

KiDS

#### **Cosmology from Weak lensing** with the Kilo-Degree Survey

Huanyuan Shan (陕欢源)

Shanghai Astronomical Observatory (SHAO)

On behalf of the KiDS collaboration

TMEX2020

Jan 8th, 2020

#### DM & DE Dominate







Lensing: "Seeing" Dark Matter

#### Cosmic Shear



Wittman et al. 2000

### First detection in 2000



Kaiser et al. 2000

#### HSC: Hyper-Suprime Cam Survey

KiDS: Kilo Degree Survey

DES: Dark Energy Survey

#### Observation => theory

 $\langle \xi_{\pm}(\theta) = \langle \gamma_t \gamma_t \rangle(\theta) \pm \langle \gamma_{\times} \gamma_{\times} \rangle(\theta) \rangle$ 

 $\xi_{+}(\theta) = \int_{0}^{\infty} \frac{ldl}{2\pi} J_{0}(l\theta) P_{\kappa}(l); \xi_{-}(\theta) = \int_{0}^{\infty} \frac{ldl}{2\pi} J_{4}(l\theta) P_{\kappa}(l)$ 

 $P_{\kappa}(l) = \frac{9H_0^4 \Omega_{\rm m}^2}{4c^4} \int_0^{\chi_{\rm h}} d\chi \frac{g^2(\chi)}{a^2(\chi)} P_{\delta}\left(\frac{l}{f_{\kappa}(\chi)},\chi\right)$ 

 $g(\chi) = \int_{-\infty}^{\chi_{\rm h}} d\chi n_{\chi}(\chi') \frac{f_K(\chi' - \chi)}{f_K(\chi')}$ 

## 2pt shear correlation function





• Measure amount of clustered matter

• 
$$S_8 = \sigma_8 (\Omega_{\rm m}/0.3)^{0.5}$$

• Dark energy with future surveys

# Cosmological constraints

Kilbinger et al. 2013

# KiDS

- 1500 sq. deg. survey
- VLT Survey Telescope (VST)
- four bands: ugri
- same footprint as VIKING
- overlap with 2dF, GAMA, SDSS, COSMOS, DEEP2



### KiDS-450



• 454 deg<sup>2</sup> (observations up to July 2015)



### Redshift distributions



Hildebrandt et al. 2017





- S<sub>8</sub> constraint very similar to CFHTLenS, pre-Planck CMB
- Tension with Planck  $2.3\sigma$  in  $S_8$

Hildebrandt et al. 2017





- S<sub>8</sub> constraint very similar to KiDS cosmic shear, pre-Planck CMB
- Tension with Planck  $2\sigma$  in  $S_8$

*Shan et al. 2018* 



# Extended cosmologies

- Massive neutrinos
- Non-zero curvature
- Evolving dark energy
- Modified gravity
- Running spectral index

Joudaki et al. 2017

# Evolving dark energy



- Resolves tension between KiDS and Planck
- Only extensions that is moderately favored by the data
- $3\sigma$  deviation from a cosmological constant
- Resolves  $H_0$  tension between Riess+16 and Planck

# Combined probes

- Cosmic shear
- Galaxy-galaxy lensing
- Galaxy clustering

• WL peak statistics





# S<sub>8</sub> results by DES-Y1 and HSC-Y1

# VIKING@VISTA

- Same footprint as KiDS
- Already finished (1350 deg<sup>2</sup>)
- ZYJHKs images
- 5σ depths of 21.2 (Ks) to 23.1 (Z)

#### KV450



Hildebrandt et al. 2019

# KiDS-1000



- 1006 deg<sup>2</sup> of imaging
- 773 deg<sup>2</sup> effective area after masking
- 9-band photometry with BPZ photo-zs



# Summary & Outlook

- Cosmic shear measurement S<sub>8</sub> with CMB-like precision
- Tension between Planck and some cosmic shear measurements. Systematics? New physics?
- Very exciting times: KiDS+VIKING/DES/HSC
- Prepare with current survey for CSS-OS/Euclid/LSST





