Rencontres de Moriond, Cosmology
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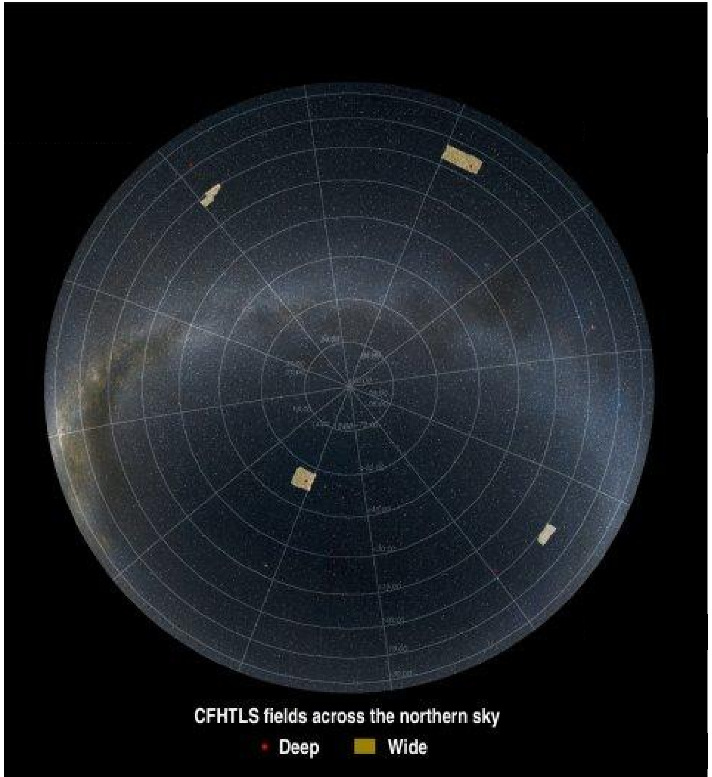
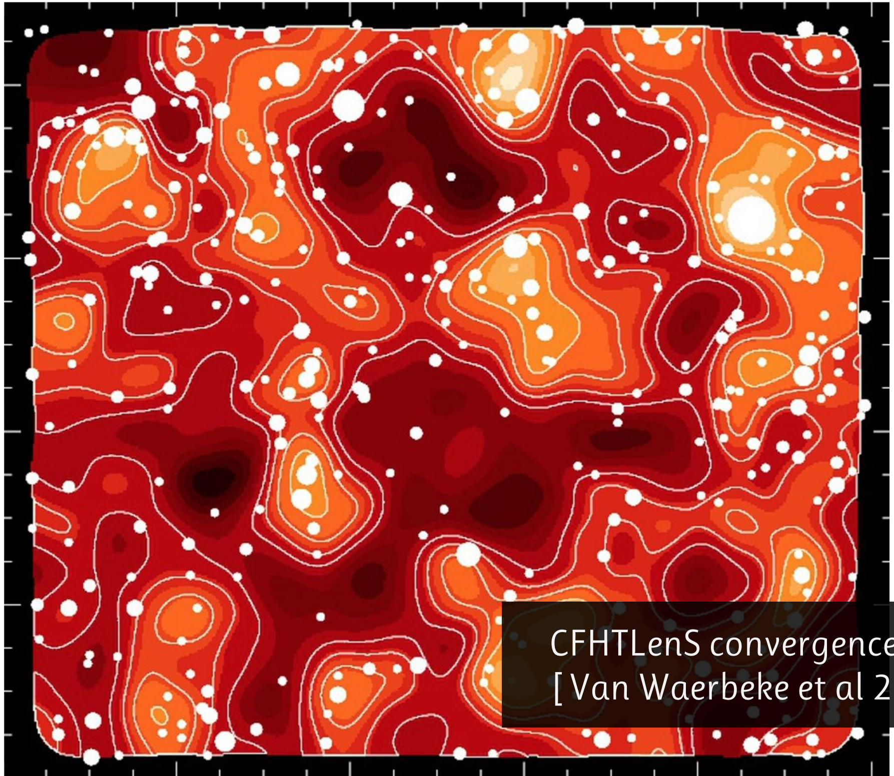
Constraining Multiplicative Bias in CFHTLenS Shear Data

Jia Liu (Columbia Univ.)

1503.06214: JL & Hill
1601.05720: JL, Ortiz-Vazquez, & Hill

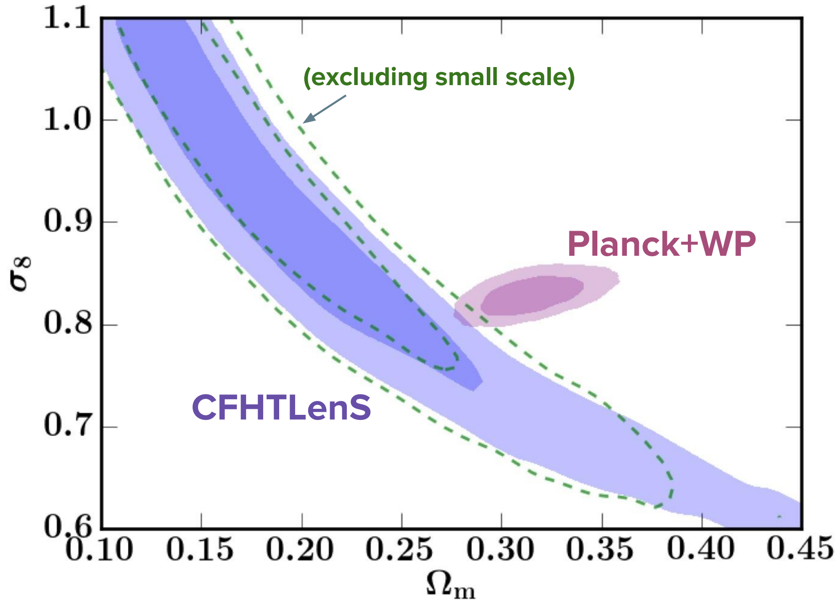
154 deg^2 Canada-France-Hawaii Telescope Lensing Survey (CFHTLenS)



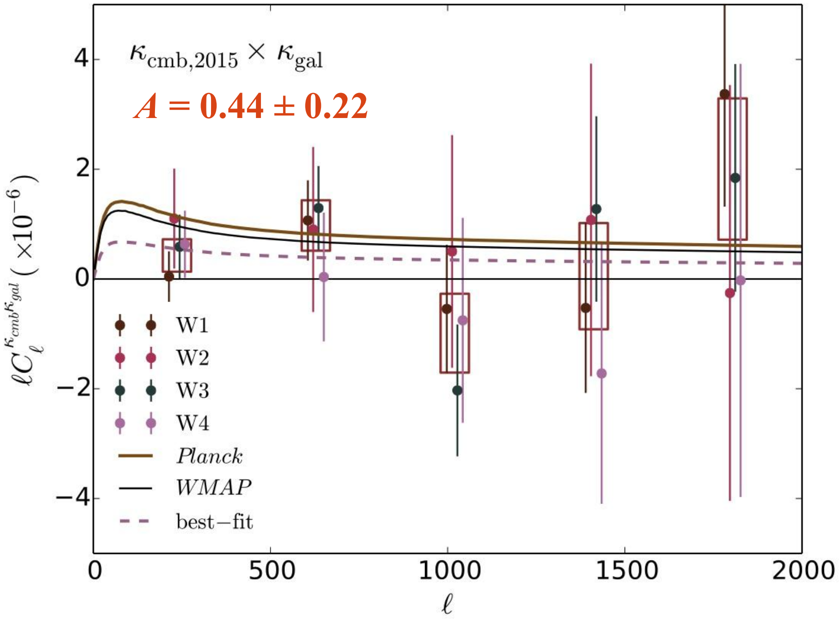


CFHTLenS convergence map
[Van Waerbeke et al 2013]

Tension with CMB Temperature Anisotropy



[MacCrann et al 2014]



[**JL** & Hill 2015, arxiv:1503.06214]

Source of the 50% Disagreement?

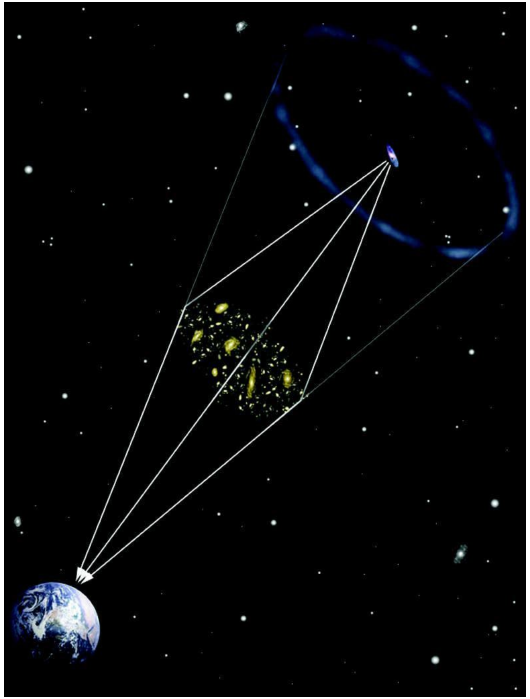
- Photo *z* (10%)
- Intrinsic Alignments (10-15%)
- Masking of tSZ Clusters (5-10%)
- Multiplicative Bias (?)
- New Physics (maybe not..yet)

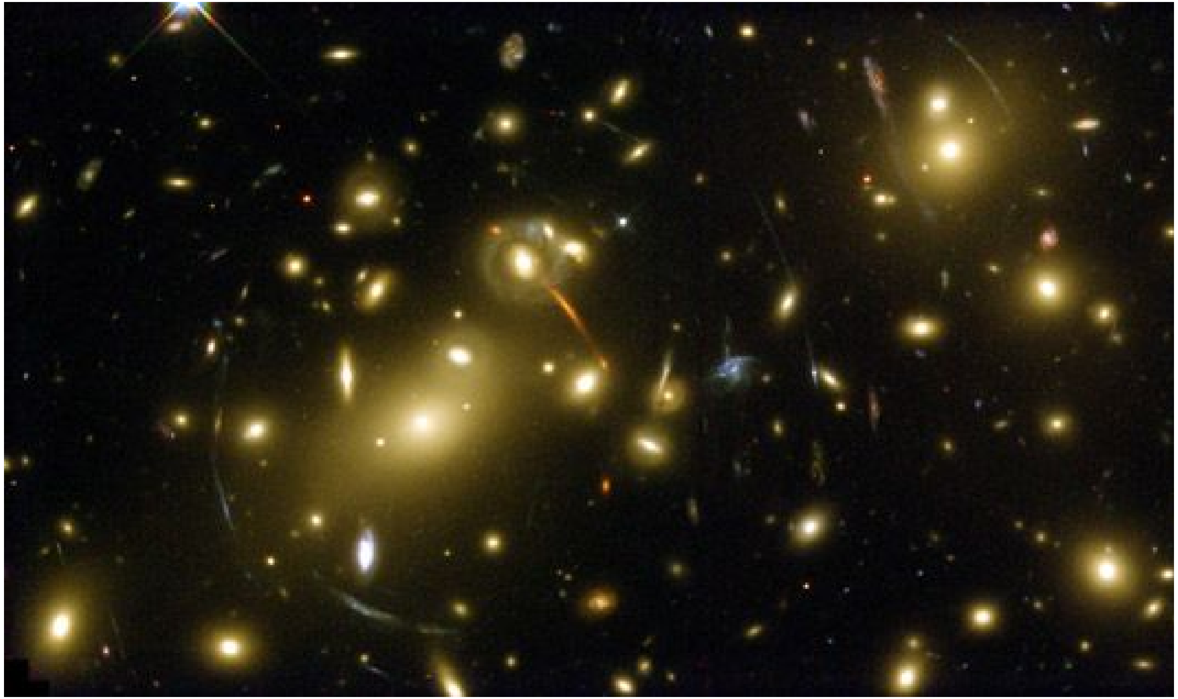
Origin of the Multiplicative Bias in Shear Measurements

Model Bias	Noise Bias	Nonlinear coupling
Mismatch between model and real galaxy shapes	PSF, pixelization	Between model and noise biases

[e.g. Kacprzak et al 2014]

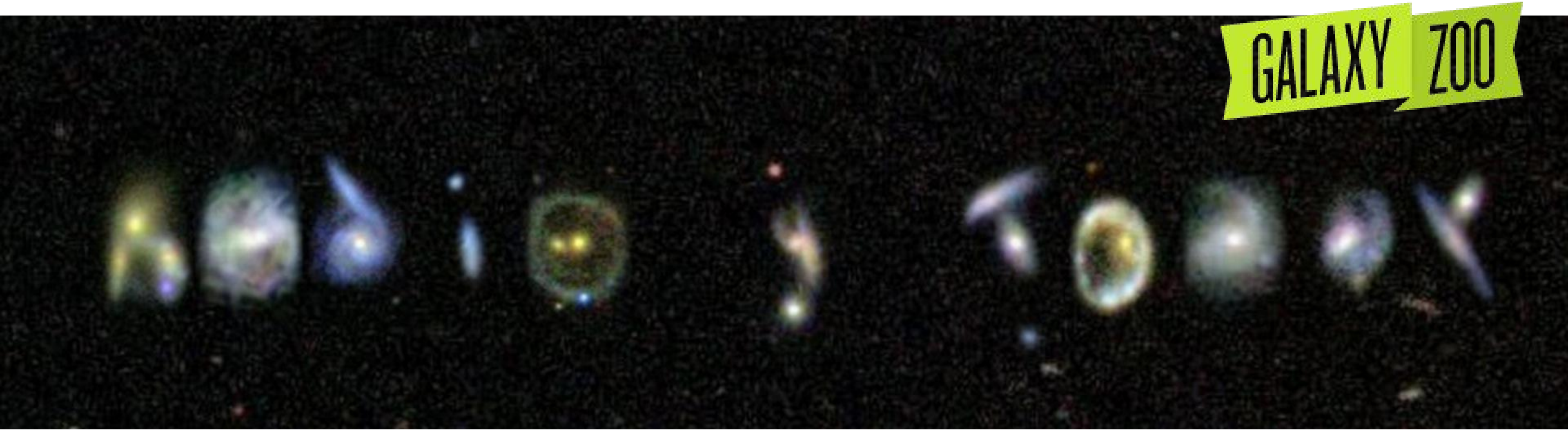
Weak Lensing and Galaxy Shapes





[NASA/STScI]

Weak Lensing and Galaxy Shapes



Weak Lensing and Galaxy Shapes

Intrinsic galaxy (shape unknown) | Gravitaional lensing causes a ***shear (g)*** | Atmosphere and telescope cause a convolution | Detectors measure a pixelated image | Image also contains noise

[C. Heymans]

Can CMB Lensing Help Cosmic Shear Surveys?

Sudeep Das,[1,2] Josquin Errard,[3] and David Spergel[4]

[1] *High Energy Physics Division, Argonne National Laboratory, 9700 S Cass Avenue, Lemont, IL 60439*
[2] *Berkeley Center for Cosmological Physics, Berkeley, CA 94720*
[3] *Computational Cosmology Center, Lawrence Berkeley National Laboratory, Berkeley, CA 94720*
[4] *Peyton Hall, Ivy Lane, Princeton University, Princeton, NJ 08544*

(Dated: November 12, 2013)

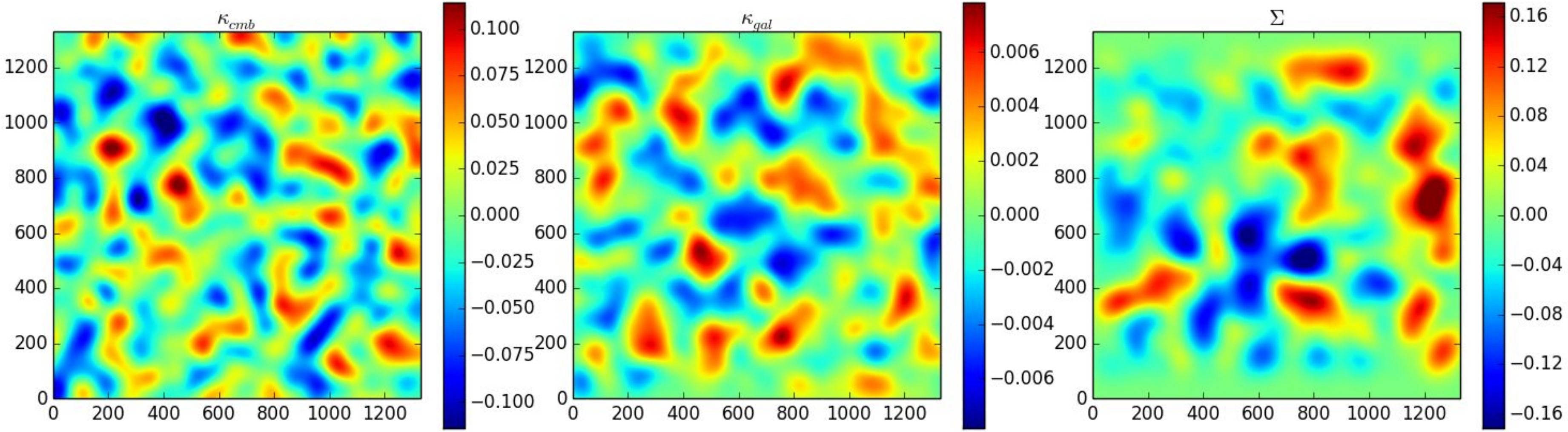
Yes! Upcoming galaxy shear surveys have the potential to significantly improve our understanding of dark energy and neutrino mass *if* lensing systematics can be sufficiently controlled. The cross-correlations between the weak lensing shear, galaxy number counts from a galaxy redshift survey, and the CMB lensing convergence can be used to calibrate the shear multiplicative bias, one of the most challenging systematics in lensing surveys. These cross-correlations can significantly reduce the deleterious effects of the uncertainties in multiplicative bias.

$$C_\ell^{\kappa_{\rm CMB}\Sigma} = \frac{3}{2}\Omega_{\rm m} H_0^2 \int d\eta\, b_\ell(\eta) W_f(\eta) \frac{g_{\rm CMB}(\eta)}{a(\eta)} P\left(\frac{\ell}{d_A}, \eta\right), \quad (4)$$

$$C_\ell^{\kappa_{\rm opt}\Sigma} = m \frac{3}{2}\Omega_{\rm m} H_0^2 \int d\eta\, b_\ell(\eta) W_f(\eta) \frac{g_{\rm opt}(\eta)}{a(\eta)} P\left(\frac{\ell}{d_A}, \eta\right). \quad (5)$$

$$\frac{C_\ell^{\kappa_{\rm opt}\Sigma}}{C_\ell^{\kappa_{\rm CMB}\Sigma}} = m \frac{g_{\rm opt}(\eta)}{g_{\rm CMB}(\eta)} \quad (6)$$

κ_{cmb}, κ_{gal}, and Σ maps

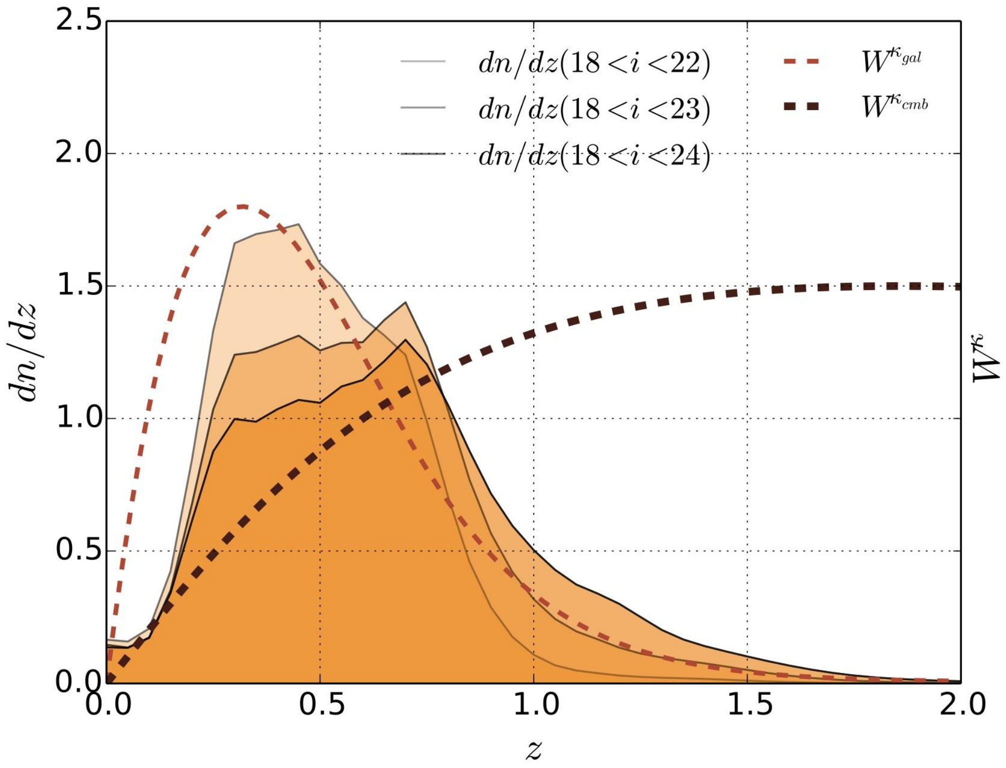


Planck convergence

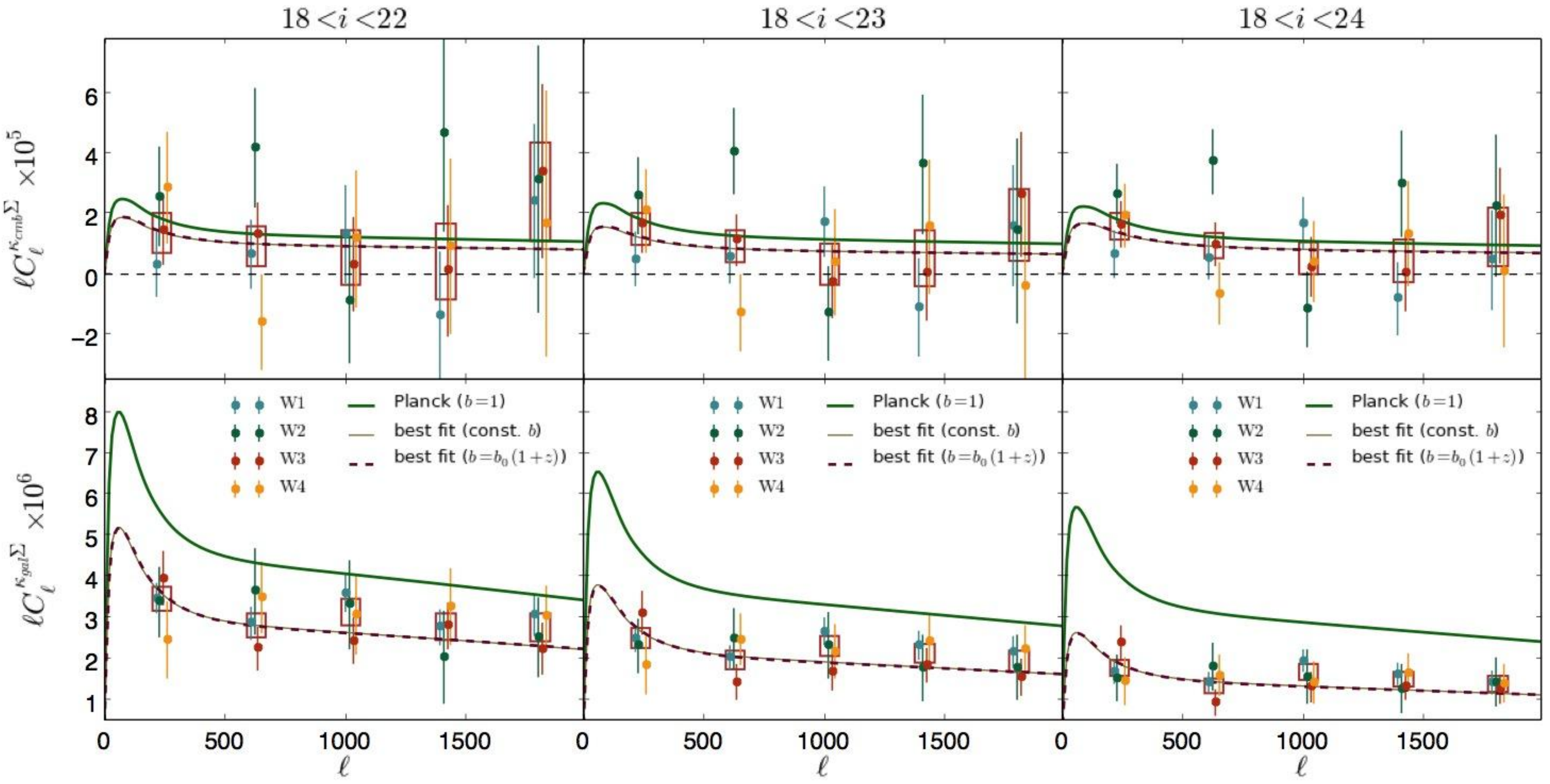
CFHTLenS convergence

CFHTLenS galaxy density

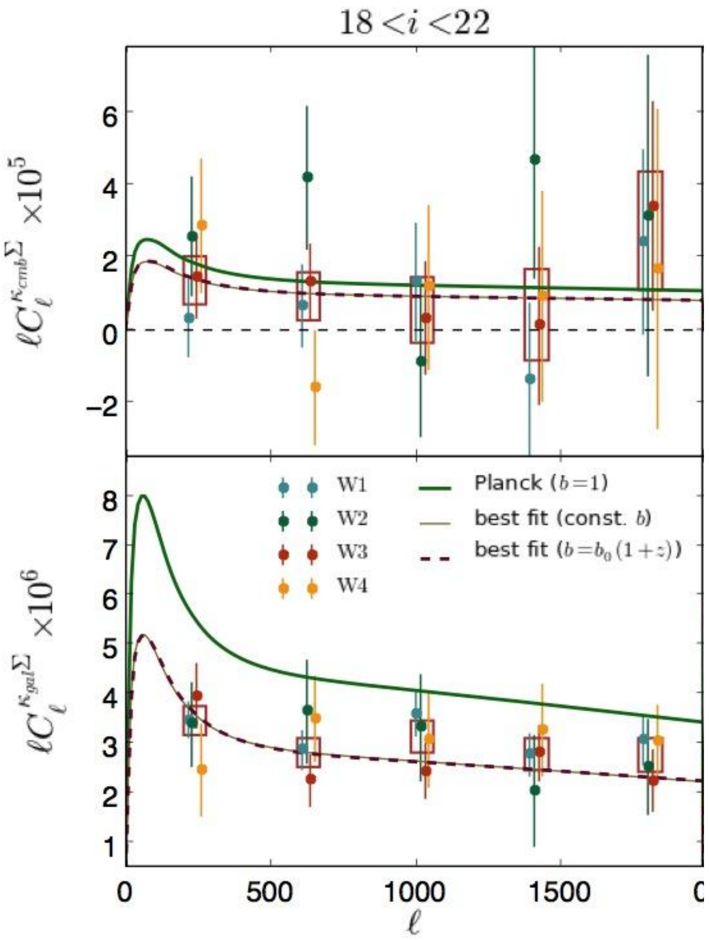
Source Distributions and Lensing Kernels



[**JL**, Ortiz-Vazquez, & Hill, 2016]



[**JL**, Ortiz-Vazquez, & Hill, 2016]



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$$\frac{C_\ell^{\kappa_{\rm opt}\Sigma}}{C_\ell^{\kappa_{\rm CMB}\Sigma}} = m \frac{g_{\rm opt}(\eta)}{g_{\rm CMB}(\eta)} \quad (6)$$

Constraints on *b* and *m*

[**JL**, Ortiz-Vazquez, & Hill 2016]

➠ A 2–4 σ evidence for the multiplicative bias (***m*** < 1) in our deepest galaxy sample.

➠ Can potentially explain the disagreement between CFHTLenS shear 2-point function and Planck temperature measurements (***m*** ~ 0.9 needed).

➠ Covariance dominated by the CMB lensing map noise at present.