

Log-normal simulation for weak gravitational lensing: application to the cross- correlation with galaxies

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with Ryu Makiya and Eiichiro Komatsu (MPA/Kavli IPMU)

lognormal_lens

- A quick and handy code
 - for studying cross-correlation of density fluctuations and galaxy distribution
 - and with other tracers of density
- **Inputs:** one file with minimum parameters
 - Cosmology
 - Power spectra of density fluctuations
 - Survey parameters (PFS and HSC)
- **Outputs:** a set of maps (in a few min.)



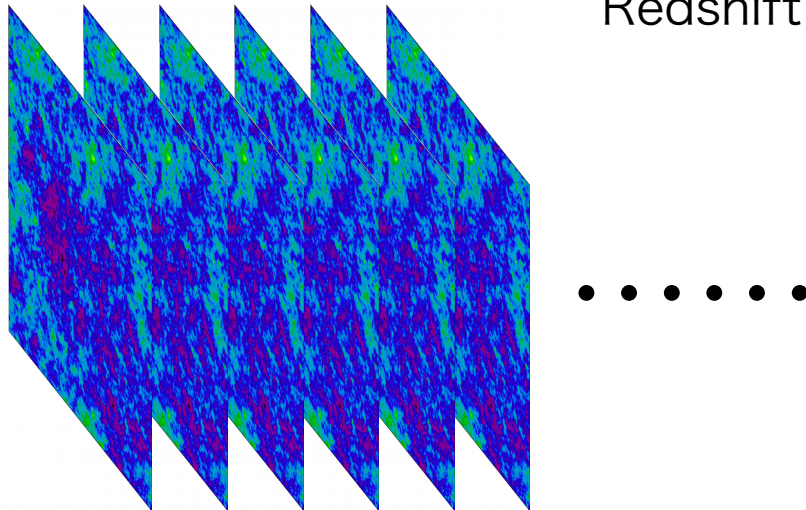
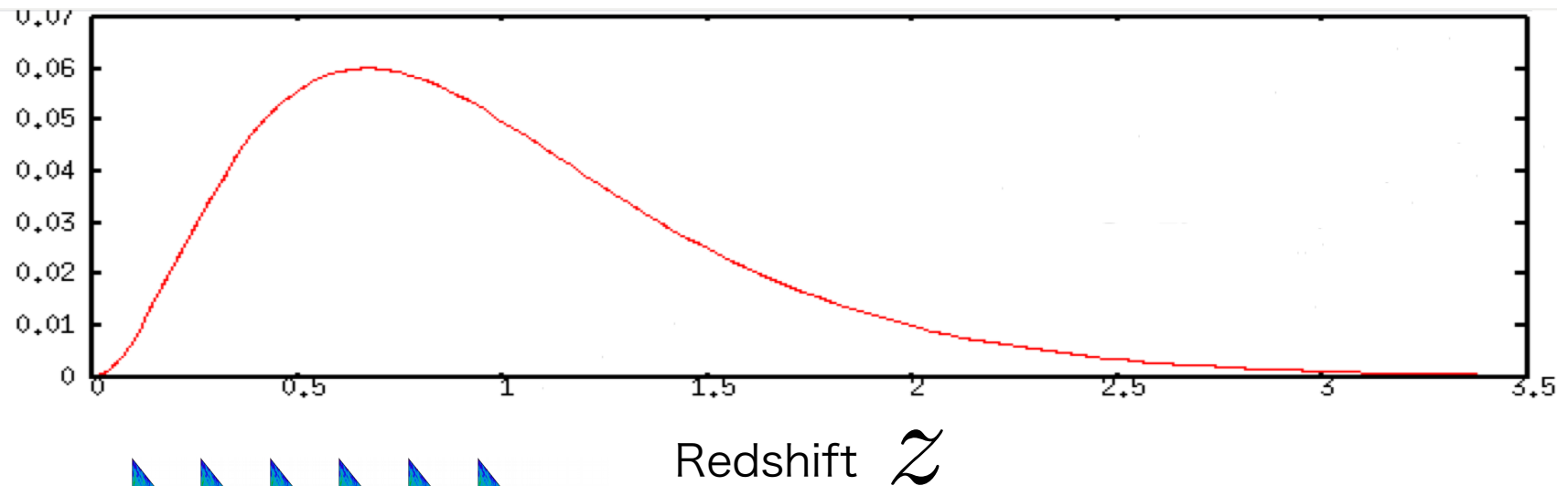
lognormal_lens consists of...

- **lognormal_galaxies** (by Makiya-san+)
 - generates DM and GALAXY distributions
 - without any modification
 - public
 - extremely faster than original version
- **RAYTRIX** (by Hamana-san)
 - Raytracing code
 - with some modifications
 - public
 - massively used and tested in HSC-related work



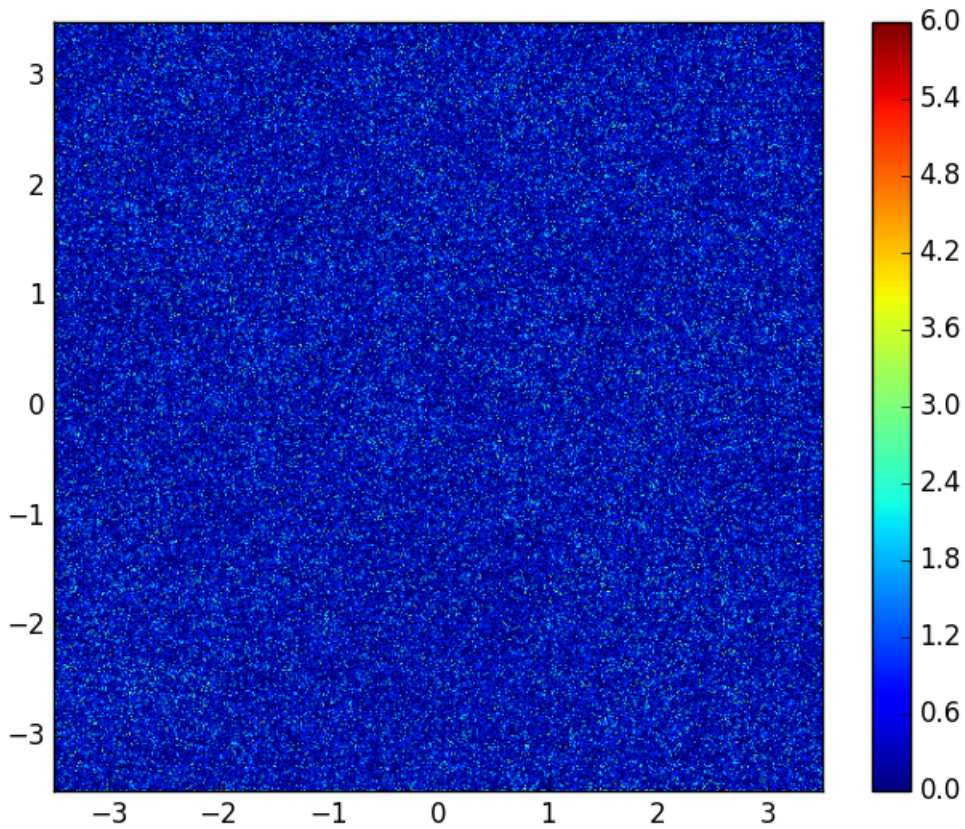
Source redshift distribution

$$p(z) \propto z^2 \exp\left(-\frac{z}{z_0}\right) \quad z_0 = 1/3 \text{ for HSC}$$

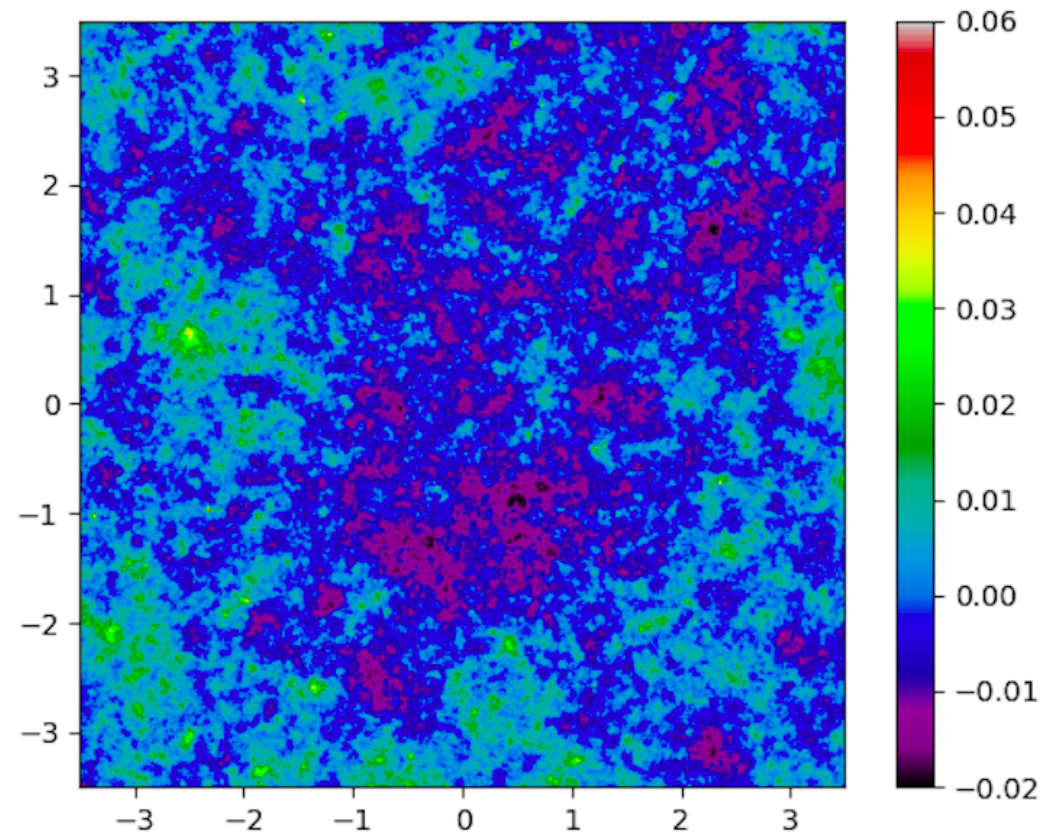


Resulting Maps

Galaxy map



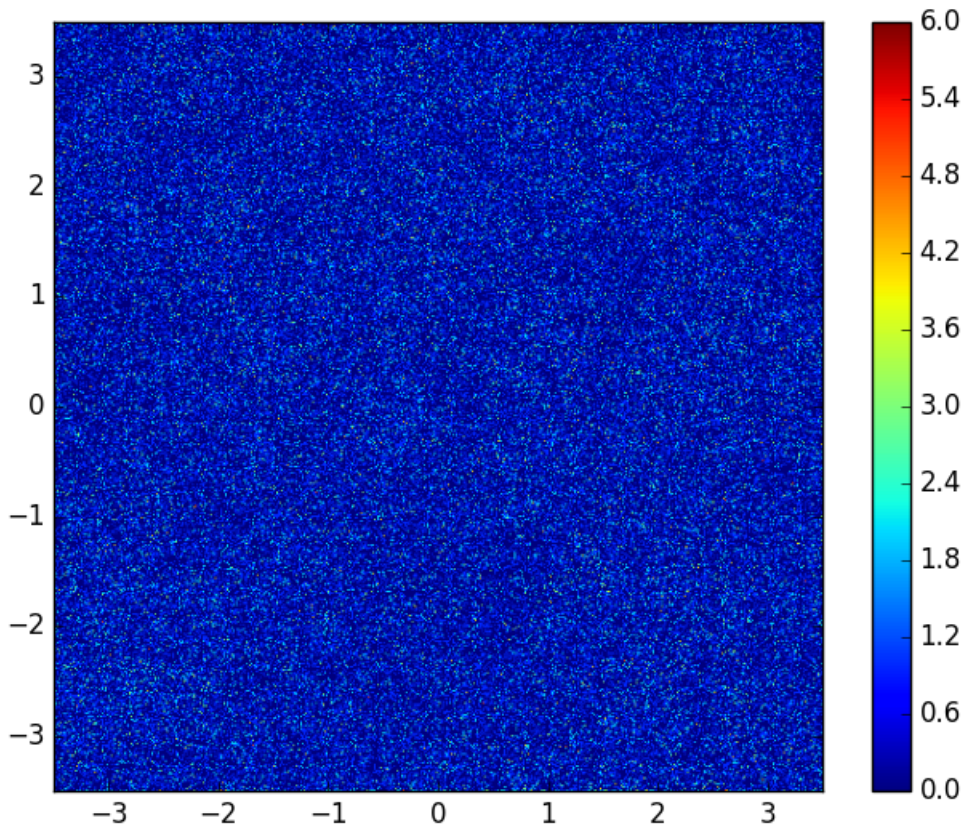
Lensing (convergence) map



PFS galaxies $z = 0.6 \sim 2.4$

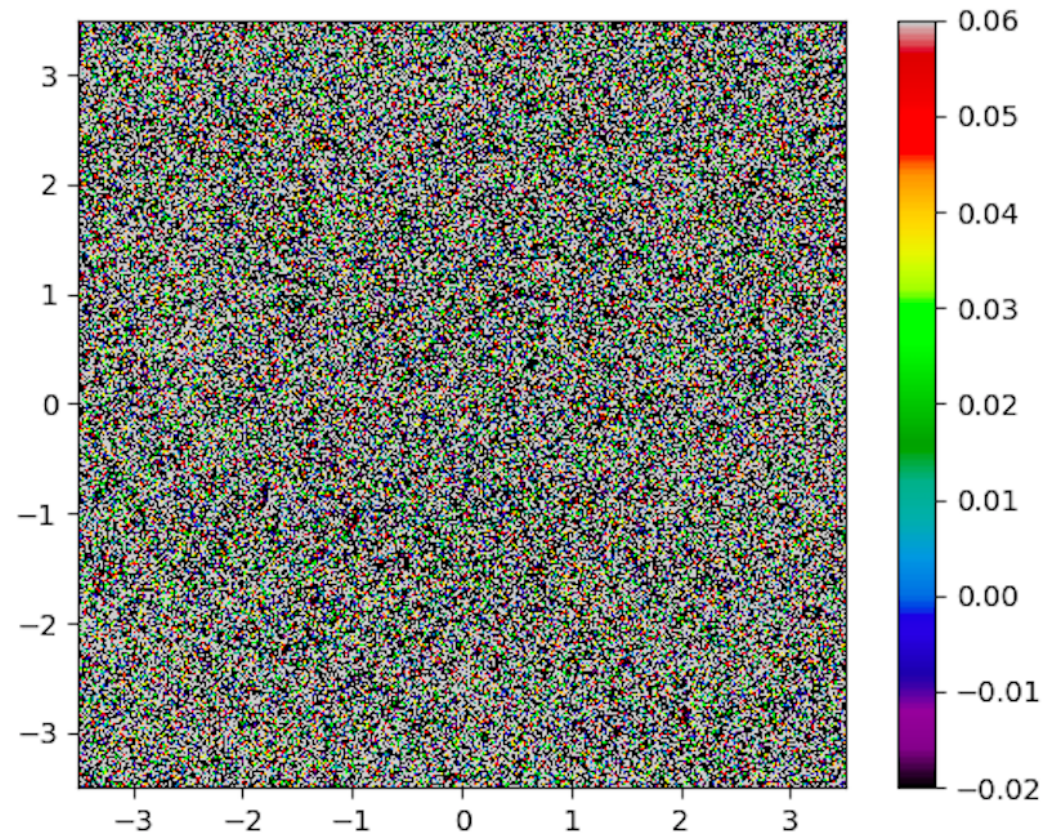
Resulting Maps

Galaxy map



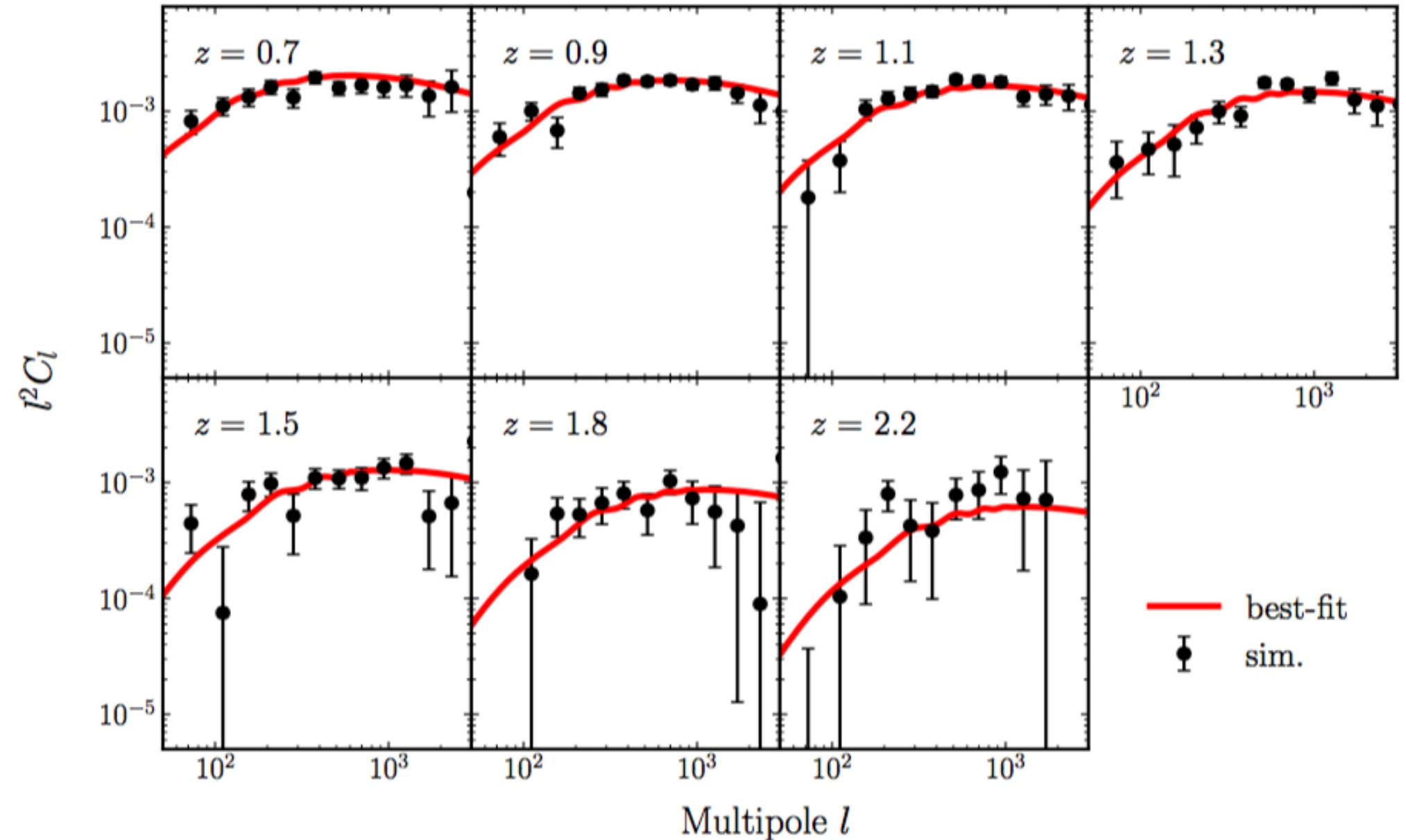
PFS galaxies $z = 0.6\sim 2.4$

Lensing (convergence) map



with shape noise

Cross-power with PFS slices



Science Goals

- The main scientific motivations for the “ultimate physics analysis” are three-folds:

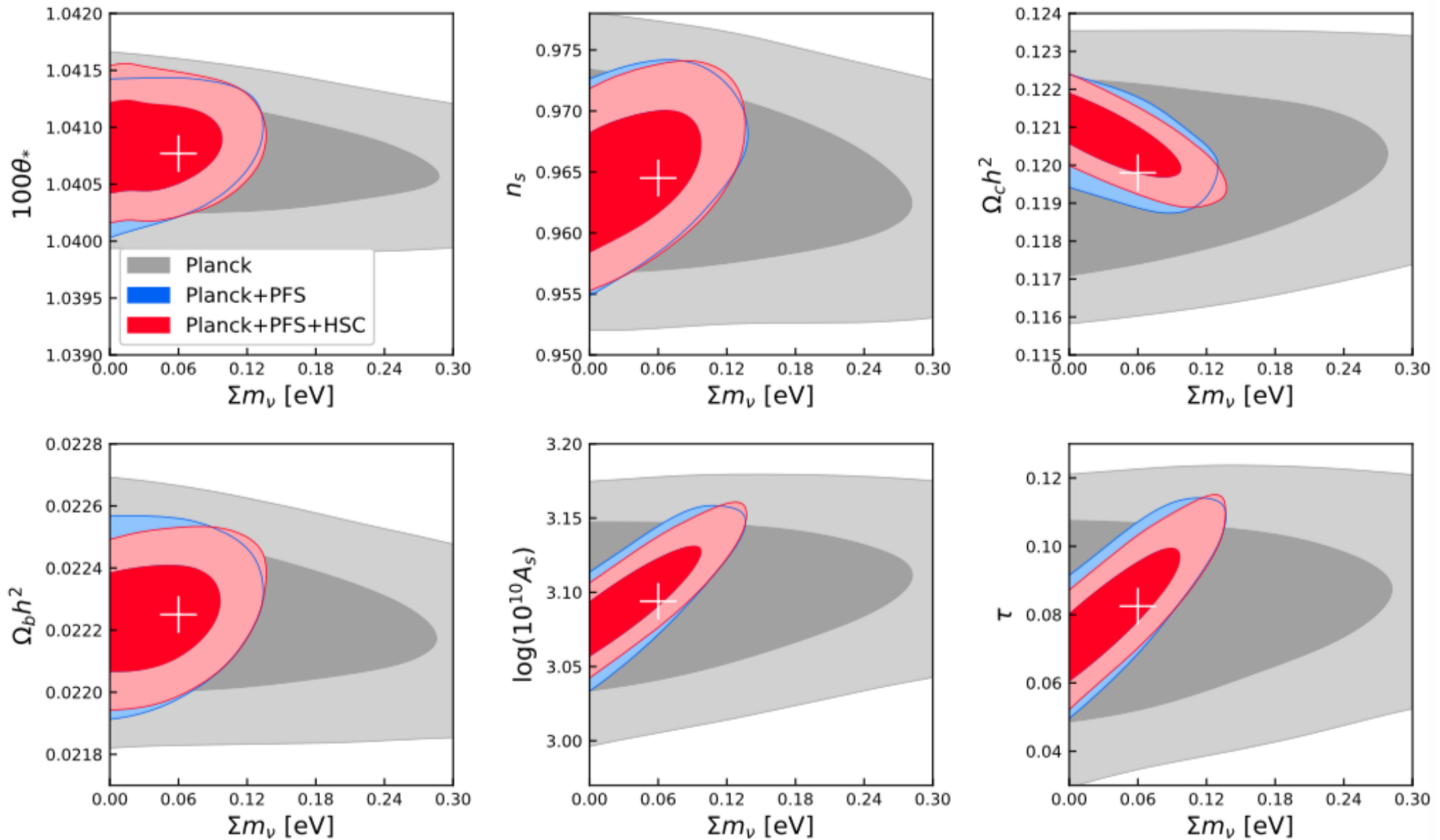
B02,03,04 Falsify the Λ CDM model by **ruling out Λ**

B01,02,03 Detect, or rule out, the inverted mass hierarchy of the neutrino mass by **measuring $\sum m_\nu < 0.1$ eV**
[95% CL]

B01 Find definitive evidence for inflation by **measuring primordial gravitational waves in the CMB**

From Eiichiro's slide

Resulting neutrino mass constraints (Λ CDM)

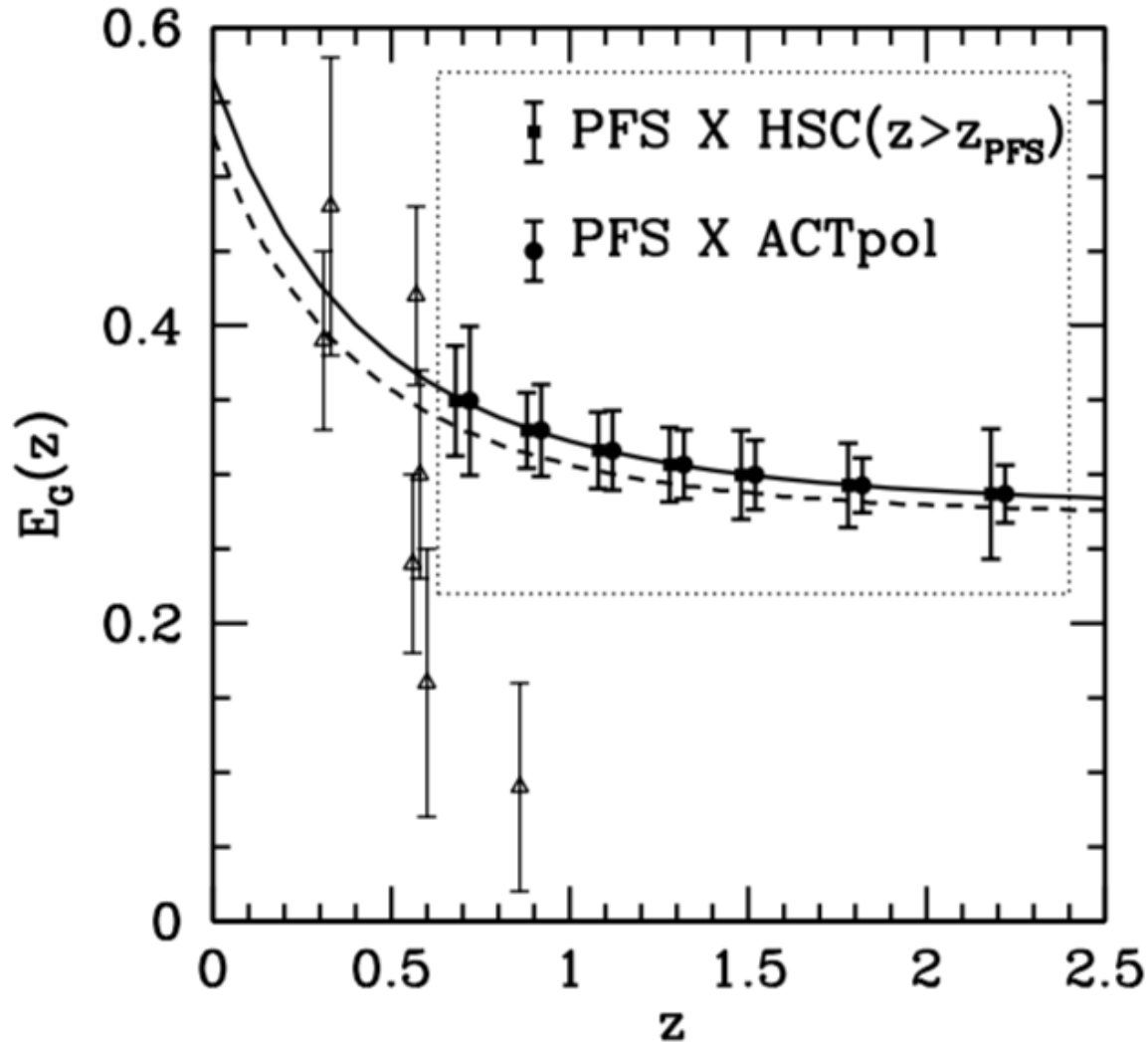


Summary

- Two codes are ready
 - `lognormal_galaxies`
 - `lognormal_lens`
- Cross-correlation of lens and galaxy
 - Neutrino mass < 0.1 eV
 - **PFS is powerful**, but lens contributes not that much...



Testing Modified Gravity



$$E_G \propto \frac{P_{\kappa g}}{P_{\theta g}}$$

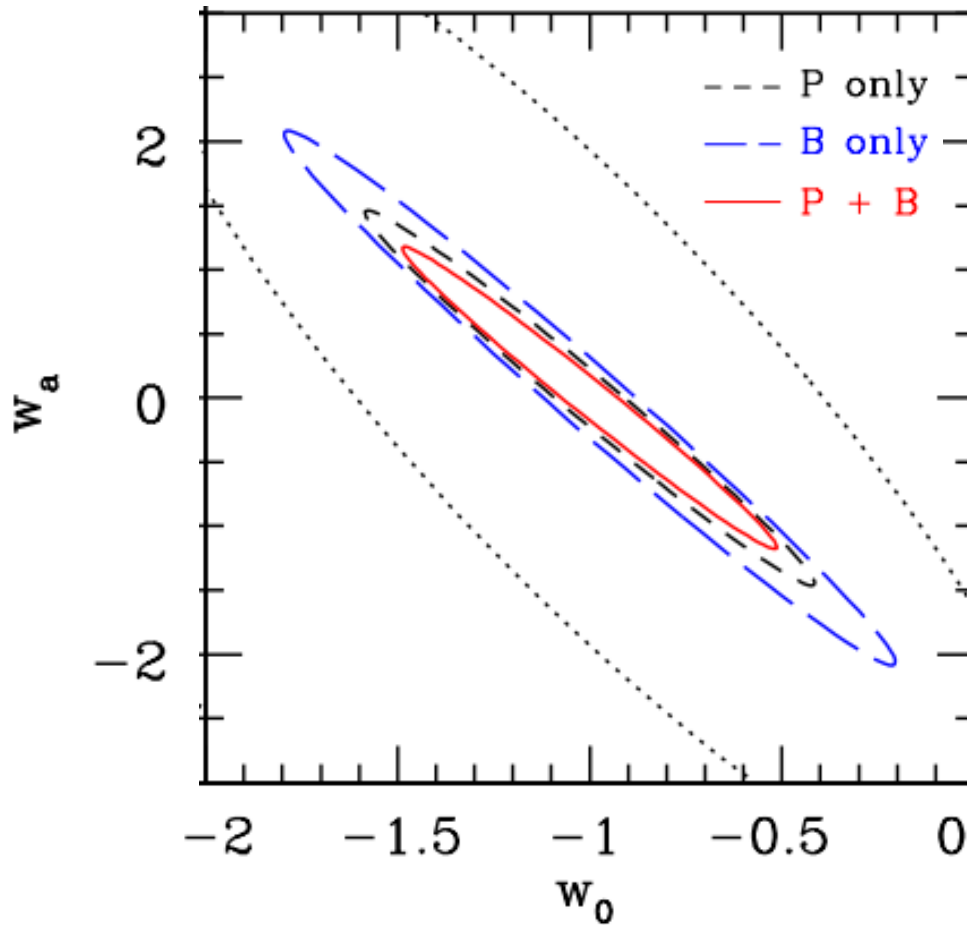
galaxy
lens
velocity

By Pengjie Zhang
from the PFS cosmology proposal

More synergy?

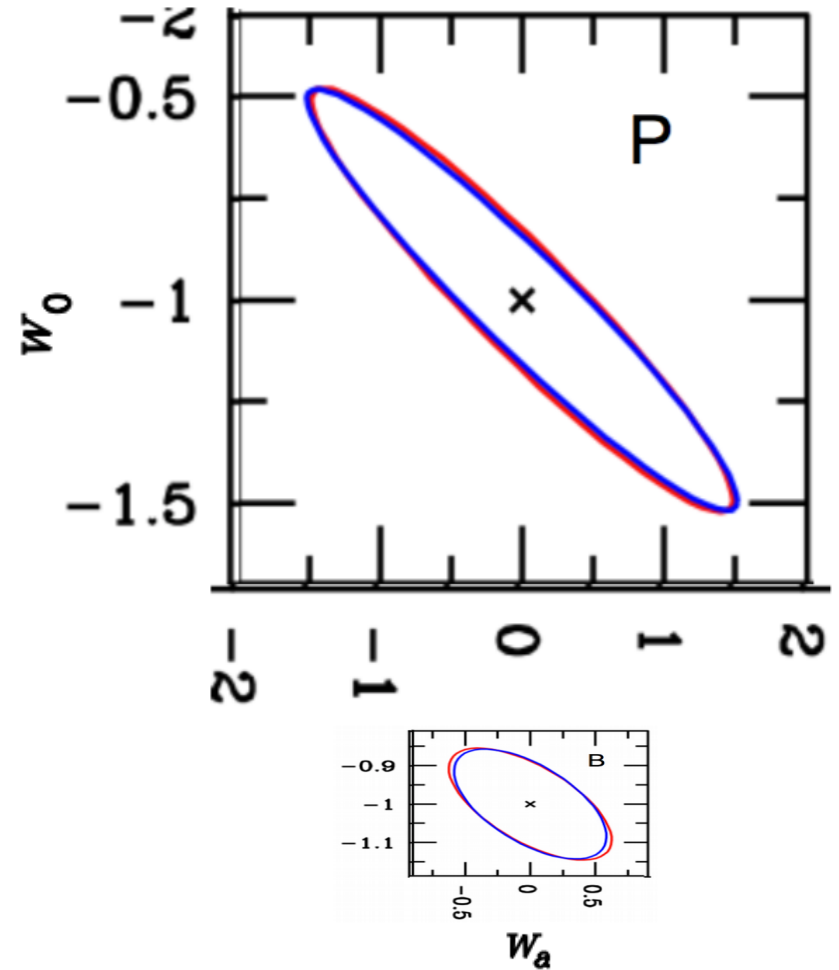
- Extracting HSC information much more
 - Higher order statistics? Bispectrum?
- Bispectrum of lens *does* recover information
 - lens-lens-lens bispectrum has been studied
 - Equivalent to 40% larger survey region
 - IK, Takada & Jain (2013), IK & Takada (2013)
 - No, bispectrum is much more powerful!
 - Sato & Nishimichi (2013)

Two conflicting claims



IK & Takada (2013)

$$P > B$$



Sato & Nishimichi (2013)

$$P \ll B$$

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- Cross-correlation of lens and galaxy
 - Neutrino mass < 0.1 eV
 - PFS is powerful, but lens contributes not that much...
- More synergy
 - E_G looks promising (by Pengjie Zhang)
 - Lens-galaxy bispectrum?

My homework this year!

