Cross-correlation triangulation

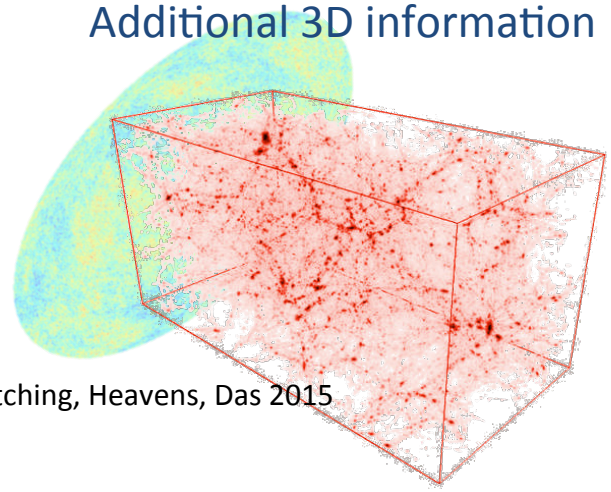
CMB Lensing, Galaxy Shapes and Galaxy Counts

Mathew Madhavacheril

with Anze and Neelima

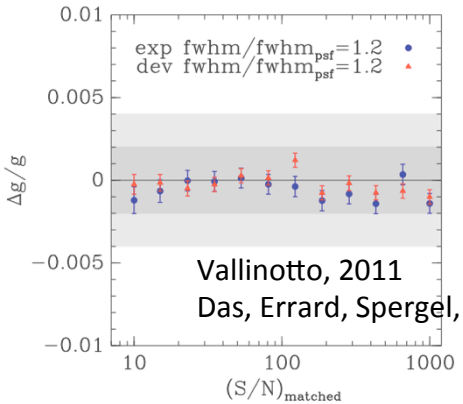
What you gain from tying in the CMB

Additional 3D information



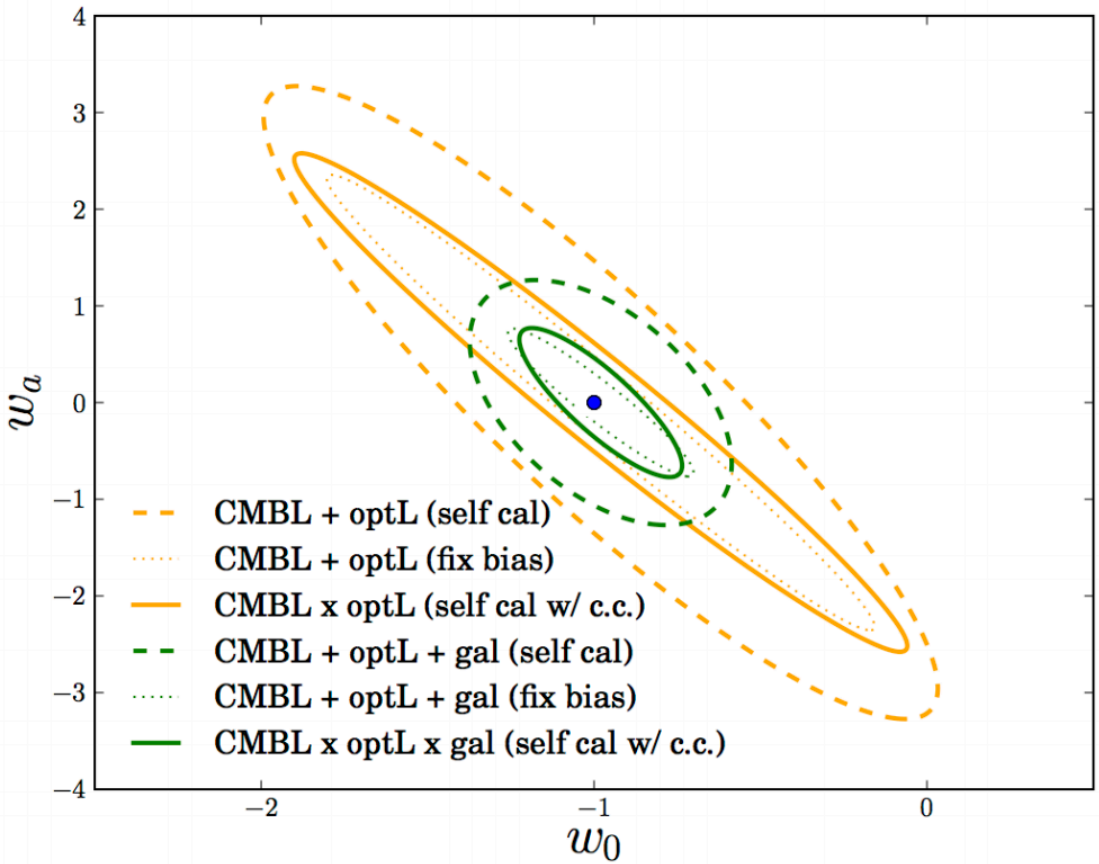
Kitching, Heavens, Das 2015

Shear calibration



Vallinotto, 2011
Das, Errard, Spergel, 2013

Motivation



Das, Errard, Spergel 2014

Ratios with spectroscopic foreground tracer

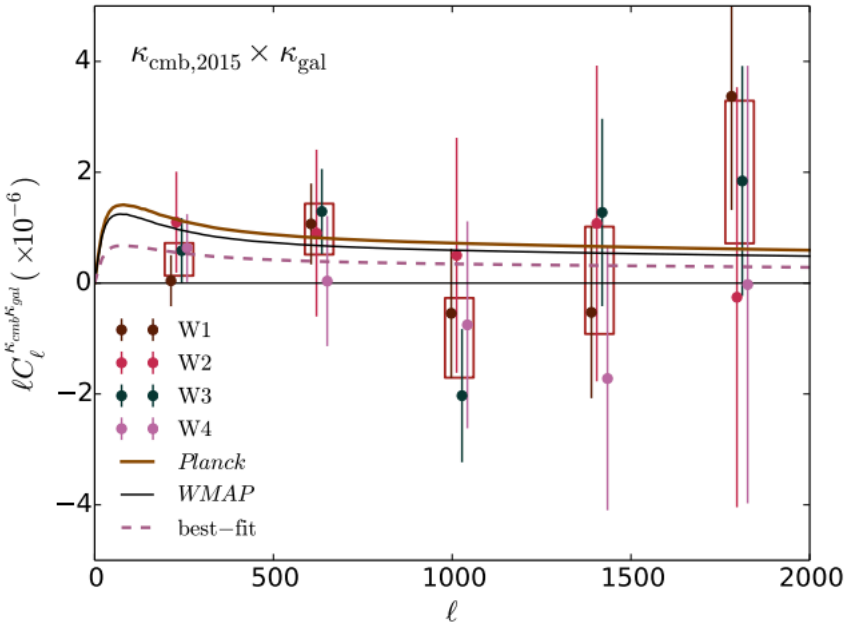
$$\frac{C_\ell^{\kappa_{\rm opt}\Sigma}}{C_\ell^{\kappa_{\rm CMB}\Sigma}} = m \frac{g_{\rm opt}(\eta)}{g_{\rm CMB}(\eta)}$$

Das, Errard, Spergel 2014

- Delta-function redshift slice
- Galaxy bias (mostly) drops out
- Growth (mostly) drops out
- Geometric ratio + multiplicative shear bias

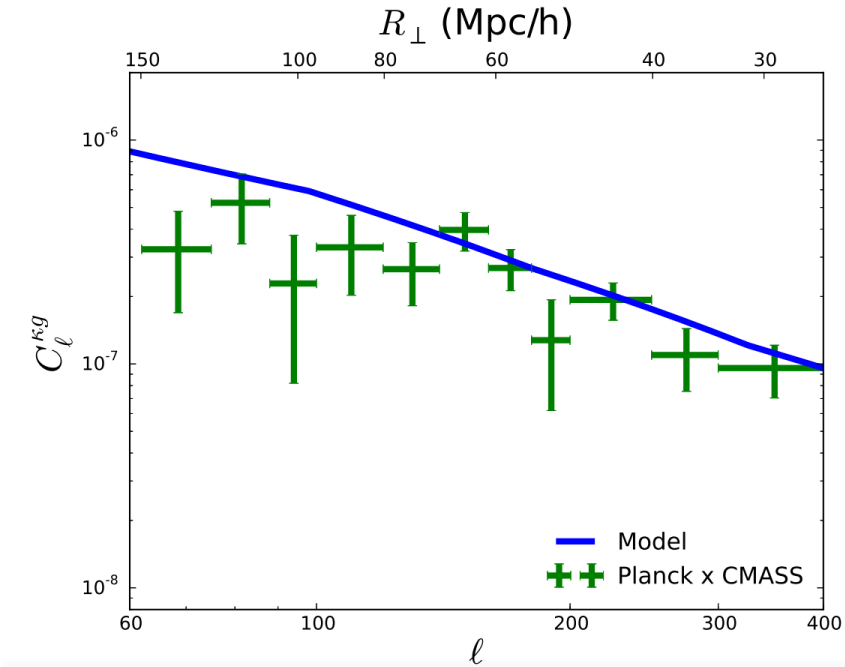
Motivation

Liu, Hill 2015 Planck x CFHTLens



~2 sigma tension with LCDM

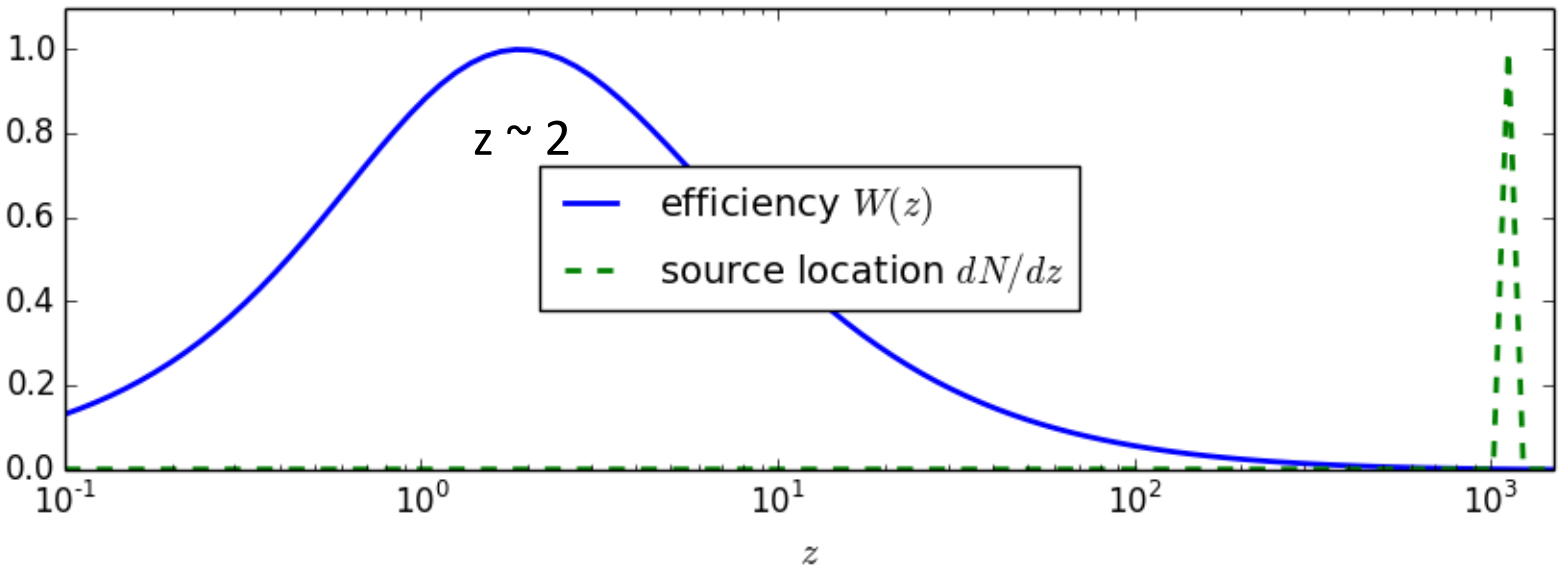
Pullen et. al. 2015 Planck x CMASS



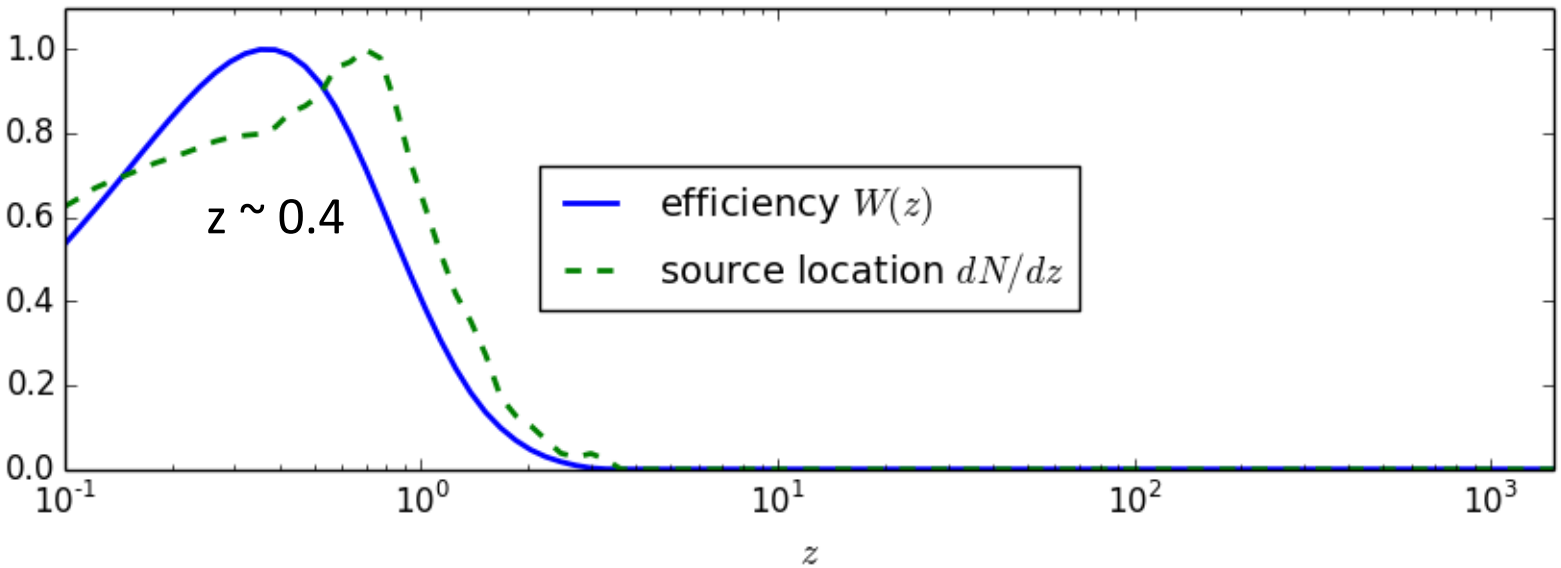
~2.6 sigma tension with LCDM

Preliminary work with Planck + BOSS + CFHTLens

CMB Lensing

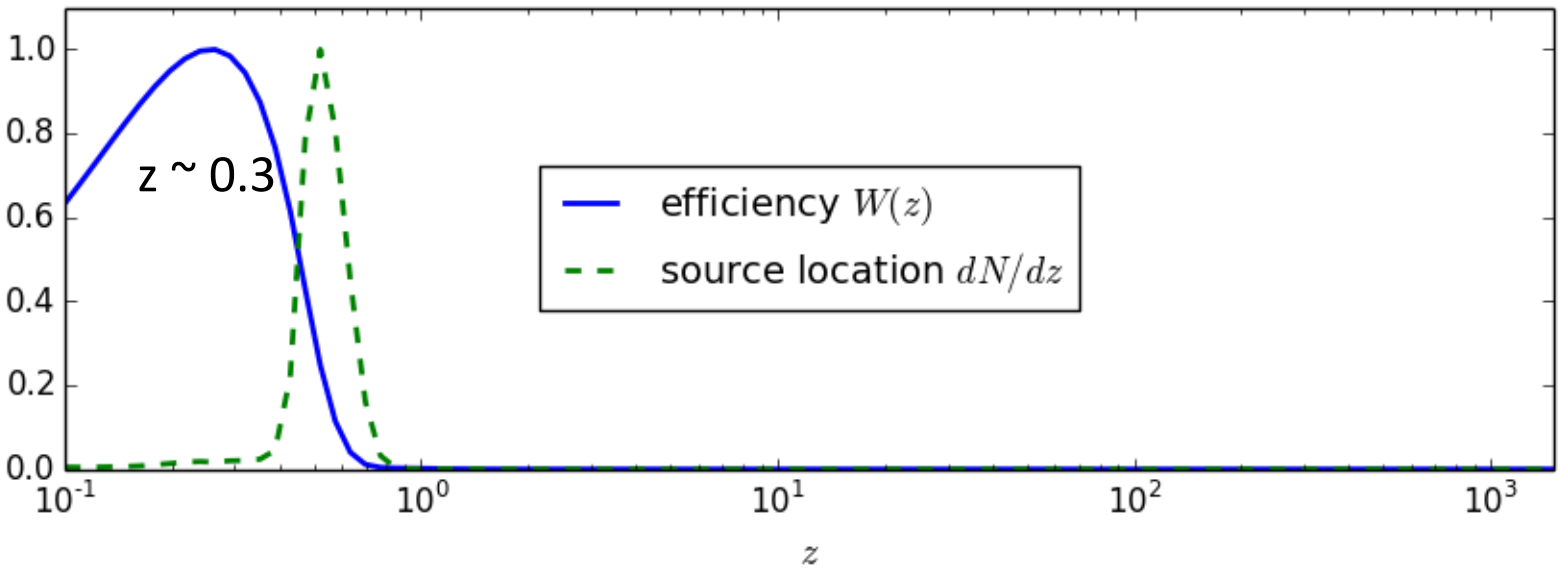

1.0
0.8
0.6
0.4
0.2
0.0
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
z
z ~ 2
efficiency $W(z)$
source location dN/dz

CFHTLens



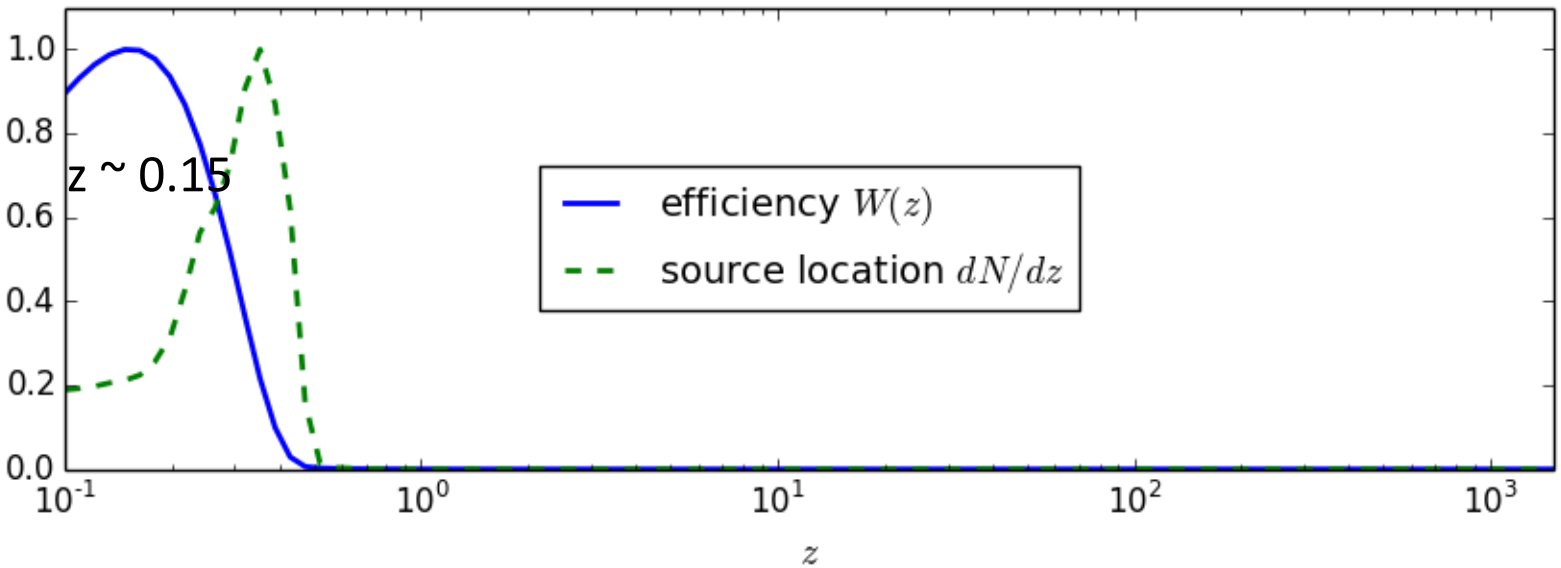
Parameters Introduced: m(z)

CMASS (High-z BOSS sample)



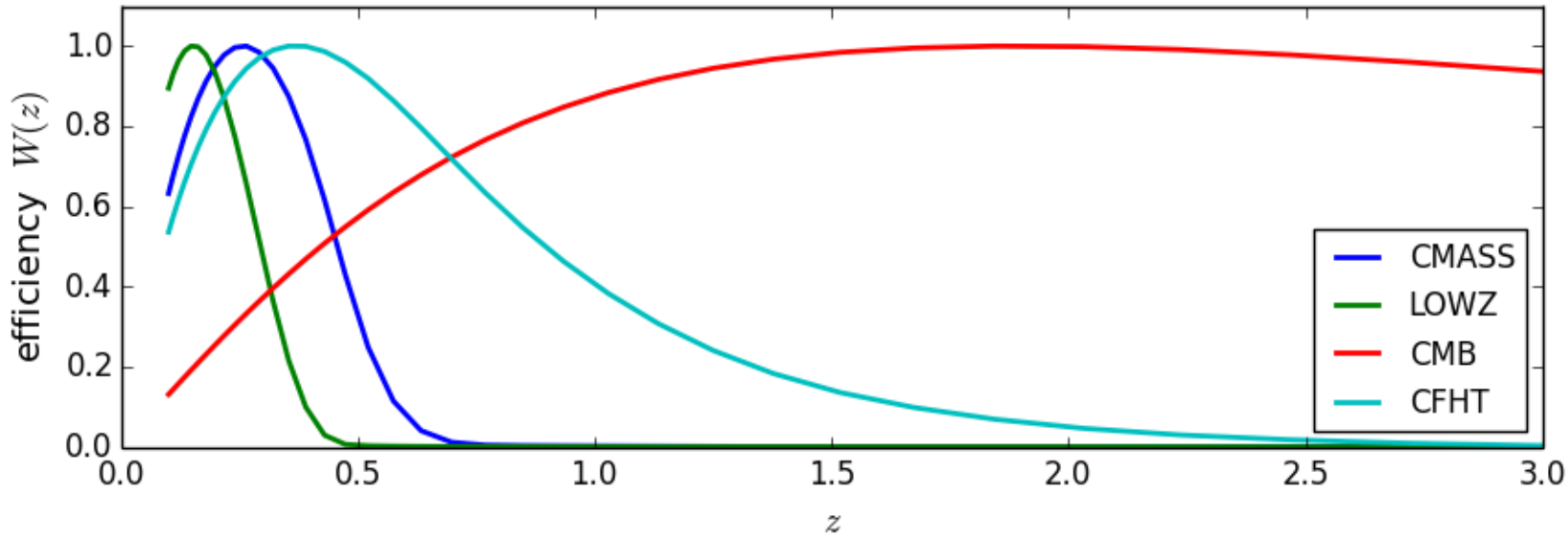
Parameters Introduced: b(k,z)

LOWZ (Low-z BOSS sample)



Parameters Introduced: b(k,z)

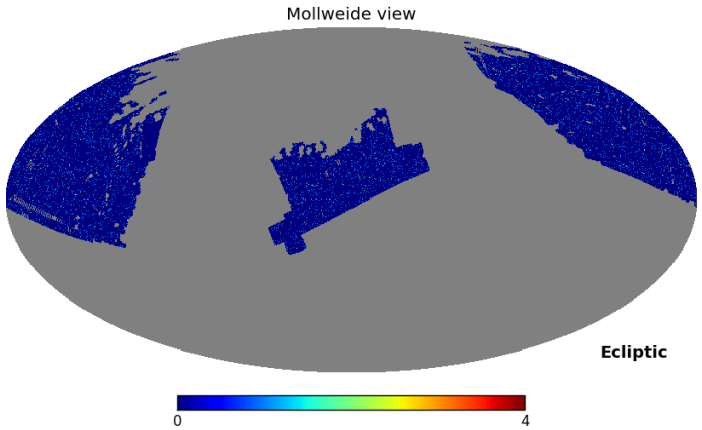
Overlapping z-ranges

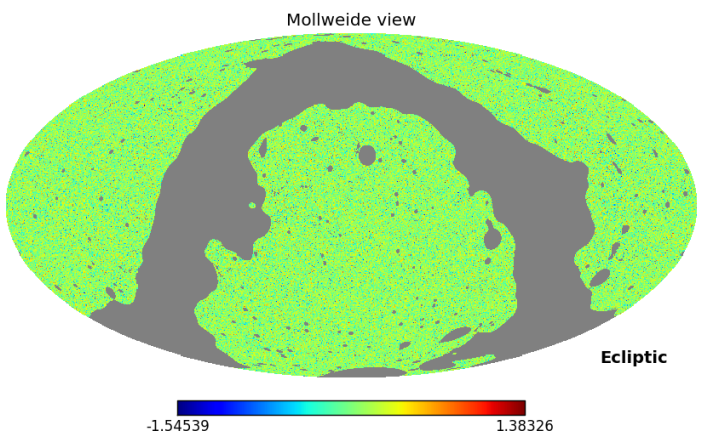


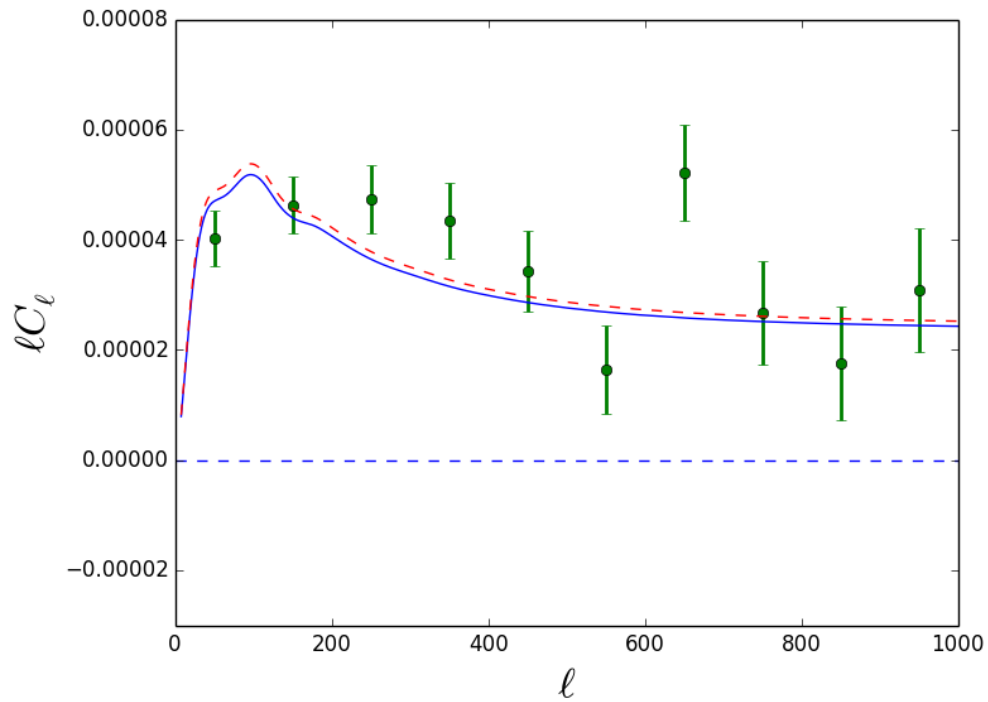
Analysis

- Shear catalog -> mass map $\kappa_{\mathbf{l}} = e^{2i\phi_{\mathbf{l}}}(\gamma_{\mathbf{l}}^1 + \gamma_{\mathbf{l}}^2)$
- Galaxy catalog + randoms -> (healpix) density map
- wget Planck lensing map
- Mask corrections
- Covariance matrices
  - Galaxy mocks
  - Planck lensing mocks

Planck x CMASS

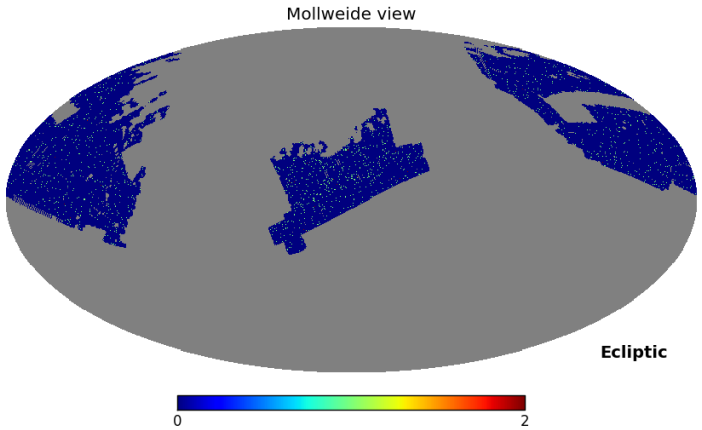


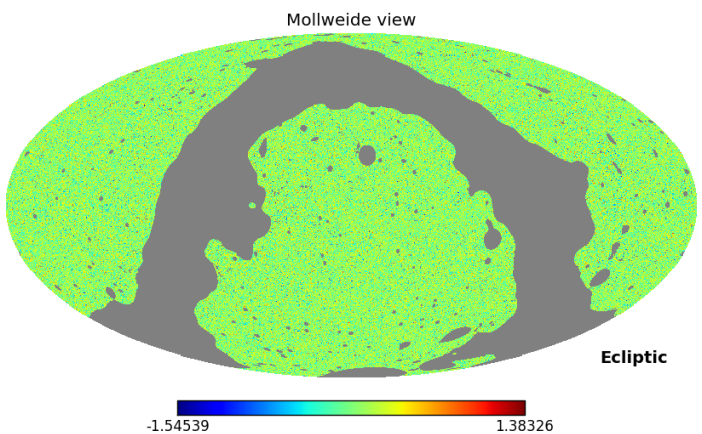


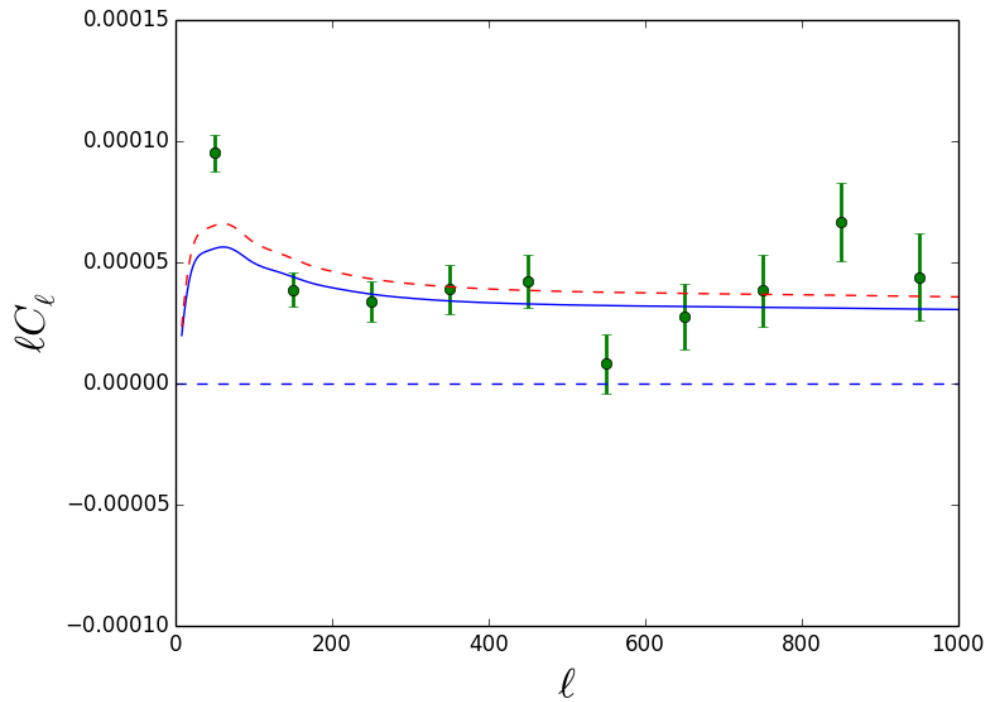


~ 18 sigma

Planck x LOWZ

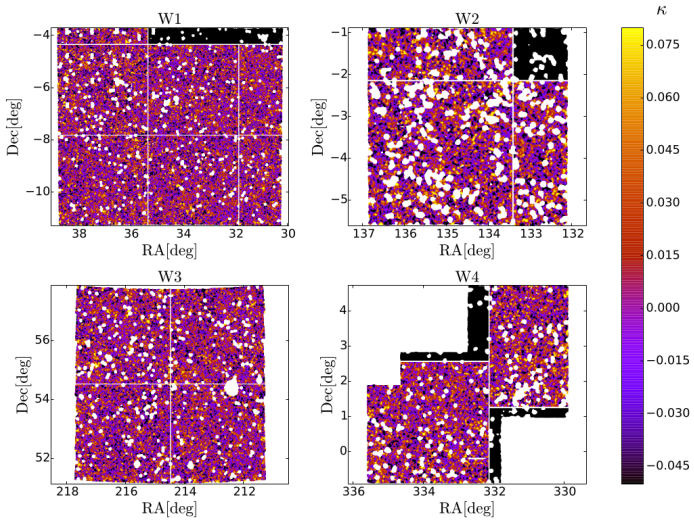


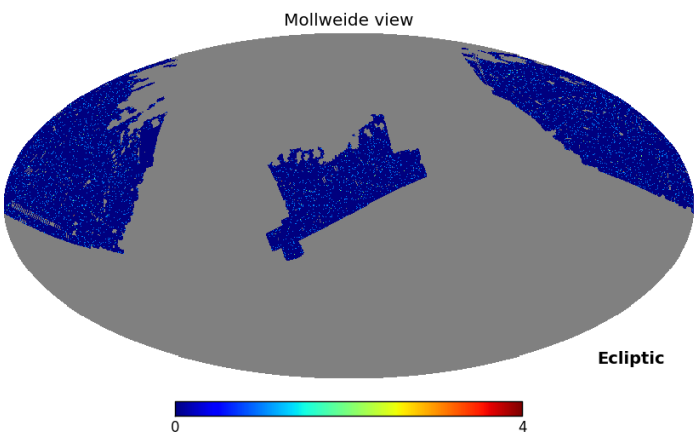


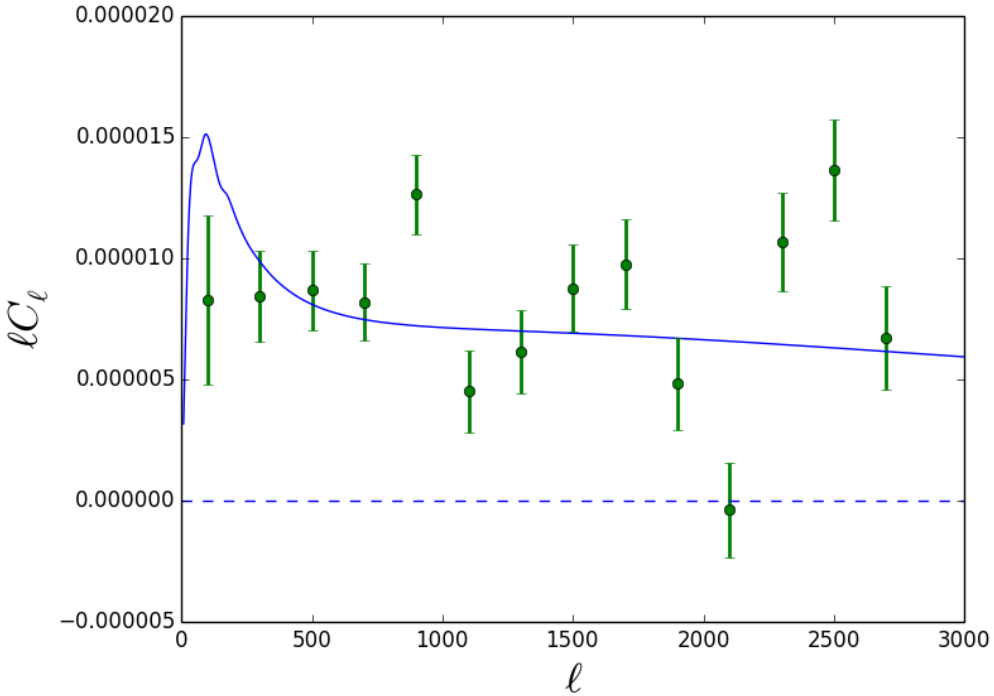


~ 16 sigma

CFHTLens x CMASS

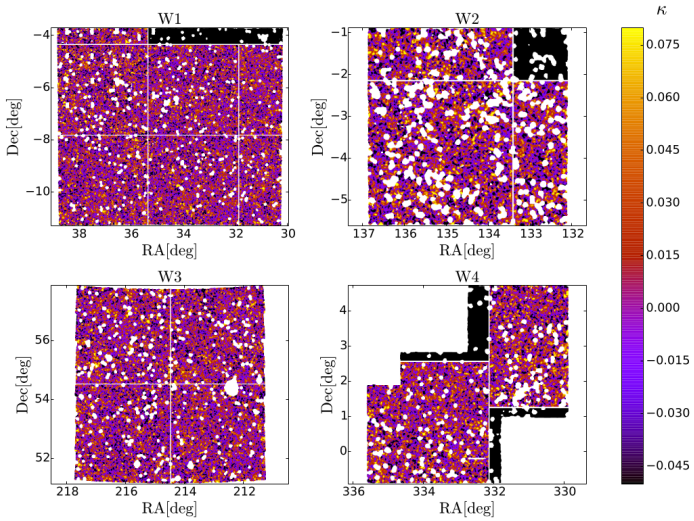


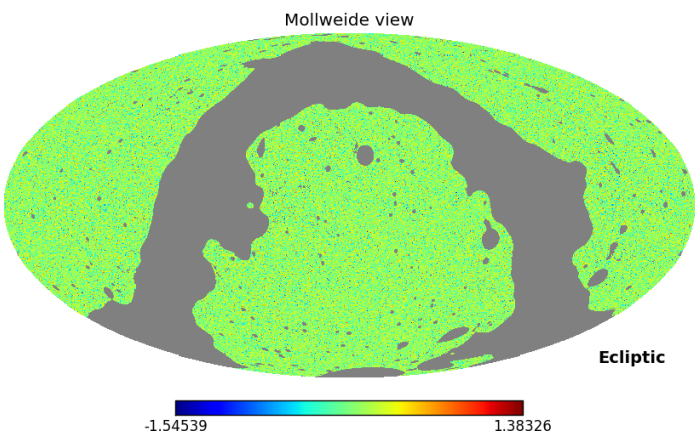


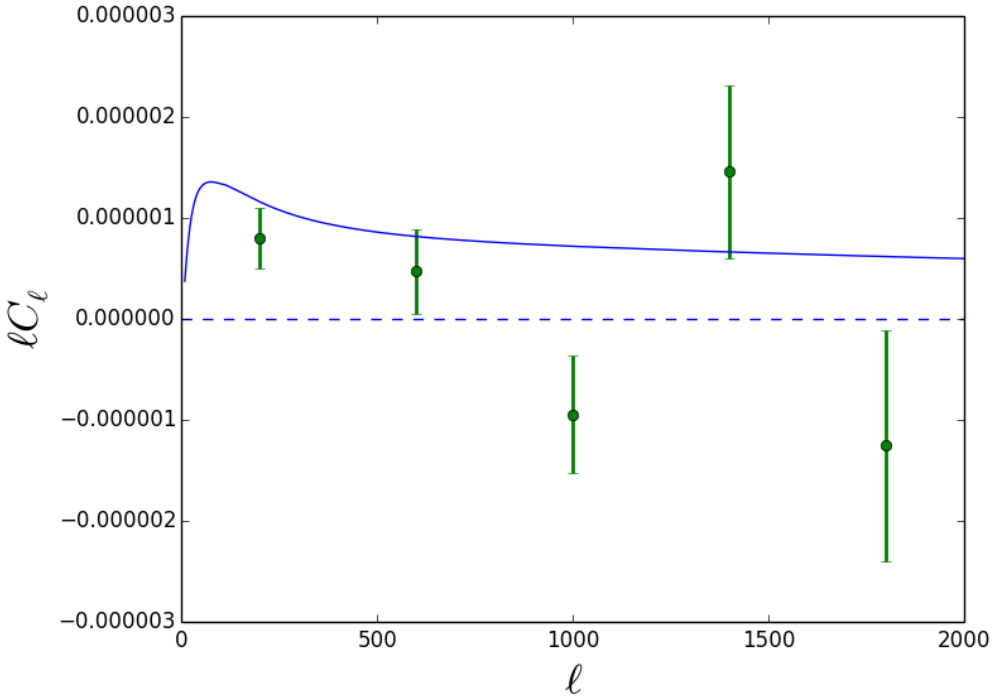


~ 17 sigma

CFHTLens x Planck

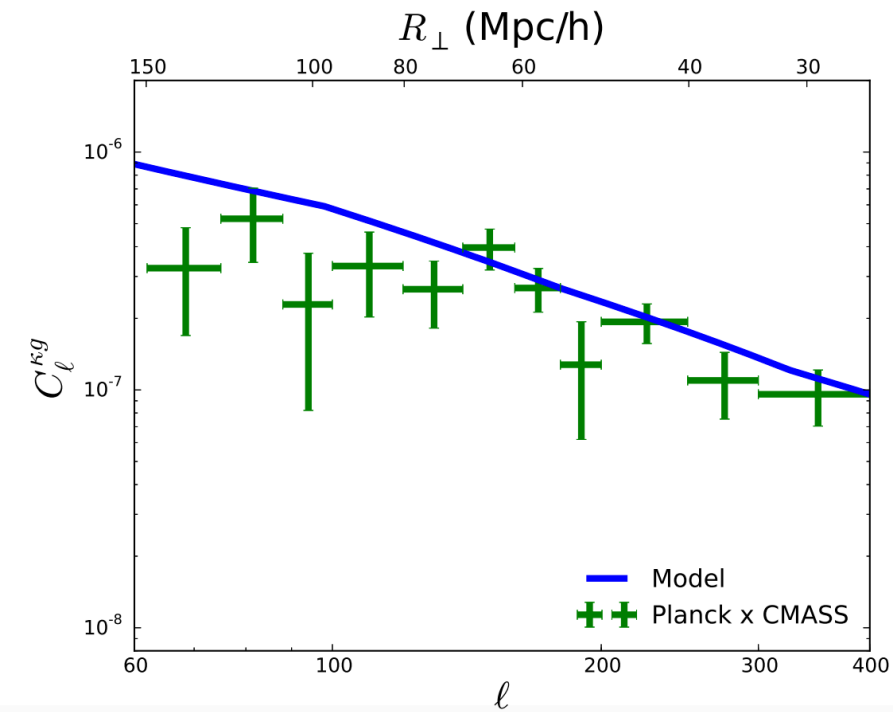




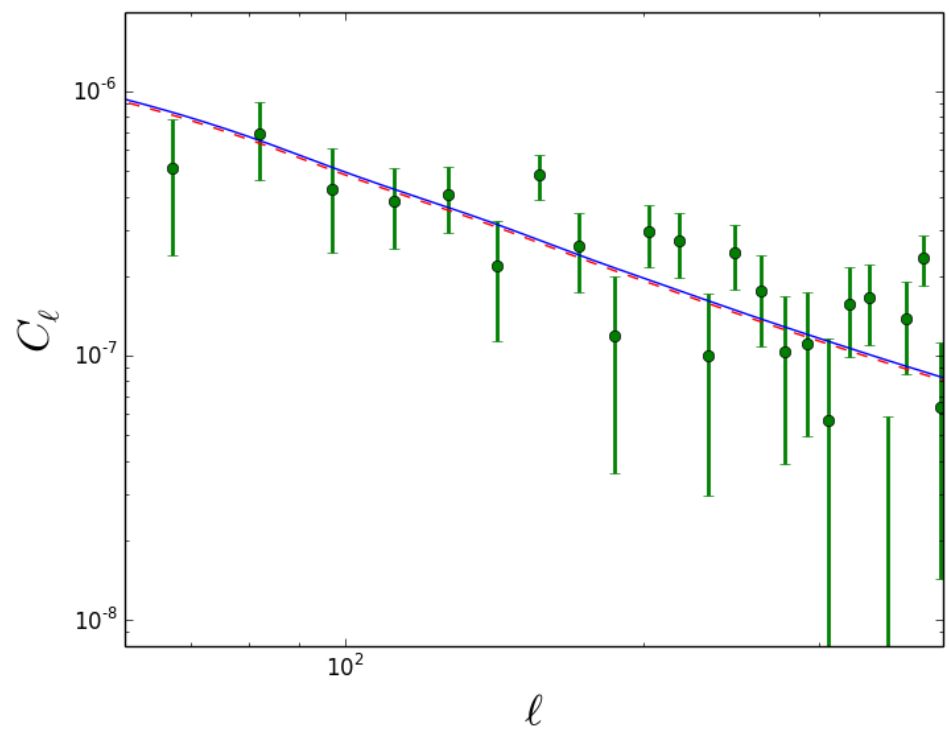


cf. Liu & Hill 2015

Planck x CMASS revisit



Pullen et. al. 2015



MM et. al. scaled randoms

Two different ways to account for selection

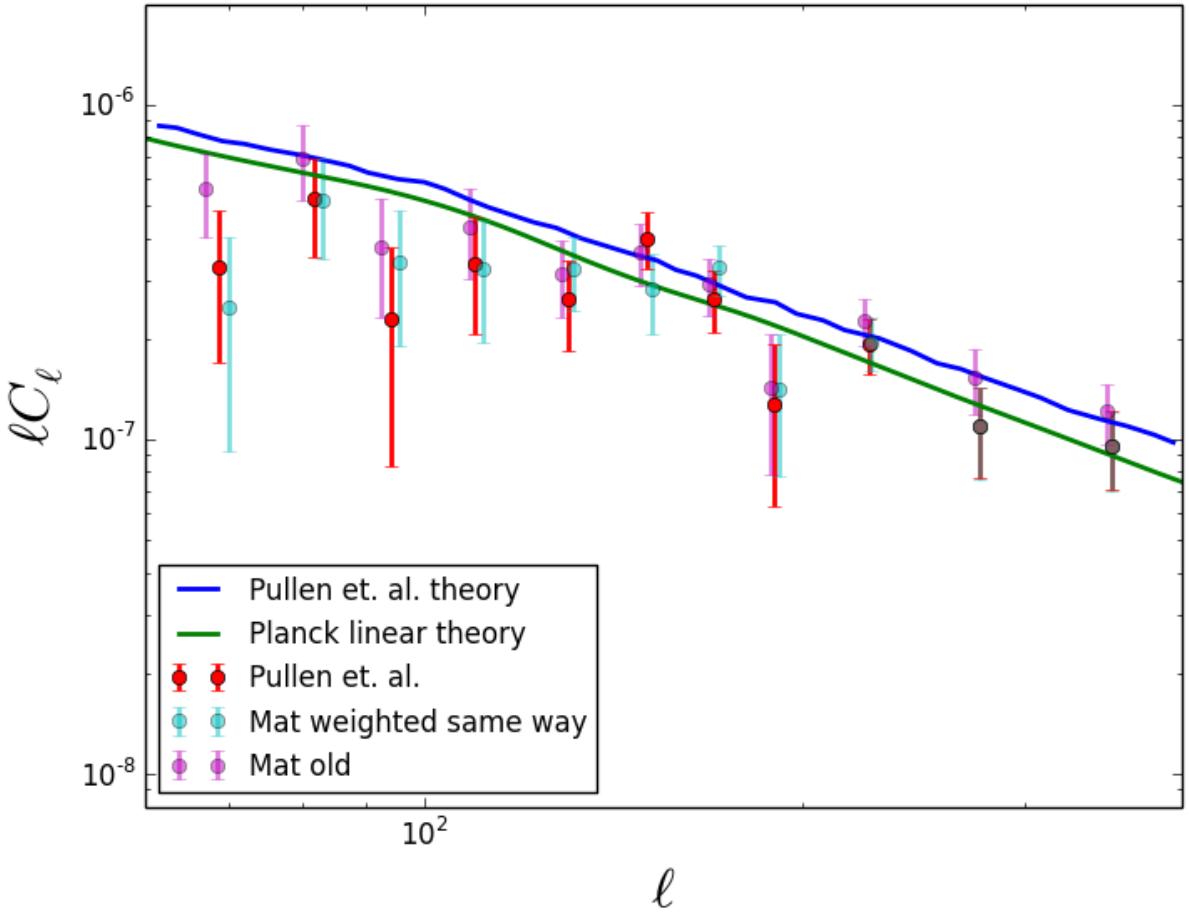
$$\delta(x_i) = \frac{\sum_{x_i} w_i}{\frac{1}{N}\sum_{\text{map}} w_i} - 1$$

Pullen et. al. 2015

$$\delta(x_i) = \frac{\sum_{x_i \text{in map}} 1}{\frac{1}{n}\sum_{x_i \text{in random}} 1} - 1$$

MM et. al. scaled randoms

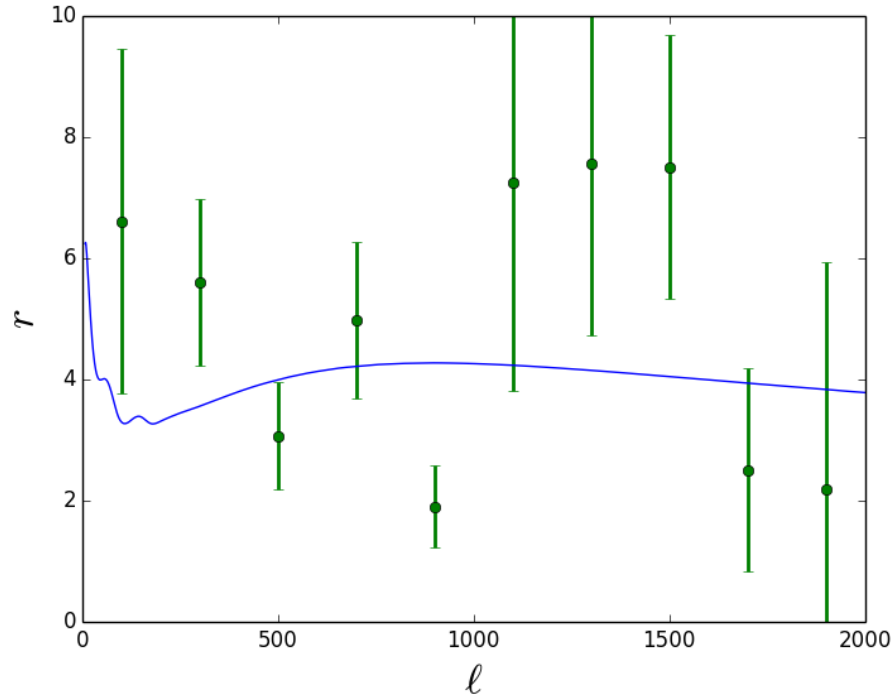
Planck x CMASS revisit



Shear Calibration

Ratio: CFHTLens x CMASS / Planck x CMASS

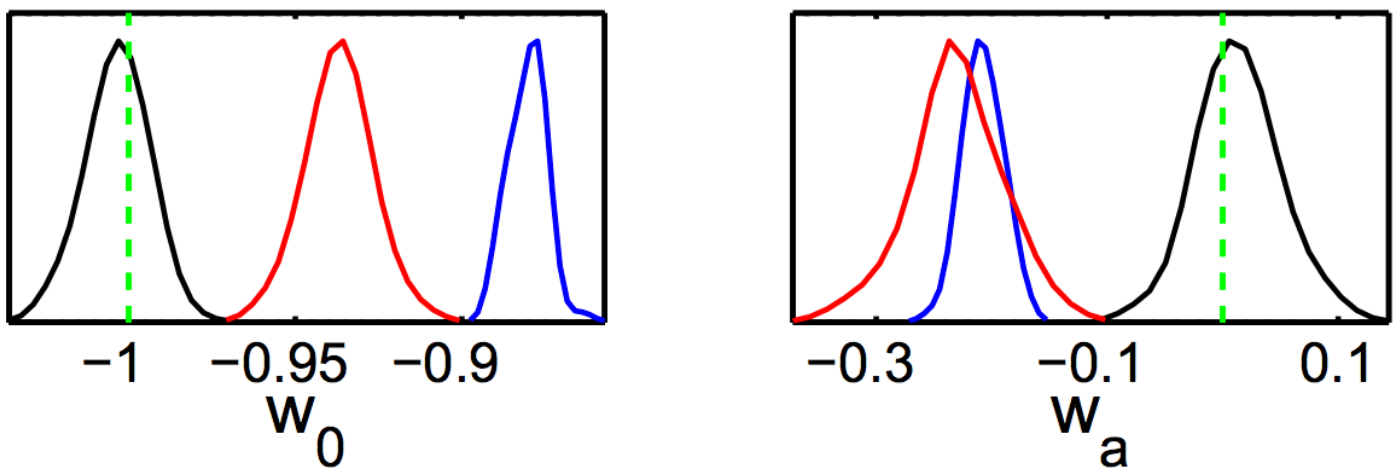
$$\frac{C_\ell^{\kappa_{\rm opt}\Sigma}}{C_\ell^{\kappa_{\rm CMB}\Sigma}} = m\,\frac{g_{\rm opt}(\eta)}{g_{\rm CMB}(\eta)}$$



In progress: constraints from joint-likelihood analysis

Scary biases from poor m(z) parametrization

Insufficient modeling of power spectrum of systematics can mimic growth



Cardone et. al. 2013 (Context: Euclid)

Huterer, Takada, Bernstein, Jain 2006
Taylor et al. 2007
Amara & Refregier 2008
Kitching et al. 2008b, 2009
Bernstein & Huterer 2010
Massey et. al. 2013

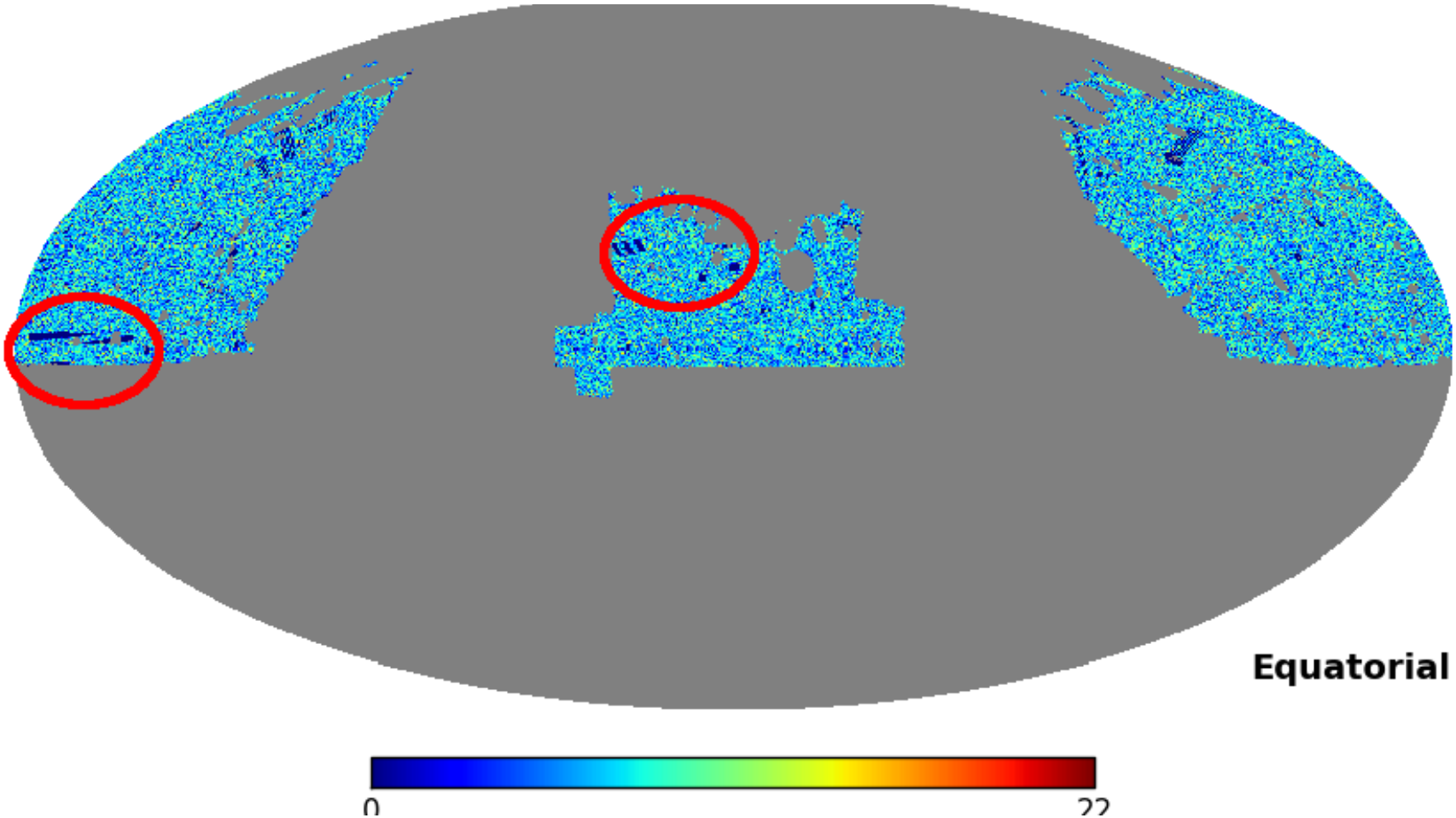
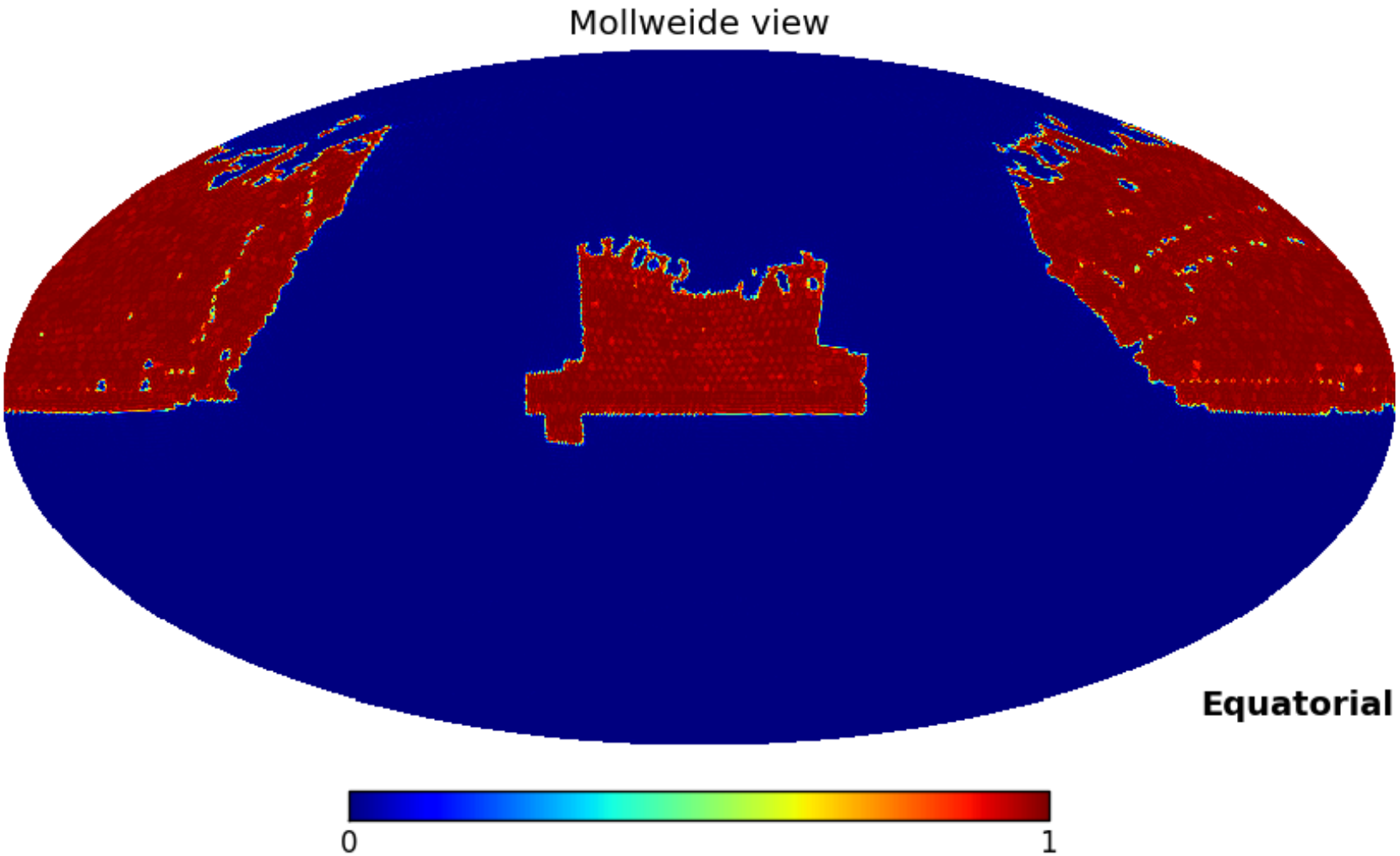
Concern: Constant *m* in redshift bins for calibration could lead to biases

Probably makes more sense to infer m(z) non-parametrically.

Summary

- Exploring how weighting method affects power in cross-correlations
- Joint likelihood analysis soon for shear calibration and constraints on growth

Randoms



Mask