Calibrate Shear Multiplicative Bias with CMB Lensing

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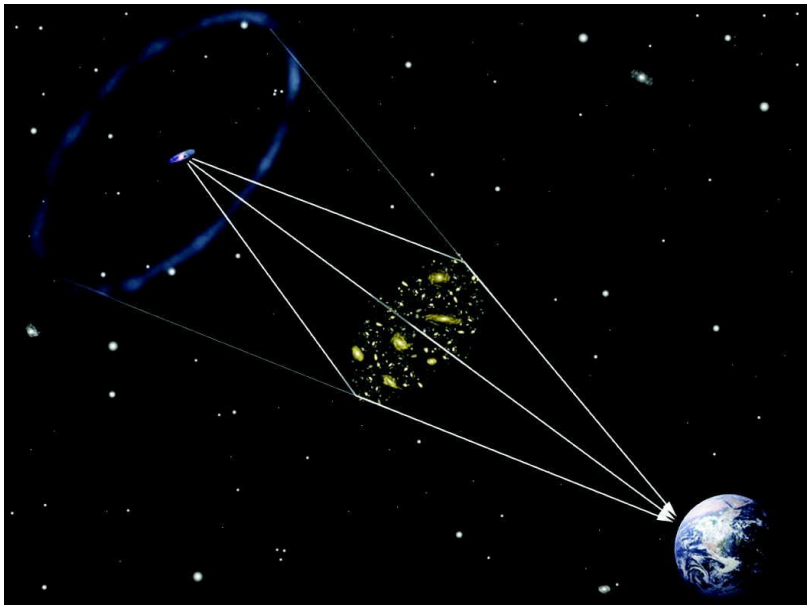
CCS @ BNL/Stony Brook, May 23rd 2016

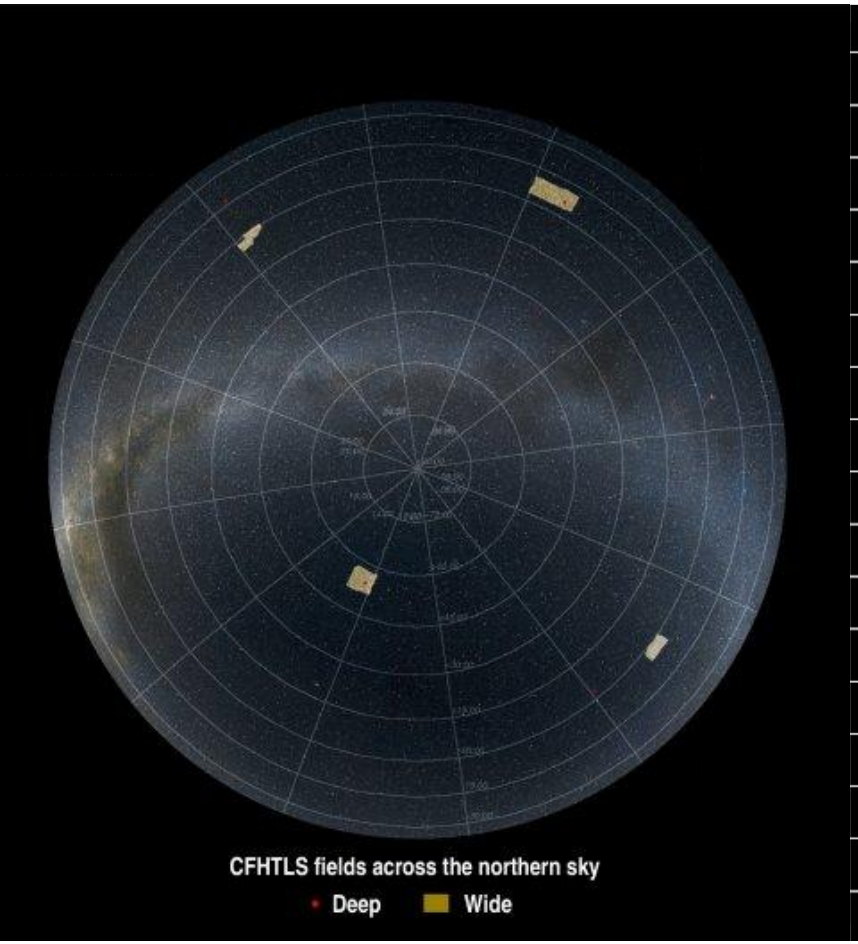
1503.06214: JL & Hill
1601.05720: JL, Ortiz-Vazquez, & Hill

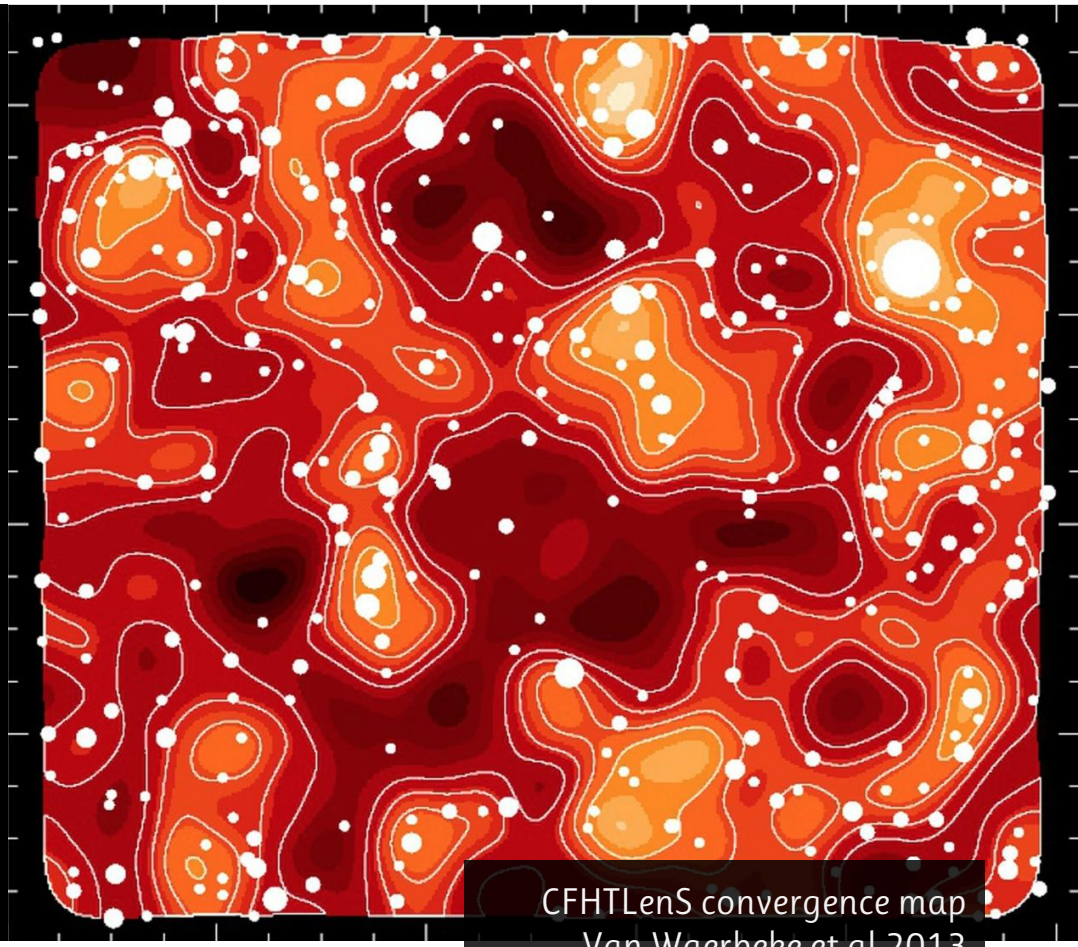
Weak Lensing



Credit: wikipedia (top), CFHTLenS (bottom)

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

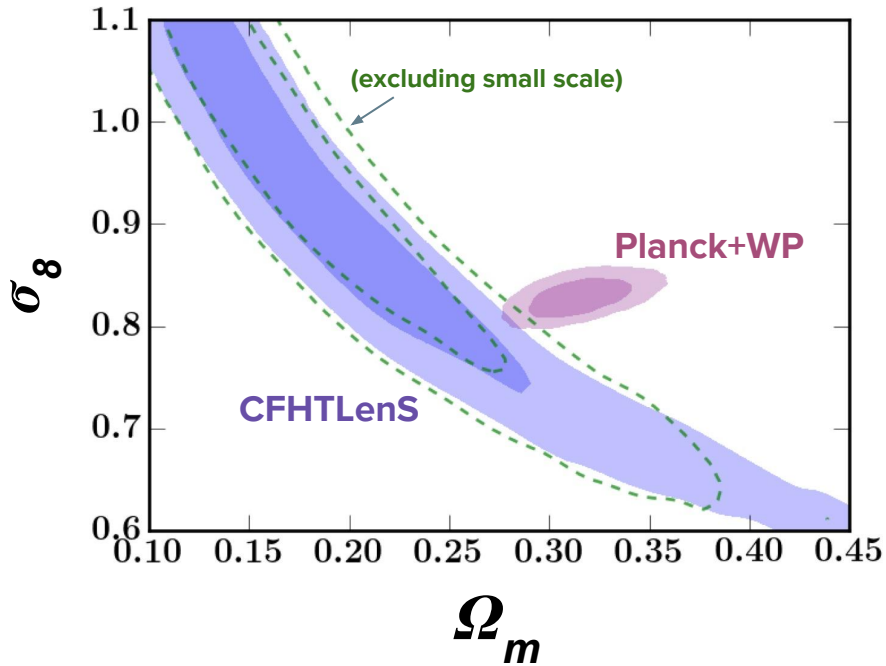




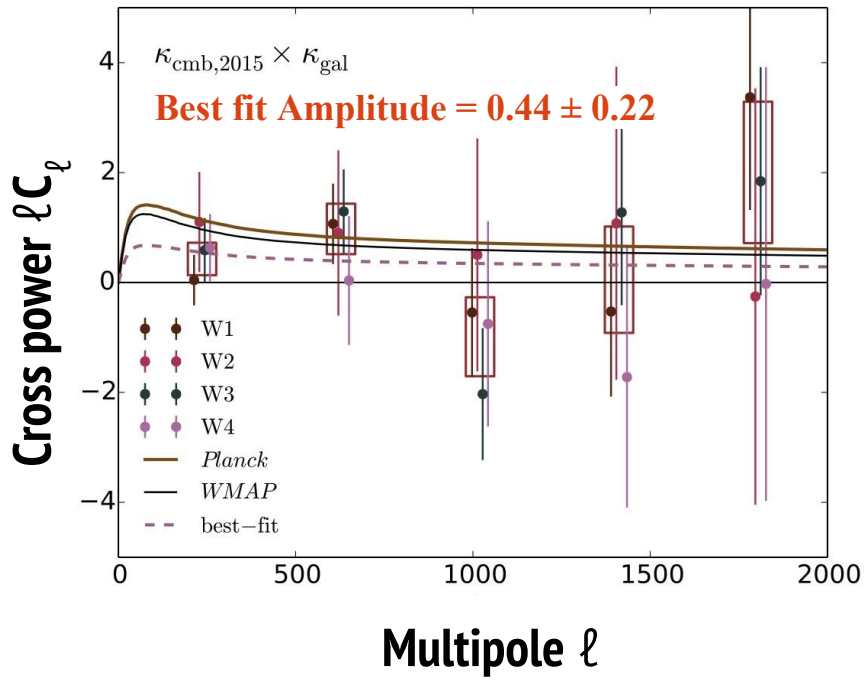
CFHTLenS convergence map
Van Waerbeke et al 2013

2σ Discrepancies between CMB Temp. & weak lensing

MacCrann et al 2014

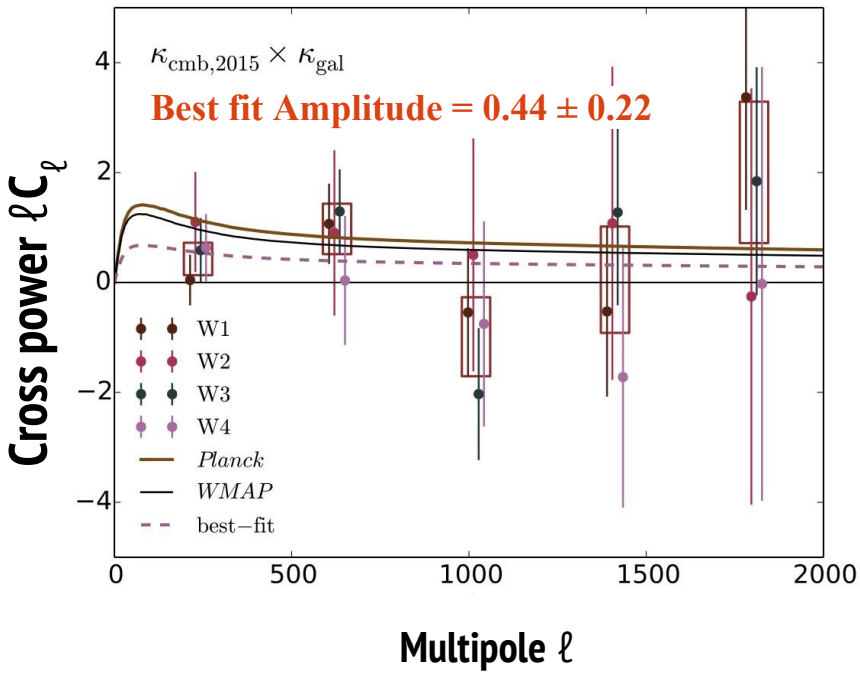


JL & Hill 2015



Sources of the 50% disagreement?

JL & Hill 2015



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

The Multiplicative Bias

Model Bias

Noise Bias

Model & Noise Bias Coupling

The Multiplicative Bias

Model Bias

Noise Bias

Model & Noise Bias Coupling

e.g. Bernstein 2010
Voigt et al 2012

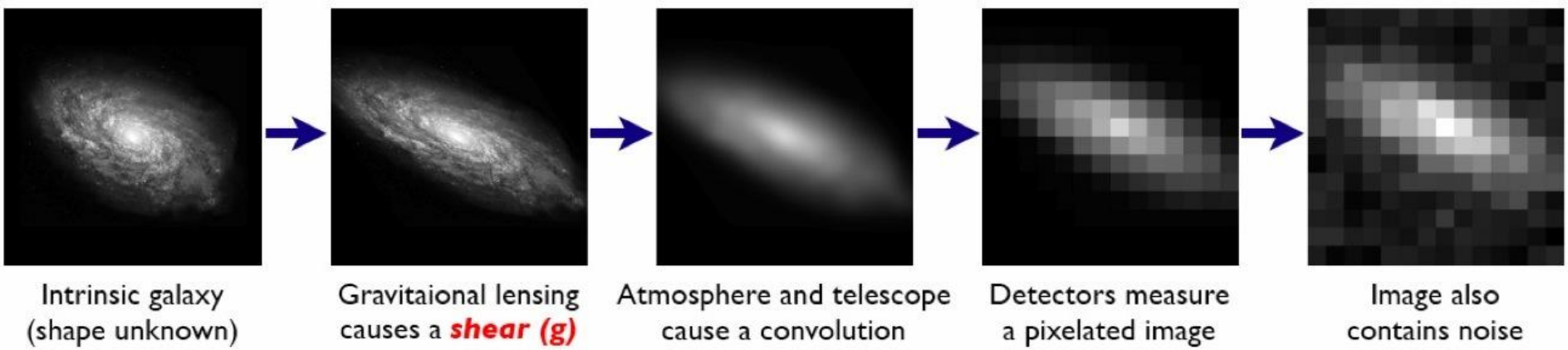
The Multiplicative Bias

Model Bias

Noise Bias

Model & Noise Bias Coupling

e.g. Melchior & Viola 2012
Okura & Futamase 2013



Credit: Catherine Heymans

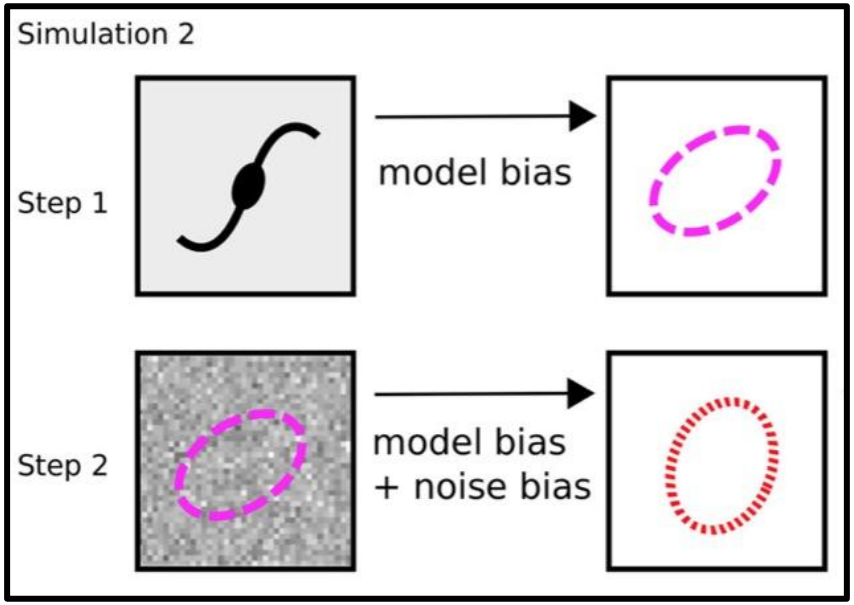
The Multiplicative Bias

Model Bias

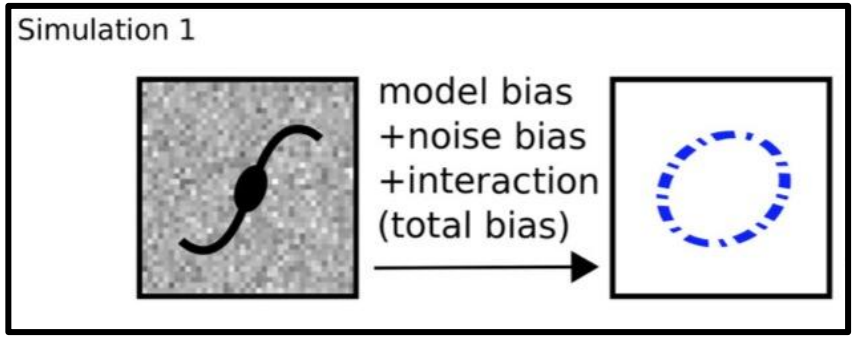
Noise Bias

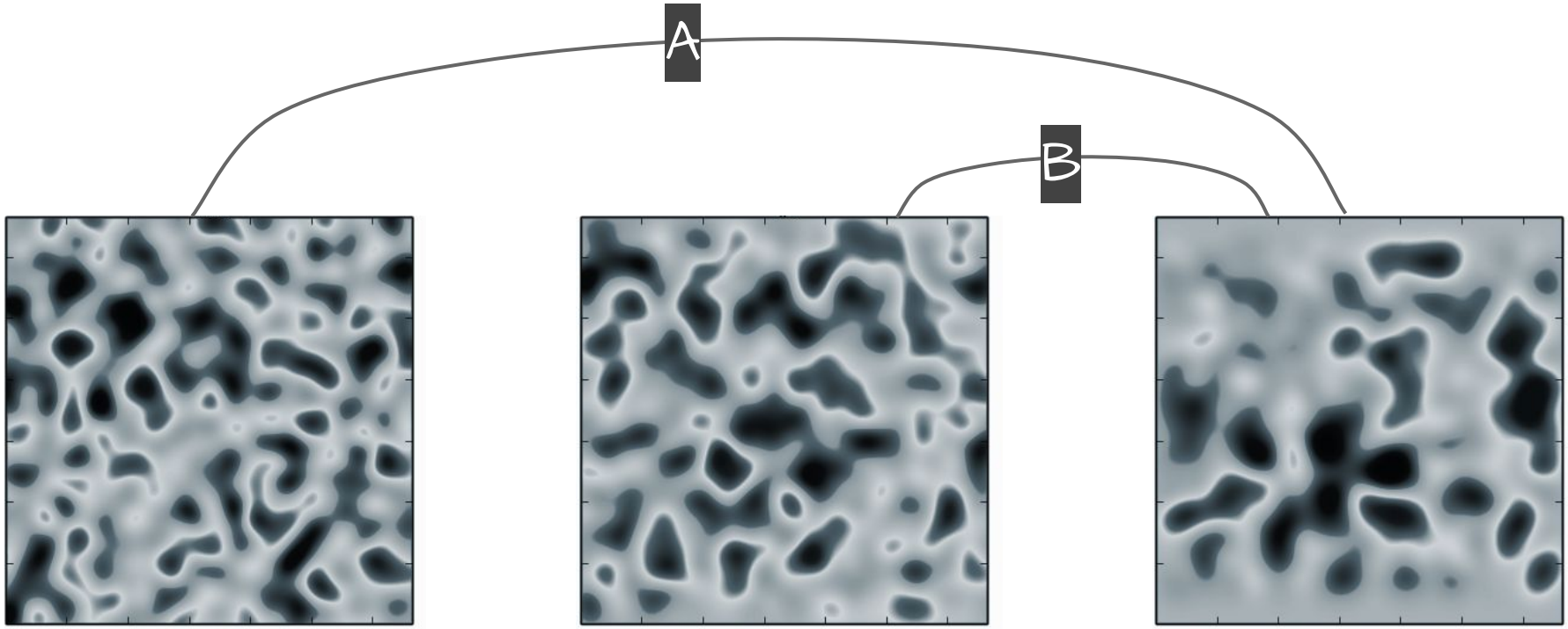
Model & Noise Bias Coupling

Kacprzak et al 2014



Differences = model & noise bias coupling





Planck
CMB lensing

CFHTLenS
galaxy lensing

CFHTLenS
galaxy density

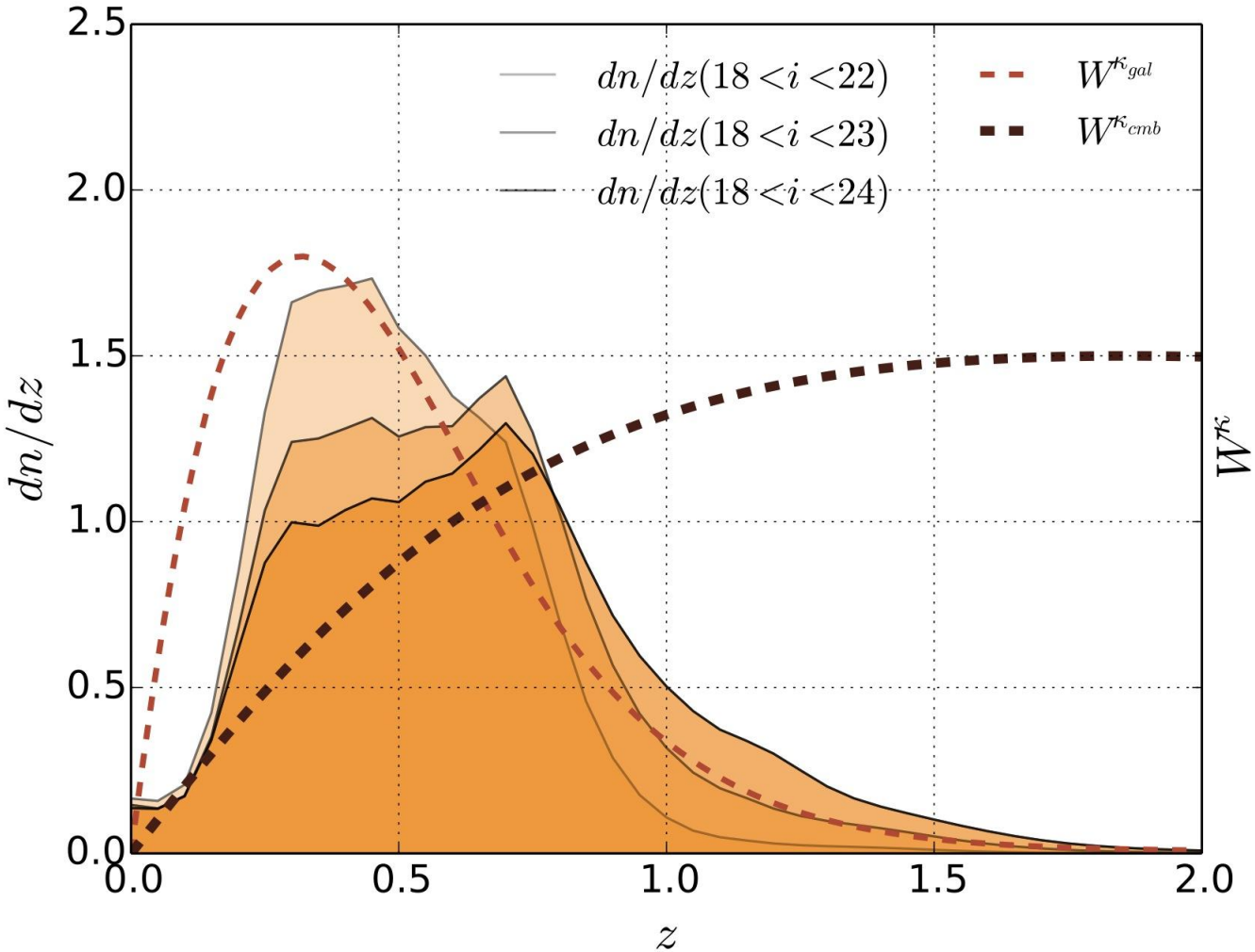
A $$C_\ell^{\kappa_{\rm CMB}\Sigma} = \frac{3}{2}\Omega_{\rm m} H_0^2 \int d\eta\, b_\ell(\eta) W_f(\eta) \frac{g_{\rm CMB}(\eta)}{a(\eta)} P\left(\frac{\ell}{d_A}, \eta\right),$$

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

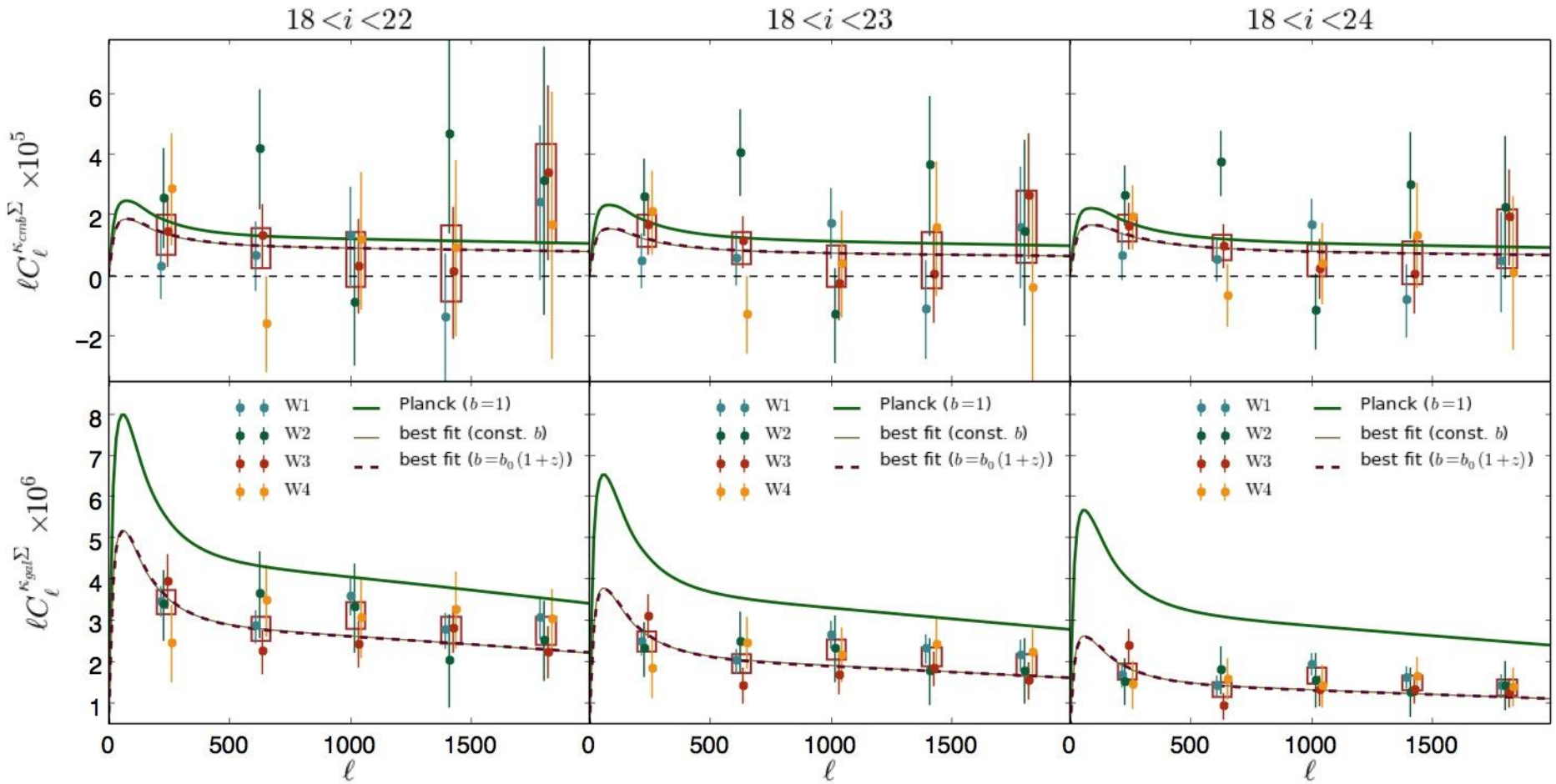
C $$\frac{C_\ell^{\kappa_{\rm opt}\Sigma}}{C_\ell^{\kappa_{\rm CMB}\Sigma}} = m \frac{g_{\rm opt}(\eta)}{g_{\rm CMB}(\eta)}$$

Formalism:
Vallinotto 2012
Das et al. 2013

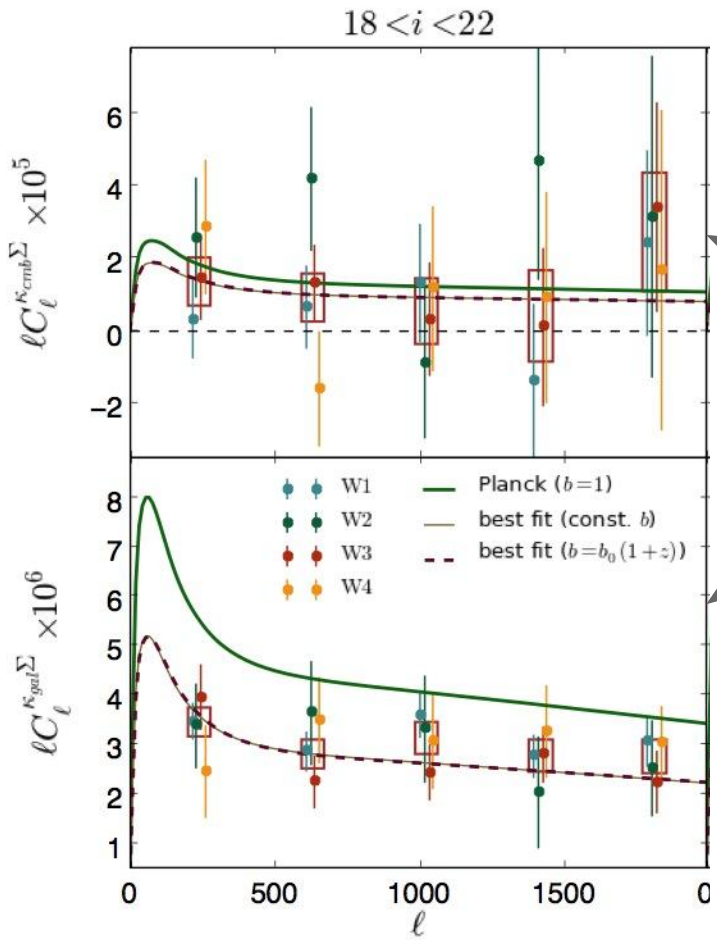
Source Distribution & Lensing Kernels



JL, Ortiz-Vazquez, & Hill, 2016



JL, Ortiz-Vazquez, & Hill, 2016



A

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

B

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

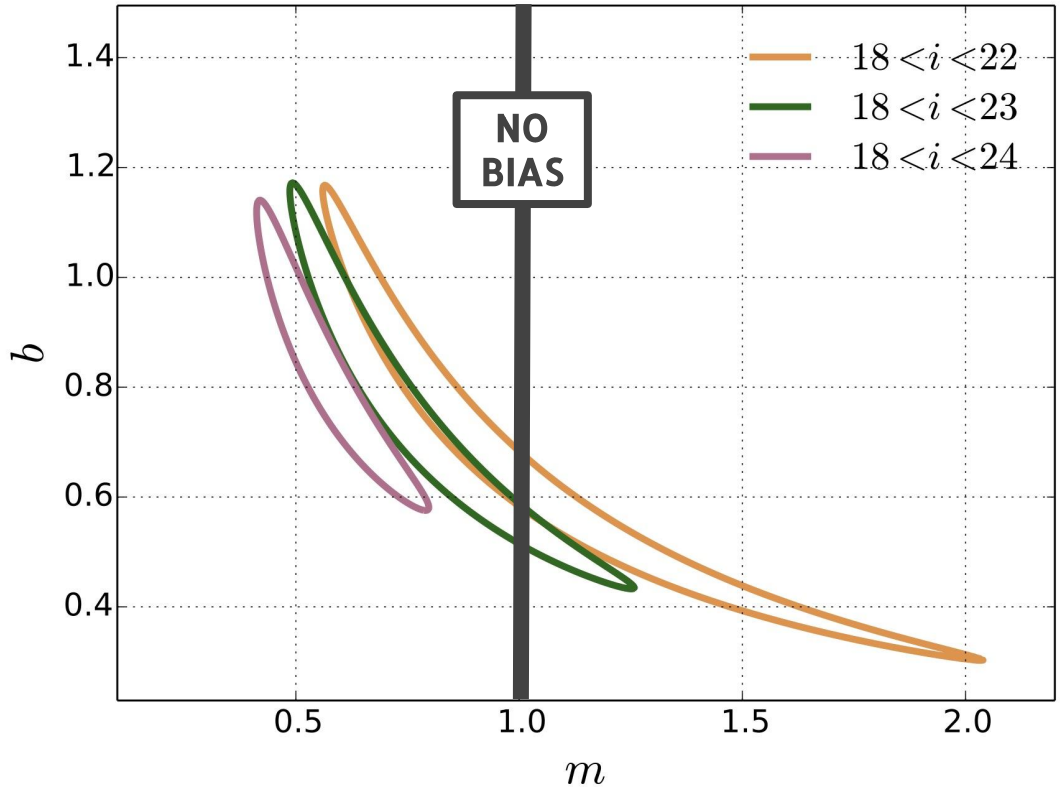
C

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

Evidence of Multiplicative Bias

➠ 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.

JL, Ortiz-Vazquez, & Hill, 2016