D01:
Ultimate Physics Analysis

Eiichiro Komatsu
(Max-Planck-Institut für Astrophysik / Kavli IPMU)
"*Cosmic Acceleration*" Symposium, Tohoku University
February 10, 2018

Why “Ultimate”?

- The aim is to develop a sound analysis method to use **<u>all information</u>** contained in **<u>multiple</u>** data sets
    - In practice, we restrict ourselves to quasi-linear regime where the amplitude of fluctuations is less than unity

Why "Ultimate"?

- The keyword is **"cross-correlations"**
- The starting point of D01 is to use all information contained in *two-point* statistics
  - Believe it or not, even this has not been done fully
- We ignore for the moment three-point and higher-order statistics (but see Kayo's talk)

LSS = Large-scale Structure; CMB = Cosmic Microwave Background

D01: The Core Team

I. Kayo
Tokyo Univ. of Tech

R. Makiya   E. Komatsu   S. Saito
MPA / Kavli IPMU

K. Takahashi
Kumamoto Univ.

- **LSS**
- **Lensing**

- **LSS**
- **Hot Gas**

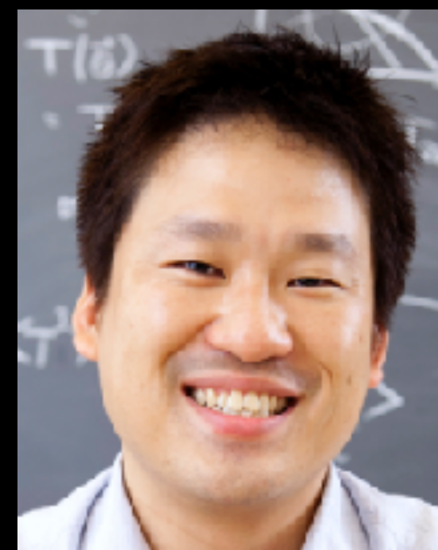
- **LSS**
- **CMB**

- **LSS**
- **Ly-alpha**

- **LSS**
- **21cm**

LSS = Large-scale Structure; CMB = Cosmic Microwave Background

The First "Acceleration Champions"!!



I. Kayo
Tokyo Univ. of Tech

R. Makiya

E. Komatsu

S. Saito

MPA / Kavli IPMU

K. Takahashi
Kumamoto Univ.

- **LSS**
- **Lensing**

- **LSS**
- **Hot Gas**

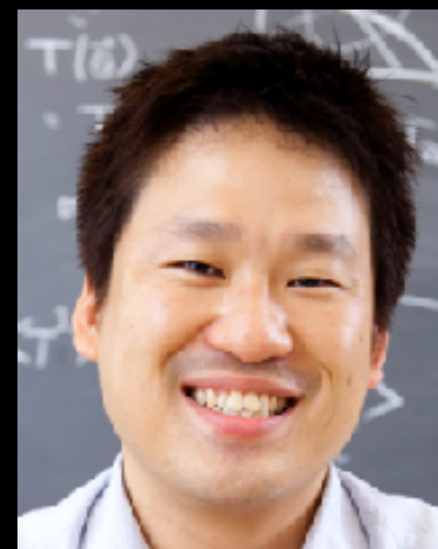
- **LSS**
- **CMB**

- **LSS**
- **Ly-alpha**

- **LSS**
- **21cm**

LSS = Large-scale Structure; CMB = Cosmic Microwave Background

D01: The Core Team



I. Kayo — Tokyo Univ. of Tech

R. Makiya, E. Komatsu, S. Saito — MPA / Kavli IPMU

K. Takahashi — Kumamoto Univ.

I. Kayo	R. Makiya	E. Komatsu	S. Saito	K. Takahashi
• **LSS**	• **LSS**	• **LSS**	• **LSS**	• **LSS**
• **Lensing**	• **Hot Gas**	• **CMB**	• **Ly-alpha**	• **21cm**

***Joint analysis*, fully taking into account the mutual cross-correlation**

Science Goals

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

B02,03,04 Falsify the ΛCDM 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**

「宇宙の加速膨張」：領域代表　村山　斉

領域事務　片山伸彦

[X00]総括班 村山 (IPMU)	[A01]Inflation 佐々木 (京都)	[A02]構造と揺らぎ 高橋 (東北)	[A02]dark energy 杉山 (名古屋)
[B01]CMB偏光 羽澄 (KEK)	$\delta\rho/\rho$, r, n_s 直接検証	CMB lensing isocurv, m_ν	cosm. params CMB lensing
[B02]imaging 宮崎 (NAOJ)	b(k)測定→ $P_{\rm primord}(k)$	weak lensing m_ν	weak lensing SNe-Ia, γ
[B03]spectroscopy 高田 (IPMU)	*primord. NG,* n_s, α_s, Ω_k	dSph, isocurv $P(k)$, m_ν	BAO $\Omega_\Lambda(z)$, γ
[B04]将来計画 臼田 (NAOJ)	varying α	Lyman α	加速直接測定
[C01]究極理論 大栗 (Caltech/IPMU)	mod. grav $>M_{Pl}$? BD?	non-Std DM	models mod. grav.

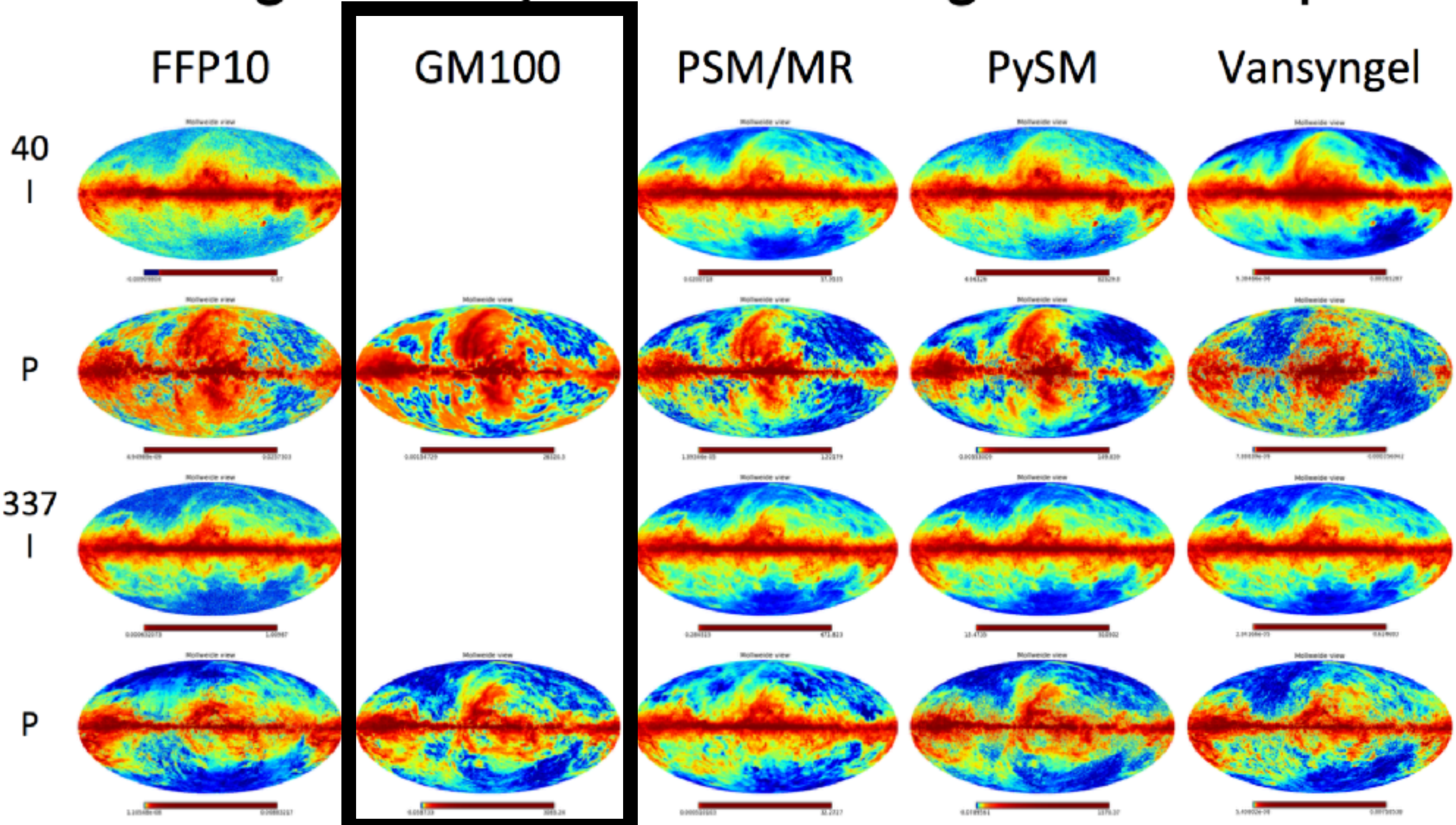
[D01]データ解析班　小松 (MPA/IPMU)

Visible Contributions to B01, 02, and 03

- **B01: CMB Sky Simulation Package "GM100"**
  - Used by the LiteBIRD foreground study group both inside and outside Japan
- **B02: Lensing Simulation "lognormal_lens" (Kayo's talk)**
  - For detailed study of the synergy between B02 and B03
- **B03: Galaxy Simulation "lognormal_galaxies" (published)**
  - Playing a leading role in shaping up the SSP Cosmology Program of PFS

B01 LiteBIRD Sky Simulation

Histogram-Equalized Foreground Maps



GM100

- Overview
- Source
- Commits
- Branches
- Pull requests
- Pipelines
- Downloads

by Hiroaki Kanai (YNU)

h kan / GM100

Overview

HTTPS https://bitbucket.org/h_kan/gm100.gi

Last updated 2018-01-27
Access level Read

0 Open PRs	1 Watcher
1 Branch	0 Forks

```
README
last update: 2017/12/7
GM100 (generation 100 maps)
----------------------------------------------------------------

Description:
This code generates simulated full-sky polarization ma
By using different random seeds, 100 different maps ar
each 15 bands. So 100 * 15 bands = 1500 fits files wil

----------------------------------------------------------------

Requirement:
This code is written by python, and needs the followin
Versions of those that it is known to work with are:

   - python 2.7.10
   - healpy 1.10.1
   - numpy 1.11.2
   - pyfits 3.3

----------------------------------------------------------------
```

Recent activity

1 commit
Pushed to h_kan/gm100
436426b fix bugs of gen.py
h kan · 2018-01-27

1 commit
Pushed to h_kan/gm100
5b8a219 fix bug of gen.py an
h kan · 2017-12-17

1 commit
Pushed to h_kan/gm100
35fb96e fix config_fg
h kan · 2017-12-17

1 commit
Pushed to h_kan/gm100
26e8210 fix gen_fg bug
h kan · 2017-12-17

1 commit
Pushed to h_kan/gm100
1345389 bug fixed
h kan · 2017-12-17

B03 PFS Cosmology Program

PFS SSP: COSMOLOGY PROGRAM

A. Boyle,[1] S. de la Torre,[2] R. de Putter,[3] O. Doré,[3,4] C. Hikage,[5] Y.-P. Jing,[6,7] I. Kayo,[8] E. Komatsu,[1,5] R. Makiya,[1,5] T. Okumura,[9] A. Pisani,[10] A. G. Sánchez,[11] S. Saito,[1] F. Schmidt,[1] M. A. Strauss,[10] T. Sunayama,[5] M. Takada,[5] P. Zhang,[12,7] and G.-B. Zhao[13,14]

(Dated: November 25, 2017)

ABSTRACT

With about 100 nights of the cosmology program of the PFS SSP, we aim at achieving two major goals: (1) To rule out the inverted hierarchy of neutrino masses by measuring $\sum m_\nu < 0.1$ eV at the 95% CL, or to determine the total mass of neutrinos if $\sum m_\nu > 0.1$ eV; and (2) To rule out the standard Λ Cold Dark Matter (ΛCDM) paradigm by finding a time evolution of dark energy density (thus ruling out the cosmological constant Λ) or finding evidence for a correction to General Relativity (GR) on cosmological scales, or to confirm ΛCDM with unprecedented precision. We shall achieve these goals by mapping out cosmological distance, the expansion rate of the Universe, and the growth rate of matter density fluctuations as a function of redshift, with only a few percent uncertainty in each of seven redshift bins between $z = 0.6$ and 2.4. We also make the full use of synergy with the imaging data from the HSC SSP; adding the cross-correlation between 3-dimensional galaxy positions from the PFS and weak gravitational lensing shears from the HSC not only improves the constraints on the neutrino mass, dark energy, and modified gravity, but also provides an important cross check of the results if we measure the neutrino mass, or discover time-evolving dark energy or the breakdown of GR on large scales, which would transform our understanding of the Universe.

B03 PFS Cosmology Program

PFS SSP: COSMOLOGY PROGRAM

A. Boyle,[1] S. de la Torre,[2] R. de Putter,[3] O. Doré,[3,4] C. Hikage,[5] Y.-P. Jing,[6,7] I. Kayo, E. Komatsu[1,5] R. Makiya,[5] T. Okumura,[9] A. Pisani,[10] A. G. Sánchez,[11] S. Saito[1] F. Schmidt,[1] M. A. Strauss,[10] T. Sunayama,[5] M. Takada,[5] P. Zhang,[12,7] and G.-B. Zhao[13,14]

D01 contributors

(Dated: November 25, 2017)

ABSTRACT

With about 100 nights of the cosmology program of the PFS SSP, we aim at achieving two major goals: (1) To rule out the inverted hierarchy of neutrino masses by measuring $\sum m_\nu < 0.1$ eV at the 95% CL, or to determine the total mass of neutrinos if $\sum m_\nu > 0.1$ eV; and (2) To rule out the standard Λ Cold Dark Matter (ΛCDM) paradigm by finding a time evolution of dark energy density (thus ruling out the cosmological constant Λ) or finding evidence for a correction to General Relativity (GR) on cosmological scales, or to confirm ΛCDM with unprecedented precision. We shall achieve these goals by mapping out cosmological distance, the expansion rate of the Universe, and the growth rate of matter density fluctuations as a function of redshift, with only a few percent uncertainty in each of seven redshift bins between $z = 0.6$ and 2.4. We also make the full use of synergy with the imaging data from the HSC SSP; adding the cross-correlation between 3-dimensional galaxy positions from the PFS and weak gravitational lensing shears from the HSC not only improves the constraints on the neutrino mass, dark energy, and modified gravity, but also provides an important cross check of the results if we measure the neutrino mass, or discover time-evolving dark energy or the breakdown of GR on large scales, which would transform our understanding of the Universe.

B03 PFS Cosmology Program

PFS SSP: COSMOLOGY PROGRAM

A. Boyle,[1] S. de la Torre,[2] R. de Putter,[3] O. Doré,[3,4] C. Hikage, Y.-P. Jing,[6,7] I. Kayo, E. Komatsu[1,5]
R. Makiya,[5] T. Okumura,[9] A. Pisani,[10] A. G. Sánchez,[11] S. Saito[1] F. Schmidt,[1] M. A. Strauss,[1] T. Sunayama,
M. Takada[5] P. Zhang,[12,7] and G.-B. Zhao[13,14]

B03 contributors

(Dated: November 25, 2017)

D01 contributors

ABSTRACT

With about 100 nights of the cosmology program of the PFS SSP, we aim at achieving two major goals: (1) To rule out the inverted hierarchy of neutrino masses by measuring $\sum m_\nu < 0.1$ eV at the 95% CL, or to determine the total mass of neutrinos if $\sum m_\nu > 0.1$ eV; and (2) To rule out the standard Λ Cold Dark Matter (ΛCDM) paradigm by finding a time evolution of dark energy density (thus ruling out the cosmological constant Λ) or finding evidence for a correction to General Relativity (GR) on cosmological scales, or to confirm ΛCDM with unprecedented precision. We shall achieve these goals by mapping out cosmological distance, the expansion rate of the Universe, and the growth rate of matter density fluctuations as a function of redshift, with only a few percent uncertainty in each of seven redshift bins between $z = 0.6$ and 2.4. We also make the full use of synergy with the imaging data from the HSC SSP; adding the cross-correlation between 3-dimensional galaxy positions from the PFS and weak gravitational lensing shears from the HSC not only improves the constraints on the neutrino mass, dark energy, and modified gravity, but also provides an important cross check of the results if we measure the neutrino mass, or discover time-evolving dark energy or the breakdown of GR on large scales, which would transform our understanding of the Universe.

Work Horse: "log-normal_galaxies"

Overview

HTTPS https://komatsu5147@bitbucket.org/l

Last updated 2017-06-29 Access level Admin	3 Open PRs	3 Watchers
	6 Branches	0 Forks

Edit README

Log-normal galaxies

Codes for generating log-normal realisations of galaxies in redshift-space, and computing the monopole, quadrupole, and hexadecapole power spectra.

Reference: A. Agrawal, R. Makiya, C.-T. Chiang, D. Jeong, S. Saito, and E. Komatsu, arXiv:1706.09195

History

- Originally developed by Donghui Jeong (Penn State Univ.) in 2011
- Enhanced by Chi-Ting Chiang (Stony Brook Univ.) through 2015 (arXiv:1306.4157 is based on this code)
- Packaged by Eiichiro Komatsu on December 28, 2015
- (v2) includes a fix in "calc_pk_const_los_ngp" by Issha

Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal

Generating log-normal mock catalog of galaxies in redshift space

Aniket Agrawal,[a] Ryu Makiya,[a,b] Chi-Ting Chiang,[c] Donghui Jeong,[d,e] Shun Saito[a] and Eiichiro Komatsu[a,b]

[a]Max-Planck-Institut für Astrophysik, Karl-Schwarzschild-Str. 1, 85741 Garching, Germany
[b]Kavli Institute for the Physics and Mathematics of the Universe, Todai Institutes for Advanced Study, the University of Tokyo, (Kavli IPMU, WPI), Kashiwa, 277-8583, Japan
[c]C.N. Yang Institute for Theoretical Physics, Department of Physics & Astronomy, Stony Brook University, Stony Brook, NY 11794, U.S.A.
[d]Department of Astronomy and Astrophysics, The Pennsylvania State University, University Park, PA 16802, U.S.A.
[e]Institute for Gravitation and the Cosmos, The Pennsylvania State University, University Park, PA 16802, U.S.A.

E-mail: aniket@mpa-garching.mpg.de, makiya@mpa-garching.mpg.de, chi-ting.chiang@stonybrook.edu, djeong@psu.edu, ssaito@mpa-garching.mpg.de, komatsu@mpa-garching.mpg.de

Received June 29, 2017
Accepted September 6, 2017
Published October 3, 2017

Abstract. We present a public code to generate a mock galaxy catalog in redshift space assuming a log-normal probability density function (PDF) of galaxy and matter density fields. We draw galaxies by Poisson-sampling the log-normal field, and calculate the velocity field from the linearised continuity equation of matter fields, assuming zero vorticity. This procedure yields a PDF of the pairwise velocity fields that is qualitatively similar to that of N-body simulations. We check fidelity of the catalog, showing that the measured two-point correlation function and power spectrum in real space agree with the input precisely. We find that a linear bias relation in the power spectrum does not guarantee a linear bias relation in the density contrasts, leading to a cross-correlation coefficient of matter and galaxies deviating from unity on small scales. We also find that linearising the Jacobian of the real-to-redshift space mapping provides a poor model for the two-point statistics in redshift space. That is, non-linear redshift-space distortion is dominated by non-linearity in the Jacobian. The power spectrum in redshift space shows a damping on small scales that is qualitatively similar to that of the well-known Fingers-of-God (FoG) effect due to random velocities, except that

JCAP10(2017)003

Work Horse: “log-normal_galaxies”

Overview

HTTPS https://komatsu5147@bitbucket.org/l

Last updated 2017-06-29 Access level Admin	3 Open PRs	3 Watchers
	6 Branches	0 Forks

Edit README

Lo

Co
rec
he

Re
Sa

Hi




Ryu Makiya / Aniket Agrawal / Shun Saito
(Kavli IPMU/MPA) (MPA) (MPA)

Chi-Ting Chiang
(Stony Brook)

Donghui Jeong
(Penn State)

- Packaged by Eiichiro Komatsu on December 28, 2015
- (v2) includes a fix in "calc_pk_const_los_ngp" by Issha

Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal

Generating log-normal mock catalog of galaxies in redshift space

Aniket Agrawal,[a] Ryu Makiya,[a,b] Chi-Ting Chiang,[c] Donghui Jeong,[d,e] Shun Saito[a] and Eiichiro Komatsu[a,b]

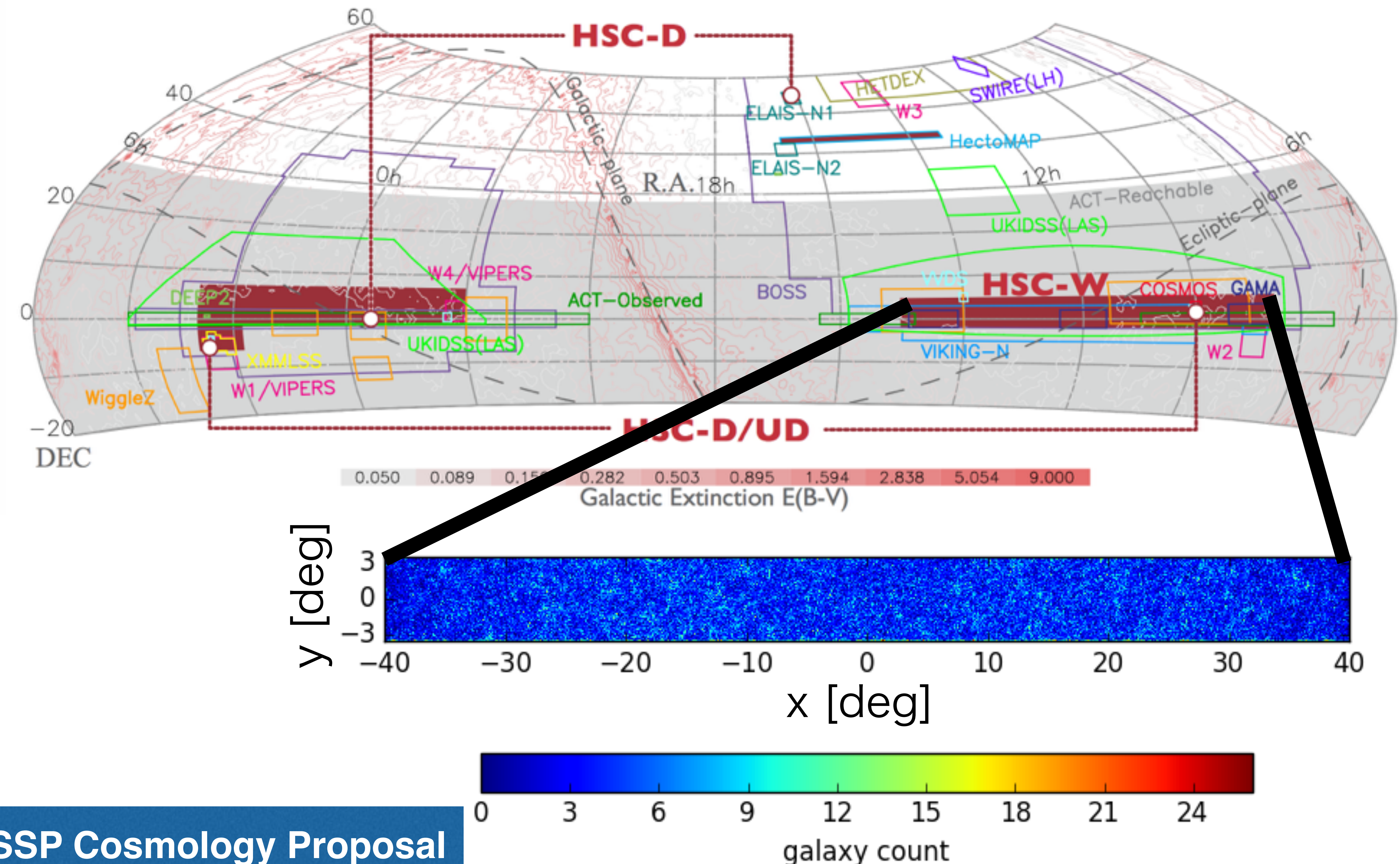
[a]Max-Planck-Institut für Astrophysik,
Karl-Schwarzschild-Str. 1, 85741 Garching, Germany
[b]Kavli Institute for the Physics and Mathematics of the Universe,
Todai Institutes for Advanced Study, the University of Tokyo, (Kavli IPMU, WPI),
Kashiwa, 277-8583, Japan
[c]C.N. Yang Institute for Theoretical Physics,

non-linear redshift-space distortion is dominated by non-linearity in the Jacobian. The power spectrum in redshift space shows a damping on small scales that is qualitatively similar to that of the well-known Fingers-of-God (FoG) effect due to random velocities, except that

JCAP10(2017)0

simulated galaxy map

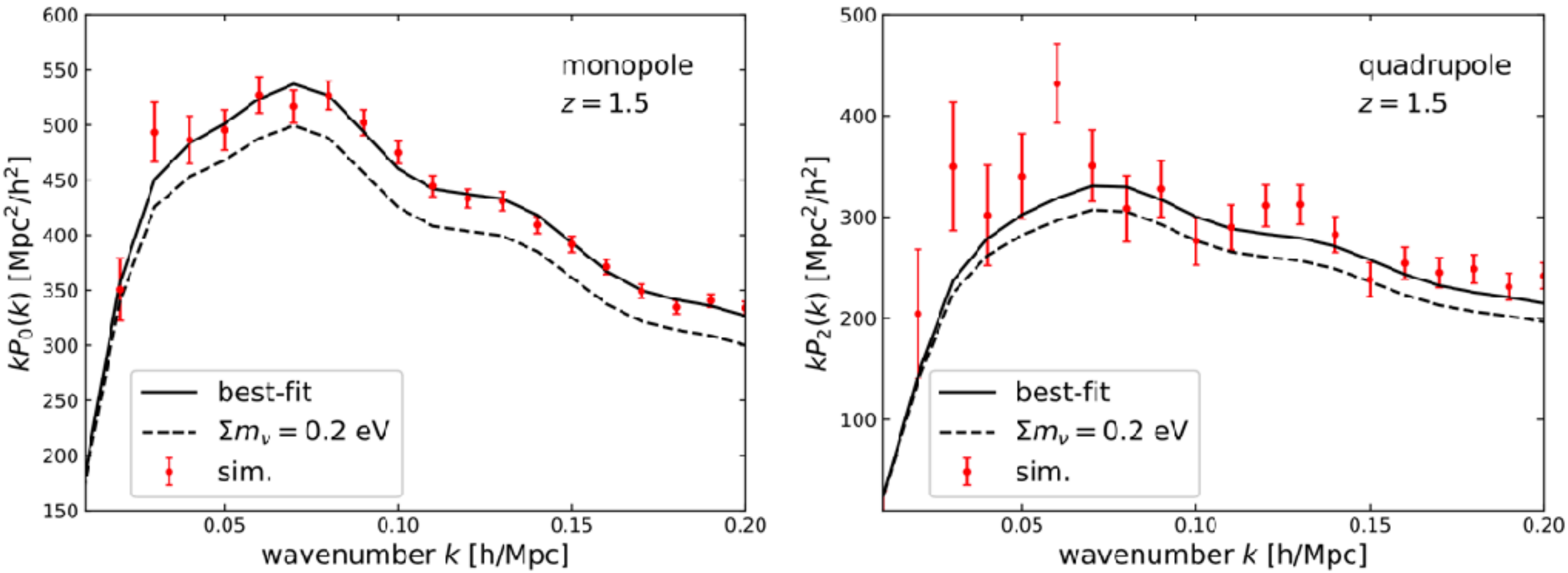
z = 1.5, spring field



SSP Cosmology Proposal

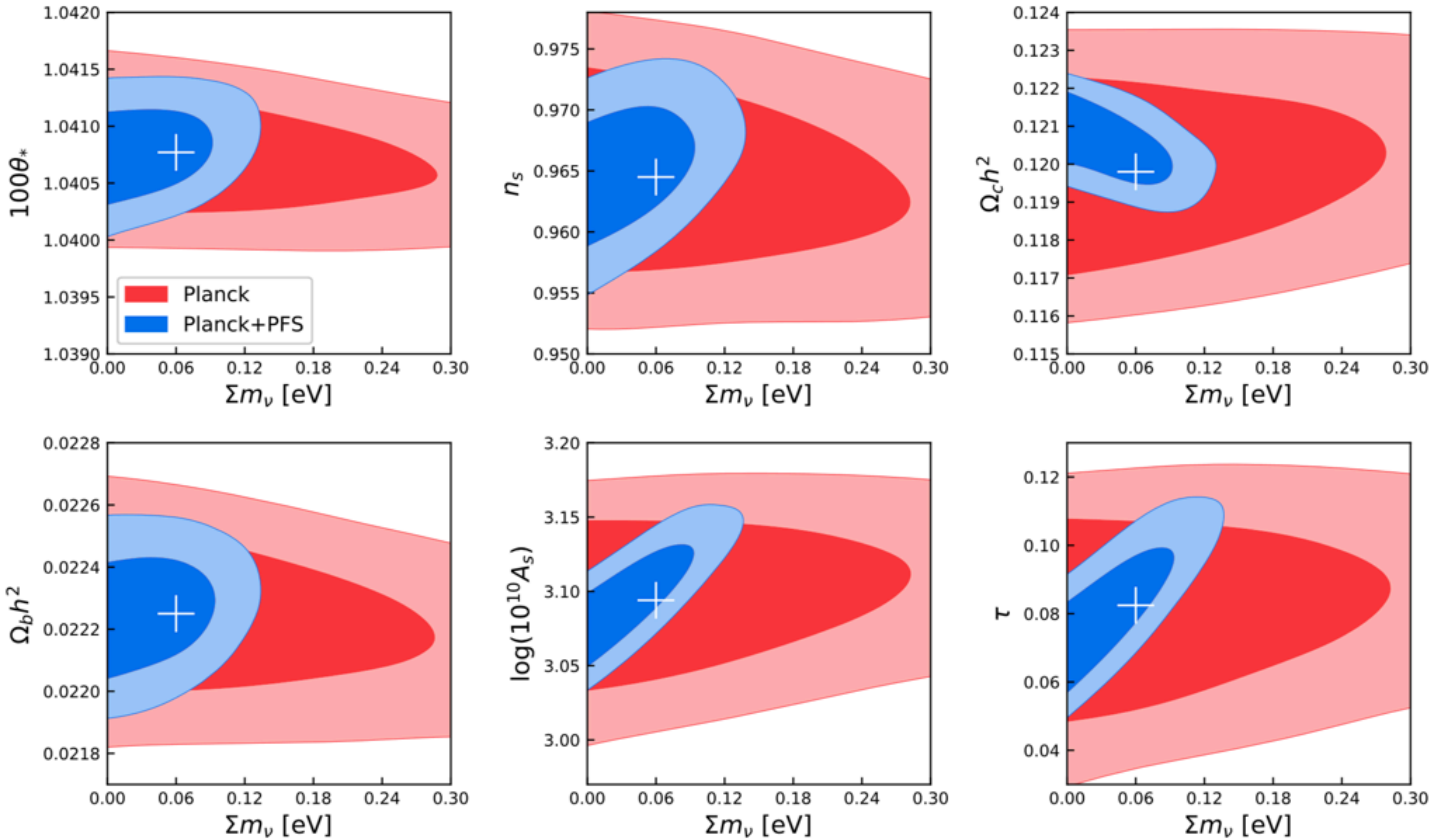
Example Deliverables: Galaxy Power Spectra

by R. Makiya



- There are six more redshift bins

[One of the] Expected Main Plot in the Cosmology Paper! by R. Makiya



B02

Synergy: HSC+PFS

PFS SSP: COSMOLOGY PROGRAM

A. Boyle,[1] S. de la Torre,[2] R. de Putter,[3] O. Doré,[3,4] C. Hikage,[5] Y.-P. Jing,[6,7] I. Kayo,[8] E. Komatsu,[1,5] R. Makiya,[1,5] T. Okumura,[9] A. Pisani,[10] A. G. Sánchez,[11] S. Saito,[1] F. Schmidt,[1] M. A. Strauss,[10] T. Sunayama,[5] M. Takada,[5] P. Zhang,[12,7] and G.-B. Zhao[13,14]

(Dated: November 25, 2017)

ABSTRACT

With about 100 nights of the cosmology program of the PFS SSP, we aim at achieving two major goals: (1) To rule out the inverted hierarchy of neutrino masses by measuring $\sum m_\nu < 0.1$ eV at the 95% CL, or to determine the total mass of neutrinos if $\sum m_\nu > 0.1$ eV; and (2) To rule out the standard Λ Cold Dark Matter (ΛCDM) paradigm by finding a time evolution of dark energy density (thus ruling out the cosmological constant Λ) or finding evidence for a correction to General Relativity (GR) on cosmological scales, or to confirm ΛCDM with unprecedented precision. We shall achieve these goals by mapping out cosmological distance, the expansion rate of the Universe, and the growth rate of matter density fluctuations as a function of redshift, with only a few percent uncertainty in each of seven redshift bins between $z = 0.6$ and 2.4. We also make the full use of synergy with the imaging data from the HSC SSP; adding the cross-correlation between 3-dimensional galaxy positions from the PFS and weak gravitational lensing shears from the HSC not only improves the constraints on the neutrino mass, dark energy, and modified gravity, but also provides an important cross check of the results if we measure the neutrino mass, or discover time-evolving dark energy or the breakdown of GR on large scales, which would transform our understanding of the Universe.

B02

Synergy: HSC+PFS

PFS SSP: COSMOLOGY PROGRAM

A. Boyle,[1] S. de la Torre,[2] R. de Putter,[3] O. Doré,[3,4] C. Hikage,[5] Y.-P. Jing,[6,7] I. Kayo,[8] E. Komatsu,[1,5] R. Makiya,[1,5] T. Okumura,[9] A. Pisani,[10] A. G. Sánchez,[11] S. Saito,[1] F. Schmidt,[1] M. A. Strauss,[10] T. Sunayama,[5] M. Takada,[5] P. Zhang,[12,7] and G.-B. Zhao[13,14]

(Dated: November 25, 2017)

ABSTRACT

With about 100 nights of the cosmology program of the PFS SSP, we aim at achieving two major goals: (1) To rule out the inverted hierarchy of neutrino masses by measuring $\sum m_\nu < 0.1$ eV at the 95% CL, or to determine the total mass of neutrinos if $\sum m_\nu > 0.1$ eV; and (2) To rule out the standard Λ Cold Dark Matter (ΛCDM) paradigm by finding a time evolution of dark energy density (thus ruling out the cosmological constant Λ) or finding evidence for a correction to General Relativity (GR) on cosmological scales, or to confirm ΛCDM with unprecedented precision. We shall achieve these goals by mapping out cosmological distance, the expansion rate of the Universe, and the growth rate of matter density fluctuations as a function of redshift, with only a few percent uncertainty in each of seven redshift

We also make the full use of synergy with the imaging data from the HSC SSP

the HSC not only improves the constraints on the neutrino mass, dark energy, and modified gravity, but also provides an important cross check of the results if we measure the neutrino mass, or discover time-evolving dark energy or the breakdown of GR on large scales, which would transform our understanding of the Universe.

Issha Kayo / lognormal_lens

Overview

HTTPS https://komatsu5147@bitbucket.org/

Last updated 2017-05-29	0 Open PRs	1 Watcher
Access level Write (revoke)	1 Branch	0 Forks

Edit README

Log-normal lens

Log-normal simulation of the convergence fields.
To run the code users also need to install lognormal_galaxies

History

- Originally developed by Issha Kayo (Tokyo University of Technology) in 2017

Overview

This package consists of the following steps:

1. Generate the matter and galaxy density field by using the external code, lognormal_galaxies
2. Ray-trace the matter density field to construct the convergence fields by using RAYTRIX, which is included in

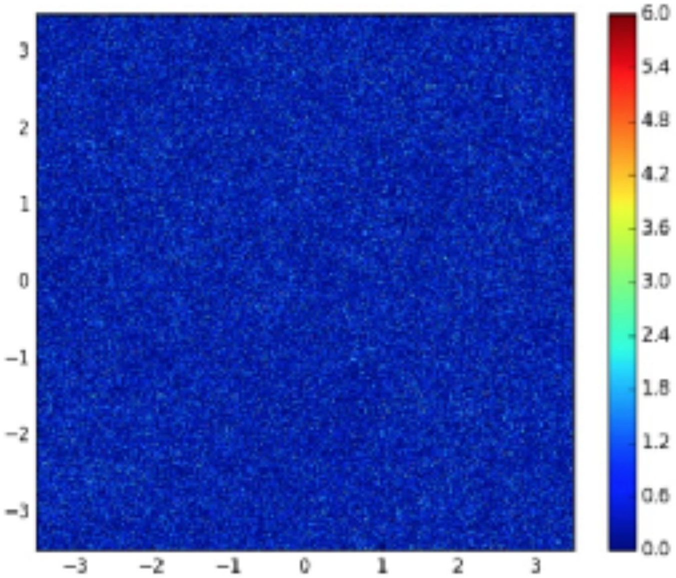
Log-normal simulation for weak gravitational lensing: application to the cross-correlation with galaxies

Ryu Makiya,[a,b] Issha Kayo,[c] Eiichiro Komatsu[a,b]

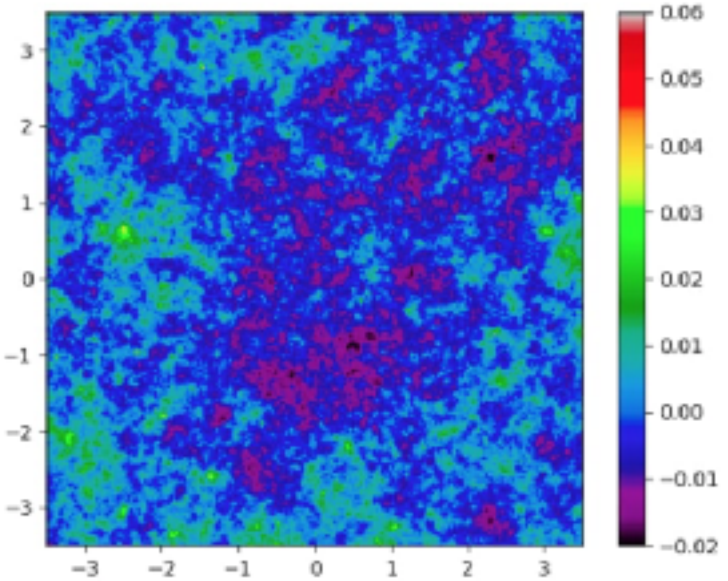
[a]Max-Planck-Institut für Astrophysik, Karl-Schwarzschild-Str. 1, 85741 Garching, Germany
[b]Kavli Institute for the Physics and Mathematics of the Universe, Todai Institutes for Advanced Study, the University of Tokyo, Kashiwa, Japan 277-8583 (Kavli IPMU, WPI)
[c]Department of Liberal Arts, Tokyo University of Technology, 5-23-22 Nishikamata, Ota-ku, Tokyo, Japan

E-mail: makiya@mpa-garching.mpg.de, kayouissha@stf.teu.ac.jp

Abstract. We ray-trace cosmic density fluctuations that follow a log-normal distribution to produce maps of weak gravitational lensing shear fields. Cross-correlation of weak lensing maps with positions of galaxies is a powerful probe of cosmology, including the mass of neutrinos. We use our simulations to study the improvement on the constraints on neutrino masses by adding the weak lensing data of, e.g., Hyper Suprime-Cam (HSC) survey, to the galaxy power spectrum in redshift space of, e.g., Prime Focus Spectrograph (PFS) survey, both on Subaru Telescope. We find that the nominal PFS survey reaches the threshold for testing the inverted mass hierarchy of $\sum m_\nu \approx 0.1$ eV assuming a flat ΛCDM model, and that adding the HSC data pushes the limit to $\sum m_\nu \approx TBD$ eV. While relaxing the assumption of the cosmological constant increases the uncertainty in the neutrino mass constraint, the weak lensing data help...? (TBD) We also simulate galaxy positions in redshift space and weak lensing data for Eulid- and WFIRST-like surveys, finding similar results.



PFS galaxies



HSC lensing

Issha Kayo / lognormal_lens

Overview

HTTPS https://komatsu5147@bitbucket.org/

Last updated 2017-05-29	0 Open PRs	1 Watcher
Access level Write (revoke)	1 Branch	0 Forks

Edit README

Log-normal lens

Issha Kayo (Tokyo Univ. of Tech) **Ryu Makiya (Kavli IPMU/MPA)**

2. Ray-trace the matter density field to construct the convergence fields by using RAYTRIX, which is included in

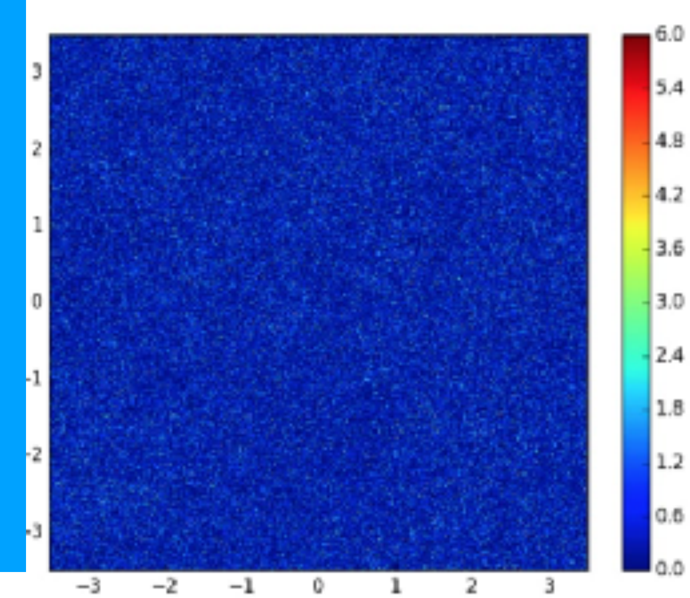
Log-normal simulation for weak gravitational lensing: application to the cross-correlation with galaxies

Ryu Makiya,[a,b] Issha Kayo,[c] Eiichiro Komatsu[a,b]

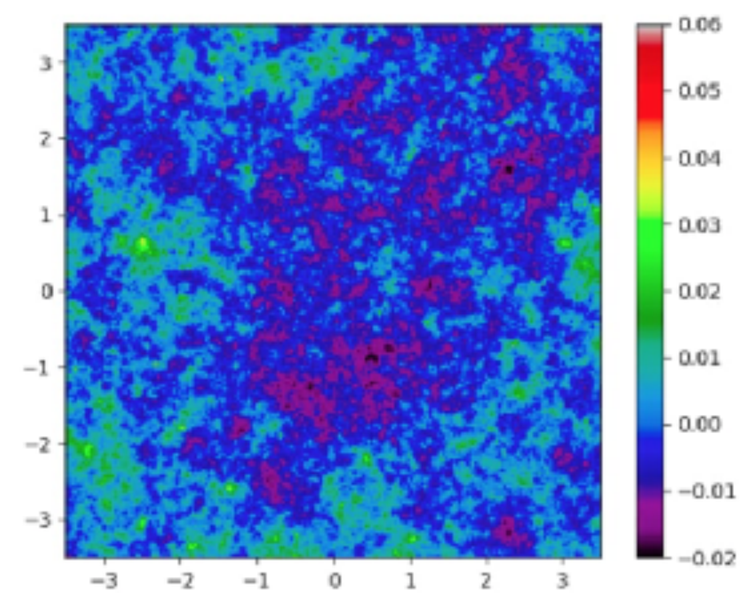
[a]Max-Planck-Institut für Astrophysik, Karl-Schwarzschild-Str. 1, 85741 Garching, Germany
[b]Kavli Institute for the Physics and Mathematics of the Universe, Todai Institutes for Advanced Study, the University of Tokyo, Kashiwa, Japan 277-8583 (Kavli IPMU, WPI)
[c]Department of Liberal Arts, Tokyo University of Technology, 5-23-22 Nishikamata, Ota-ku, Tokyo, Japan

E-mail: makiya@mpa-garching.mpg.de, kayouissha@stf.teu.ac.jp

Abstract. We ray-trace cosmic density fluctuations that follow a log-normal distribution to produce maps of weak gravitational lensing shear fields. Cross-correlation of weak lensing maps with positions of galaxies is a powerful probe of cosmology, including the mass of neutrinos. We use our simulations to study the improvement on the constraints on neutrino masses by adding the weak lensing data of, e.g., Hyper Suprime-Cam (HSC) survey, to the galaxy power spectrum in redshift space of, e.g., Prime Focus Spectrograph (PFS) survey, both on Subaru Telescope. We find that the nominal PFS survey reaches the threshold for testing the inverted mass hierarchy of $\sum m_\nu \approx 0.1$ eV assuming a flat ΛCDM model, and that adding the HSC data pushes the limit to $\sum m_\nu \approx TBD$ eV. While relaxing the assumption of the cosmological constant increases the uncertainty in the neutrino mass constraint, the weak lensing data help...? (TBD) We also simulate galaxy positions in redshift space and weak lensing data for Eulid- and WFIRST-like surveys, finding similar results.

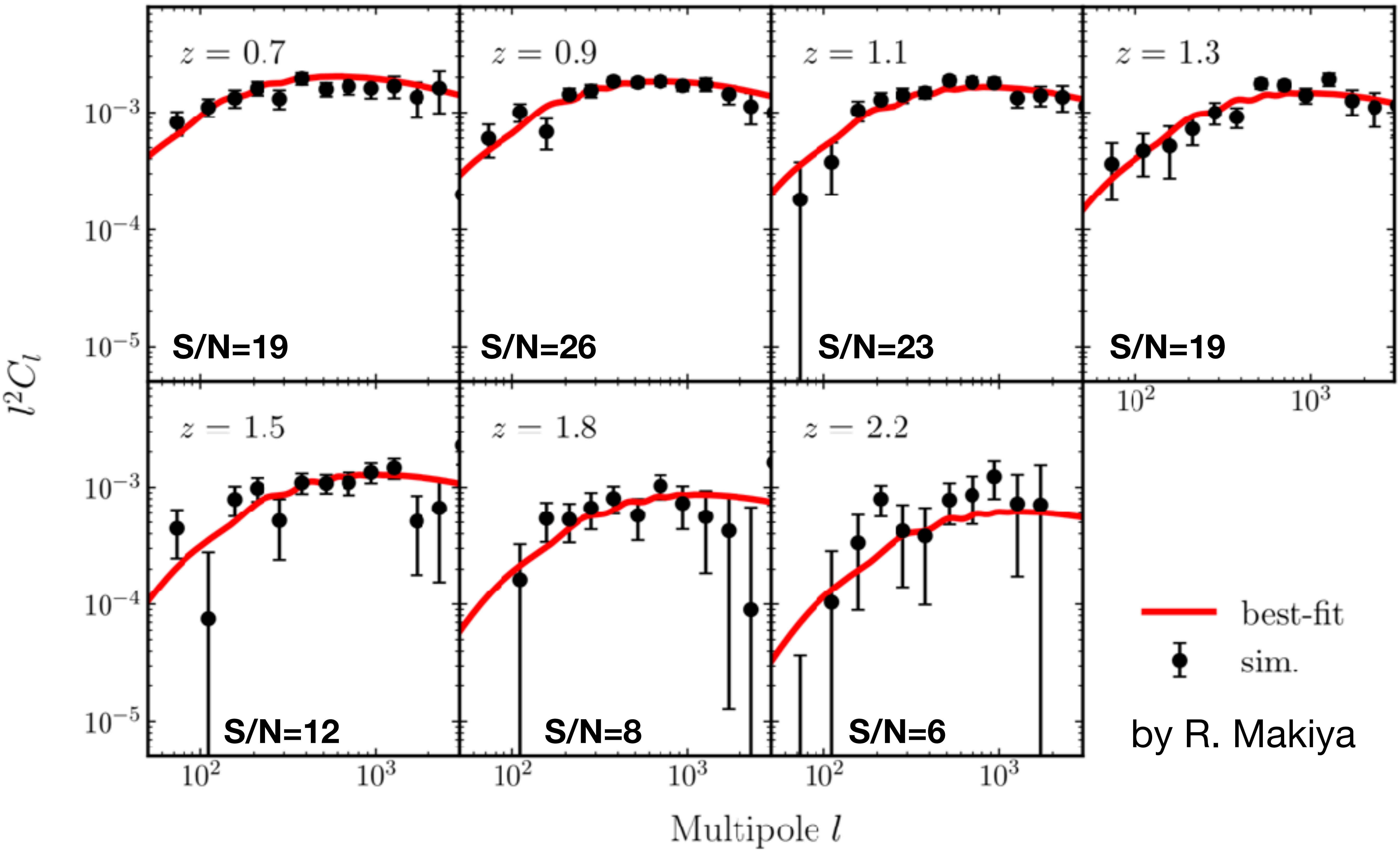


PFS galaxies



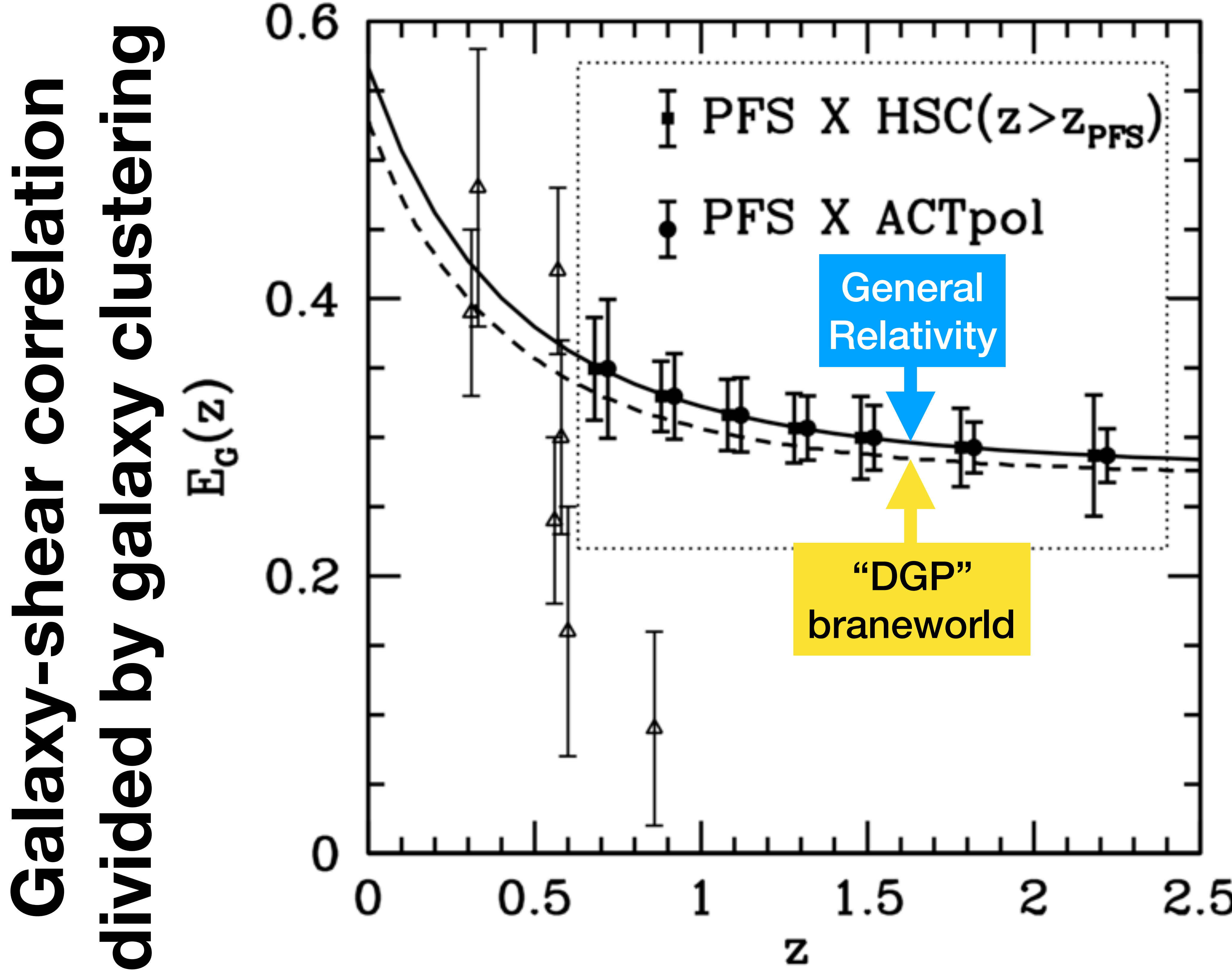
HSC lensing

Galaxy-shear Cross Spectra



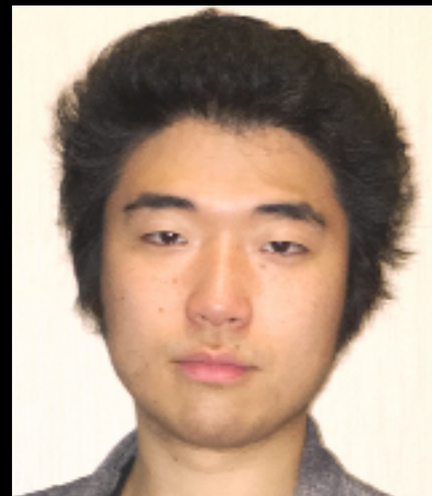
by R. Makiya

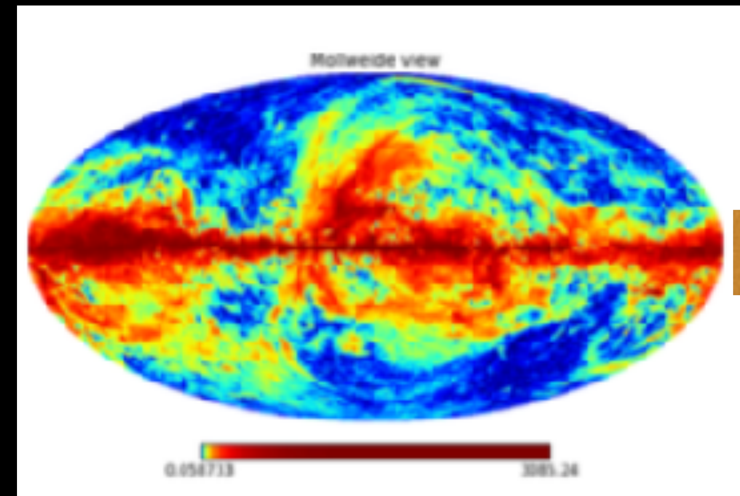
Testing Modified Gravity (Weak lensing + Galaxy clustering)

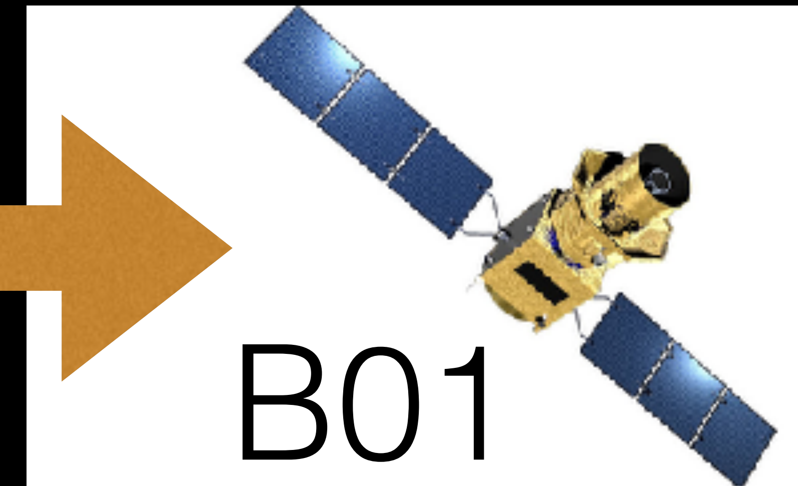


Pengjie Zhang (Shanghai Jiao Tong)

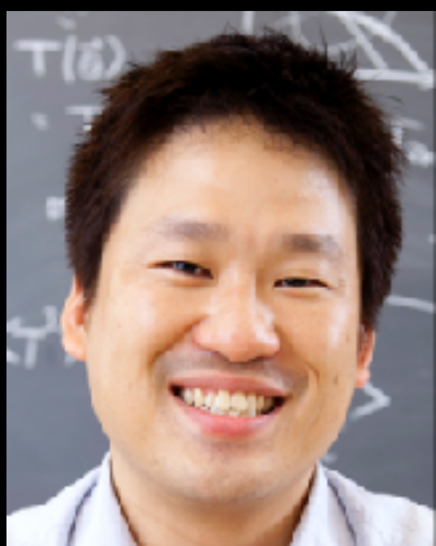
“GM100”



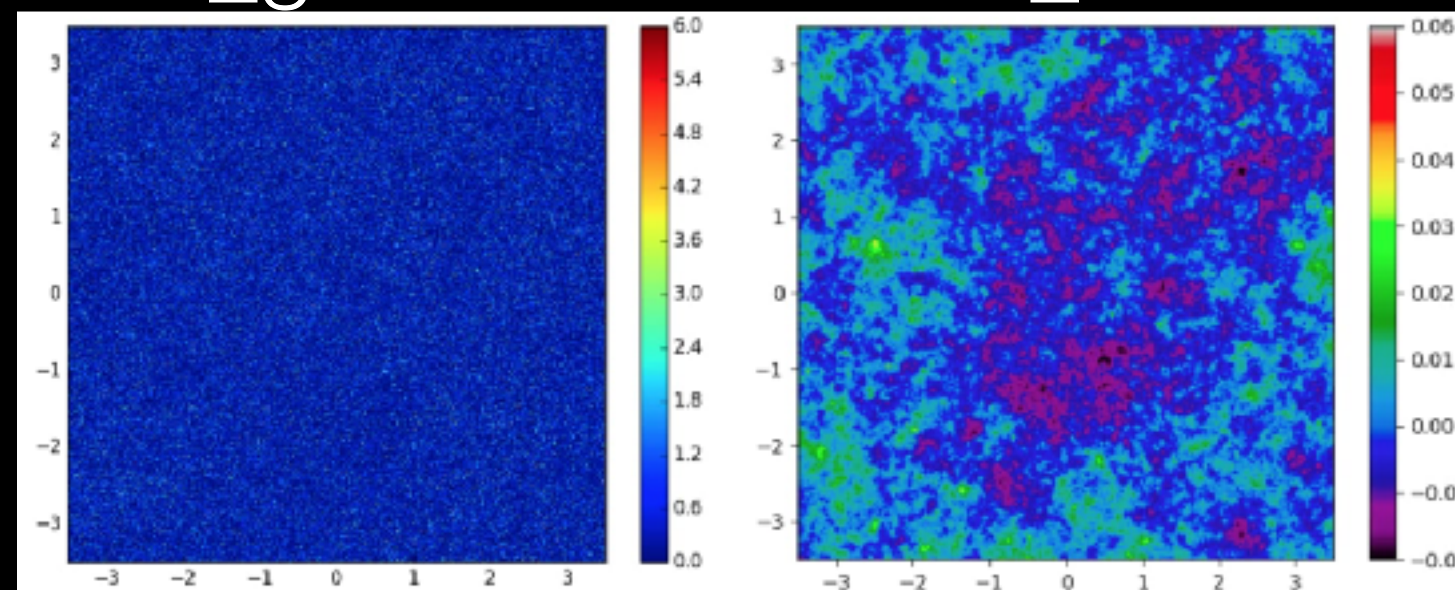




B01



“LN_galaxies” “LN_lens”



PFS galaxies **HSC lensing**

cross!

B03 B02

Going Beyond Tradition

- A hot, new tool in cosmology: **“intensity mapping”**
- The best known example is the intensity mapping using **neutral hydrogen lines** (21 cm lines)
- Exciting science also with **Lyman-alpha** intensity mapping
- Coming Soon: “*lognormal_im*”!

We also take orders :)

B01

We have a student from Oxford working on LiteBIRD. Can we do something interesting?

PHYSICAL REVIEW D
covering particles, fields, gravitation, and cosmology

Accepted Paper

Finding the chiral gravitational wave background of an axion-SU(2) inflationary model using CMB observations and laser interferometers

Phys. Rev. D

Ben Thorne, Tomohiro Fujita, Masashi Hazumi, Nobuhiko Katayama, Eiichiro Komatsu, and Maresuke Shiraishi

Accepted 8 January 2018

ABSTRACT

B01 D01

ABSTRACT

A detection of B-mode polarization of the Cosmic Microwave Background (CMB) anisotropies would confirm the presence of a primordial gravitational wave background (GWB). In the inflation paradigm this would be an unprecedented probe of the energy scale of inflation as it is directly proportional to the power spectrum of the GWB. However, similar tensor perturbations can be produced by the matter fields present during inflation, breaking the simple relationship between energy scale and the tensor-to-scalar ratio r. It is therefore important to find ways of distinguishing between the generation mechanisms of the GWB. Without doing a full model selection, we analyse the detectability of a new axion-SU(2) gauge field model by calculating the signal-to-noise of future CMB and interferometer observations sensitive to the chirality of the tensor spectrum. We forecast the detectability of the

Three-way interaction too!

B01

Do you have an interesting inflation model that can be tested by LiteBIRD?

A01

Of course I do!

Three-way interaction too!

B01

A01

Calculate this

To Takashi Hiramatsu

from Facebook

Three-way interaction too!

B01

A01

Ask Eiichiro

"Done, but how can we see this in the data?"

Three-way interaction too!

B01

Jawohl

A01

Ask Eiichiro

"Done, but how can we see this in the data?"

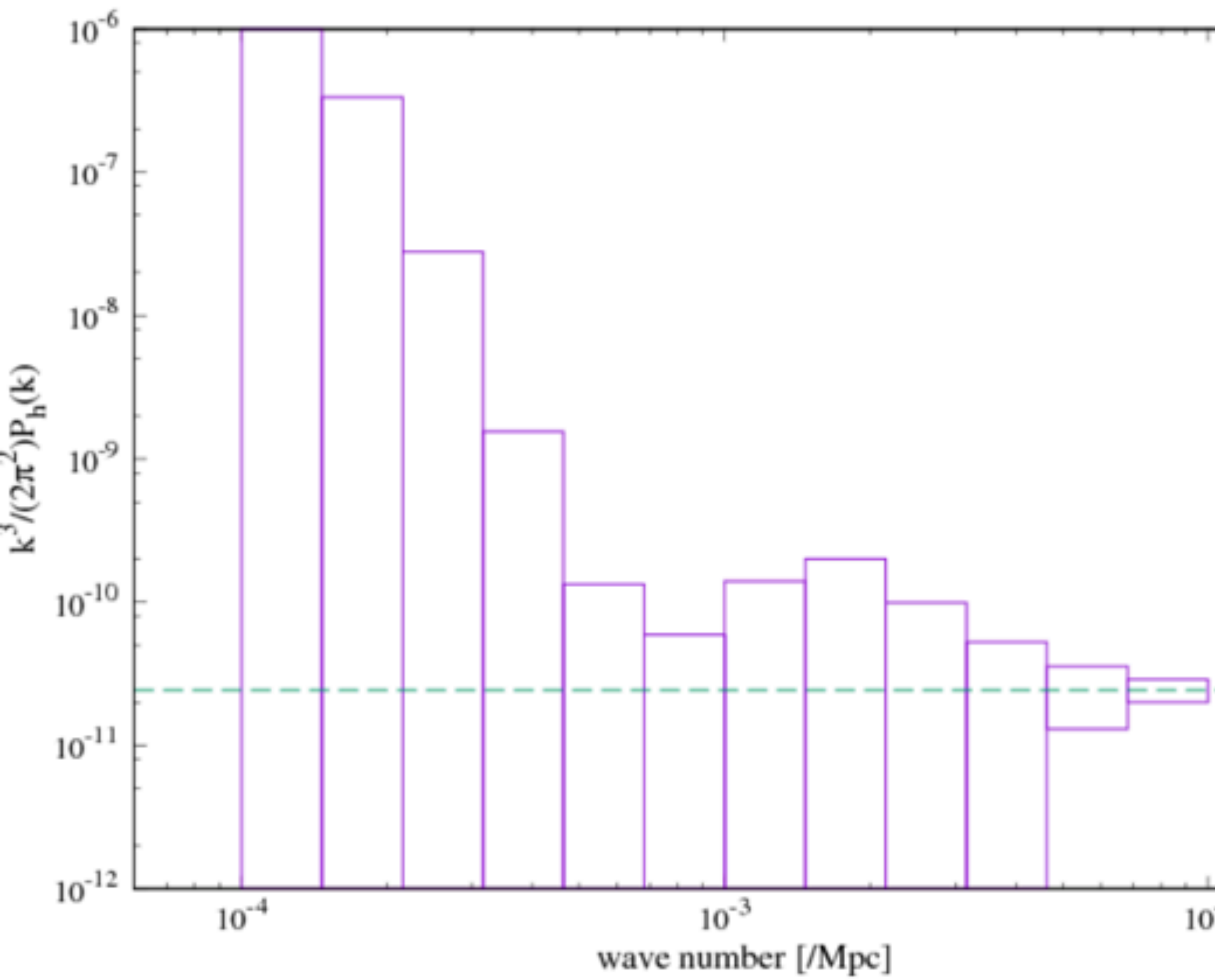
Three-way interaction too!

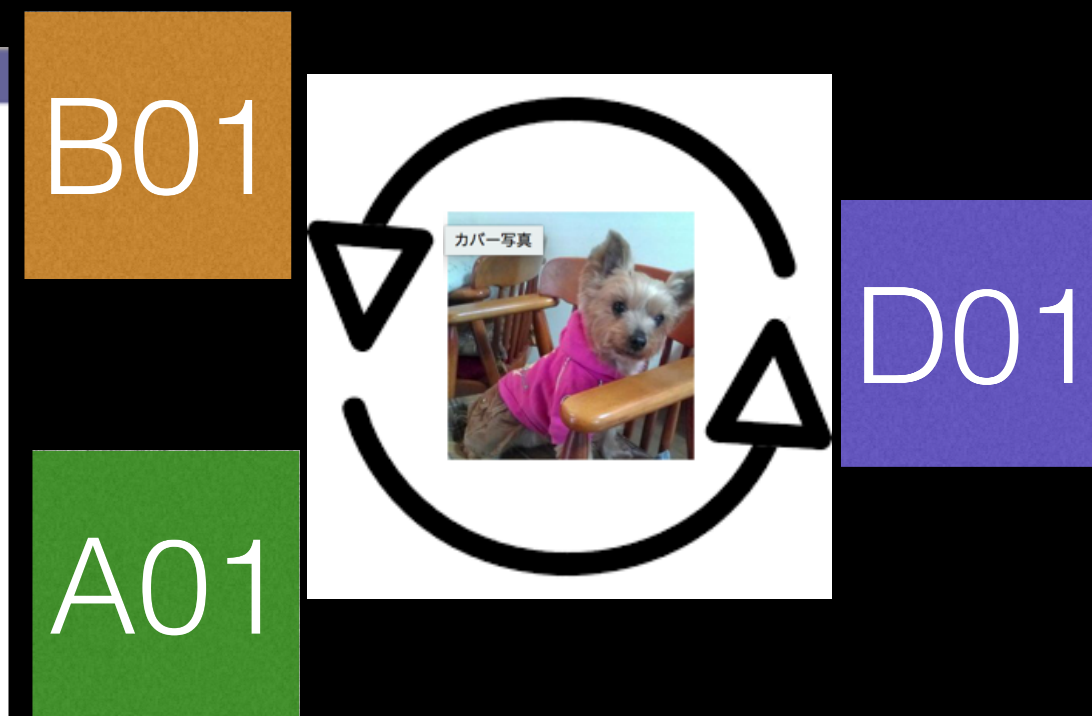
B01

A01

Web App (by T. Hiramatsu)

Spectrum Reconstructor [SREC ver.0.99.1]





Fisher & covariance matrices

χ^2	σ^2	PTE

PTE = Probability to exceed, given as 1-F(χ) with F(χ) being the cumulative chi-squared distribution function.

MAKE PLOT

Basic | Drawing | Built-in models | Custom models

Basic parameters

Error-bar type	(F^-1)_ii	
Tensor-to-scalar ratio	0.01	
Spectral index	0.0	
bin type	log	
k_{min}	0.0001	Mpc^{-1}
k_{max}	0.01	Mpc^{-1}
Number of bins	12	
Noise level	1.0	
l_{max}	500	$l_{max} \leq 500$
Delensing factor λ	1.0	denominator of $F_{ij} \supset \lambda C_l^{lens}$
With cosmic variance ?	yes	

NOTE : Hovering over parameter names shows pop-up information on each parameter.

Opening talk (Chair: Miyazaki)	*Prof. Hitoshi MURAYAMA*	
理学研究科合同C棟青葉サイエンスホール, 東北大学	10:30 - 11:00	
Research achievements of the D01 and impacts on the other groups	*Prof. Eiichiro KOMATSU*	
理学研究科合同C棟青葉サイエンスホール, 東北大学	11:00 - 11:20	
Log-normal simulation for weak gravitational lensing: application to the cross-correlation with galaxies	*Dr. Issha KAYO*	
Probing gas physics from the SZ-galaxy cross-correlations	*Dr. Ryu MAKIYA*	
理学研究科合同C棟青葉サイエンスホール, 東北大学	11:40 - 12:00	
Reconstruction of primordial tensor power spectrum from B-mode observations	*Dr. Takashi HIRAMATSU*	
理学研究科合同C棟青葉サイエンスホール, 東北大学	12:00 - 12:20	
Discussion and feedback on the D01 activities		
理学研究科合同C棟青葉サイエンスホール, 東北大学	12:20 - 12:30	
Lunch break + poster session		
理学研究科合同C棟青葉サイエンスホール, 東北大学	12:30 - 13:30	

Opening talk (Chair: Miyazaki) — *Prof. Hitoshi MURAYAMA*

理学研究科合同C棟青葉サイエンスホール, 東北大学 — 10:30 - 11:00

Research achievements of the D01 and impacts on the othe — *Prof. Eiichiro KOMATSU*

理学研究科合同C棟青葉サイエンスホール, 東北大学 — 11:00 - 11:20

Log-normal simulation for weak gravitational lensing: appli
correlation with galaxies — *Dr. Issha KAYO*

Probing gas physics from the SZ-galaxy cross-correlations — *r. Ryu MAKIYA*

理学研究科合同C棟青葉サイエンスホール, 東北大学

Reconstruction of primordial tensor power spectrum from B-mode obser

理学研究科合同C棟青葉サイエンスホール, 東北大学

Discussion and feedback on the D01 activities

理学研究科合同C棟青葉サイエンスホール, 東北大学 — 12:20 - 12:30

Lunch break + poster session

理学研究科合同C棟青葉サイエンスホール, 東北大学 — 12:30 - 13:30

Opening talk (Chair: Miyazaki) *理学研究科合同C棟青葉サイエンスホール, 東北大学*	*Prof. Hitoshi MURAYAMA*	10:30 - 11:00
Research achievements of the D01 and impacts on the other groups *理学研究科合同C棟青葉サイエンスホール, 東北大学*	*Prof. Eiichiro KOMATSU*	11:00 - 11:20
Log-normal simulation for weak gravitational lensing: application to the cross-correlation with galaxies	*Dr. Issha KAYO*	
Probing gas physics from the SZ-galaxy cross-correlations *理学研究科合同C棟青葉サイエンスホール, 東北大学*	*Dr. Ryu MAKIYA*	11:40 - 12:00
Reconstruction of primordial tensor power spectrum from B-mode observations *理学研究科合同C棟青葉サイエンスホール, 東北大学*	*Dr. Takashi HIRAMATSU*	12:00 - 12:20
Discussion and feedback on the D01 activities *理学研究科合同C棟青葉サイエンスホール, 東北大学*		12:20 - 12:30
Lunch break + poster session *理学研究科合同C棟青葉サイエンスホール, 東北大学*		12:30 - 13:30

We will probably run out of time, but if we do have time left in the end, we would like to hear what we can do for you!