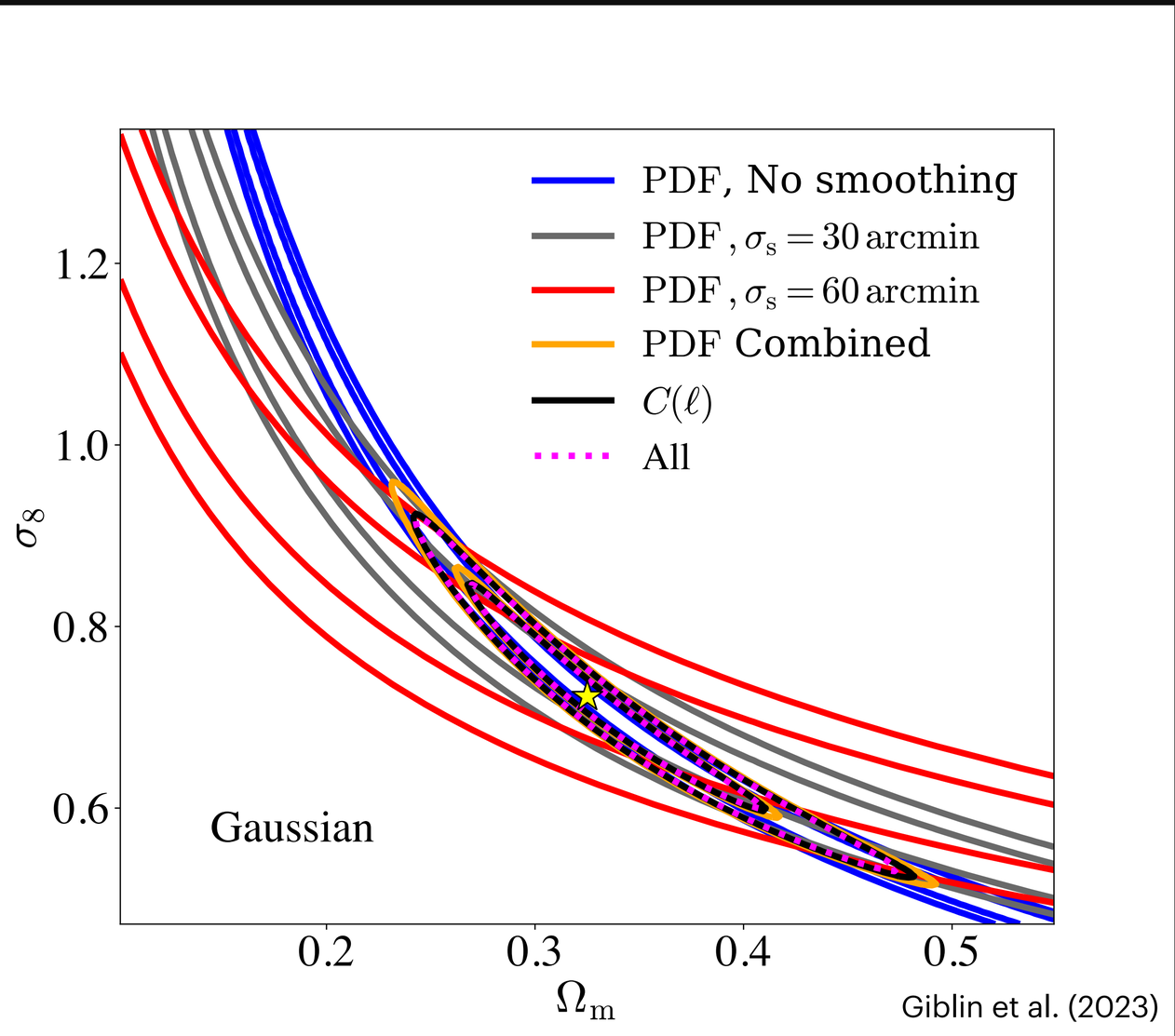


Giblin et al. (2023)

PDF vs 2pt Stats

The sanity test: a Gaussian field

- C(ell) and PDF(κ) predictions from healpy.
- Combined PDF constraints converge to C(ell) constraints.

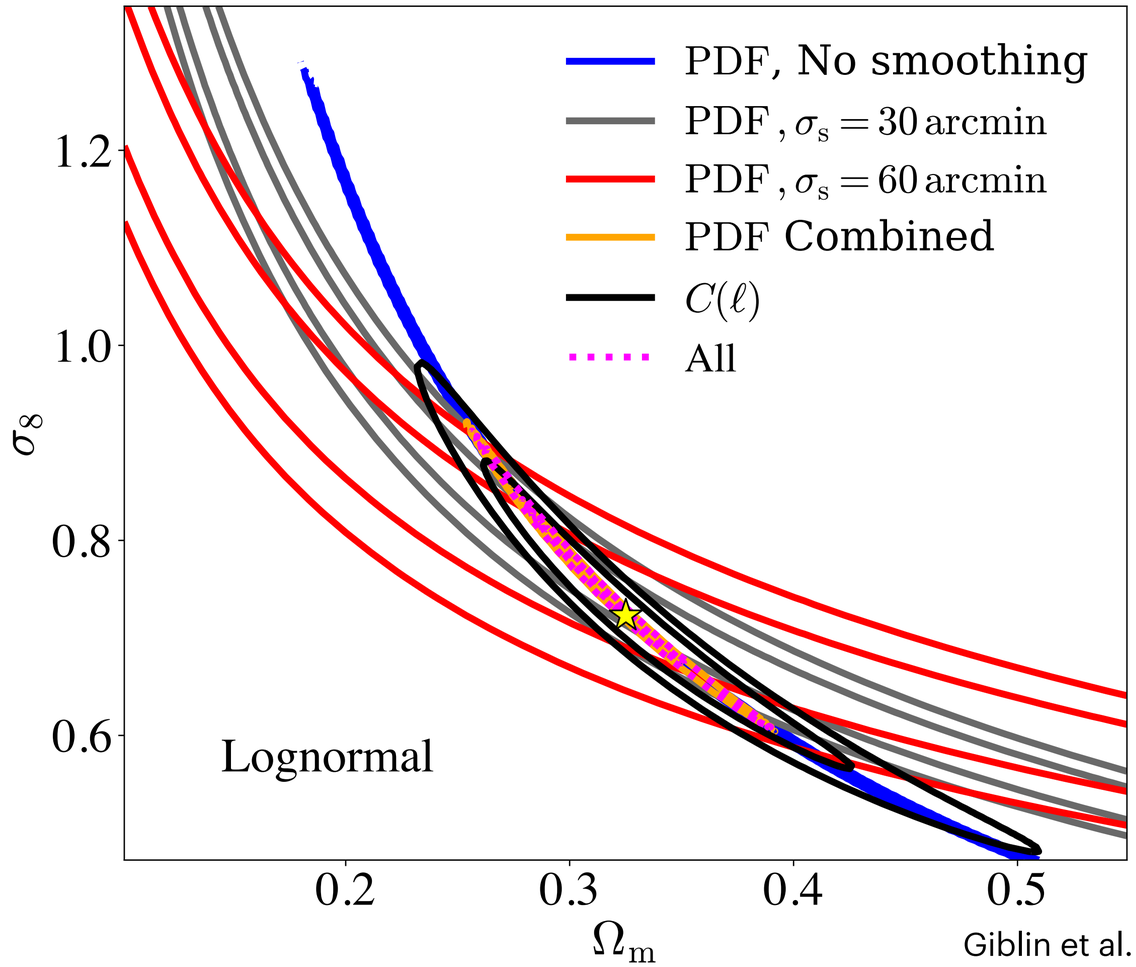


Giblin et al. (2023)

PDF vs 2pt Stats

The test case: a lognormal field

- C(ell) and PDF(κ) predictions from FLASK.
- Combined PDF constraints offer significant improvement on the C(ell)



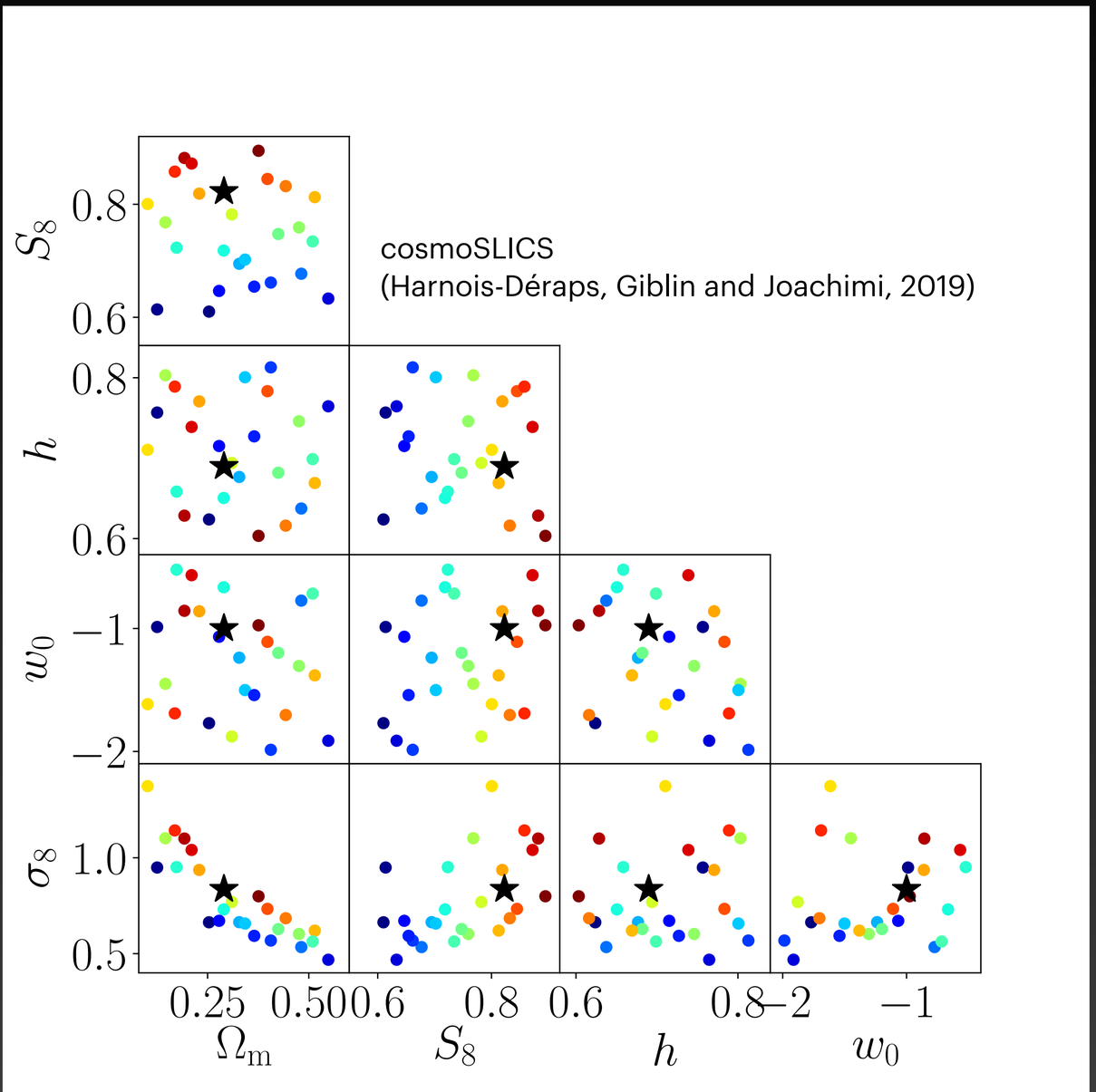
Giblin et al. (2023)

Moving towards real cosmological fields:
how do we model the cosmological dependence?

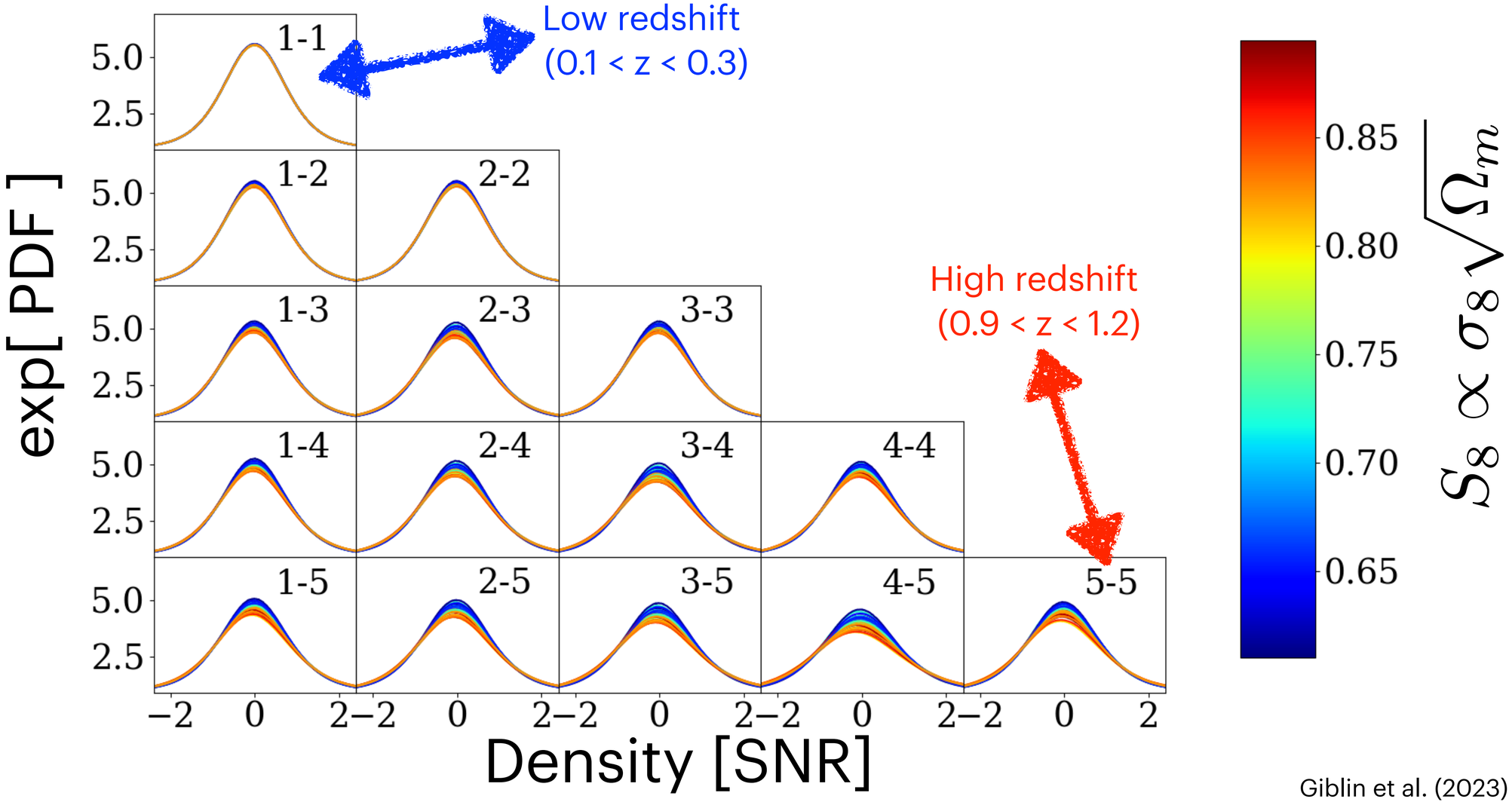
$$\mathcal{L}(\boldsymbol{d}|\boldsymbol{\pi}) \propto \exp\left(-\frac{1}{2}\left[\boldsymbol{d}-\boldsymbol{m}(\boldsymbol{\pi})\right]^{\intercal}\boldsymbol{\Sigma}^{-1}\left[\boldsymbol{d}-\boldsymbol{m}(\boldsymbol{\pi})\right]\right)$$

Require a model for
our statistics as a function of
cosmological parameters $\boldsymbol{\pi}$

....with numerical simulations!

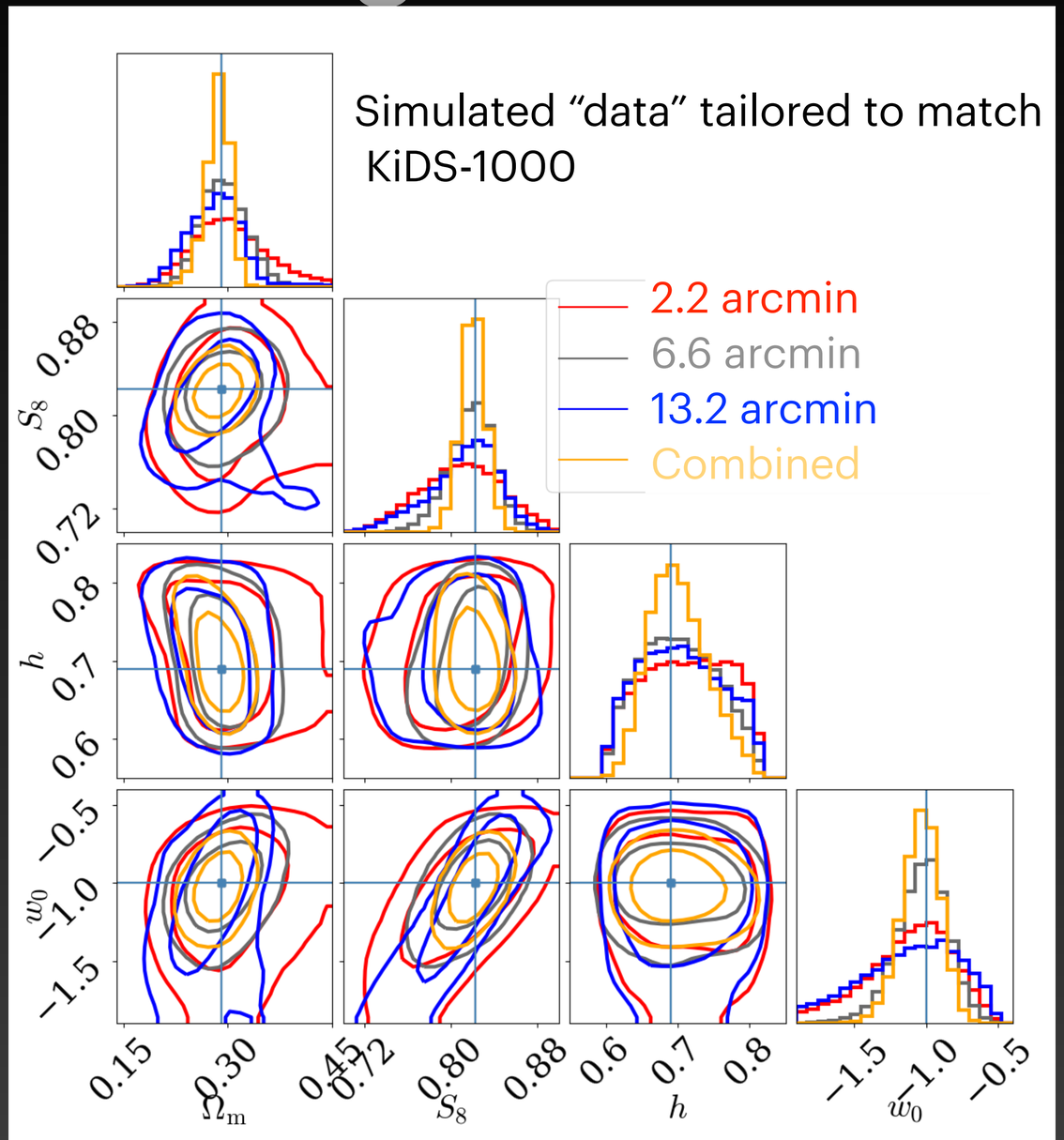


....with numerical simulations!



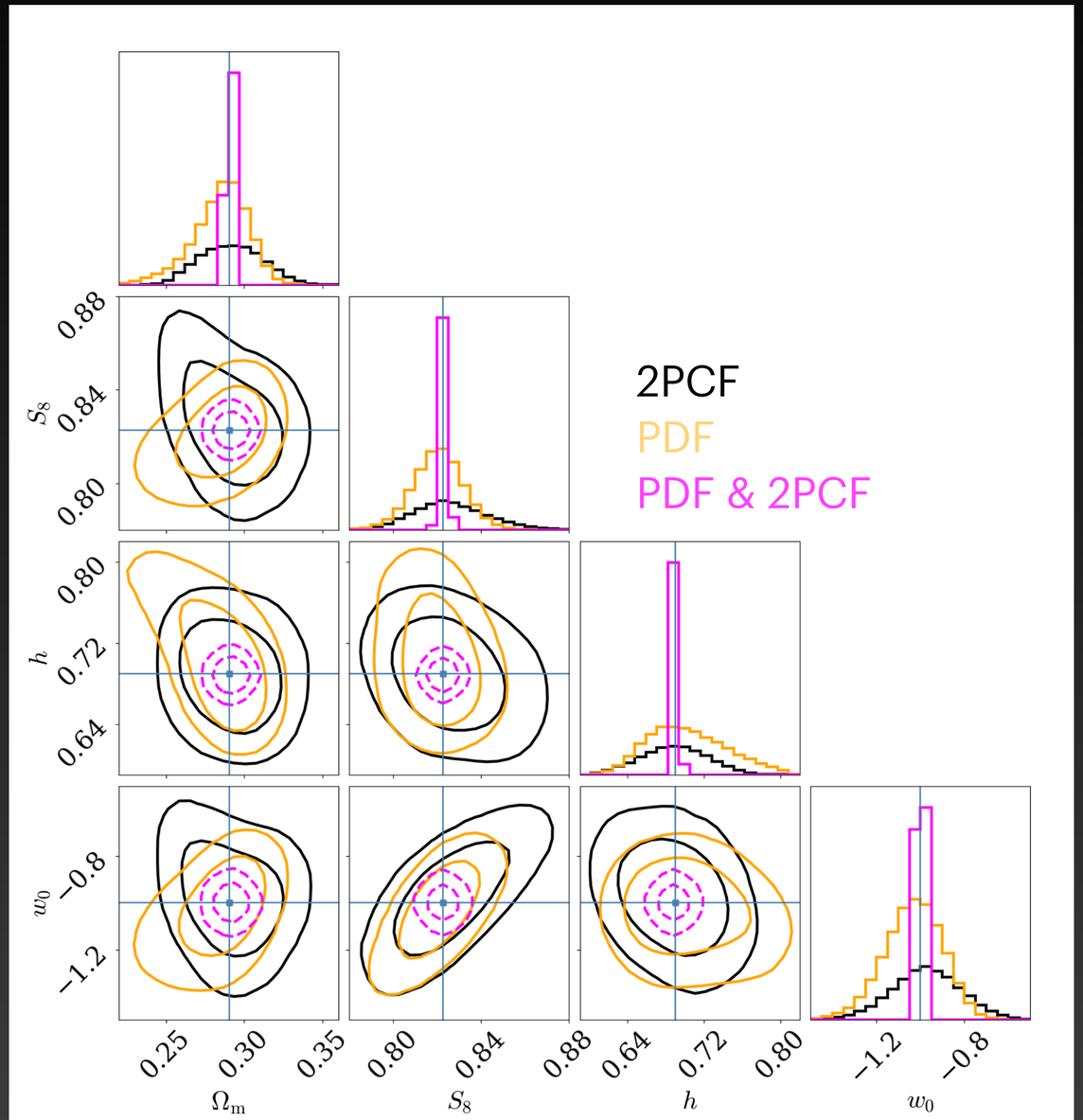
Giblin et al. (2023)

Cosmological constraints



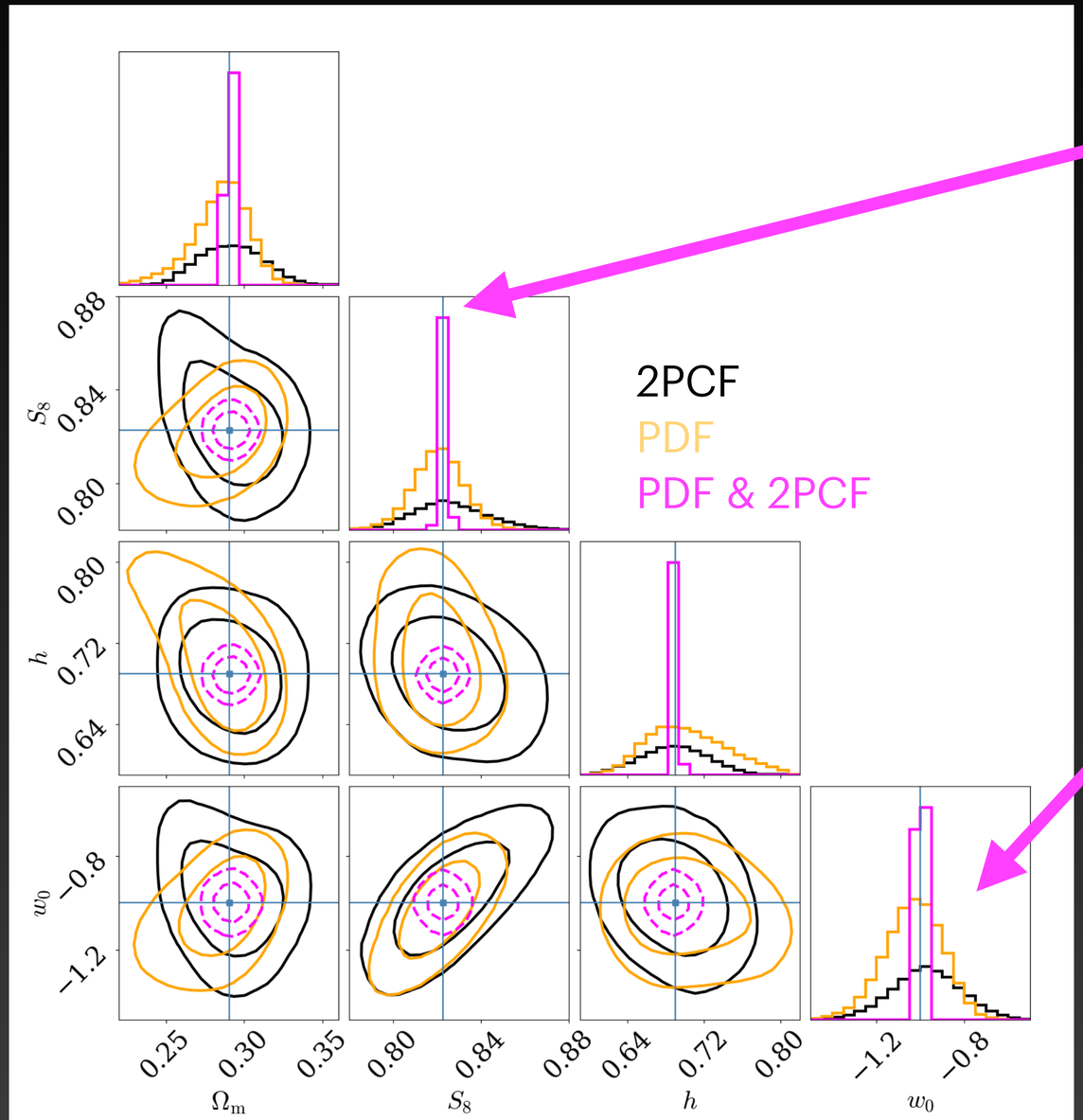
Giblin et al. (in 2023)

Cosmological constraints



Giblin et al. (in 2023)

Cosmological constraints

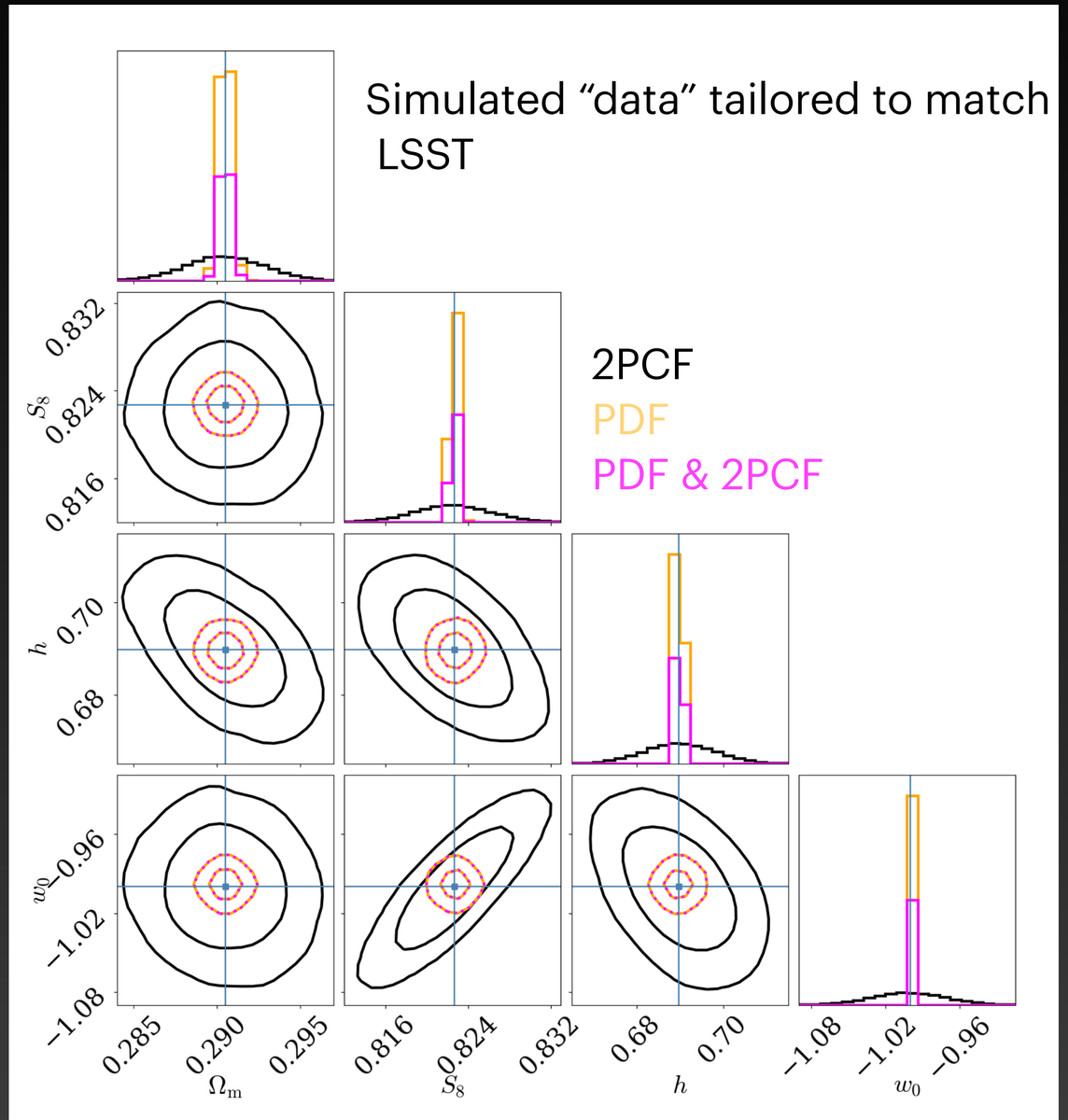


~50% improvement on S_8 constraint

~45% improvement for w_0

Giblin et al. (in 2023)

Cosmological constraints



The combined-scale PDF captures **all** of the information in the 2PCF **and more**.

~86%-98% gains in precision

Giblin et al. (in 2023)

Summary

- There’s information beyond 2nd order in our data!
- The lensing PDF is one way to get at it, by measuring the non-Gaussianity of the field directly.
- Measuring the lensing PDF on different scales is the key to optimising constraining power.
- For a Stage-III WL surveys, improvements over 2PCFs of ~30-50%.
- The future is bright! With LSST this approach really starts to shine.