Sterrewacht Leiden

A direct measurement of tomographic lensing power spectra from CFHTLenS

(in press at MNRAS; arXiv1509.04071)

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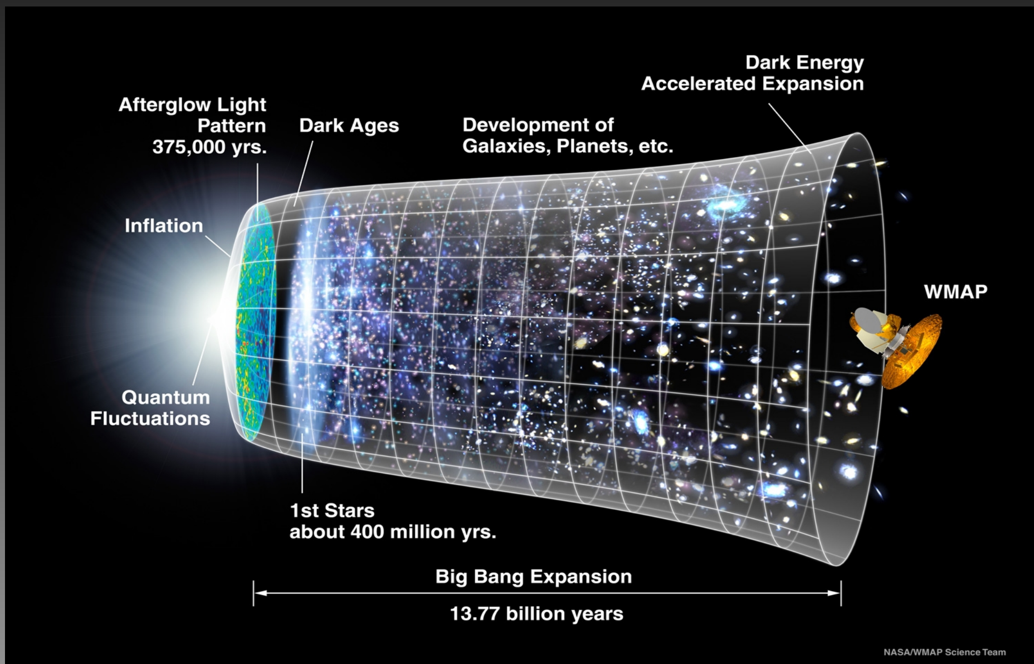
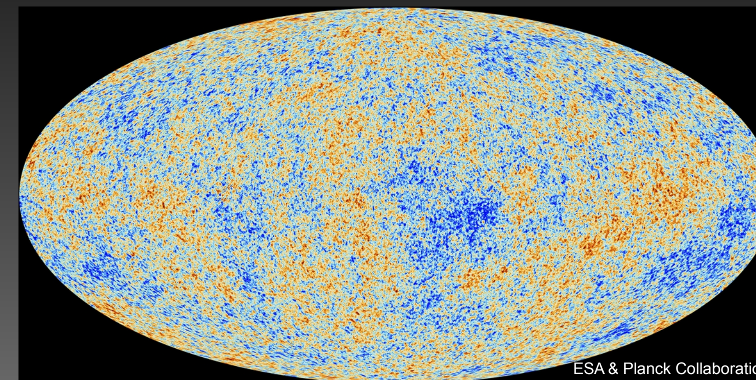
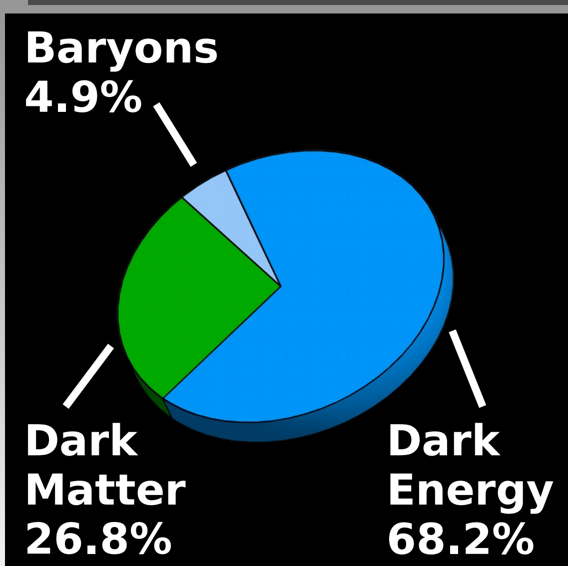
I. Introduction

Cosmological model







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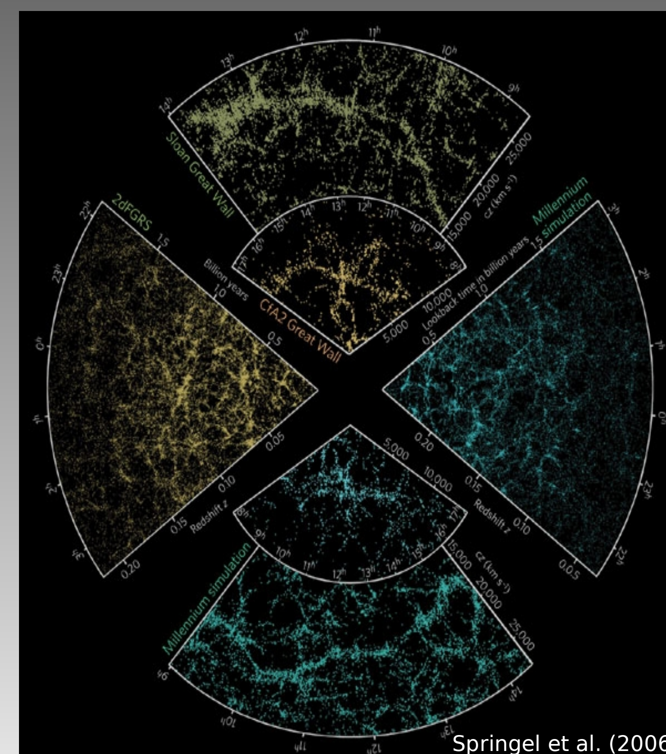
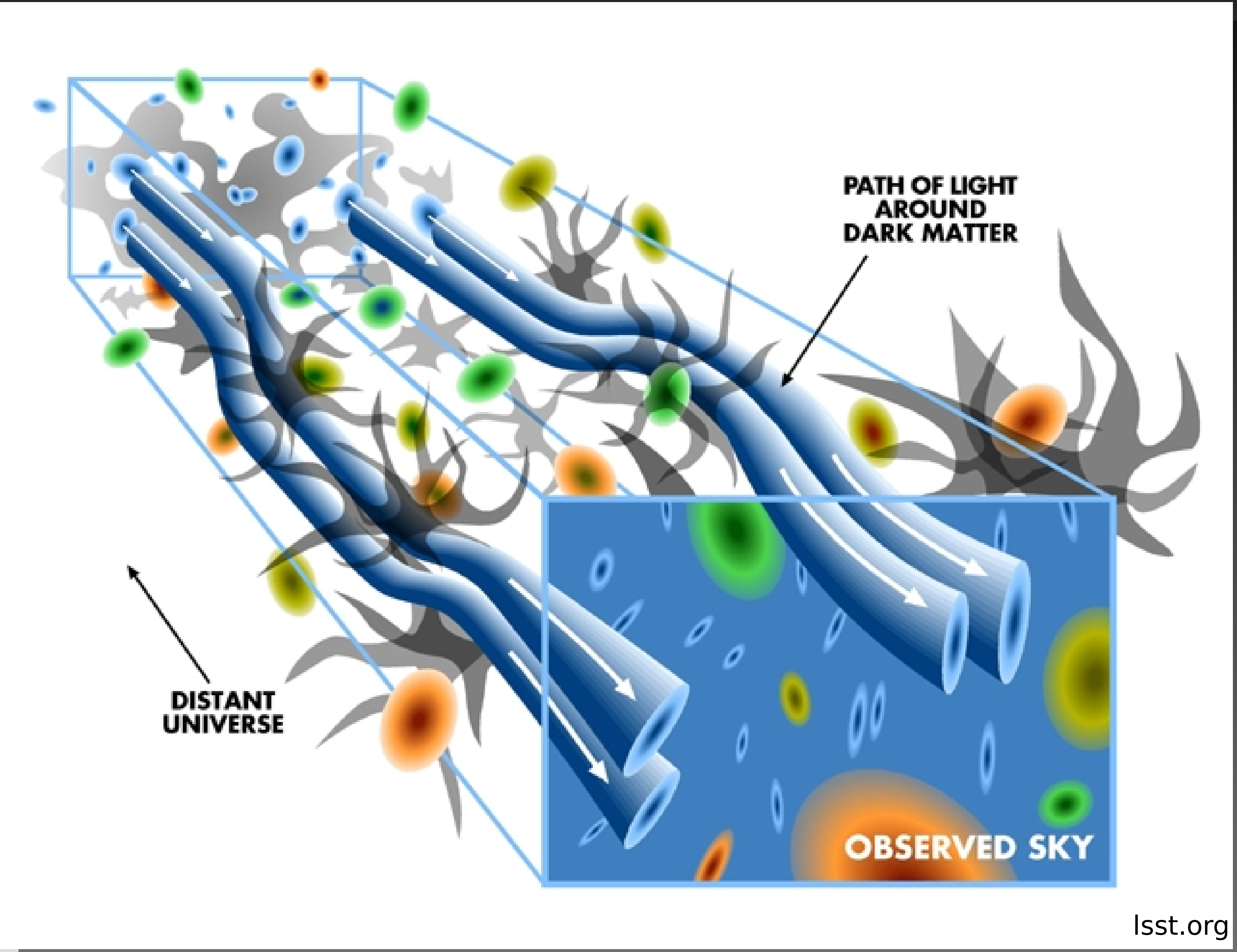


Lensing statistic:



shear-shear
(a.k.a. cosmic shear)

Weak lensing: Future

10^2 deg^2	CFHTLenS	17 gals/arcmin^2	$z_m = 0.75$	completed
	RCSLenS	6 gals/arcmin^2	$z_m = 0.60$	
10^3 deg^2	KiDS	9 gals/arcmin^2	$z_m = 0.70$	ongoing
	HSC	20 gals/arcmin^2	$z_m = 1.00$	
	DES	8 gals/arcmin^2	$z_m = 0.65$	
10^4 deg^2	Euclid	30 gals/arcmin^2	$z_m = 0.90$	> 2020
	LSST	31 gals/arcmin^2	$Z_m = 1.00$	

Weak Lensing: Challenges

1) Accurate photometric redshifts

2) Shape noise:

Bridle et al. (2009)

“The bigger (deeper) the survey the smaller the uncertainties!”

3) Blending (!)

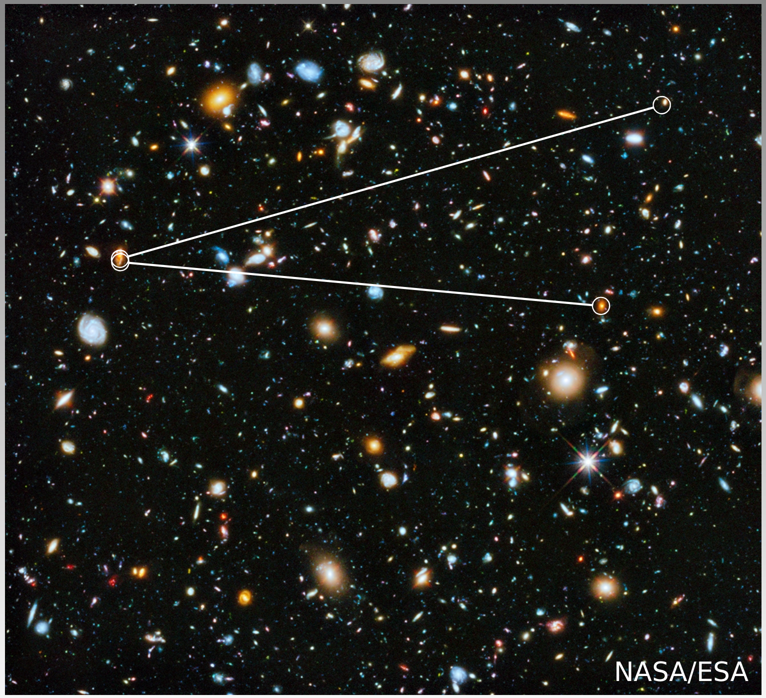
II. Cosmic Shear

Lensing of LSS:

Theory:

$$C^{\mathrm{EE}}_{\mu\nu}(\ell) = \frac{9\Omega_{\mathrm{m}}^2 H_0^4}{4c^4} \int_0^{\chi_{\mathrm{H}}} \mathrm{d}\chi \, \frac{g_\mu(\chi) g_\nu(\chi)}{a^2(\chi)} P_\delta\left(k = \frac{\ell}{f_{\mathrm{K}}(\chi)}; \chi\right)$$

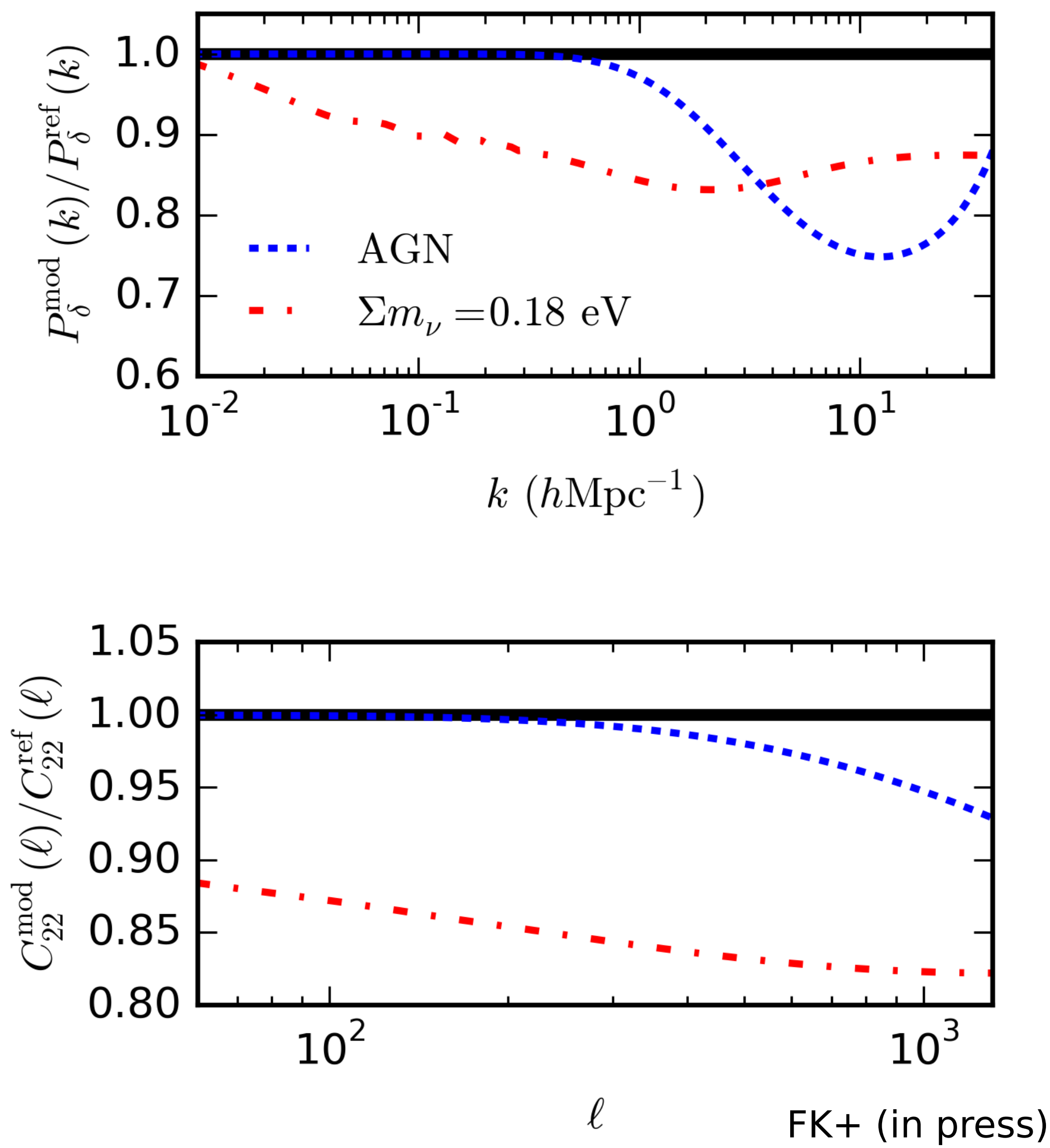
"geometry" "physics"



measurements:

correlation functions $\Longleftrightarrow$ **power spectra**

Baryons & neutrinos:

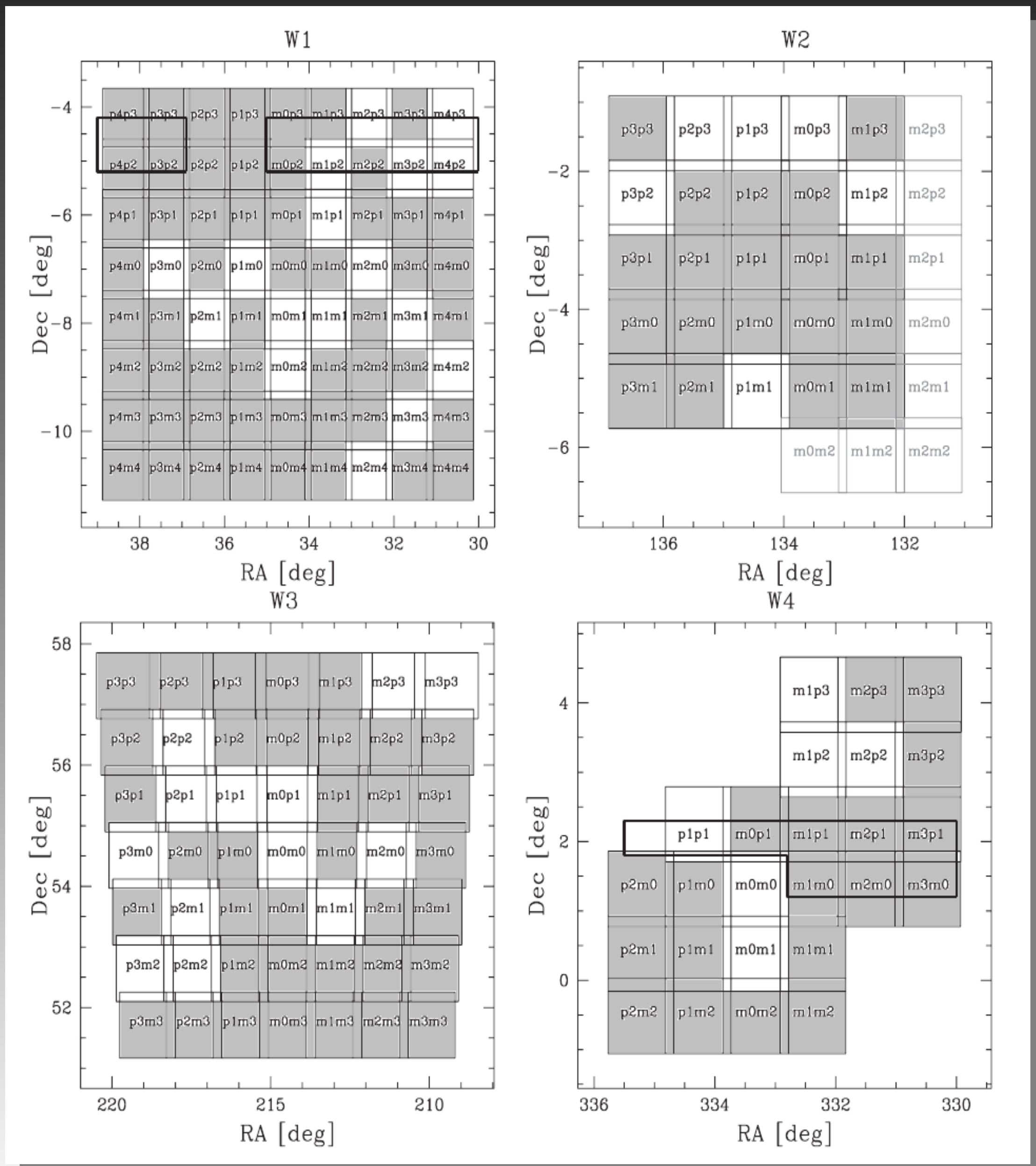


FK+ (in press)

integration over lensing kernel

- AGN feedback from OWLS after Harnois-Déraps et al. (2015)
- 3 degenerate, massive neutrinos with Σm_ν = 0.18 eV

The CFHTLenS case:



Erben et al. (2012)

~154 deg² (~115 deg²)

n_{gal} = 17 gals/arcmin²

two redshift slices:

z_1: $0.50 < z \leq 0.85$
z_2: $0.85 < z \leq 1.30$

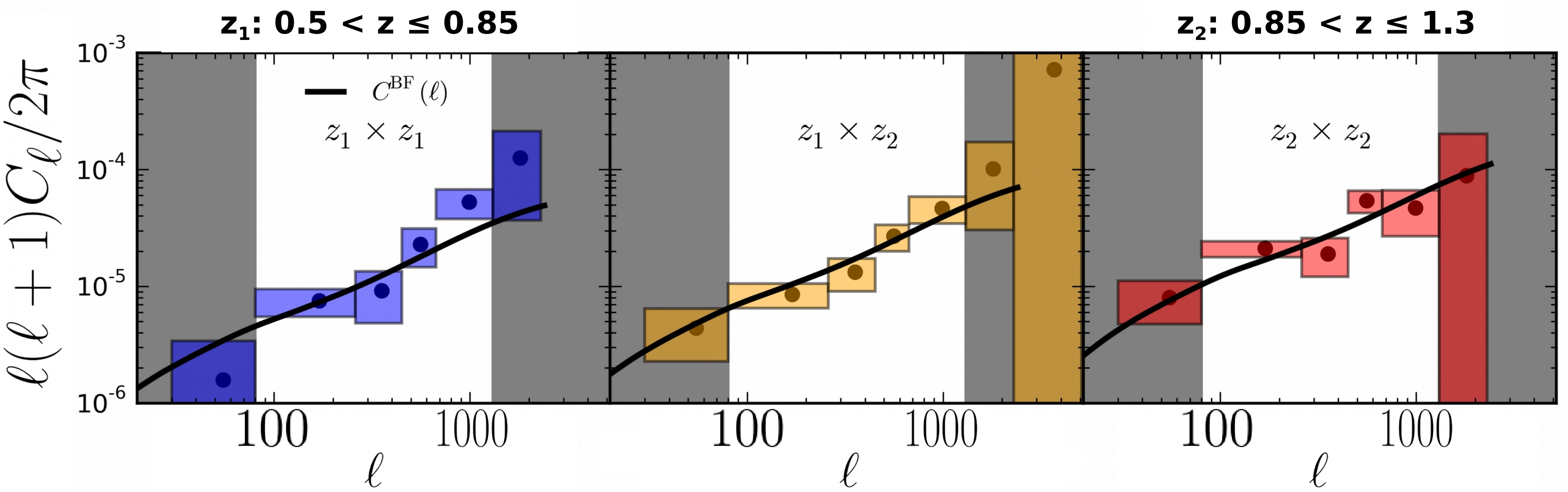
minimize intrinsic alignments

!!! PUBLIC data !!!

Results: Multipole Space

quadratic estimator method (Hu & White 2001)
expanded to include photometric redshift bins

WL power spectra from CFHTLenS
(W1, W2, W3 & W4 combined with inverse variance weights)



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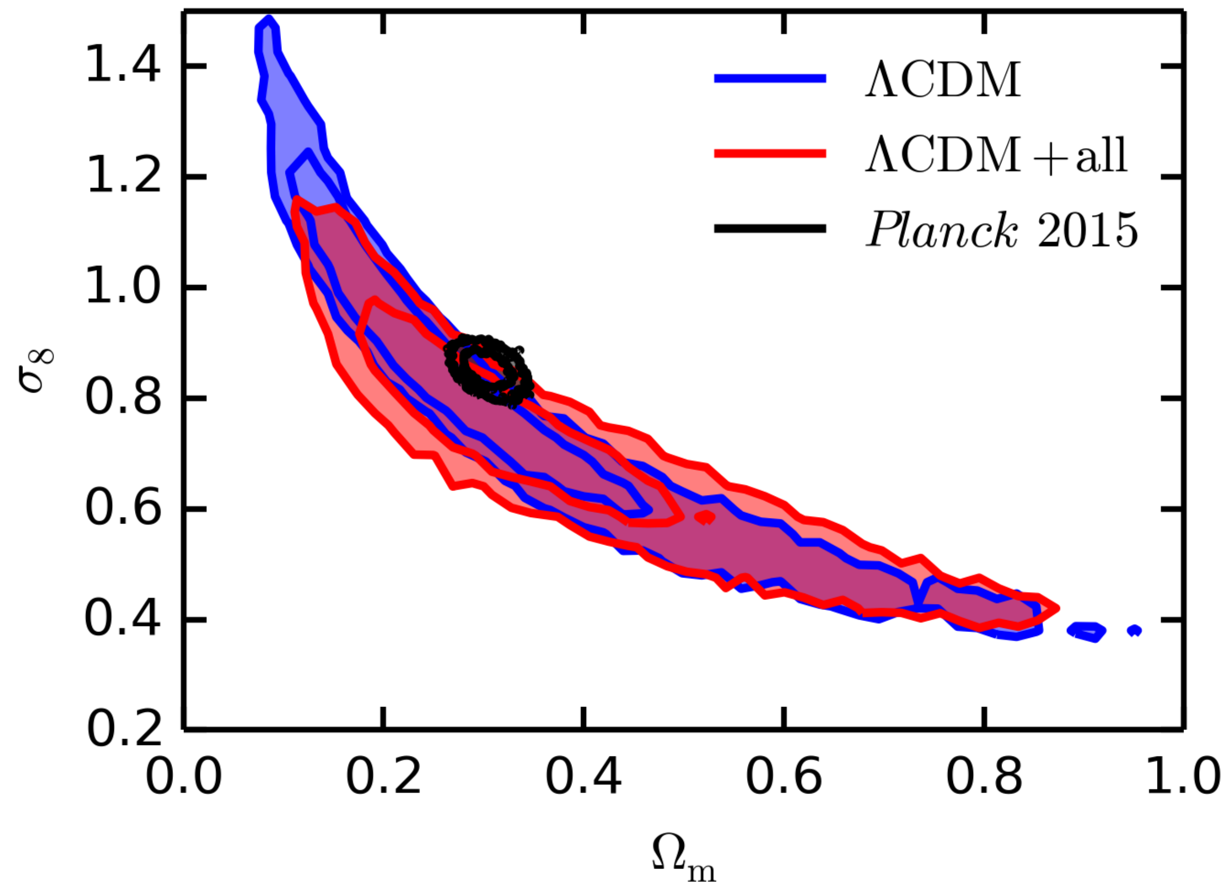
Cosmological inference:



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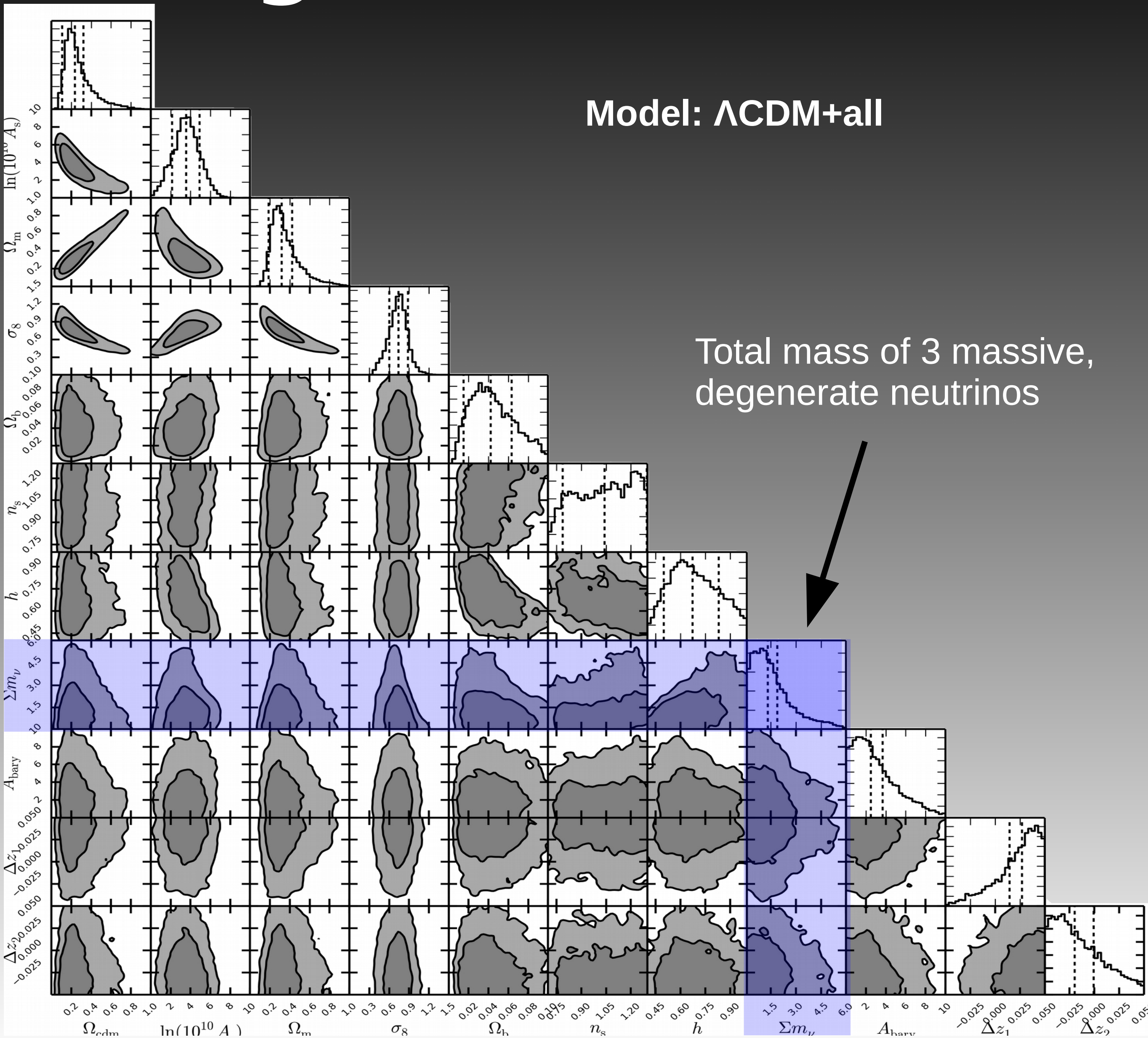
Cosmological inference:



Model: ΛCDM+all

Total mass of 3 massive, degenerate neutrinos

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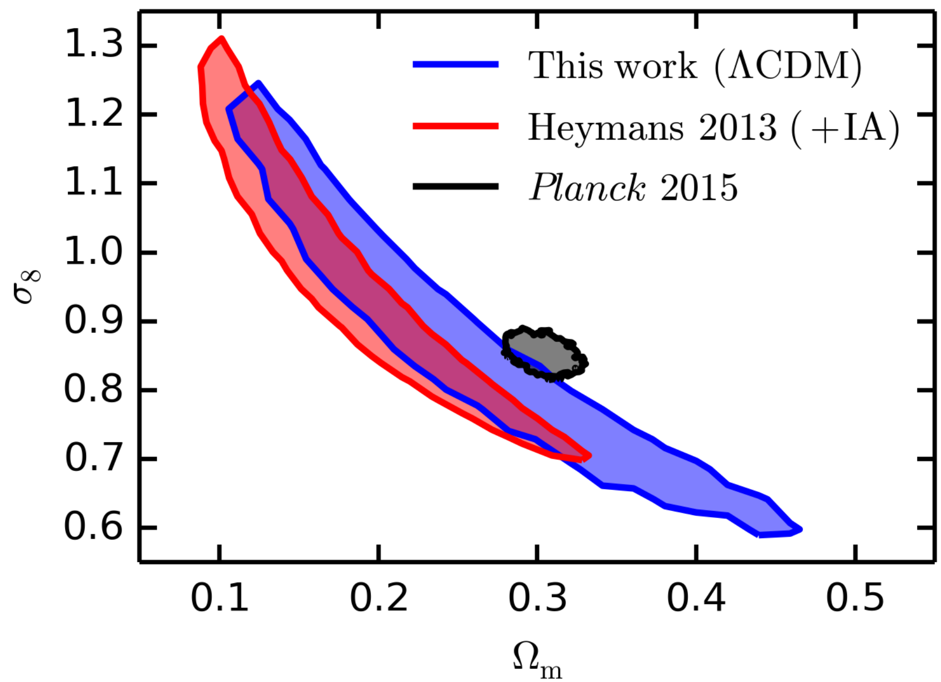
Cosmological inference:



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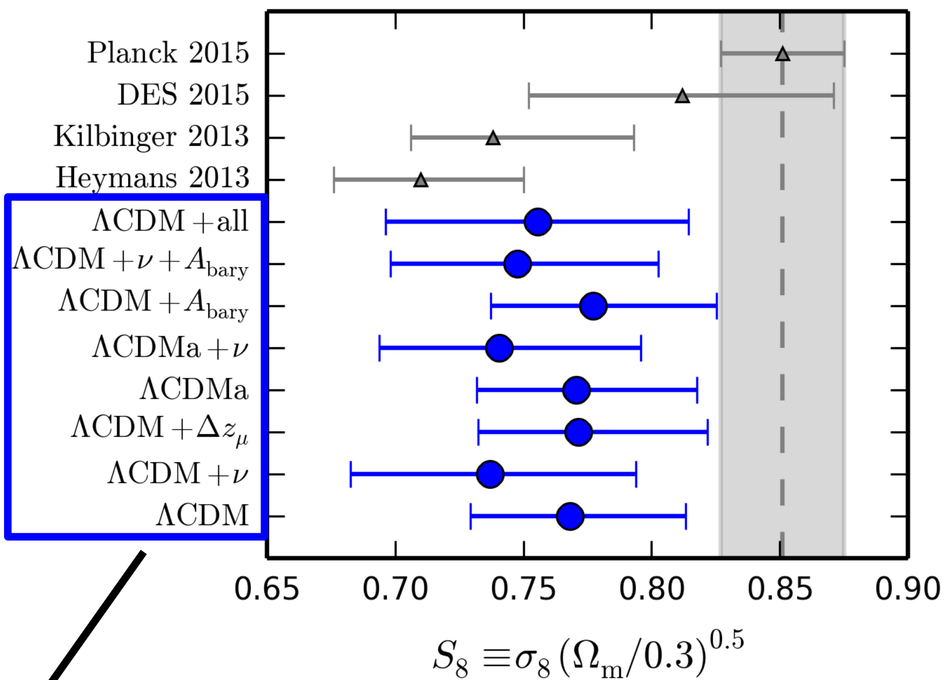

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Which model describes the data the best?

Evidences:

likelihood analysis performed with *Monte Python* (Audren et al. 2012) and *Multinest* (Feroz et al. 2008, 2009, 2013)

Evidences:

Model	$\ln \mathcal{Z}$	$2 \ln K$ ($K \equiv \mathcal{Z}_i / \mathcal{Z}_{\Lambda\mathrm{CDM}}$)
ΛCDM	-40.96 ± 0.06	0
ΛCDMa	-41.07 ± 0.06	-0.22
$\Lambda\mathrm{CDM} + \nu$	-41.63 ± 0.07	-1.34
$\Lambda\mathrm{CDMa} + \nu$	-41.83 ± 0.07	-1.74
$\Lambda\mathrm{CDM} + A_{\mathrm{bary}}$	-41.66 ± 0.06	-1.40
$\Lambda\mathrm{CDM} + \nu + A_{\mathrm{bary}}$	-42.48 ± 0.07	-3.04
$\Lambda\mathrm{CDM} + \Delta z_{\mu}$	-40.75 ± 0.07	0.42
$\Lambda\mathrm{CDM}$ + all	-42.19 ± 0.07	-2.46

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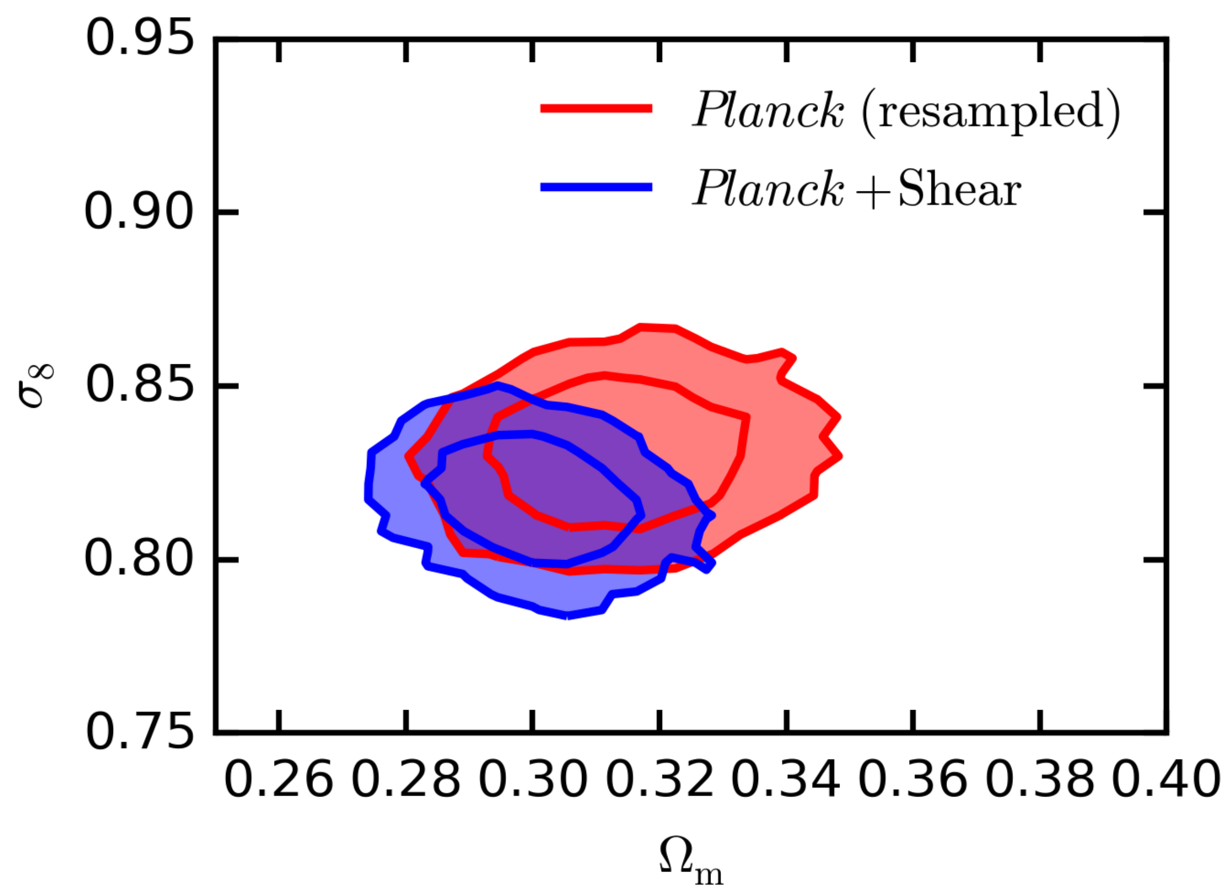
Cosmological inference:



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↳ Degeneracy broken: $\mathbf{\Omega_m}$ = 0.300 +/- 0.011, $\boldsymbol{\sigma_8}$ = 0.818 +/- 0.013

III. Conclusions

A direct extraction of the lensing power spectrum is a “cleaner” way to compare data with theory.

The power spectrum results show overall consistency with previous results based on correlation-functions.

Ongoing and future lensing surveys have the potential to constrain distinct features in multipole space such as left by massive neutrinos or baryon feedback with high precision.