KiDS+VIKING: Cosmic shear tomography with optical+IR data



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European Research Council

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KiDS-VIKING-450



Wrong or new physics?



Observation -> theory

$$\xi_{\pm}(\theta) = \langle \gamma_{\rm t} \gamma_{\rm t}$$

$$\xi_{+}(\theta) = \int_{0}^{\infty} \frac{\mathrm{d}\ell\,\ell}{2\pi} \,\mathrm{J}_{0}(\ell\theta) \,P_{\kappa}(\theta)$$
$$P_{\kappa}(\ell) = \frac{9H_{0}^{4}\Omega_{\mathrm{m}}^{2}}{4c^{4}} \int_{0}^{\chi} g(\chi) = \int_{\chi}^{\chi_{\mathrm{h}}} \mathrm{d}\chi$$

 $_{\rm t} \rangle \left(\theta \right) \pm \left\langle \gamma_{\rm X} \gamma_{\rm X} \right\rangle \left(\theta \right)$

 $_{\kappa}(\ell); \quad \xi_{-}(\theta) = \int_{0}^{\infty} \frac{\mathrm{d}\ell\,\ell}{2\pi} \,\mathrm{J}_{4}(\ell\theta) \,P_{\kappa}(\ell)$ $^{\chi_{\mathrm{h}}} \mathrm{d}\chi \, \frac{g^2(\chi)}{a^2(\chi)} P_{\delta}\left(\frac{\ell}{f_K(\chi)},\chi\right)$ $\chi'(p_{\chi}(\chi'))\frac{f_K(\chi'-\chi)}{f_K(\chi')}$







 $S_8 \equiv \sigma_8 \sqrt{\Omega_{
m m}/0.3}$



KV450

sDIR DIR-w/o-COSMOS DIR-w/o-COSMOS&VVDS DIR-w/o-VVDS DIR-w/o-DEEP2 DIR-C15 CC-fit CC-shift OQE-shift no-deltaz IA-Gauss IA-linear-PS IA-z-evolution no-baryons wide-baryons no-systematics no-systematics_merr all-xip nu0 nu0p26 no-bin1 no-bin2 no-bin3 no-bin4 no-bin5 iterative-covariance KiDS-450 DESy1_cosmic-shear HSC DR1 Planck-2015_TT-lowP Planck-Legacy_TT-TE-EE-lowE 0.9 1.0 1.1





 $S_8 \equiv \sigma_8 \sqrt{\Omega_{
m m}/0.3}$

Photometric redshifts



Wright et al. (2018)



Re-weight spec-z surveys to be more representative.

- Magnitude space needs to be fully covered. 1.
- 2. Requires unique relation colour-redshift relation.



Redshift calibration



Redshift distributions





Self-organising map

Fiducial Training







~99% coverage of 9D mag space in KV450.

Wright et al. in prep.



Testing KiDS-VIKING photo-z on MICE

MICE Grand Challenge: an all-sky lightcone Nbody simulation using 40003 particles and 4096 processors



Cosmological Simulations @ Marenostrum Supercomputer

~200 million galaxies over 5000 sq.deg and up to a redshift z=1.4Not the same as the data but similarly complex as the data.

Tests on MICE2





Spectroscopic calibration of DES-Y1







Caveat: Re-weighting done in 4D only.

Joudaki et al. (2019), arXiv:1906.09262





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 3.2σ tension **between WL** and Planck

Asgari et al. submitted



Problems with the redshifts

- Calibration with photo-z (e.g. COSMOS-2015):
 - Outliers => underestimate <z>
 - Bias => **under**estimate <z>
- Calibration with spec-z:
 - Magnitude-space coverage => underestimate <z>
 - Uniqueness of colour-redshift relation => underestimate <z>
 - Wrong spec-z => <z> drawn to the mean of all spec-z
- Clustering redshifts:
 - Evolving galaxy bias
 - Magnification effects



~85% of the sources. Mean redshifts good to $\sigma_{<z>} < 0.007$.

KV450 "gold" sample

Wright et al. in prep.



Summary & Outlook

- (KV450, DES-Y1 recalibrated).
- Are we "wrong"? Systematics? Redshift calibration?
- Other LSS probes show similar discrepancies. Related to H_0 crisis? Serious problem for ΛCDM ?
- Exciting times: KiDS+VIKING and DES finished;

• $\sim 2-3\sigma$ tension in S₈ between Planck and low-z WL measurements

all 3 stage-III surveys analysing several times more data now.