

宇宙論的ボイド形成における ダークエネルギーの影響

Effects of Dark Energy perturbation on
the formation of cosmic void

Takao Endo(1★),

Atsushi J. Nishizawa(1,2) and Kiyotomo Ichiki(1,3)

1 Graduate School of Science, Nagoya University, Aichi 464-8602, Japan,

2 Institute for Advanced Research, Nagoya University, Aichi 464-8602, Japan,

3 Kobayashi Maskawa Institute, Nagoya University, Aichi 464-8602, Japan

Background, Motivation and Goal

- ✓ Is Dark Energy cosmological constant?

Vacuum energy: one of the most preferable candidate
for cosmological constant

- ✓ Cosmological constant problem

Theoretically 10^{120} Observationally
 $\rho_{\text{vac}} \gg \rho_{\Lambda}$

- ✓ My goal is to study the nature of dark energy through large scale structure formation, focusing on cosmic voids.

What I conduct

❖ **Dark energy**: a fluid having negative pressure, constant equation of state ” w ”, speed of sound ” c_s^2 ”

❖ **Spherical model**[Basse et al. (2011)]

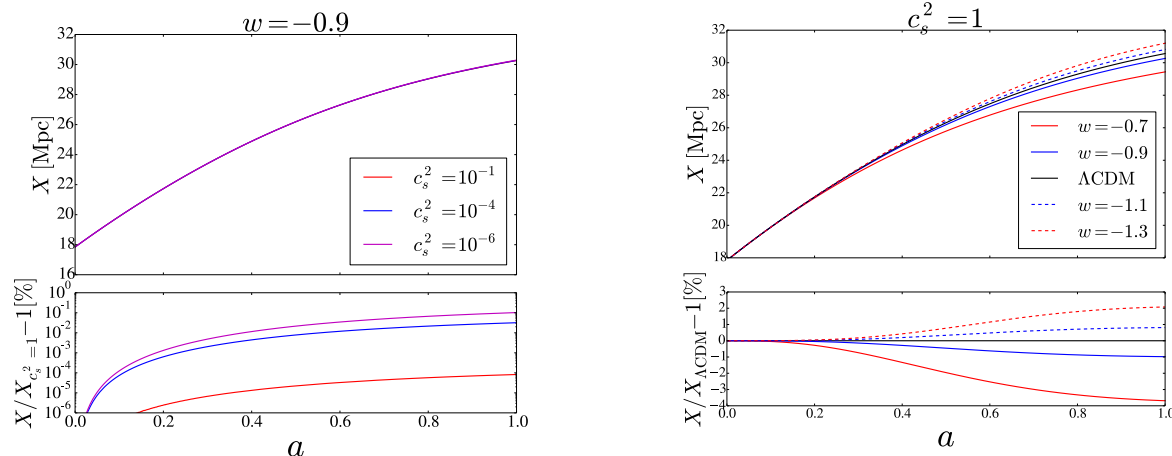
$$\frac{1}{R} \frac{d^2 R}{dt^2} = -\frac{4\pi G}{3} [\bar{\rho}_m(1 + \delta_m) + \bar{\rho}_{de}(1 + \delta_{de}) + 3(\bar{P}_{de} + \delta P_{de})]$$

❖ **Void size distribution**[Sheth & van de Weygaert 2004]

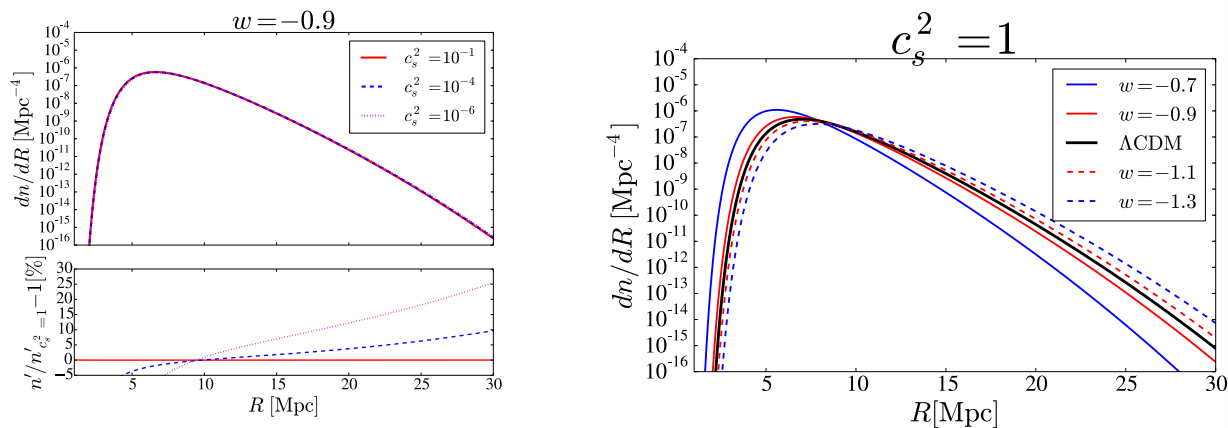
$$\frac{dn}{dR} = (1 + \delta_m)^{1/3} \frac{3}{4\pi R_L^3} f(\nu, \delta_v, \delta_c) \frac{d\nu}{dR_L}$$

Results

Spherical model

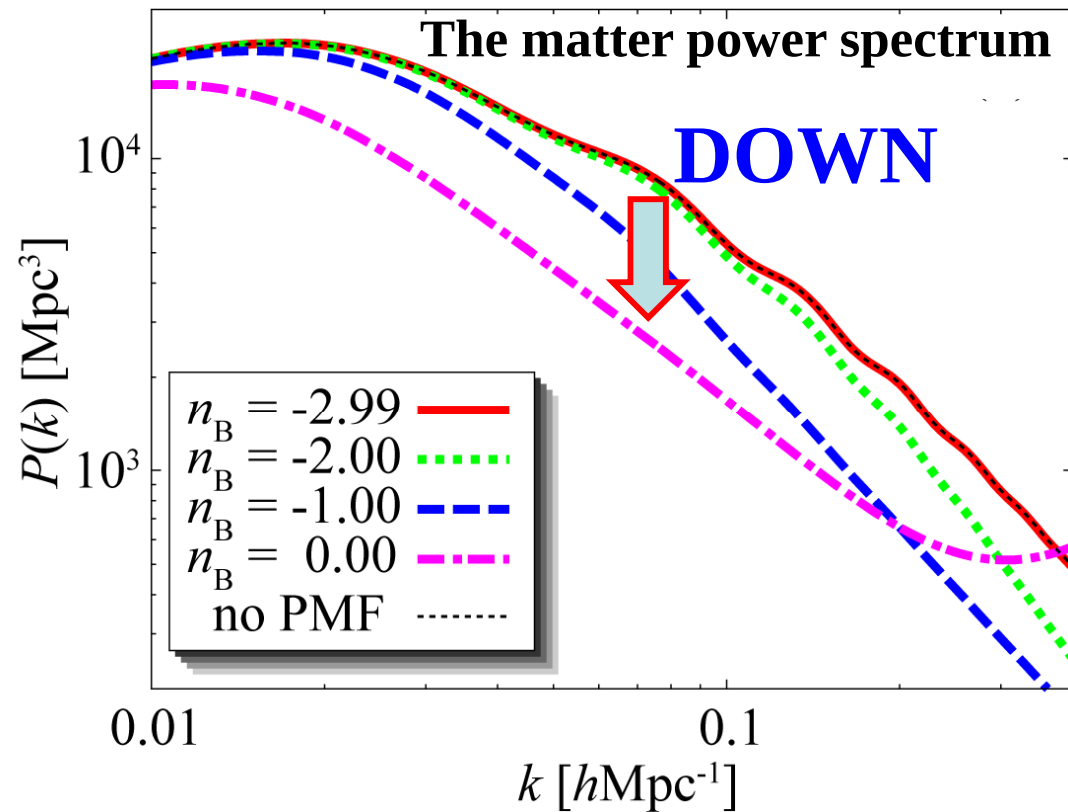


Void abundance



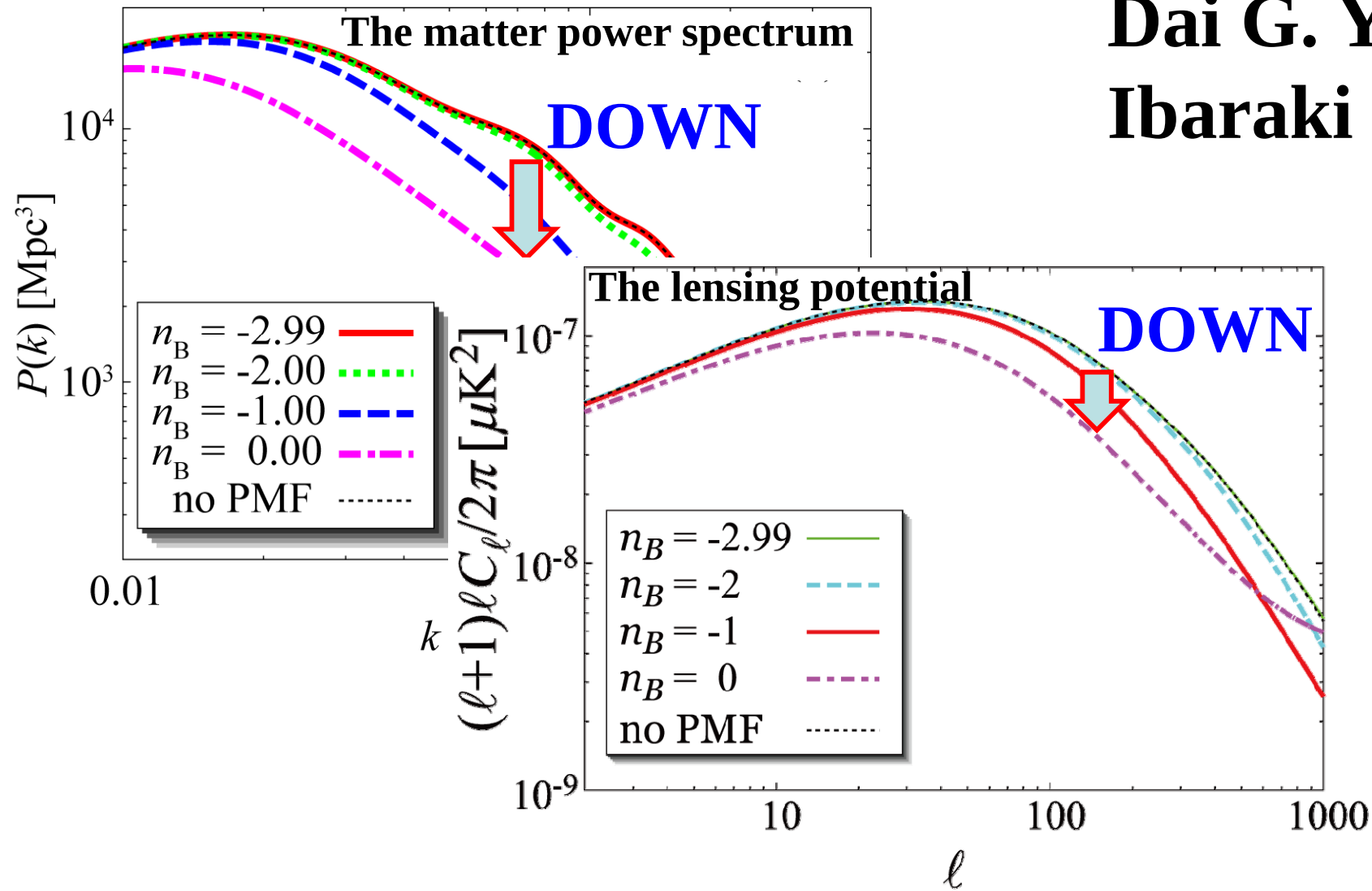
The Primordial Magnetic Field in the CMB and the matter power spectrum

Dai G. Yamazaki
Ibaraki University



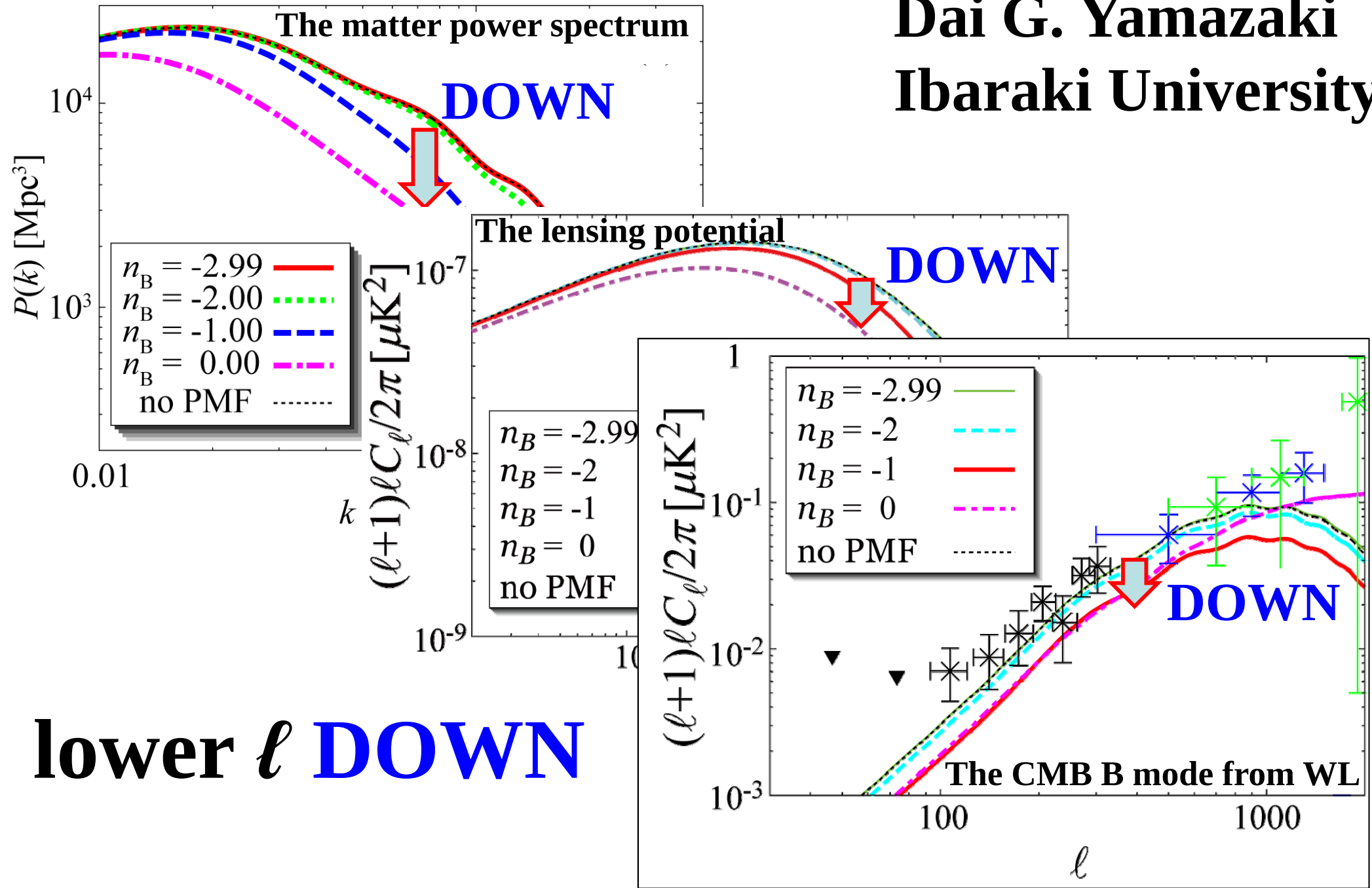
The Primordial Magnetic Field in the CMB and the matter power spectrum

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The Primordial Magnetic Field in the CMB and the matter power spectrum

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Probing relationship between galaxies and their surrounding gas with the HSC survey

Kavli IPMU Tomohiro Nozawa
with Masahiro Takada, Ting-wen Lan et al

Motivation

- Understand the galaxy formation and evolution
- Key triggers = Outflows and Accretion of gas

But poorly unknown...

→ To better understand them,
characterize the relationship between
galaxies and the surrounding gas



Quasar absorption lines from
Sloan Digital Sky Survey

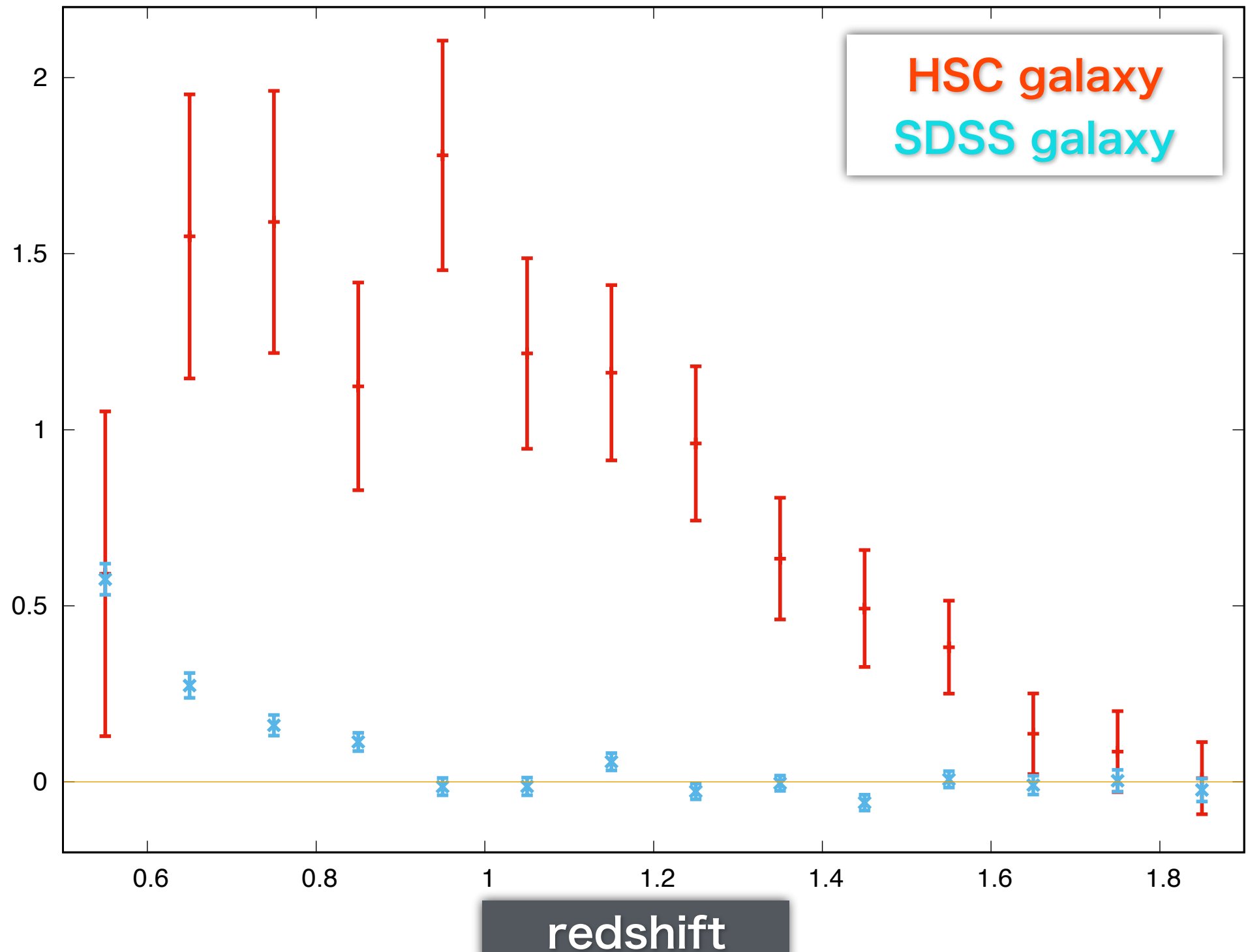


Subaru Hyper-Supreme Cam galaxy catalog



We get the correlation signal across much wider redshift range using **HSC galaxy catalogs** than previous work

The number of galaxies
along one MglI absorber



Hybrid Higgs Inflation

○[†] Seiga Sato, [‡]R.Easther , [†]K.Maeda,& [‡] N.Musoke

[†]Waseda U. [‡] Auckland U.

Inflation

the most of inflation models need a scalar field “inflaton” .

Standard Model

Scalar field = Higgs field

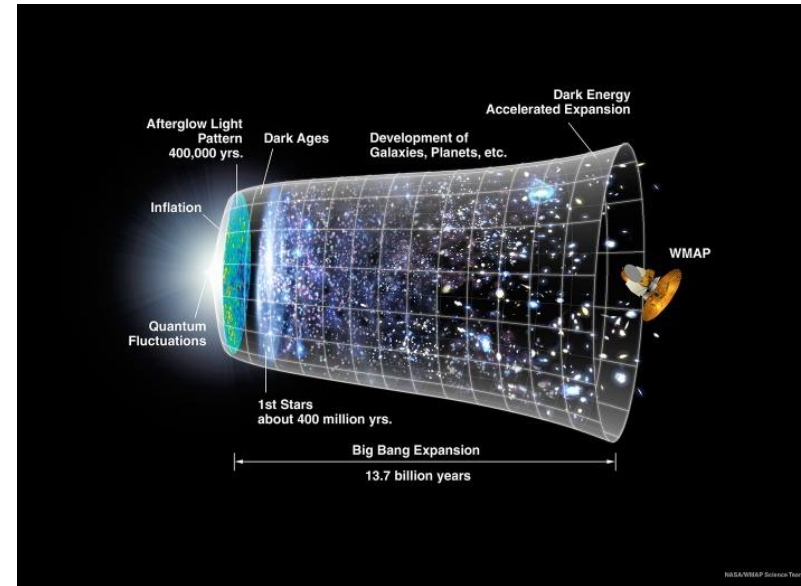
Inflaton = Higgs ?

Higgs inflation

$$L = \frac{M_p^2}{2} R - g^{\mu\nu} \frac{\partial_\mu h \partial_\nu h}{2} - V(h)$$

$$h : \text{Higgs} \quad V = \frac{\lambda}{4} (h^2 - v^2)^2 \cong \frac{\lambda}{4} h^4$$

$$\lambda \sim 0.1$$



NASA(2006)

mass →	~2.3 MeV/c ²	~1.275 GeV/c ²	~173.07 GeV/c ²	0	~126 GeV/c ²
charge →	2/3	2/3	2/3	0	0
spin →	1/2	1/2	1/2	1	0
	u up	c charm	t top	g gluon	H Higgs boson
	d down	s strange	b bottom	γ photon	
	e electron	μ muon	τ tau	Z Z boson	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	

Wikimedia commons

Inflation

the most of inflation models need a scalar field “inflaton” .

Standard Model

Scalar field = Higgs field

Inflaton = Higgs ?

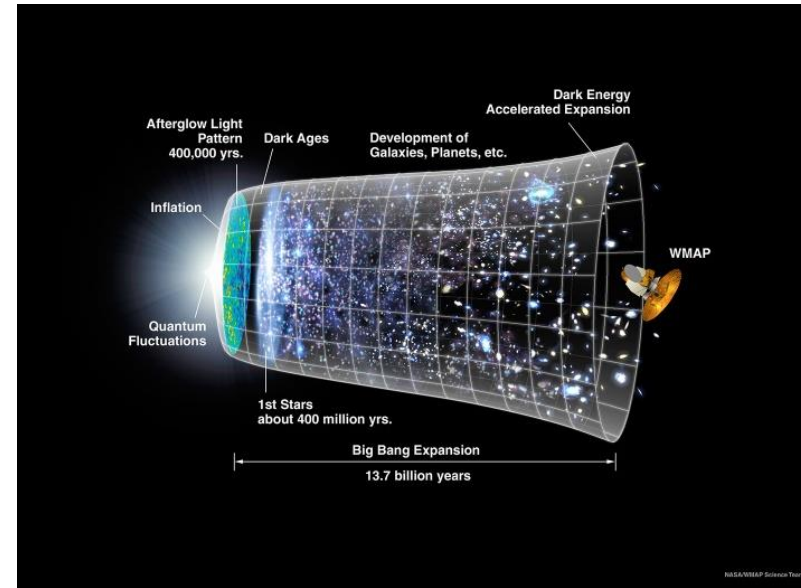
Higgs inflation

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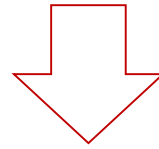


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	e electron	μ muon	τ tau	Z Z boson	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	

Wikimedia commons

GR + Higgs term + gravitational coupling of Higgs



Horndeski theory

Generalized Higgs inflation

K.Kamada, T.Kobayashi, T.Takahashi,
M.Yamaguchi, & J.Yokoyama(2012)

$$S = \sum_{i=2}^5 \int d^4x \sqrt{-g} L_i$$

$$L_2 = K(\phi, X)$$

$$L_3 = -G_3(\phi, X) \square \phi$$

$$L_4 = G_4(\phi, X) R + G_{4X} \left[(\square \phi)^2 - (\nabla_\mu \nabla_\nu \phi)^2 \right]$$

$$L_5 = G_5(\phi, X) G_{\mu\nu} \nabla^\mu \nabla^\nu \phi$$

$$- \frac{1}{6} G_{5X} \left[(\square \phi)^3 - 3(\square \phi)(\nabla_\mu \nabla_\nu \phi)^2 + ((\nabla_\mu \nabla_\nu \phi)^3) \right]$$

Some approximation are needed.

Generalized Higgs inflation

(non-minimal coupling)

Higgs inflation

B.L.Spokoiny(1984)

$$\left(\frac{M_p^2}{2} - \xi \frac{h^2}{2} \right) R$$

New Higgs inflation

C.Germani&A.Kehagias (2010)

$$\left(g^{\mu\nu} - \frac{G^{\mu\nu}}{M^2} \right) \frac{\partial_\mu h \partial_\nu h}{2}$$



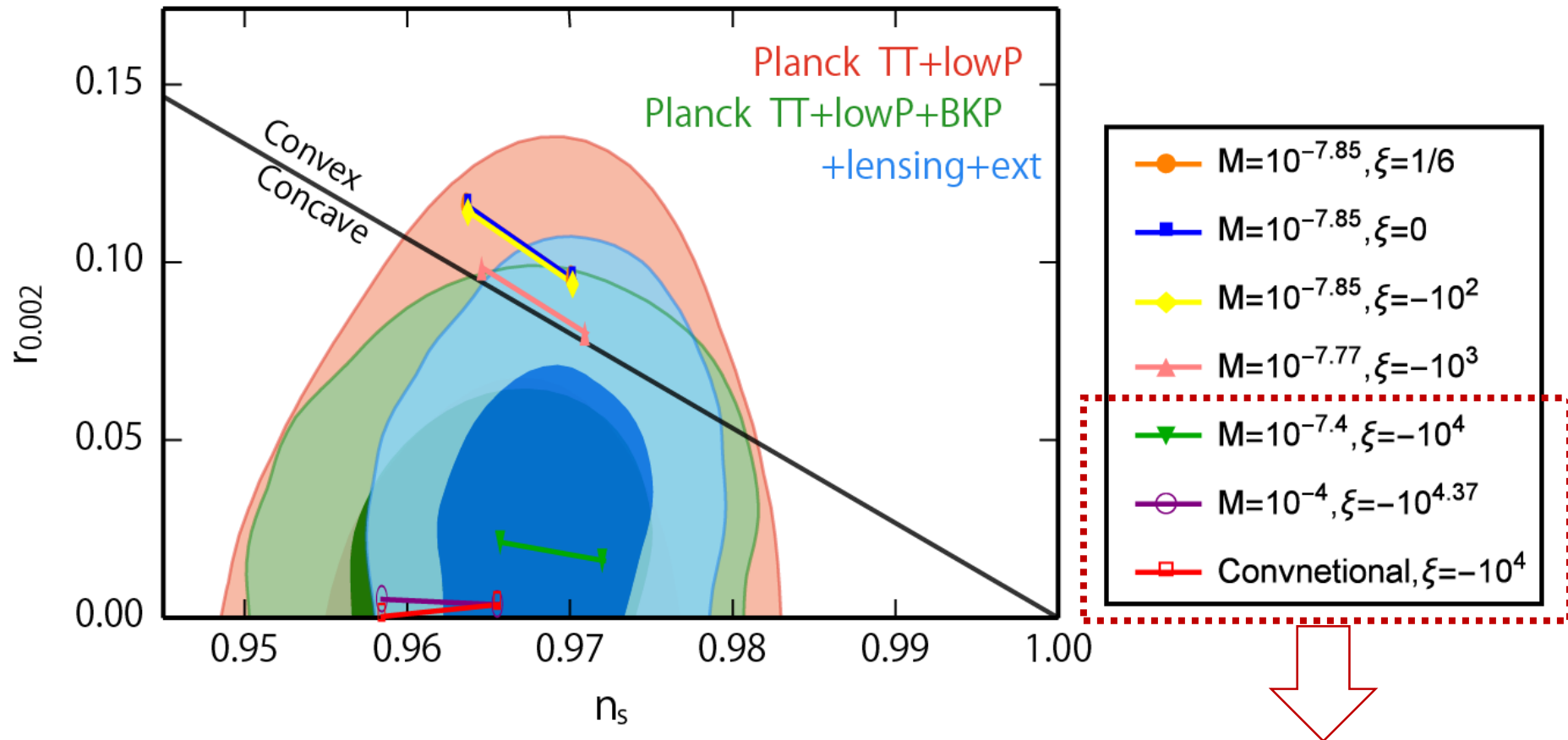
Hybrid Higgs inflation

Disformal transformation

+

Truncation of
higher derivative terms

Cosmological perturbations of the hybrid Higgs inflation





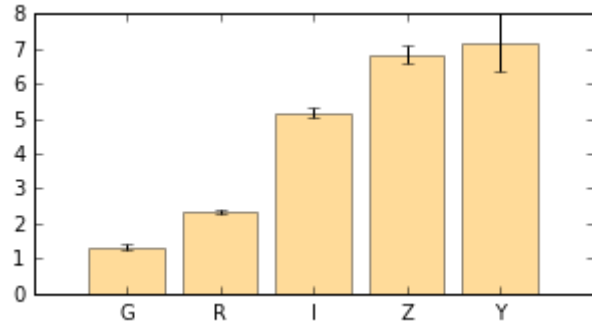
Kanazawa Institute of Technology

Predicting Photo-z using Deep Learning

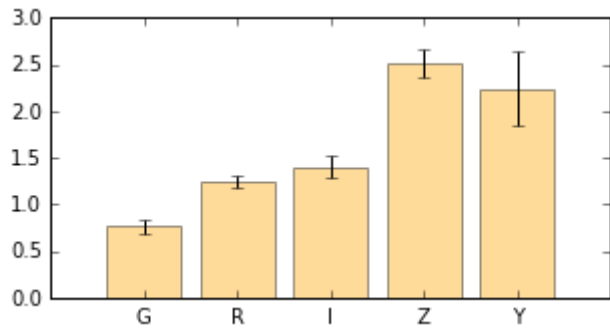
Jun Nakano

Kanazawa Institute of Technology

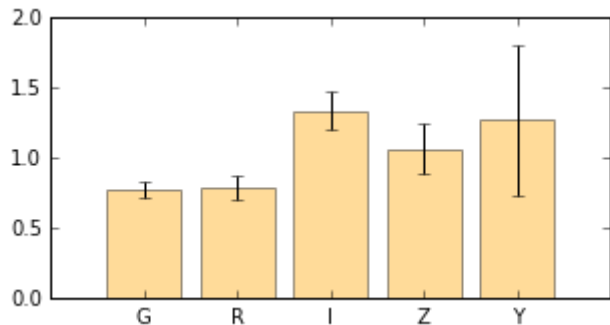
Predicting z from 5-Band **Flux** of Subaru HSC



$z =$
 $\rightarrow 0.73$



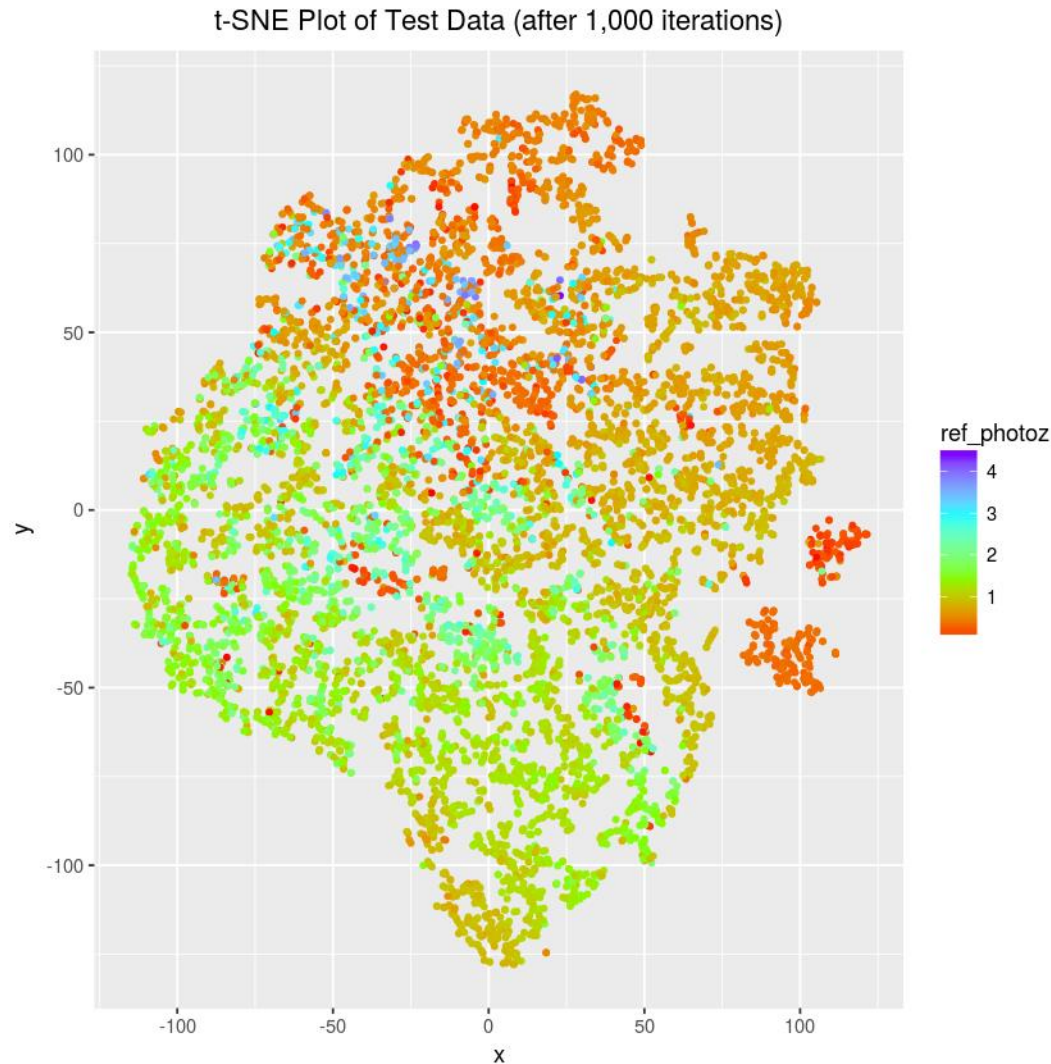
$\rightarrow 1.81$



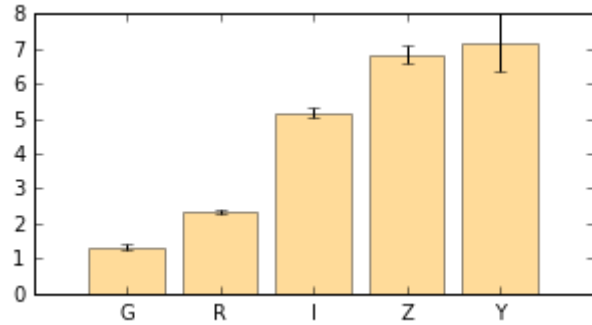
$\rightarrow 2.93$

Degeneracy makes prediction tough!

- t-SNE plot of (G, R, I, Z, Y) data points

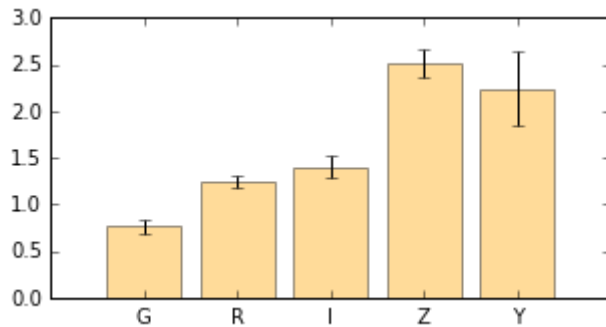


Predicting z from 5-Band **Flux** of Subaru HSC



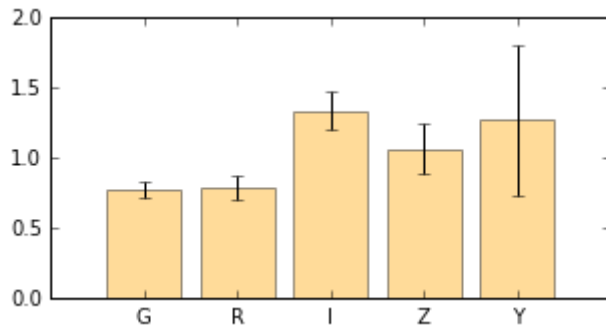
+ other features

$z =$
 $\rightarrow 0.73$



+ other features

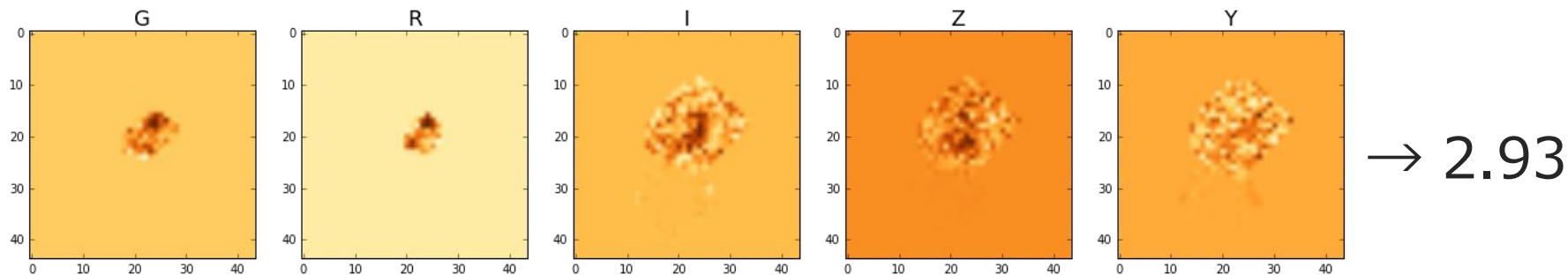
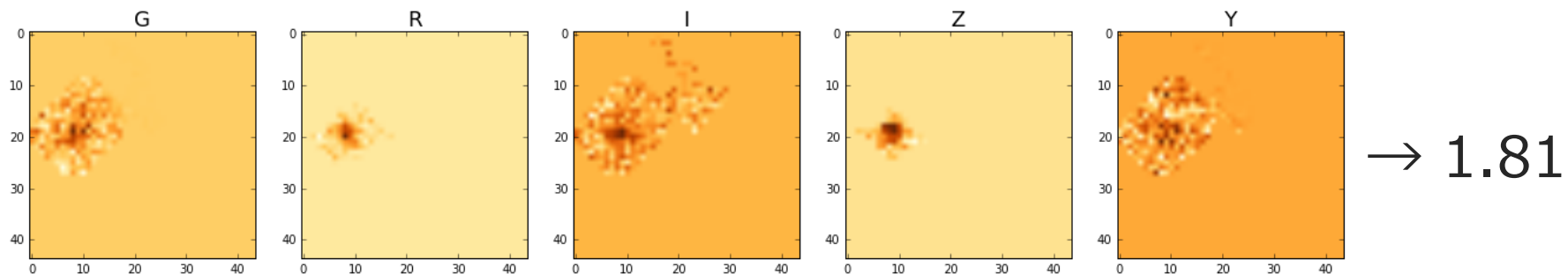
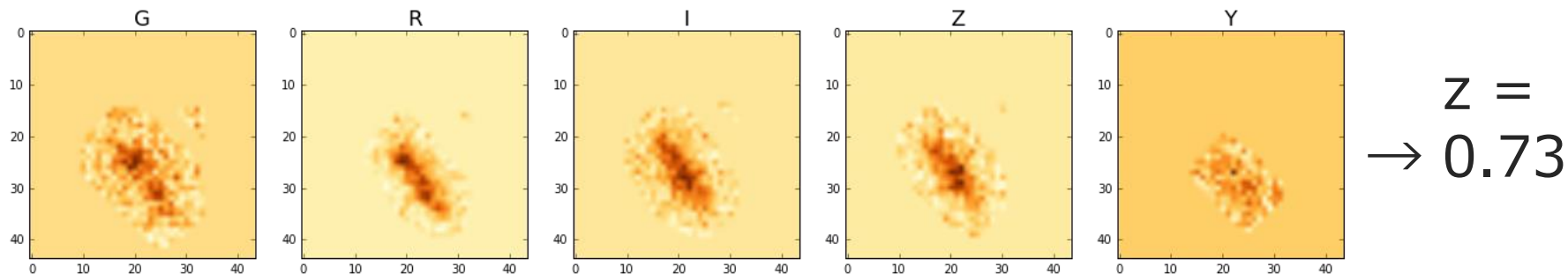
$\rightarrow 1.81$



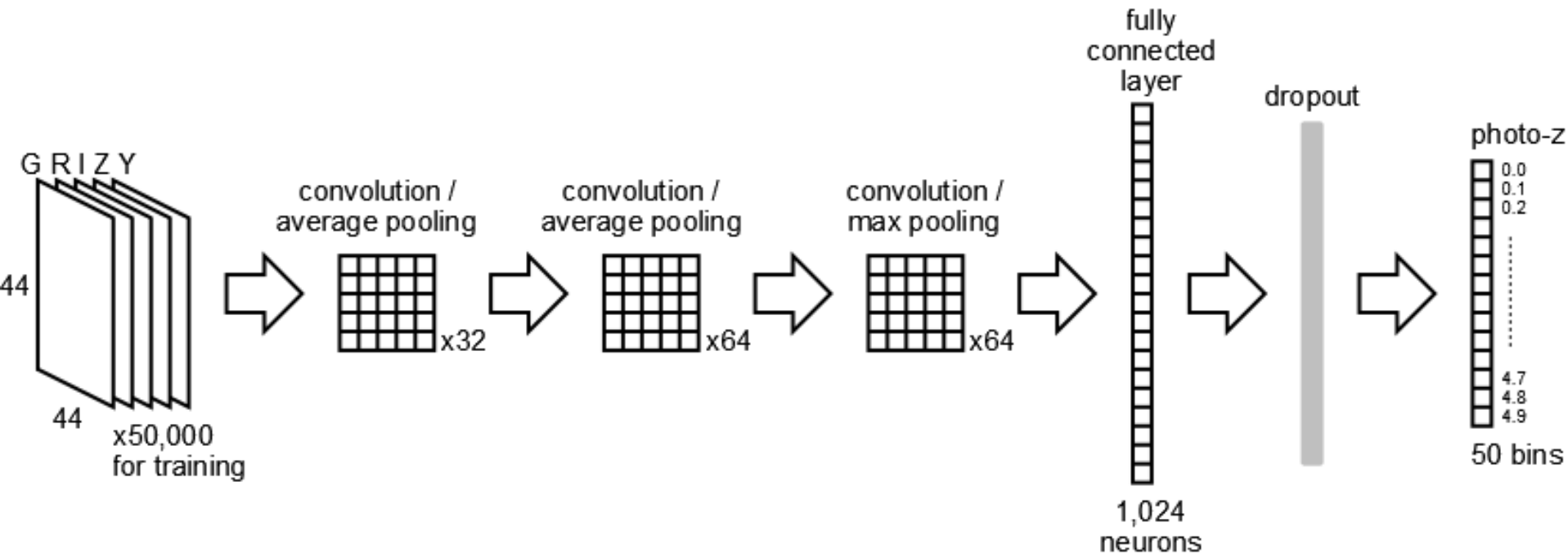
+ other features

$\rightarrow 2.93$

Predicting z from 5-Band **Image** of HSC

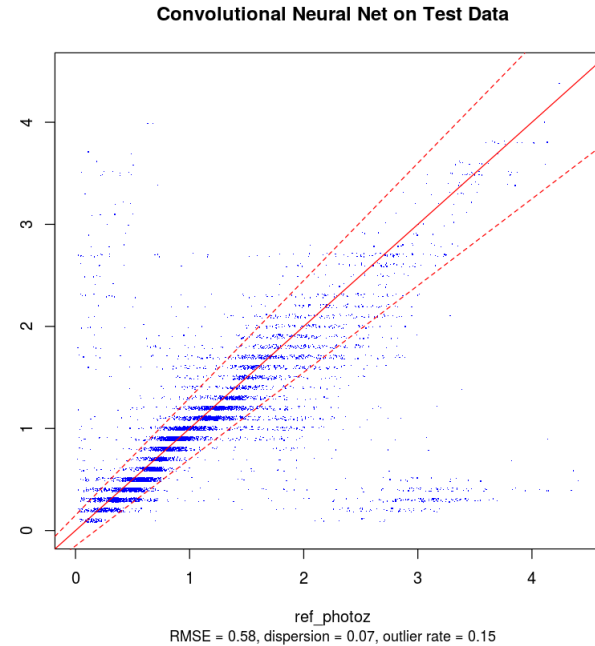
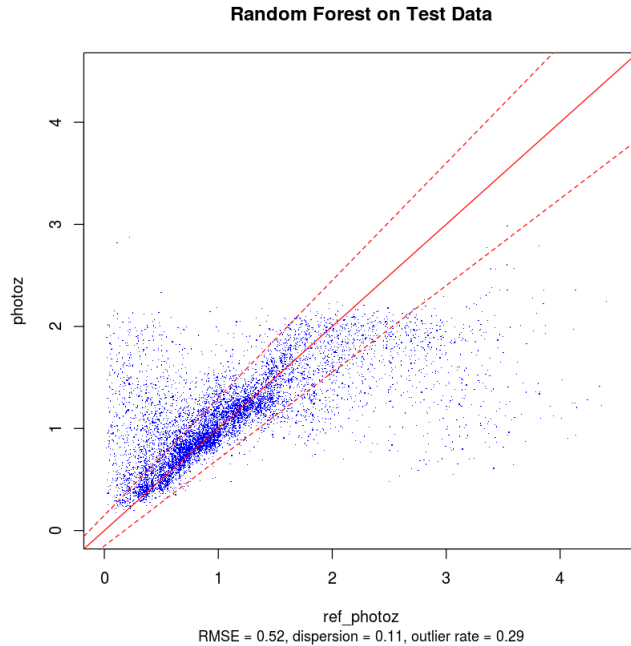


➤ Convolutional Neural Network (CNN)



Aggregated Flux

Raw Image

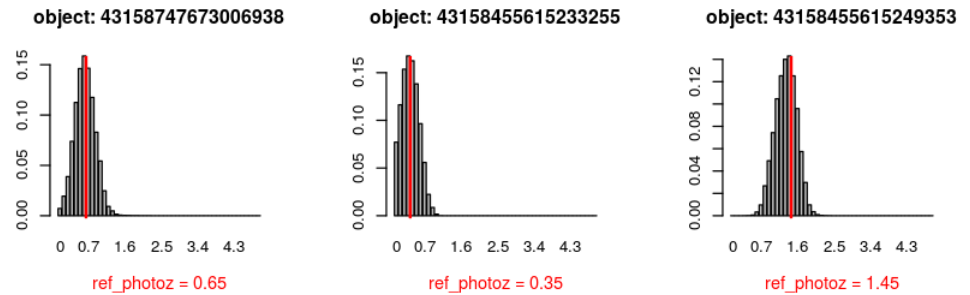


RMSE	0.52	0.58	+12%
Dispersion	0.11	0.07	-36%
Outlier Rate	0.29	0.15	-48%

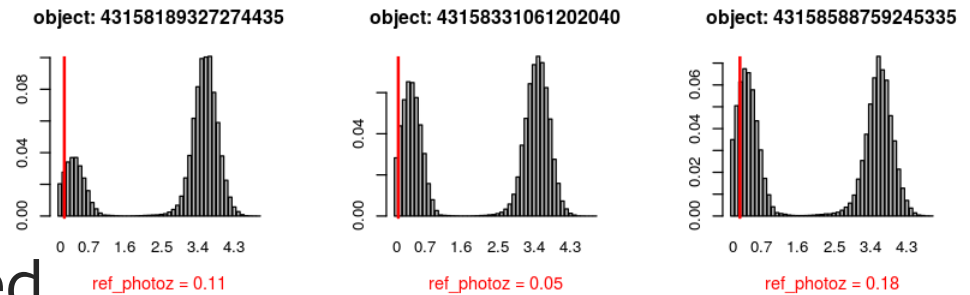


➤ Our CNN model outputs "probability distribution" of z .

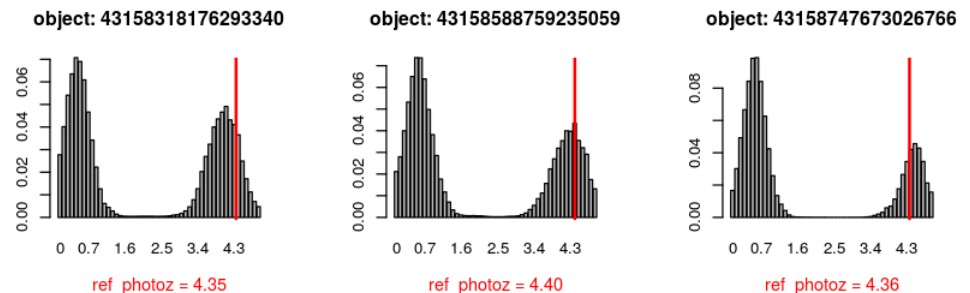
❖ Almost right



❖ Hugely overestimated



❖ Hugely underestimated



Kinematic

Sunyaev-Zel'dovich Effect

JSPS fellow (Kavli IPMU)

Naonori Sugiyama

Collaborators:

Teppei Okumura and David Spergel

Velocity (Cosmology)

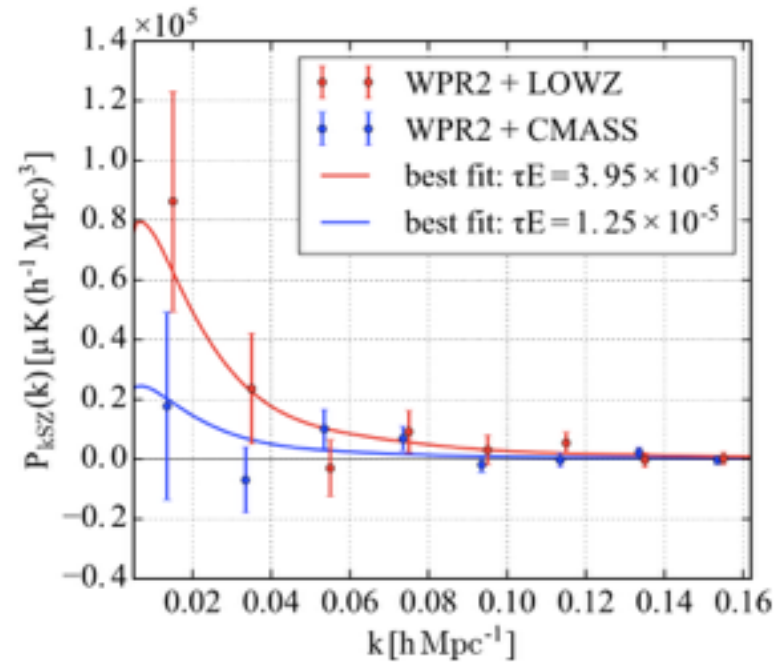
$$\frac{\delta T_{\text{KSZ}}}{T_{\text{CMB}}} = - \tau \left(\frac{\hat{n} \cdot \vec{v}}{c} \right)$$

Optical depth (Astrophysics)

CMB x Galaxy

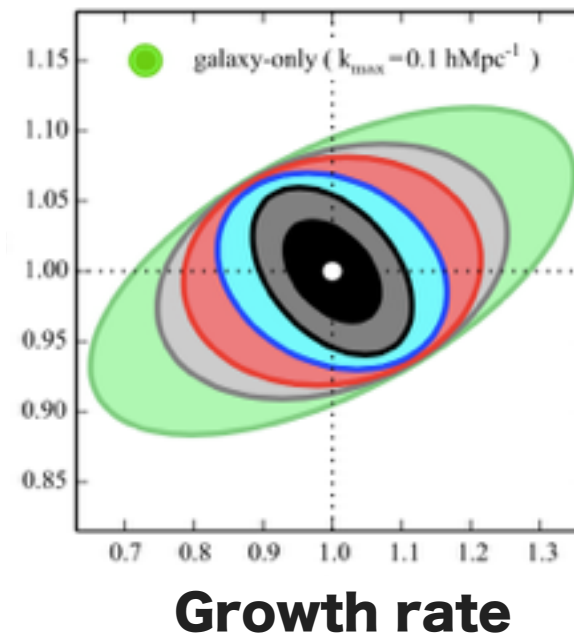
Pairwise velocity

Planck x BOSS



Future!

Hubble parameter



CMB-S4 x BOSS

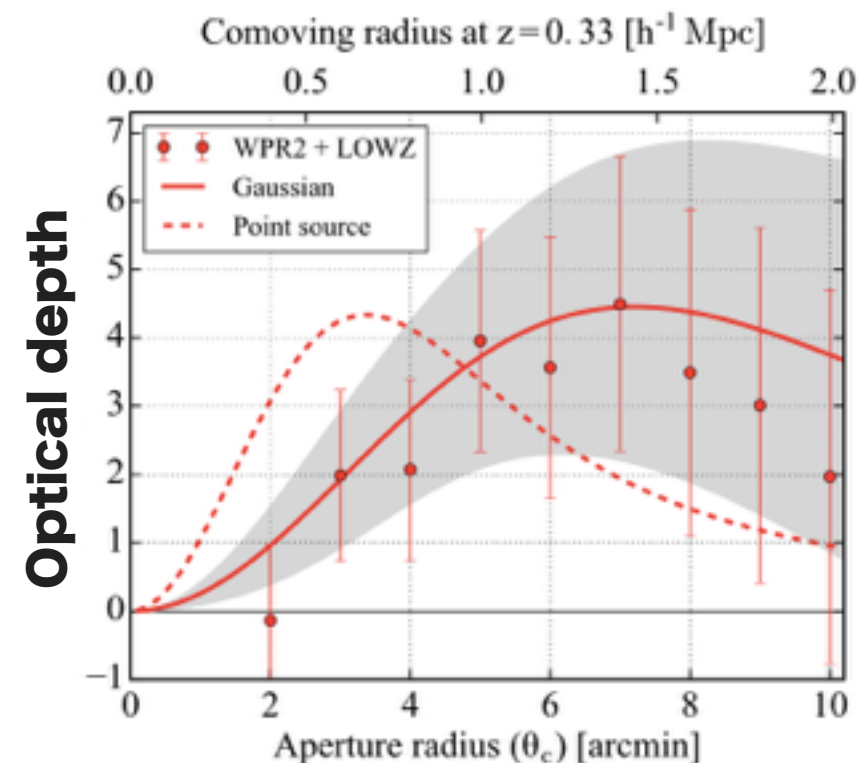
Joint analysis with RSDs

Error on f and H :

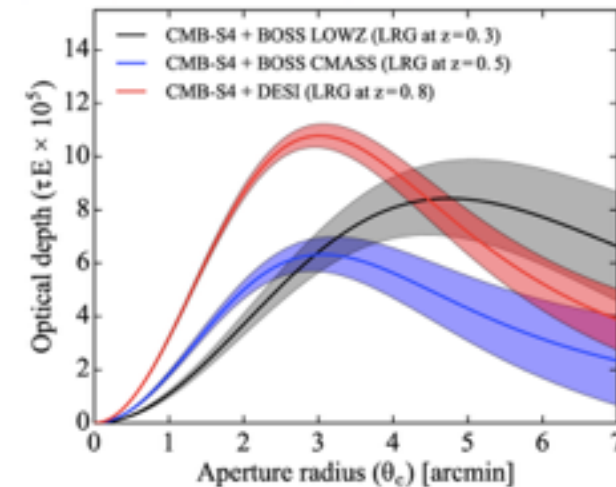
50~70%

Optical depth

Planck x BOSS



Future!



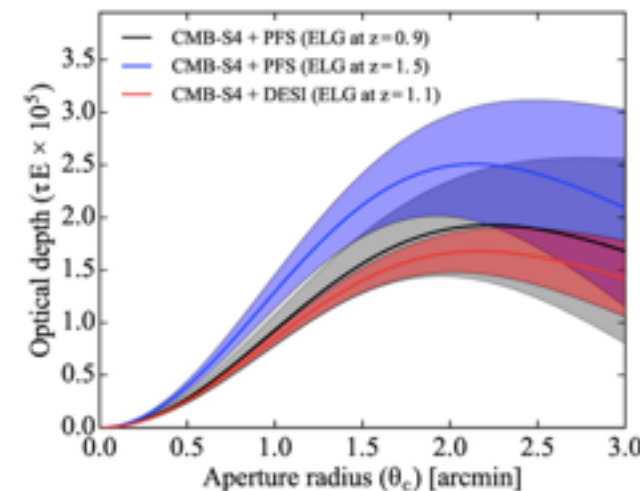
CMB-S4 x DESI

S/N~**70**

LRGs

$10^{13} M_{\text{sun}}$

$z \sim 0.7$



CMB-S4 x PFS

S/N~**20**

ELGs

$10^{12} M_{\text{sun}}$

$z > 1.0$

GW150914 and primordial black holes

Teruaki Suyama (RESCEU, University of Tokyo)

Collaborators: Misao Sasaki, Takahiro Tanaka, Shuichiro Yokoyama

PRL 117, 061101 (2016)

PHYSICAL REVIEW LETTERS

week ending
5 AUGUST 2016



Primordial Black Hole Scenario for the Gravitational-Wave Event GW150914

Misao Sasaki,¹ Teruaki Suyama,² Takahiro Tanaka,^{3,1} and Shuichiro Yokoyama⁴

¹*Center for Gravitational Physics, Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606-8502, Japan*

²*Research Center for the Early Universe (RESCEU), Graduate School of Science, The University of Tokyo, Tokyo 113-0033, Japan*

³*Department of Physics, Kyoto University, Kyoto 606-8502, Japan*

⁴*Department of Physics, Rikkyo University, Tokyo 171-8501, Japan*

(Received 3 April 2016; published 2 August 2016)

We point out that the gravitational-wave event GW150914 observed by the LIGO detectors can be explained by the coalescence of primordial black holes (PBHs). It is found that the expected PBH merger rate would exceed the rate estimated by the LIGO Scientific Collaboration and the Virgo Collaboration if PBHs were the dominant component of dark matter, while it can be made compatible if PBHs constitute a

We proposed a scenario that the detected GW was caused by the merger of primordial black holes.

Mini-workshop on “inflation” held by A01 group

10 March, 2016, Yukawa institute

10:00 - 11:00 Tomo Takahashi "Probing inflationary models on small scales"

11:30 - 12:30 Teruaki Suyama

"Probing primordial perturbation on small scales"

14:00 - 15:00 Chris Byrnes

"CMB power asymmetry" coffee & discussion

15:30 - 16:30 Chunshan Lin

"Beyond GR and Beyond SM: two ideas about early universe"

16:30 - 17:30 Tsutomu Kobayashi

"Primordial non-Gaussianities of gravitational waves beyond Horndeski"

This work was ignited at this workshop!!



新学術領域「なぜ宇宙は加速するか？ - 徹底的究明と将来への挑戦 - MAR2017

@Kobayashi Hall KEK

8th.Mar, 2017

Cosmological constraints on Lorentz symmetry violation

宇宙論的観測を用いたLorentz対称性の破れの検証

Shun Arai (Nagoya University C-lab, M2)

Shun Arai, S.Sibiryakov and Y.Urakawa in prep.

Shun Arai, D.Nitta and H.Tashiro Phys. Rev. D 94, 124048



Cosmological constraints on Lorentz symmetry violation

Cosmological constraints on Lorentz symmetry violation

Electro-Magnetism



Newton mechanics

Special Relativity (1905)

Cosmological constraints on Lorentz symmetry violation

Electro-Magnetism



Newton mechanics

Special Relativity (1905)

Lorentz symmetry

GR

QFT

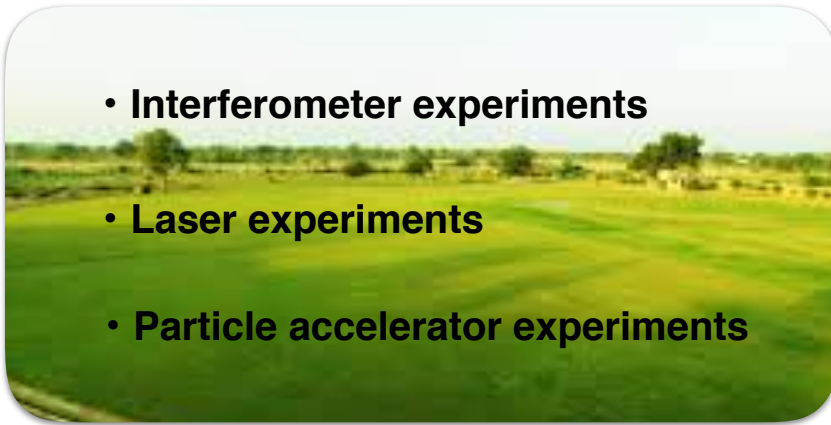
String theory



Cosmological constraints on Lorentz symmetry violation

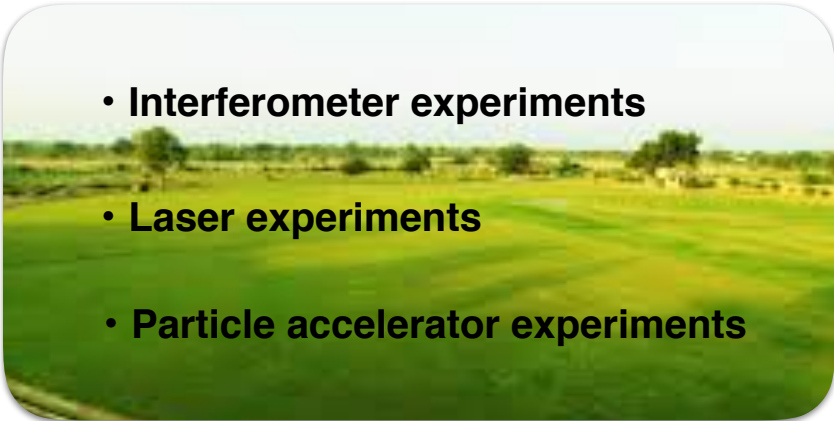
Ground-based experiments

- Interferometer experiments
- Laser experiments
- Particle accelerator experiments



Cosmological constraints on Lorentz symmetry violation

Ground-based experiments

- 
- Interferometer experiments
 - Laser experiments
 - Particle accelerator experiments

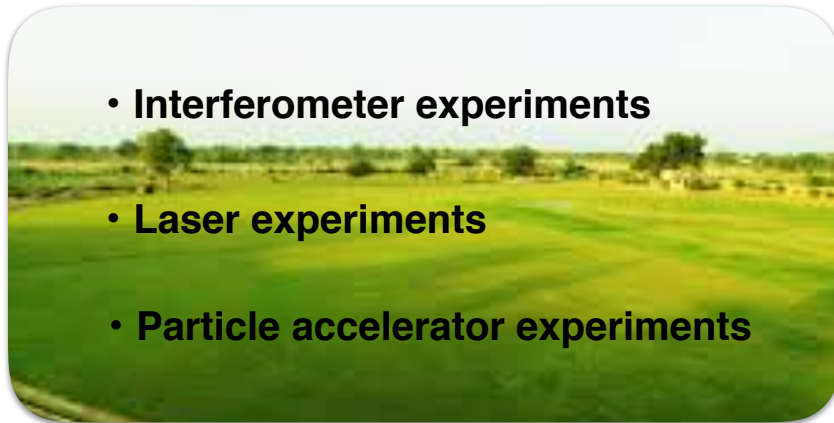
Astrophysical experiments

- 
- Gamma Ray Burster (GRB)
 - GZK cutoff
 - Gravitational Waves

Cosmological constraints on Lorentz symmetry violation

Ground-based experiments

- Interferometer experiments
- Laser experiments
- Particle accelerator experiments

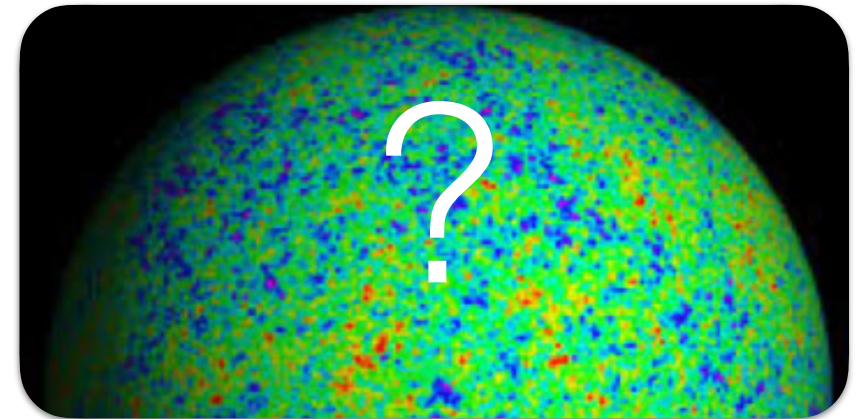


Astrophysical experiments

- Gamma Ray Burster (GRB)
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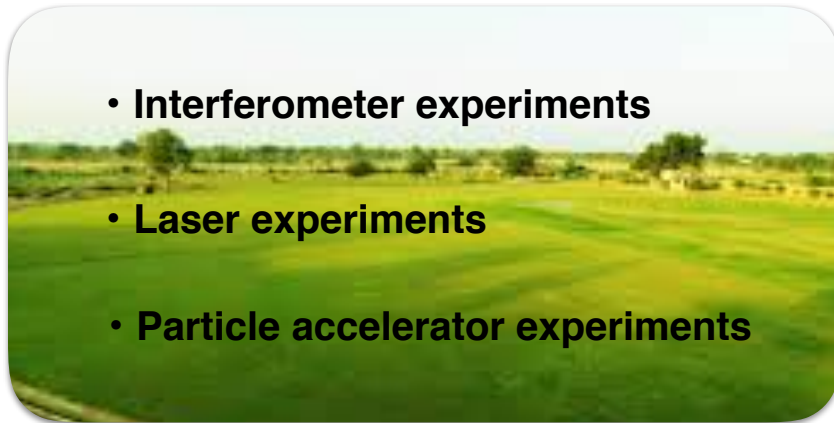
Cosmological experiments



Cosmological constraints on Lorentz symmetry violation

Ground-based experiments

- Interferometer experiments
- Laser experiments
- Particle accelerator experiments

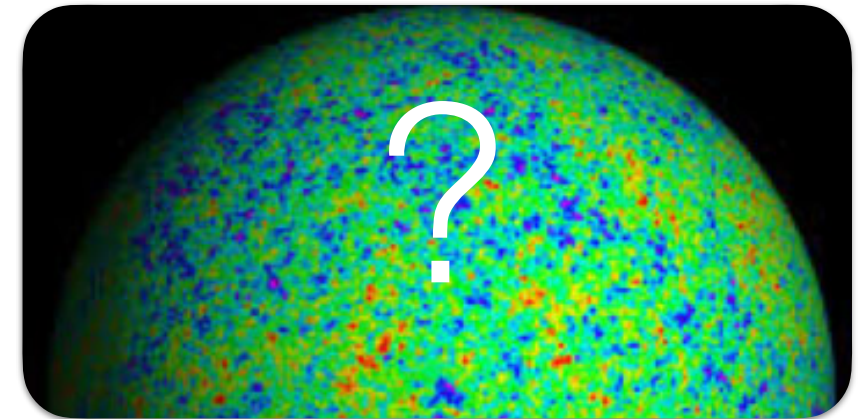


Astrophysical experiments

- Gamma Ray Burster (GRB)
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- Gravitational Waves



Cosmological experiments



How can Lorentz Violation be constrained in the cosmological context?

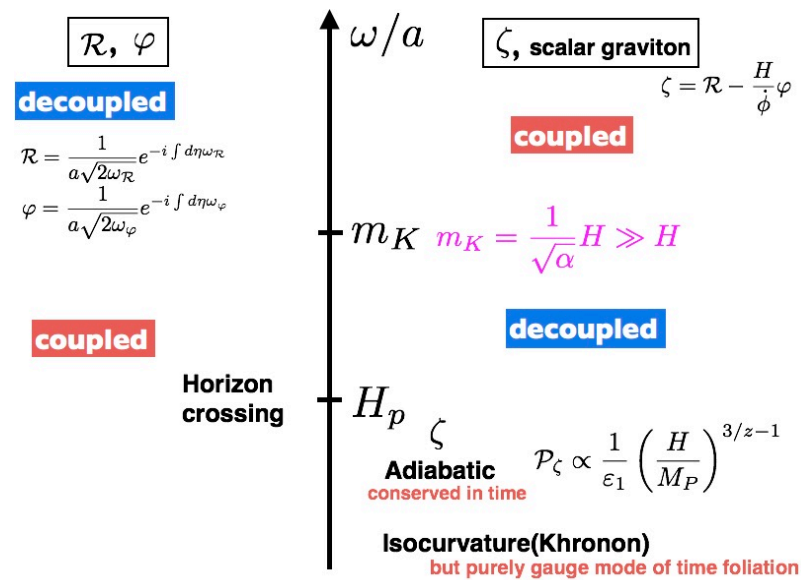


Cosmological constraints on Lorentz symmetry violation

Cosmological constraints on Lorentz symmetry violation

- Ultra high energy scale : Inflation

- initial density fluctuations



- Smoking gun for Lorentz Violation (LV)

$$n_t = -\frac{r}{8c_s}$$

$$n_t \propto -\frac{3-z}{z} \frac{r}{16} \quad \longrightarrow \quad n_t = 0 \quad (z = 3)$$

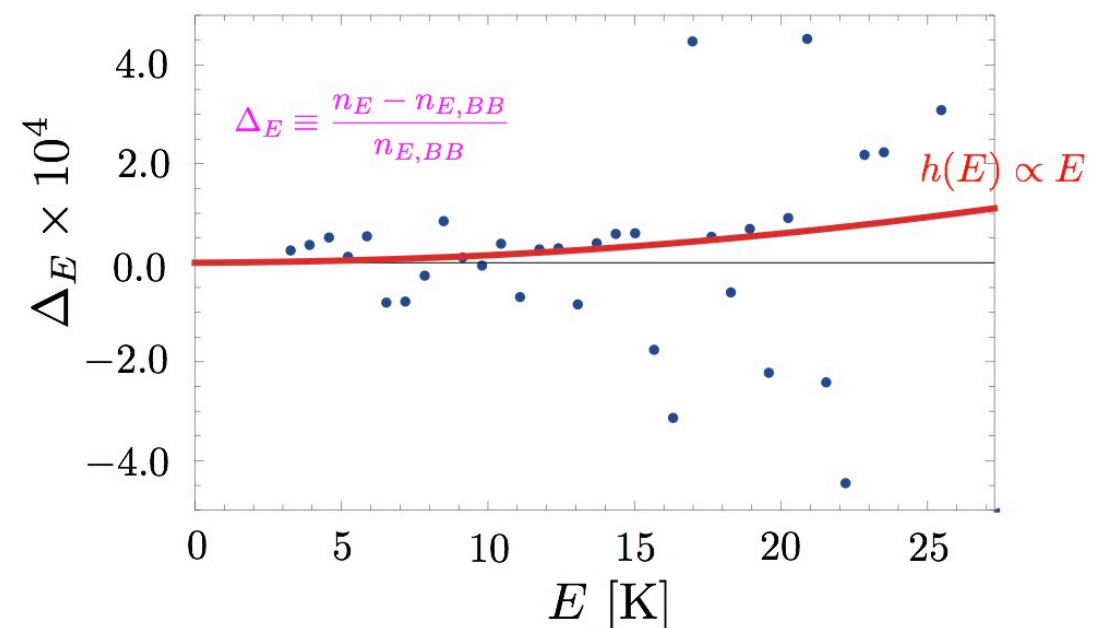
- **initial density fluctuations**



$$n_t = -\frac{r}{8c_s}$$

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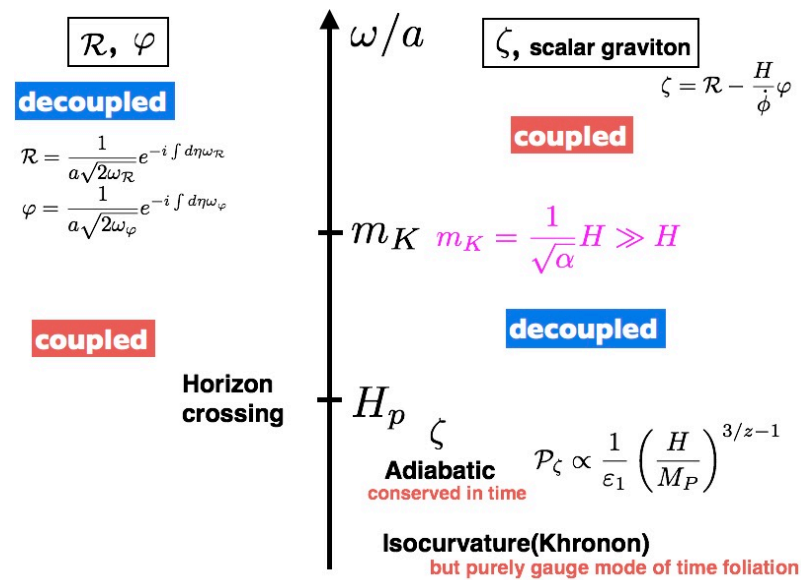
- **CMB distortions from LV**



Cosmological constraints on Lorentz symmetry violation

- Ultra high energy scale : Inflation

- initial density fluctuations



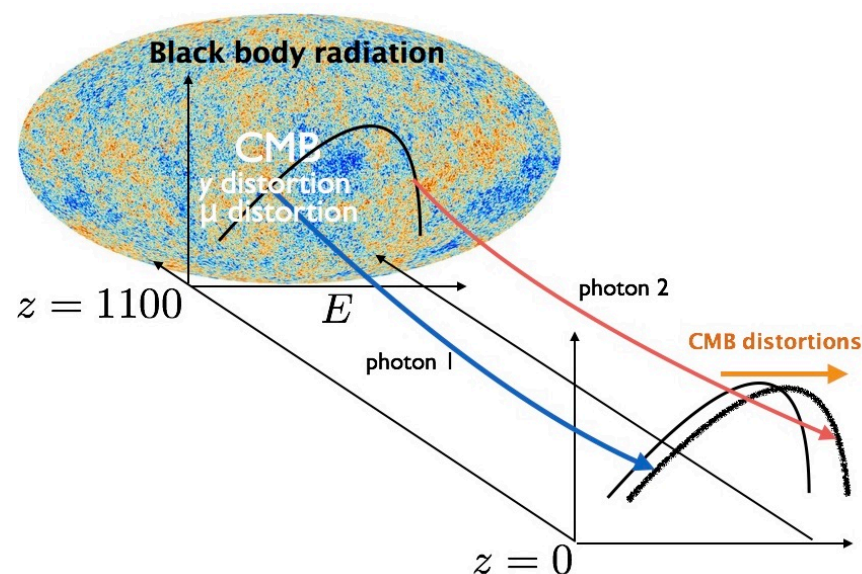
- Smoking gun for Lorentz Violation (LV)

$$n_t = -\frac{r}{8c_s}$$

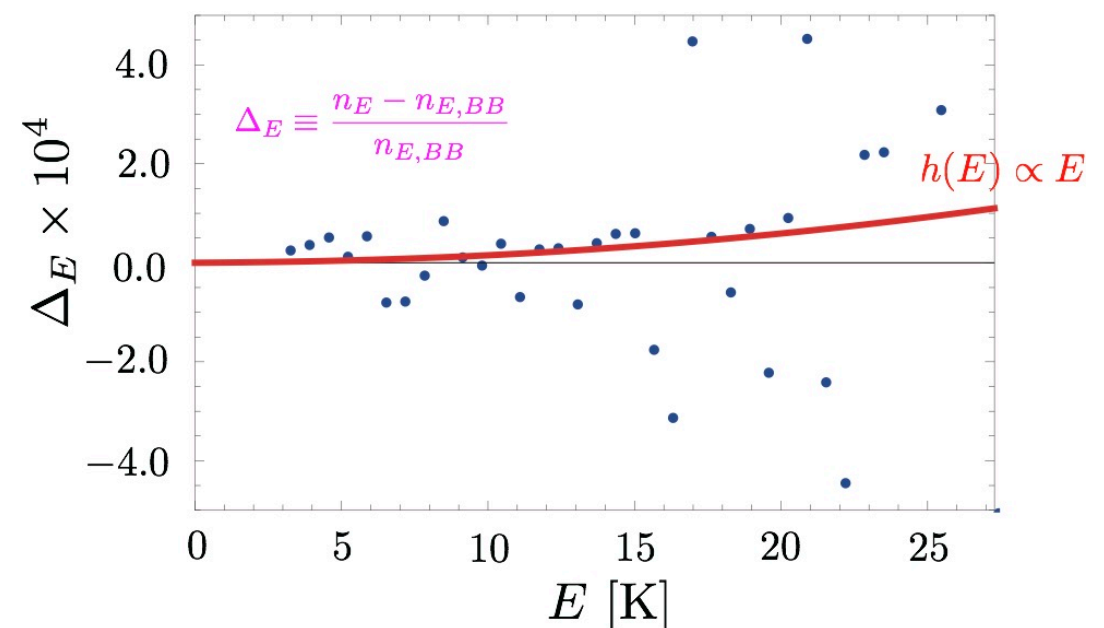
$$n_t \propto -\frac{3-z}{z} \frac{r}{16} \rightarrow n_t = 0 \quad (z = 3)$$

- Ultra long distance : CMB observations

- CMB distortions from LV



- Observational constraints for LV in cosmological distance



Please come to my poster :-)

Scales set by the cosmological constant

Ivan Arraut

Tokyo University of Science.

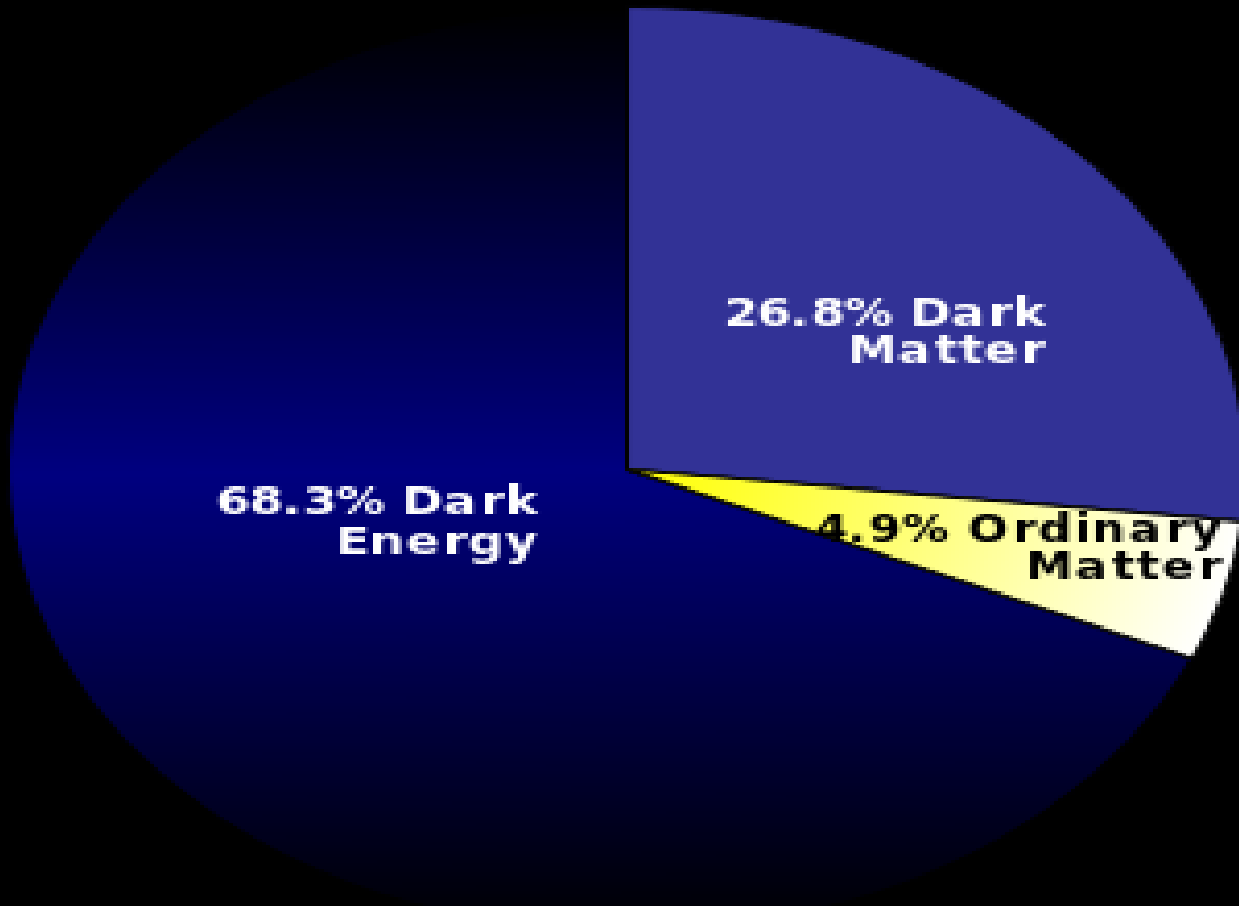
JSPS Fellow.

Based on

- 1). **Braz.J.Phys. 38 (2008) 425-430.**
- 2). **Class.Quant.Grav. 26 (2009) 125006.**
- 3). **Mod.Phys.Lett. A24 (2009) 2133-2137.**
- 4). **Central Eur.J.Phys. 9 (2011) 926-938.**
- 5). **Int.J.Mod.Phys. D23 (2014) 1450008.**
- 6). **Int.J.Mod.Phys. D24 (2015) 1550022 .**
- 7). **PTEP 2014 (2014) 023E02 with Hideo Kodama.**
- 8). **Phys.Rev. D90 (2014) 124082 .**

Motivation

- Composition of the universe in agreement with the standard model of Cosmology.



Dark Energy

The easiest way for explaining the accelerated expansion of the Universe, is introducing a cosmological constant

$$S_{EH} = \int d^4x \sqrt{-g} (R - 2\Lambda) \quad \longrightarrow \quad R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = \Lambda g_{\mu\nu}$$

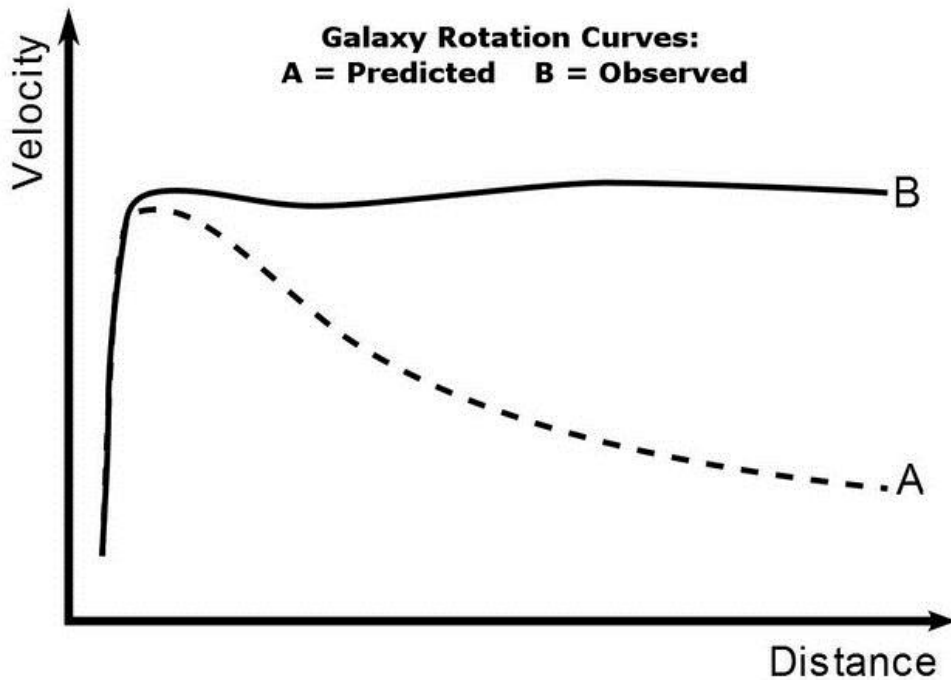
The theory is invariant under the transformation

$$\delta g_{\mu\nu} = -2\nabla_{(\mu} \zeta_{\nu)}$$

But then what's the problem with introducing the cosmological constant? We should be happy with that. What's going on?

The calculations from zero point quantum fluctuations provide a huge value in comparison with observations.

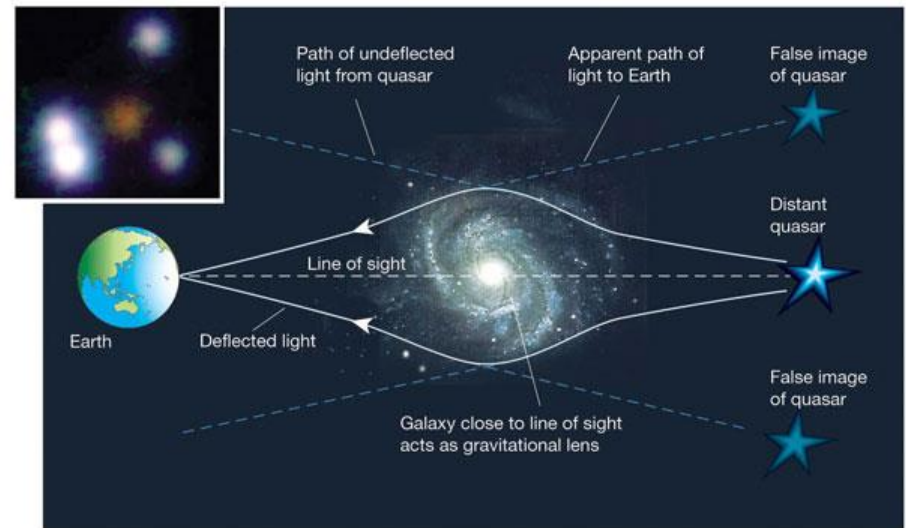
Dark Matter



We do not have a satisfactory explanation for the observed galactic dynamics.

We cannot explain the extra effect in gravitational lenses.

The easiest explanation is Dark Matter.



What are the relevant scales involved?

For Dark Matter scales, for galaxies, the cosmological constant is related to the scales of Dark Matter.

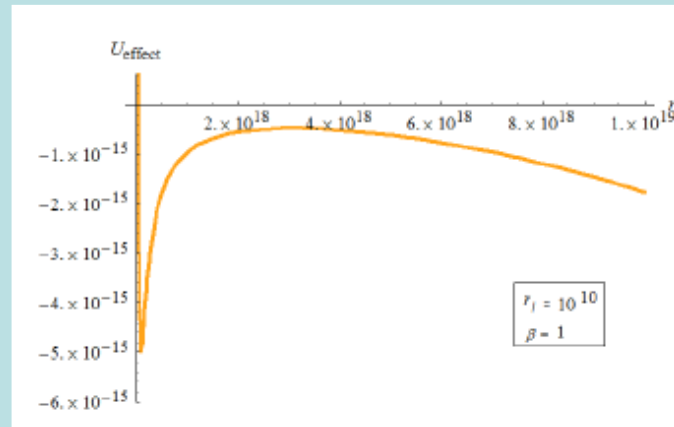
$$m\mu \left(\frac{a}{a_0} \right) \vec{a} = \vec{F}$$



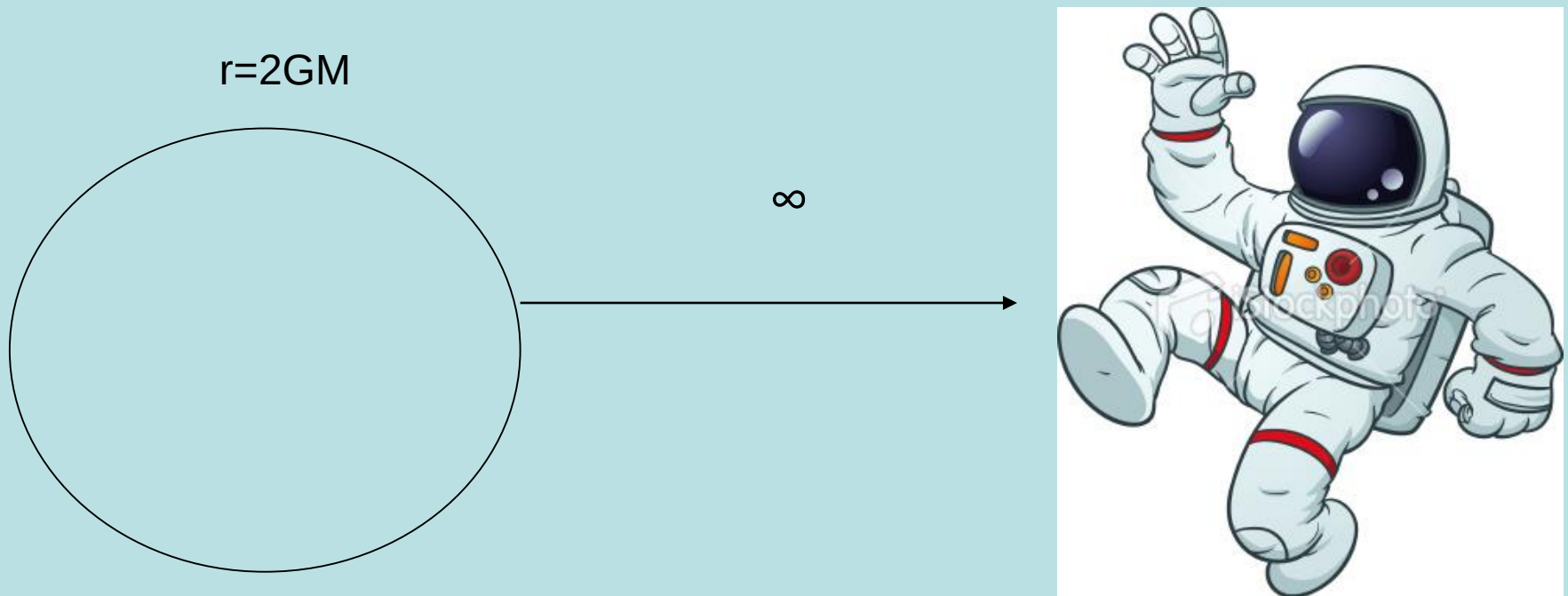
Geometric average.

For Dark Energy, the scale after which the accelerated expansion of the universe becomes relevant is defined by

$$r_0 = \left(\frac{3}{2} r_s r_\Lambda^2 \right)^{1/3}$$



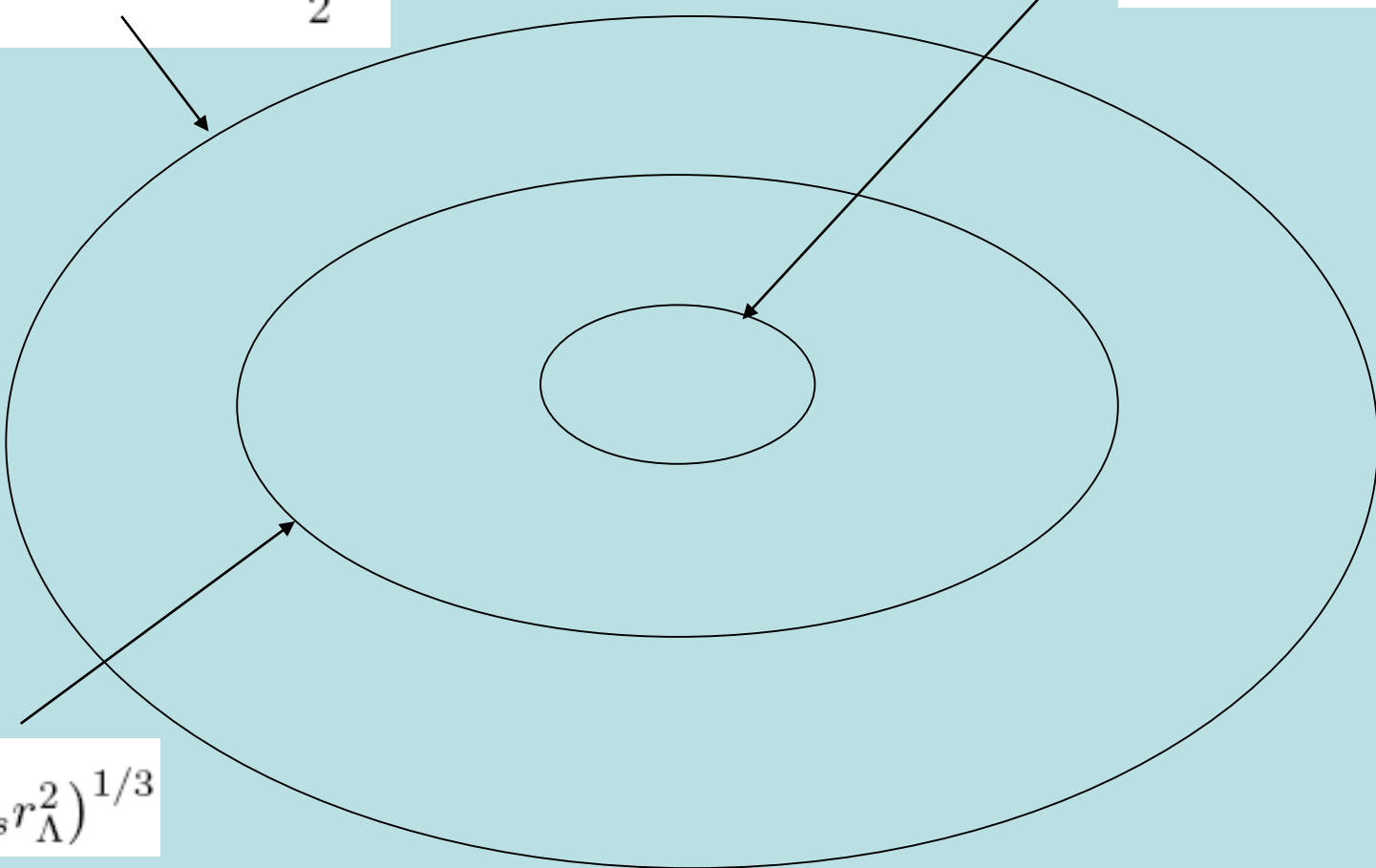
The BH temperature can be described in terms of the surface gravity. The surface gravity is the acceleration of a body near the horizon as it is perceived by a static observer. In the Schwarzschild space, that observer is at infinity. (The normalization is in principle arbitrary).



This is equivalent to normalize the time-like Killing vector as:

$$K^2 = -1 \quad (\gamma_t = 1) \quad \text{with} \quad K = \gamma_t \frac{\partial}{\partial t}$$

Let's take a look for the Schwarzschild de-Sitter space in Static Coordinates.

$$r_{CH} \approx \sqrt{3}r_{\Lambda} - \frac{1}{2}r_s$$


The diagram consists of three concentric ellipses centered on the same point. The innermost ellipse represents the event horizon, the middle ellipse represents the apparent horizon, and the outermost ellipse represents the cosmological horizon. Arrows point from the equations to their respective horizons: one from the top-left equation to the outermost ellipse, one from the top-right equation to the innermost ellipse, and one from the bottom-left equation to the middle ellipse.

$$r_{BH} \approx r_s + \frac{1}{6} \frac{r_s^4}{r_{\Lambda}^3}$$

$$r_0 = \left(\frac{3}{2} r_s r_{\Lambda}^2 \right)^{1/3}$$

"A search for Low-Mass Black Holes via Optical Rapid Variability"

Tomoki Morokuma
(Univ. of Tokyo, IoA)

- Nearby low-mass ($<10^6$ Msun) AGN could be a remnant of seed black holes of very high-redshift quasars.
- Establish a new method to effectively find low-mass AGN (candidates) w/ optical high-cadence wide-field imaging data.
- Rapid variability is expected.
- Let's find the lowest-mass BHs.
- Prepare PFS survey.

A search for Low-Mass Black Holes via Optical Rapid Variability

Morokuma+2016, PASJ, 68, 40
Taniguchi, Y. 2017, master thesis

Tomoki Morokuma (The University of Tokyo, Institute of Astronomy)

Abstract We present a new method to effectively select candidates of low-mass active black hole (BH) at galaxy centers using high-cadence optical imaging data and our first spectroscopic identification of an active 2.7×10^5 Msun BH at $z=0.164$. This active BH was originally selected by a criterion of rapid optical variability from a few hours to a day based on Subaru Hyper Suprime-Cam (HSC) g-band imaging data taken in 1-hour cadence. Broad and narrow H and many other emission lines are detected in our optical spectra taken with Subaru FOCAS and the BH mass is measured with the broad H emission line width and luminosity. We also show effectiveness of our variability selection for low-mass active BHs by combining HSC & PFS wide-field capabilities. In addition, we are evaluating optical variability in a short time scale (hours) of known low- z low-mass BHs at $z \sim 0.1$ with L05-m Kiso Schmidt telescope and found that significant and rapid variability are detected from 2 of the 30 sample objects.

1. Introduction

AGN is a useful tool to study various kinds of astronomical fields including very high redshift universe (Mortlock+2011) and cosmology (Yoshi+2014). Low-mass black holes (BHs, $< 10^6$ Msun) are building blocks of more massive BHs and a key population of seed BHs and observed correlations between BH & galaxy (bulge) properties.

$\Rightarrow$ An effective methods to find low-mass BHs is desired. Previous methods so far include...

- detailed fitting of galaxy spectra (SDSS) by Greene+2007, Dunlop
- a few hundreds low-mass (2×10^5 Msun) BHs identified at $z \sim 0.35$
- limited by SDSS spectroscopic depths & wavelength range
- search for X-ray sources in galaxies w/ low stellar masses ($< 10^9$ Msun) $\Rightarrow$ expected to host $< 10^6$ Msun BHs
- three $\sim 10^5$ Msun BH discovered
- spectroscopy & X-ray observation for nearby galaxies
- recently 5×10^4 Msun identified w/ high-R spec (Kawaguro+)
- Barth+2004, Reines+2011, ...

2. Methodology

- (Type-1) AGN show optical variability in general.
- Less luminous, more variable (Vanden Berk+2004)
- Dynamical time scale in UV-short-optical for active $< 10^6$ Msun BH is shorter than a few days.
- NGC 4395 (3.6×10^5 Msun BH) shows rapid variability (Wiersma+2005)
- $\Rightarrow$ High-cadence imaging survey: effective for low-mass active BHs.
- insensitive to redshift (except for apparent brightness)
- time dilation effect: a factor of $(1+z)$
- other methods (X-ray etc.) require an initial guess of a distance (photo- z) to estimate luminosity or a large amount of spectroscopic time.

3. Subaru/HSC+FOCAS Observations

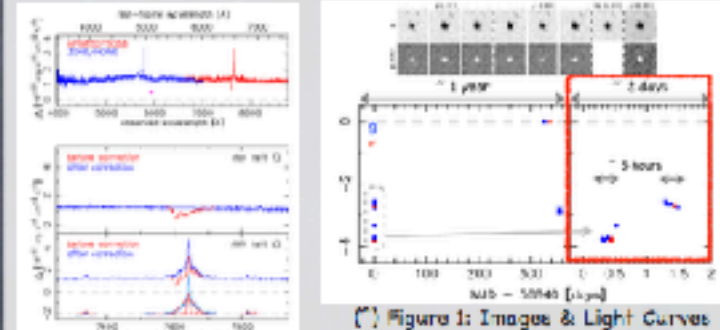
- 2-night transient survey (SHOOT, Tanaka+2015, ApJ)
- 1-hour cadence survey w/ HSC (July 2 & 3, 2014)
- g: [10 minutes per visit] $\times$ [3 visits per night] $\times$ [2 nights]
- r: [10 minutes per visit] $\times$ [1 visit per night] $\times$ [2 nights]
- another survey w/ HSC on May 24, 2015 (used as references)
- adopt an image subtraction method to find rapidly (intranight and/or between these two nights) variable sources.

2-night follow-up spectroscopy w/ FOCAS on July 22, 2015

- VPH850/SY47 (R⁺500) to get H α
- 1200 sec $\times$ 3
- 2 AGN identified
- narrow "broad" H α @ $z=0.164 \Rightarrow$ size ~ 4
- AGN w/ LINER-like line ratio @ $z \sim 0.3$
- 1 night lost due to instrument trouble

4. Initial Result & Future w/ HSC & PFS

Detected intranight & 1-day-scale variability of a galaxy w/ HSC.



(*) Figure 2: VPH850/SY47 & 3008/None spectra w/ FOCAS (top panel). Very unfortunately, the H α /[NII] lines are located around an atmospheric abs. region and careful corrections are applied using a spectrum of a star within the same slitmask.

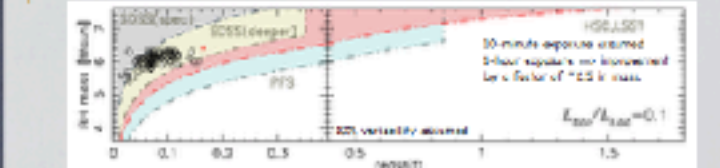


Figure 3: Survey power comparison (SDSS, HSC, Subaru/PFS). Our imaging survey has advantage over SDSS because we can find lower mass BHs at higher redshifts. Subaru/PFS overcomes our capability in terms of mass range but such a PFS blind survey is very inefficient because of the low active fraction of such low-mass BHs ($\sim 0.1\%$; Greene & Ho 2007). Our imaging pre-selection will provide good targets for a systematic survey w/ PFS. PFS blind survey (like SDSS) is also powerful.

5. Low-mass BHs are really rapidly variable?

- "Quasars" (w/ high mass BHs) are known to be variable (> 0.1 mag) in months-years time scales. (Kelly+2013 etc.)
- No systematic studies on time scales of optical variability for AGN w/ low-mass BH. $\Rightarrow$ need to verify their variabilities.
- Our Study
- monitor 20 AGN w/ low-mass BHs (10^4 (4.9) $- 10^7$ (6.3) Msun)
- w/ KWFC (2x2 deg²) on L05-m Kiso Schmidt telescope
- high cadence: 0.5-1 hrs (KISS; TM+2014, Taniguchi 2017)
- Variability detected from 9 of the sample objects.
- higher variability amplitudes than quasars in a 1 day time scale.

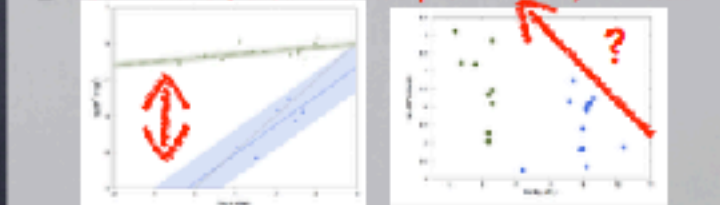
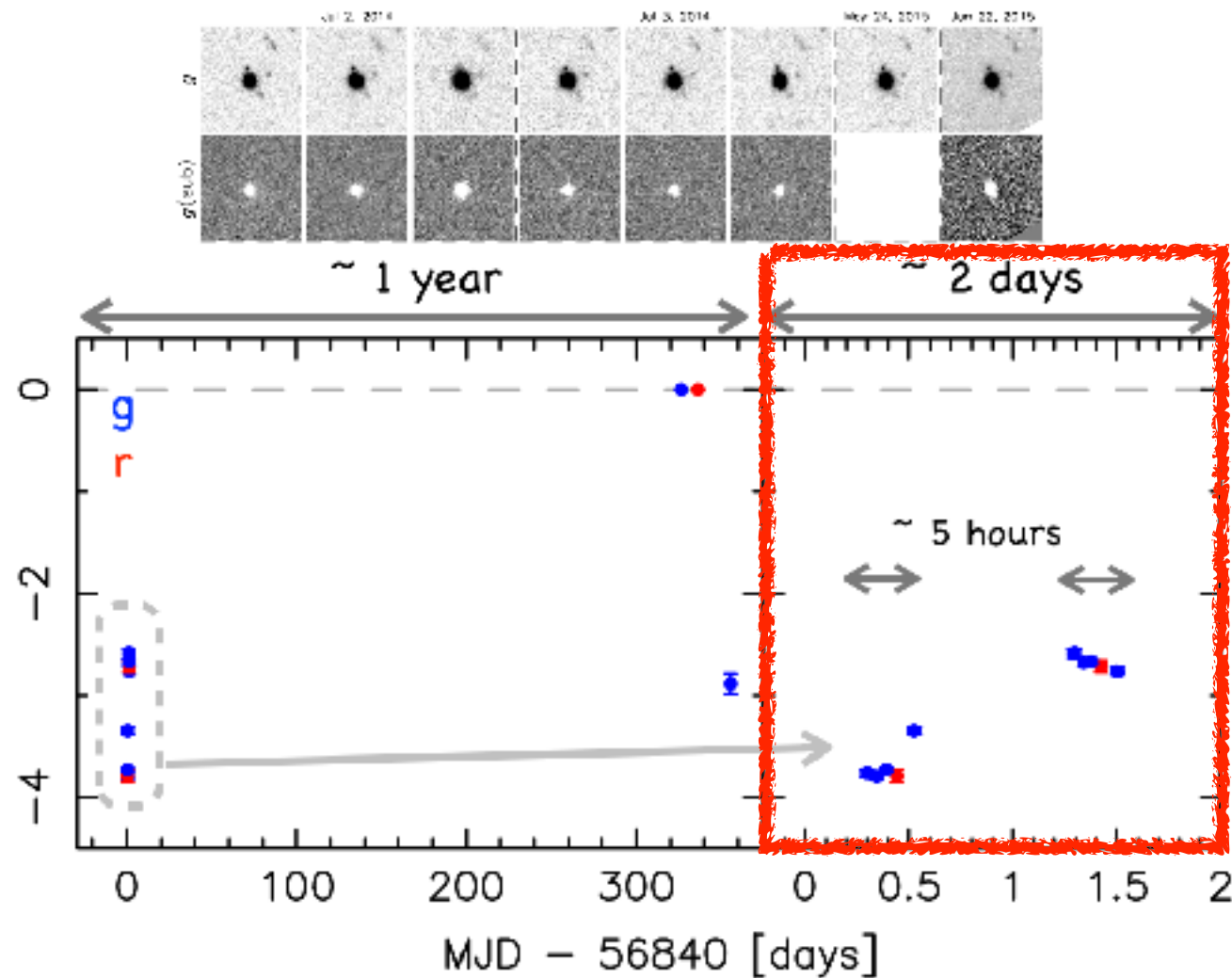


Figure 4 (left): "structure function" (ensemble variability amplitude as a function of time scale) of AGN w/ low/high mass BH. Figure 5 (right): structure function amplitude as a function of black hole mass.



Subaru/HSC

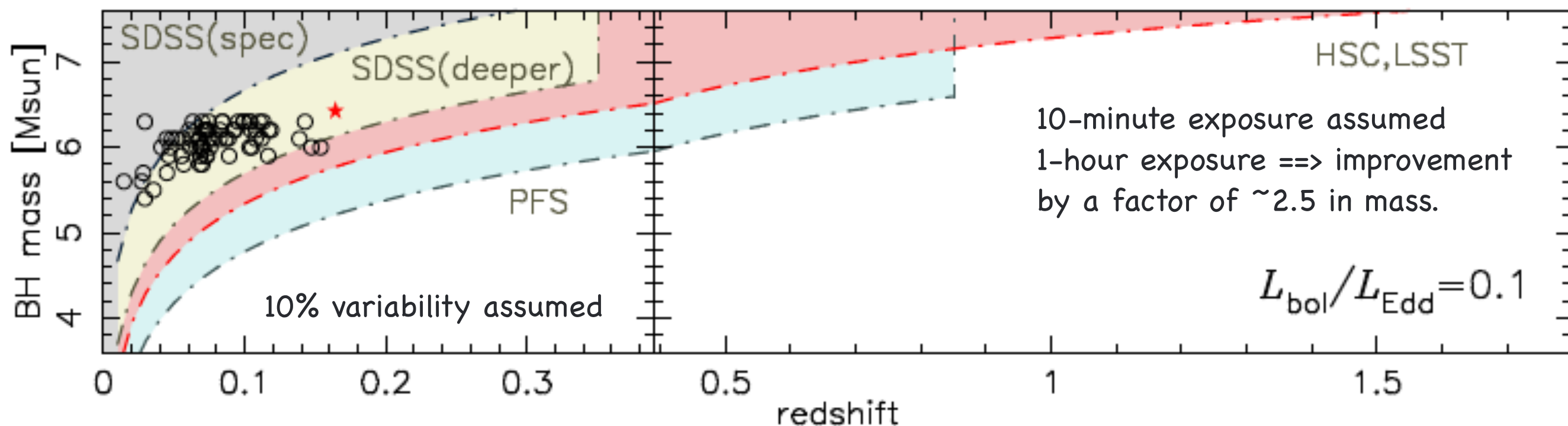
wide-field, 1-hour cadence

Subaru/FOCAS spectroscopy

$\Rightarrow 2 \times 10^6 \text{ Msun} @ z=0.16$

(TM+2016, PASJ, 68, 40)

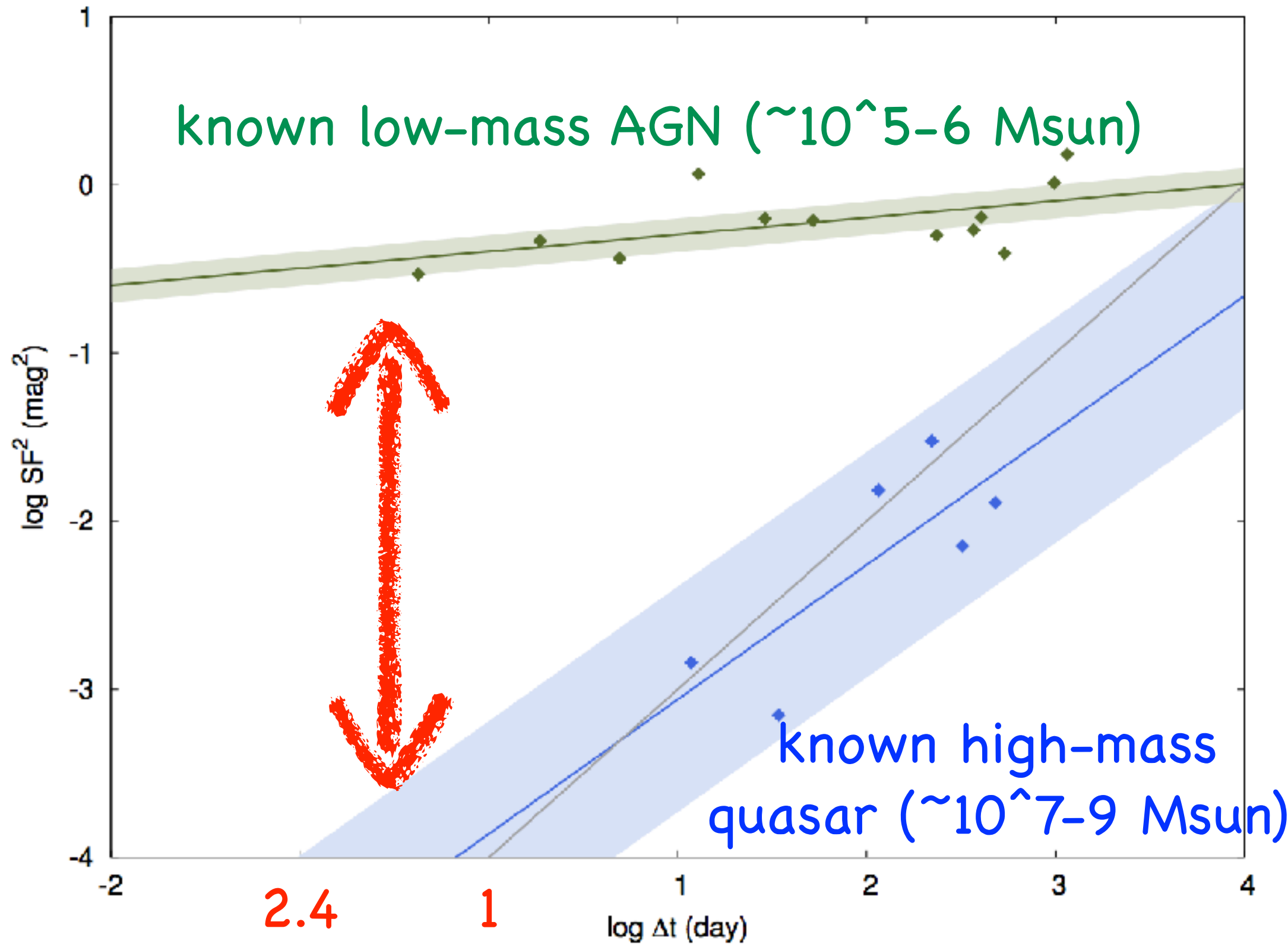
Subaru/PFS



- ❑ Blind galaxy survey (as done in SDSS, Greene+2007 etc.)
- ❑ targeted survey for objects showing rapid variability in HSC data.

Low-mass BHs are really rapidly variable?

High-Cadence Monitoring w/ 1m Kiso telescope for “known” low-mass AGN



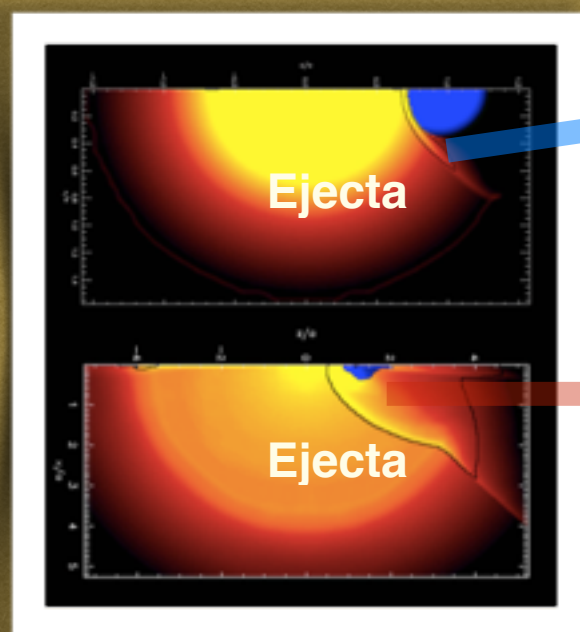
Hunting for Early-Phase Type Ia Supernovae in Subaru/HSC Era

Ji-an Jiang¹, Mamoru Doi^{1,2,3}, Keiichi Maeda⁴, Toshikazu Shigeyama², Naoki Yasuda³, Tomoki Morokuma^{1,3}, Ken'ichi Nomoto³, Nao Suzuki³, Nozomu Tominaga^{3,5}, Masaomi Tanaka^{3,6}, Hisanori Furusawa⁶, Željko Ivezić⁷, Andrew Connolly⁷, Saurabh Jha⁸, Pilar Ruiz-Lapuente⁹, Stritzinger Maximilian¹⁰, Peter Yoachim⁷, Paolo Mazzali^{11,12}, Christopher Ashall¹¹, Lifan Wang^{13,14}, Ferdinando Patat¹⁵, Jeremy Mould¹⁶, David Jones¹⁷, et al.

Why early-phase Type Ia Supernovae? Why Subaru?

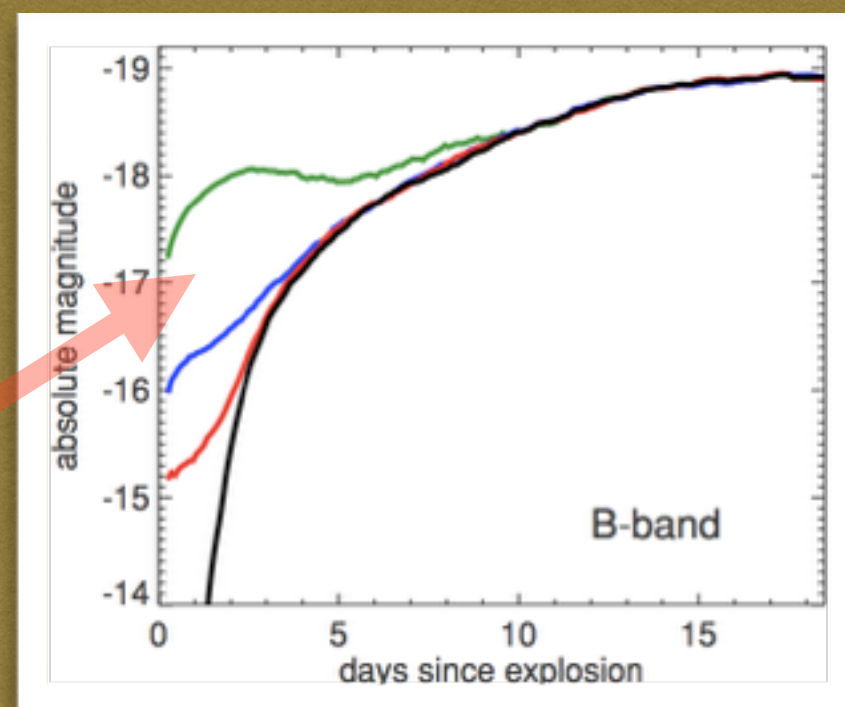
The light curve and spectral information of Type Ia Supernovae within a few days after the explosion ("early-phase SNe Ia", ESNe Ia) provides a unique perspective for understanding both the SNe Ia progenitor and the explosion mechanism issue. However, due to the dimness of ESNe Ia and the low limiting magnitude of previous/on-going SN surveys with 1-m class telescopes, very limited ESNe Ia have been well observed so far. Thanks to the great performance of Subaru/HSC, systematical investigations for ESNe Ia can be realized.

Searching for ESNe Ia with the "companion-ejecta interaction"

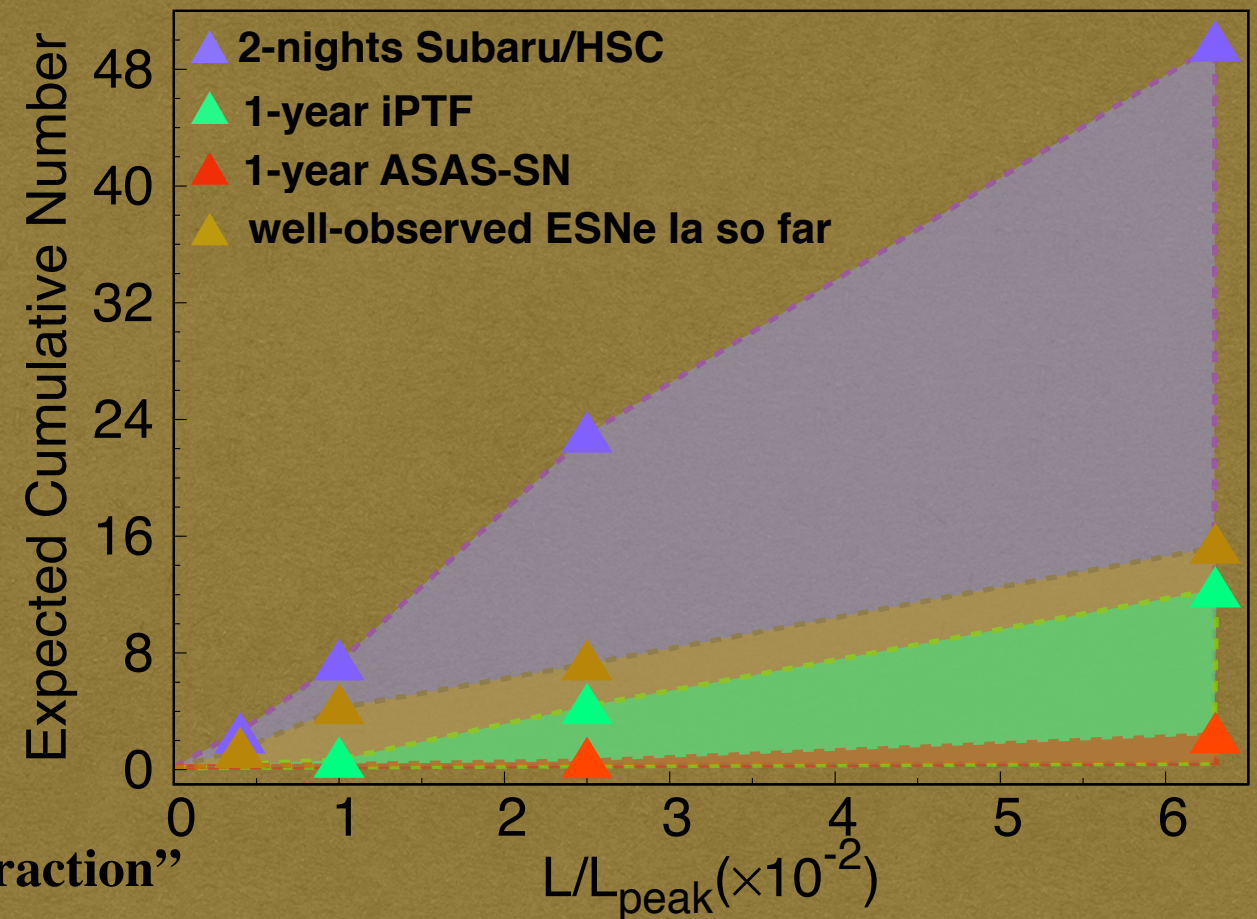


Collision between
ejecta and the
companion occurs

Photons are
emitted from the
collision region.



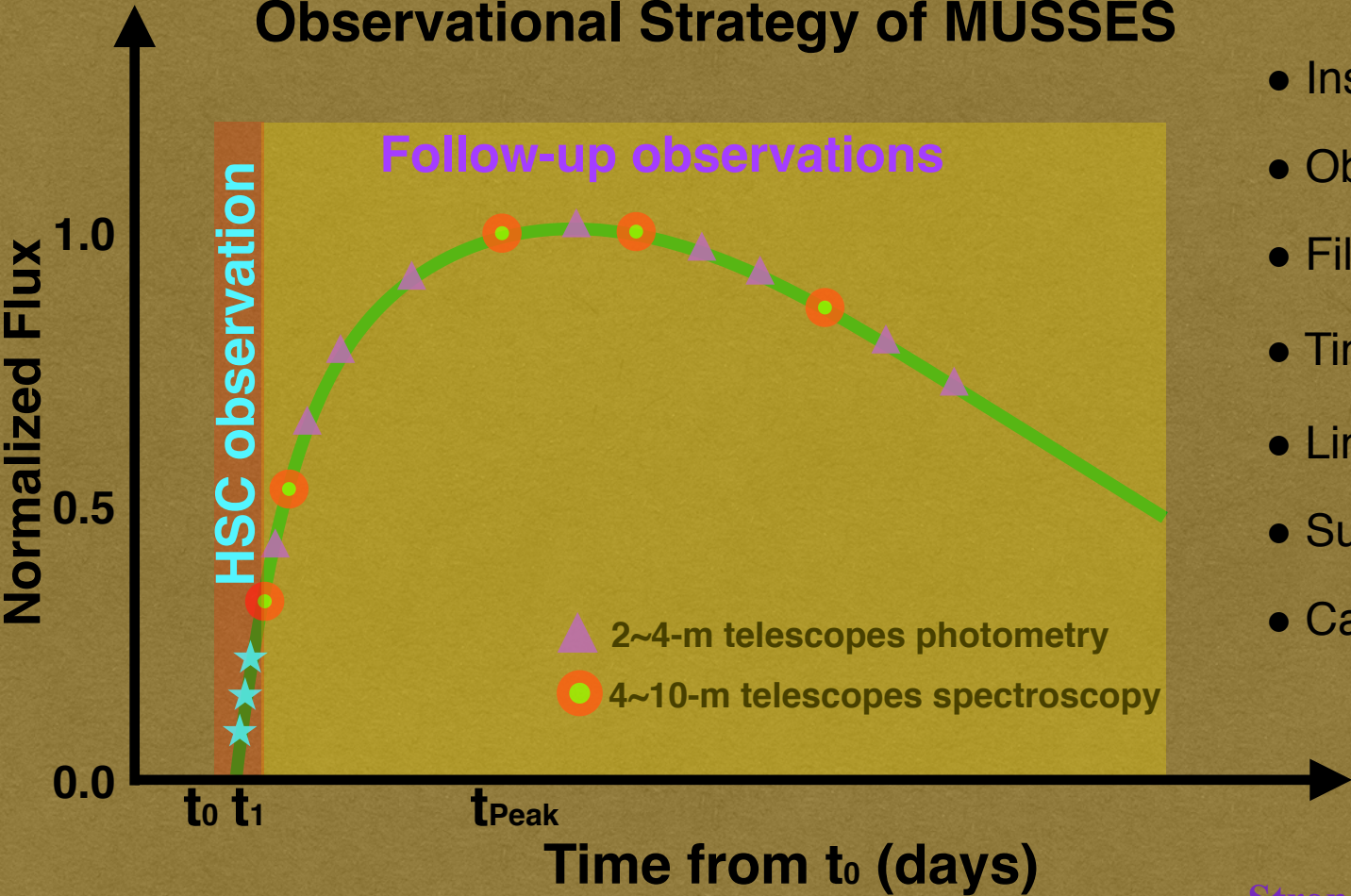
The strength of the
early emission is
correlated to the type
of companion. Such
specific feature only
can be discovered
within a few days
after the supernova
explosion.



Hunting for Early-Phase Type Ia Supernovae in Subaru/HSC Era

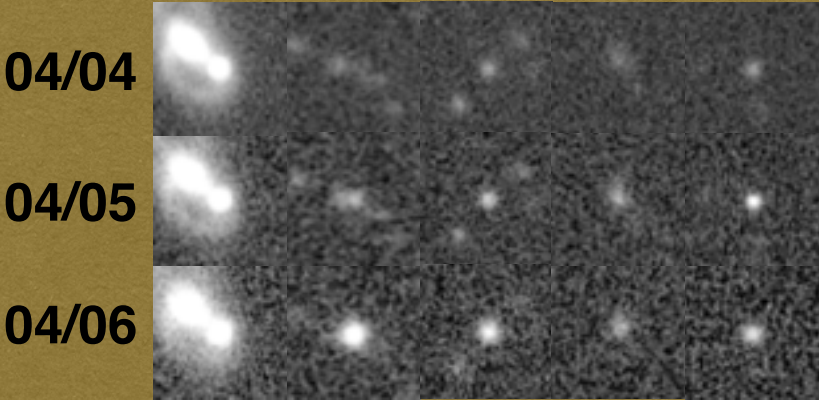
The **MU**lti-band **S**urvey with **S**ubaru for **E**arly-phase **S**Ne Ia (**MUSSES**) is a new supernova survey project which aims to systematically investigate the early photometric/spectroscopic behavior of Type Ia supernovae (SNe Ia) with Subaru/HSC and other 2–10 m class telescopes. In the first MUSSES observing run (Apr-Jun, 2016), several early-phase SNe have been discovered successfully.

Observational Strategy of MUSSES



- Instruments: Subaru/HSC + 2–10 m telescopes
- Observation mode: HSC survey+ follow-up observations
- Filters: g - and r -band for the Subaru/HSC observation
- Time Allocation: 2-nights Subaru/HSC per observing run
- Limiting magnitude (S/N = 5): ~ 26.0 mag in g -band
- Survey area: ~ 60 deg² per observing run
- Cadence: 1 day

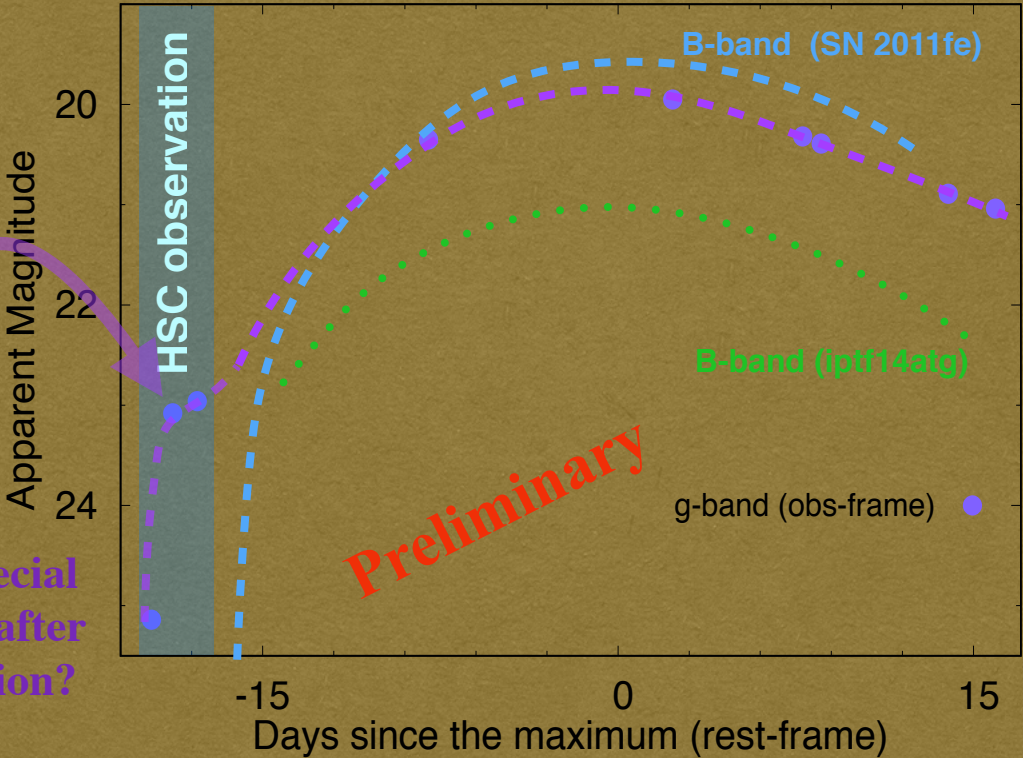
MUSSES Early-phase SNe



The first MUSSES observing run has been carried out from April to June, 2016. Five early-phase SNe have been discovered. In addition, one of ESNe shows very peculiar early-phase light curve.

Strong optical emission in the very early time has been detected!

Something special happens soon after the SN explosion?



No. 12

アンドロメダ銀河のHSC観測による 原始ブラックホール探査

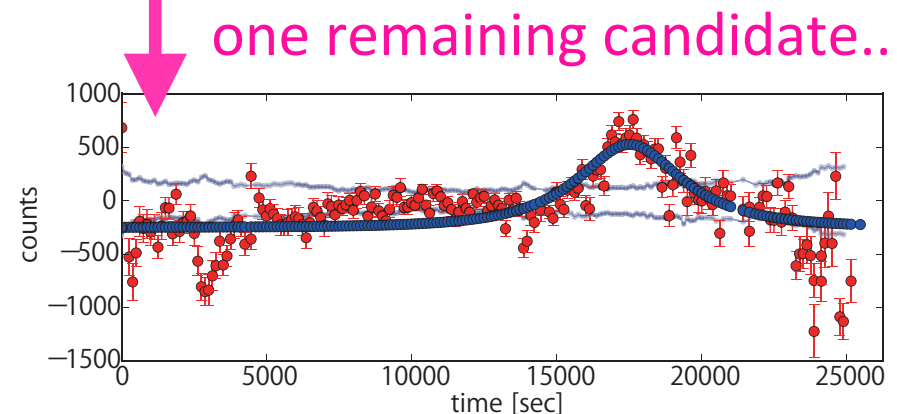
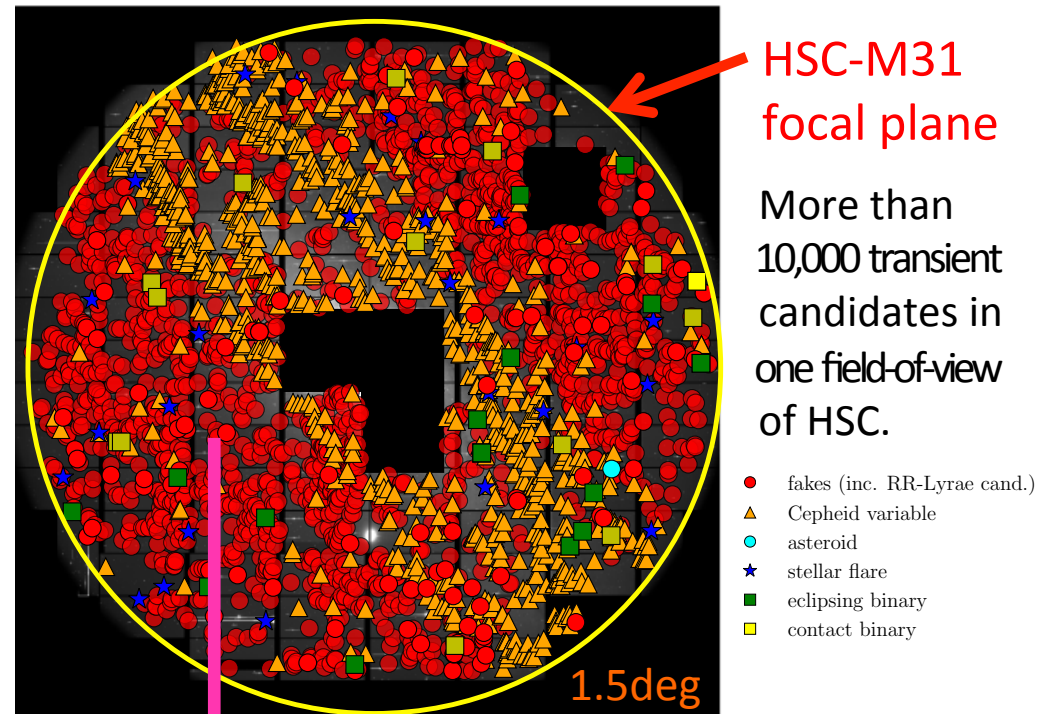
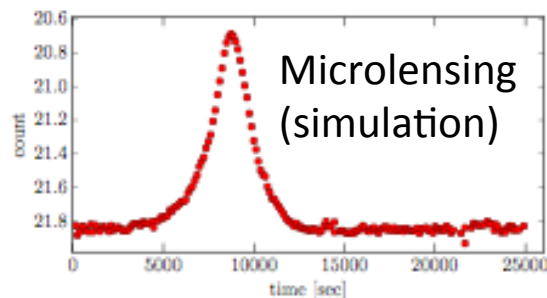
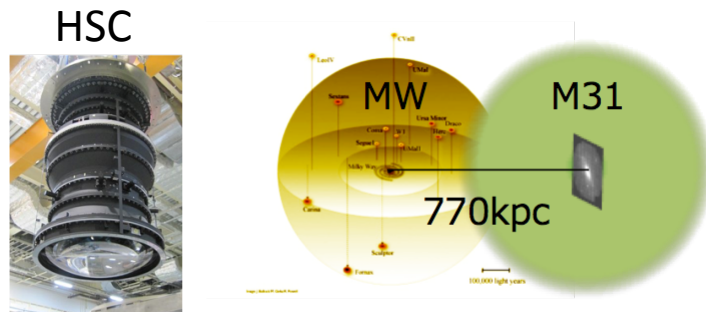
(Tightest upper bound on the abundance of
primordial black holes with Hyper Suprime-
Cam dense-cadence observation of M31 stars)

Hiroko Niikura (UTokyo/KIPMU)

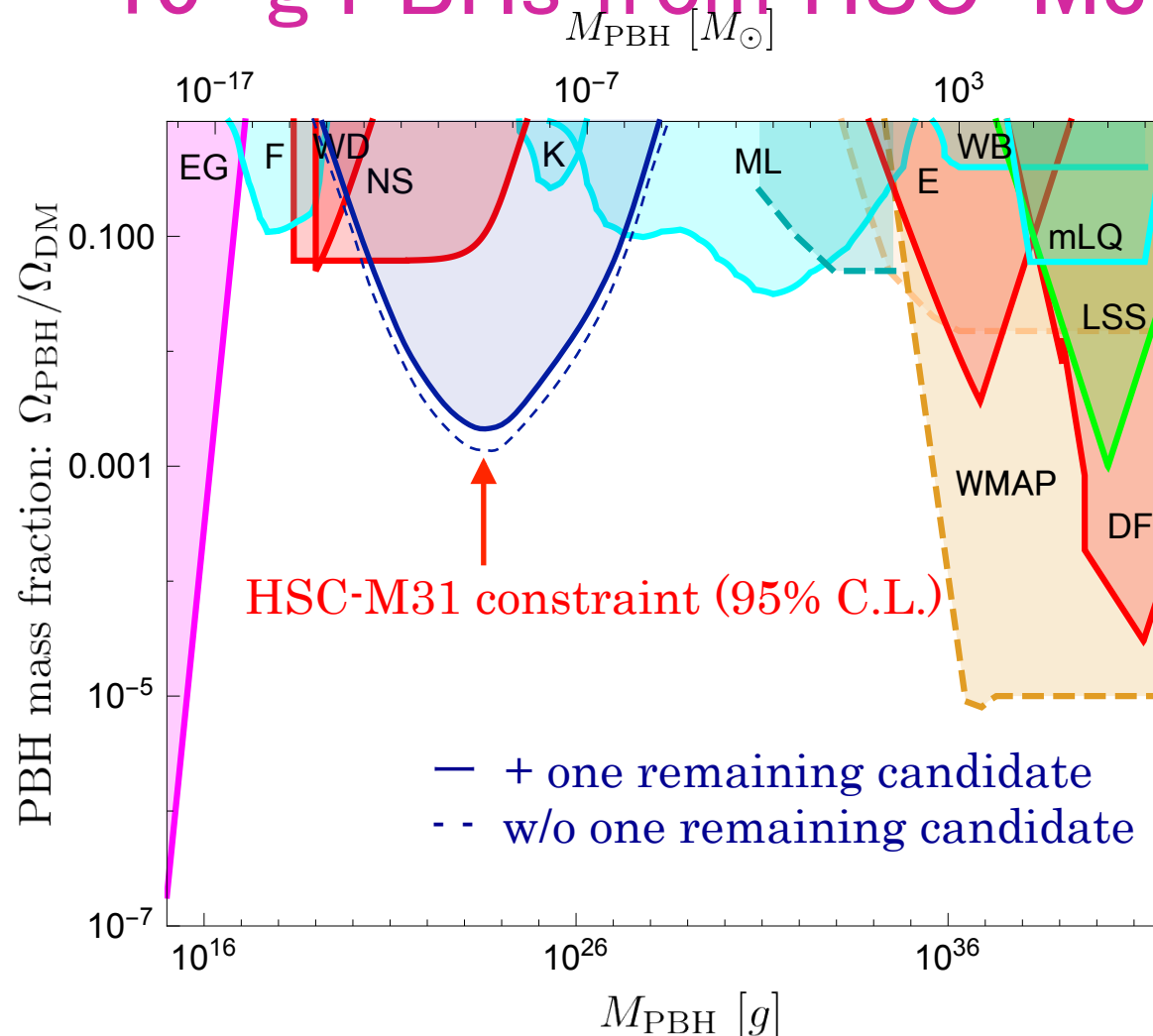
Collaborators: Masahiro Takada, Naoki Yasuda (Kavli IPMU)
Robert Lupton (Princeton), Takahiro Sumi (Osaka),
Surhud More, Anupreeta More, Masamune Oguri (UTokyo),
Masashi Chiba (Tohoku)

Dark matter search by HSC-M31 transient survey

- HSC-M31 observation for 7-hours, taking images every two minutes by r-band
- Target: microlensing effect by PBH, a candidate of dark matter (or put constraint on the abundance of PBH.)



The tightest constraint on the abundance of 10^{25} g PBHs from HSC-M31



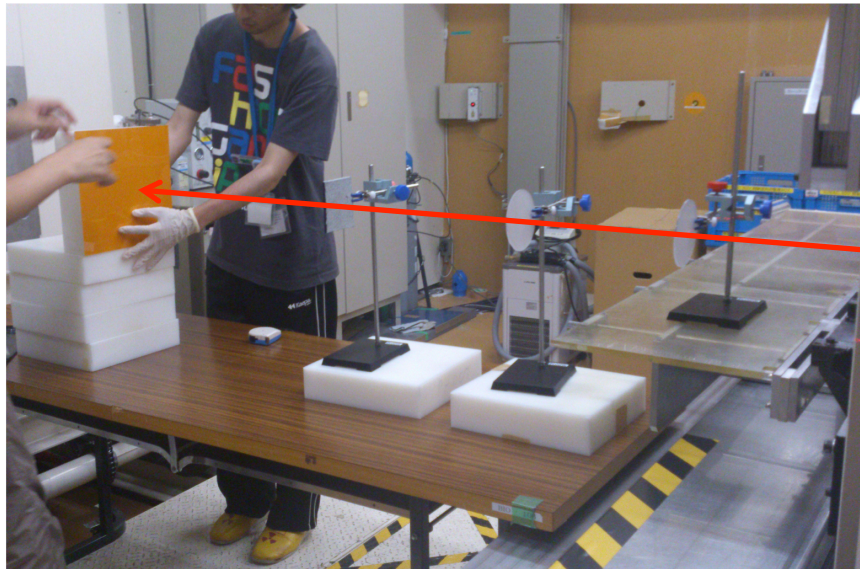
- From null-detection of microlensing events from PBHs, we can put constraint on the upper limit on the abundance of PBH to the total dark matter

Irradiation tests of the LiteBIRD optical components using a 160 MeV proton beam at HIMAC

K. Komatsu, H. Ishino, A. Kibayashi, S. Uozumi, Y. Yamada, Y. Kida, T. Funaki, N. Hidehira, T. Matsumura^A, N. Katayama^A, K. Hattori^A, M. Hazumi^B, Y. Minami^B, Y. Sekimoto^C, T. Hasebe^C, K. Karatsu^C, S. Nakamura^D, H. Irie^D, T. Fujino^D, T. Yamashita^D, H. Kanai^D, Y. Hori^E, A. Suzuki^E, B. Westbrook^E, O. Jeong^E, I. Shirley^E, J. Hubmayr^F, and LiteBIRD Working Group

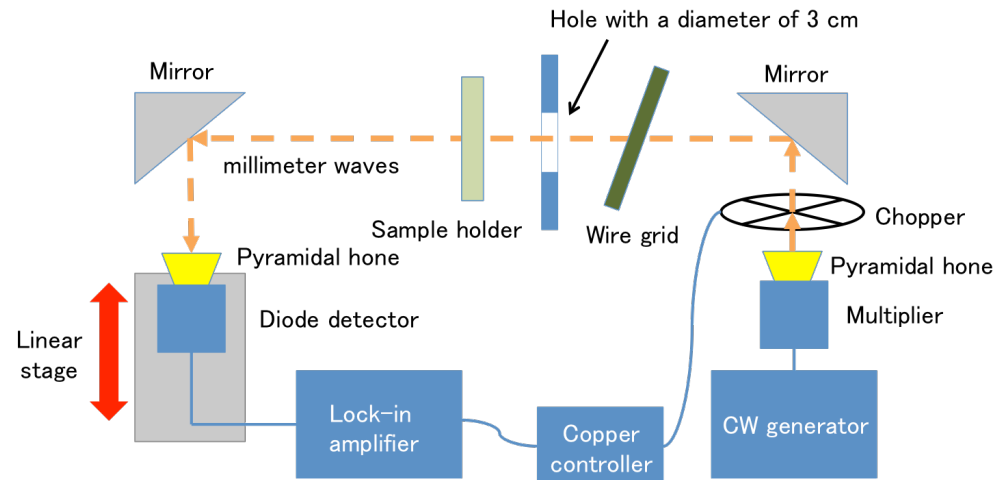
Okayama University, IPMU^A, KEK^B, National Astronomical Observatory of Japan^C, Yokohama National University^D, University of California, Berkeley Physics Department^E, NIST Boulder^F

Irradiate 160MeV proton beam at HIMAC



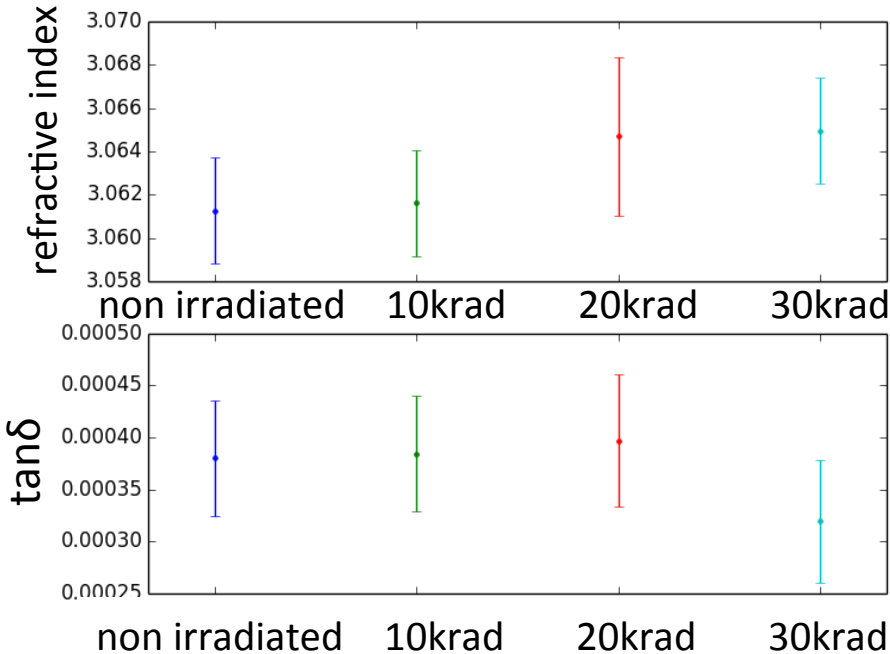
red arrow : proton beam

Milli-meter wave intensity measurement system

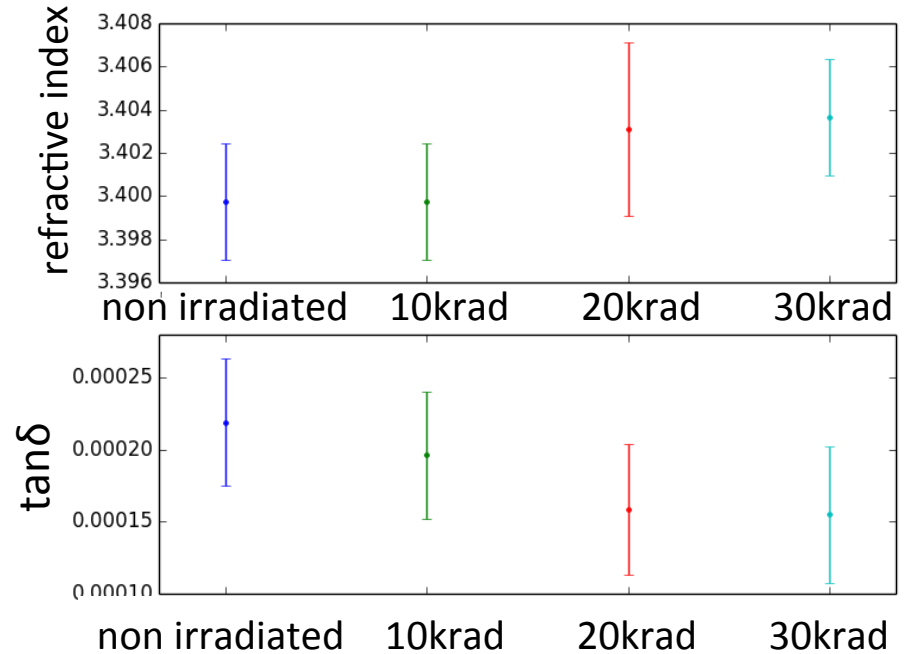


Refractive indexes and $\tan\delta$

Sapphire ordinary axis



Sapphire extraordinary axis

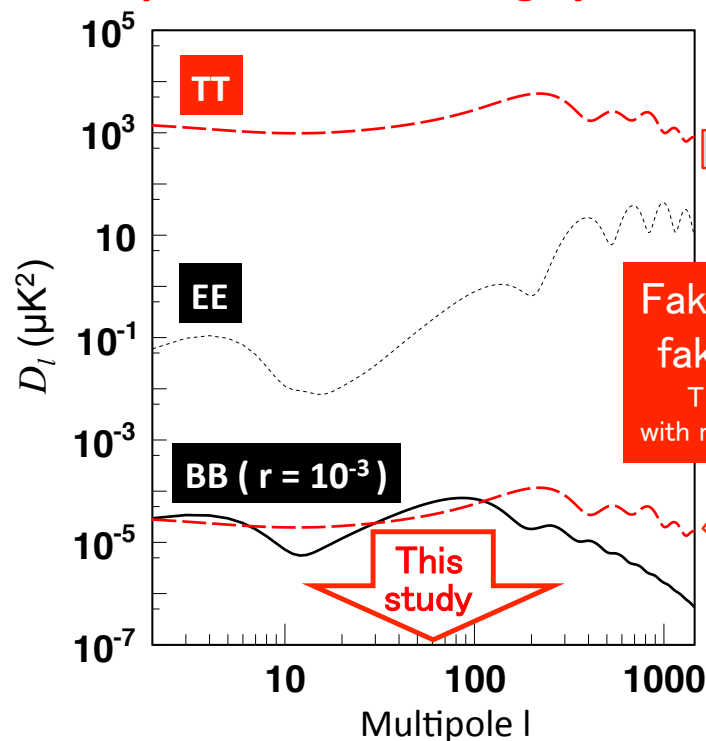


Refractive indexes and $\tan\delta$ of the samples with and without irradiation are consistent within the error.

“Superconducting Mirror” towards ultimate measurements of CMB B-modes

Motivation – Drastic mitigation of fake B-modes due to “fake” polarization caused by instrumental imperfection

Fake-pol. is source of big syst. bias



Fake signal due to fake polarization

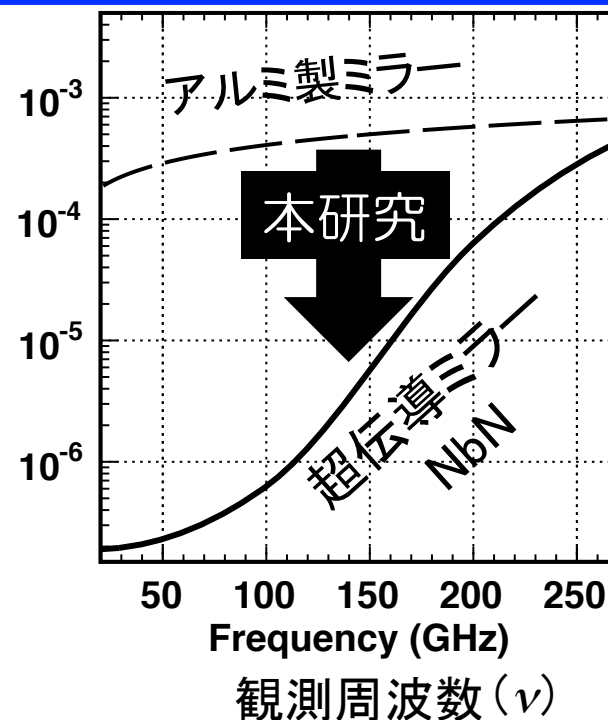
$T \rightarrow P$ fraction = 0.1%
with mitigation by cross-link

In principle,
it's unavoidable
∵ resistivity $\rho \neq 0$

$$P_{\text{fake}} \propto \sqrt{\rho\nu} \times (T_{\text{mirror}} - T_{\text{radiation}})$$

ミラー1枚あたりの
偽偏光の割合

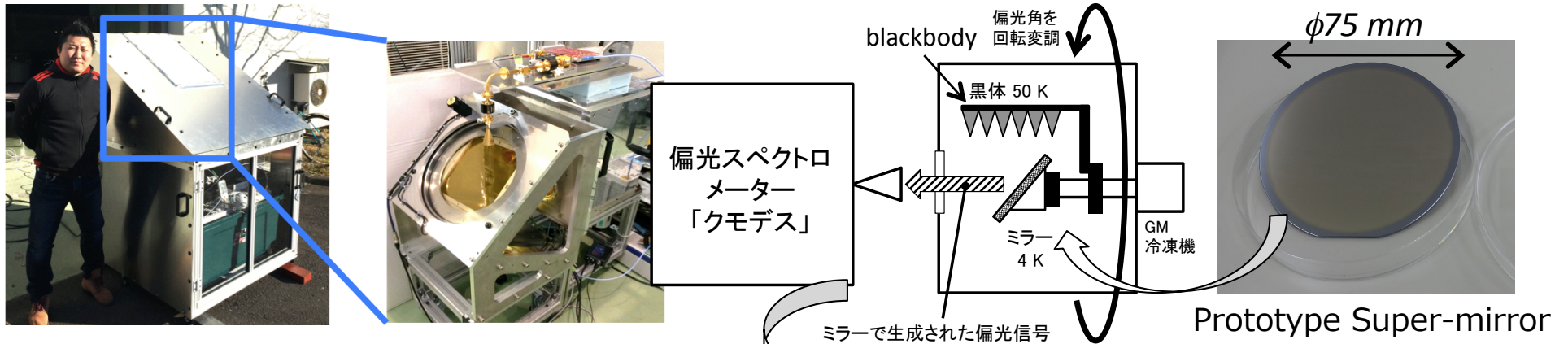
Fraction of fake polarization



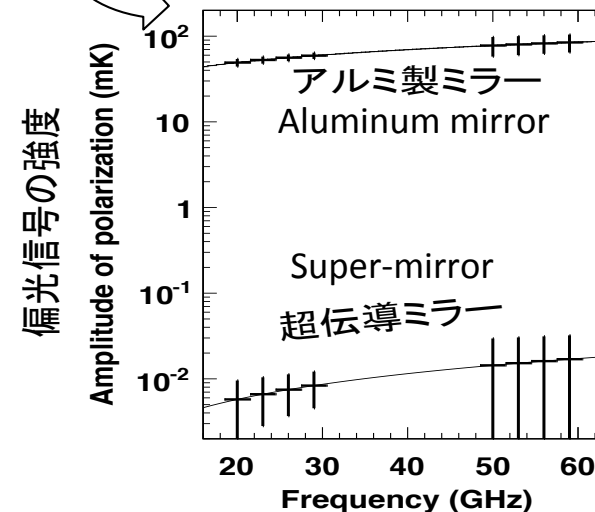
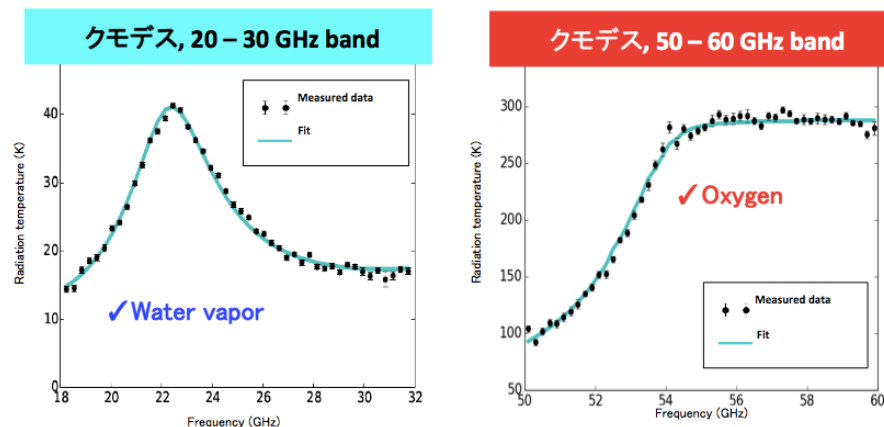
We can make an effort to be lower fake polarization !
From “normal” to “super” conductive mirror

“Superconducting Mirror” towards ultimate measurements of CMB B-modes

We plan to confirm by using infrastructure for superconducting sensor and high-sensitive spectrometer for next-generation meteorology



High-sensitive spectrometer “KUMODES” and its measured spectra of atmospheric radiation



Forecast of measured spectra by using KUMODES. Its high sensitivity allows us to measure faint signal for three days

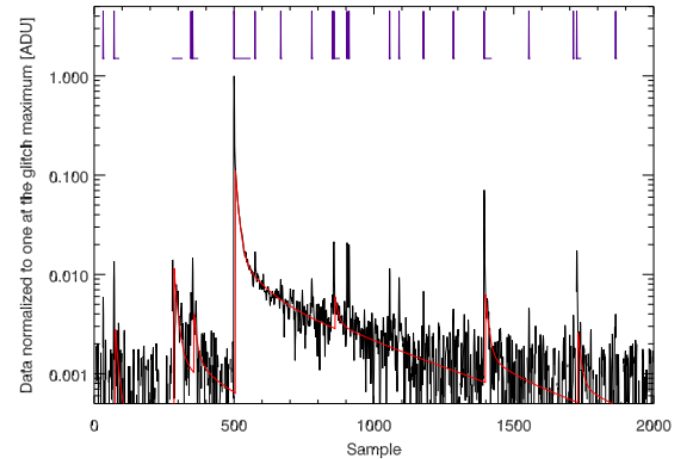
For the evaluation of cosmic ray effects on LiteBIRD detectors

Yuto Minami on behalf of LiteBIRD team
KEK

Cosmic ray study and phonon propagation

In Planck experiment

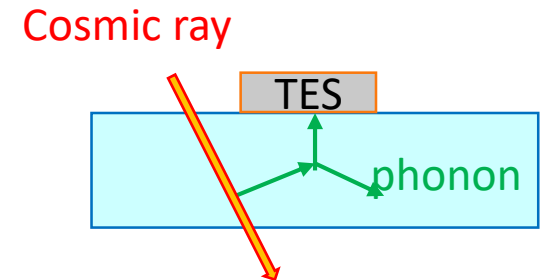
- High level of data loss from cosmic ray interaction with detectors
- They modeled it with **ballistic phonons** and thermal diffusion



Glitch events and fitted templates

In LiteBIRD, two things are targeted

- Mitigation of the cosmic ray effects by attenuating the phonon propagation
- Cosmic ray simulation to make a glitch templates

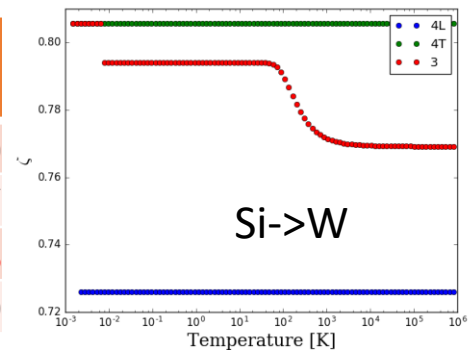


Reduce the phonon transmissivity from Si wafer

By inserting metal layer between Si and TES bolometer

Material	Density (g/cm ³)	Sound velocity (m/s)	Impedance (g/m ² /s)	Transmissivity against Si
Si	2.328	8433.0	1.963	1.000
Au	19.320	3240.0	6.260	0.727
W	19.250	5200.0	10.010	0.548
Pd	12.000	4540.0	5.448	0.779

Calculation with impedance mismatch model



Calculation with diffusive mismatch model

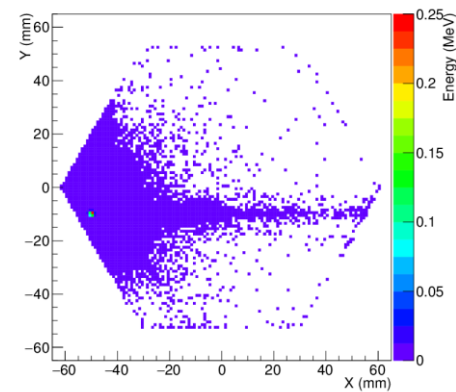
Cosmic ray simulation for overall LiteBIRD system

Cosmic ray and phonon simulations

- Proton flux at L2
- Spherical satellite around detectors

Prospects

- Phonon attenuation in metals
- Phonon propagation to the TES bolometer
- Comparison with TES radiation test



Energy leakage at the surface of Si wafer

Prospects of direct search for dilaton / axion fields with extreme high-intensity lasers

Kensuke Homma

Hiroshima Univ. / IZEST, Ecole Polytechnique

on behalf of the SAPPHIRES collaboration

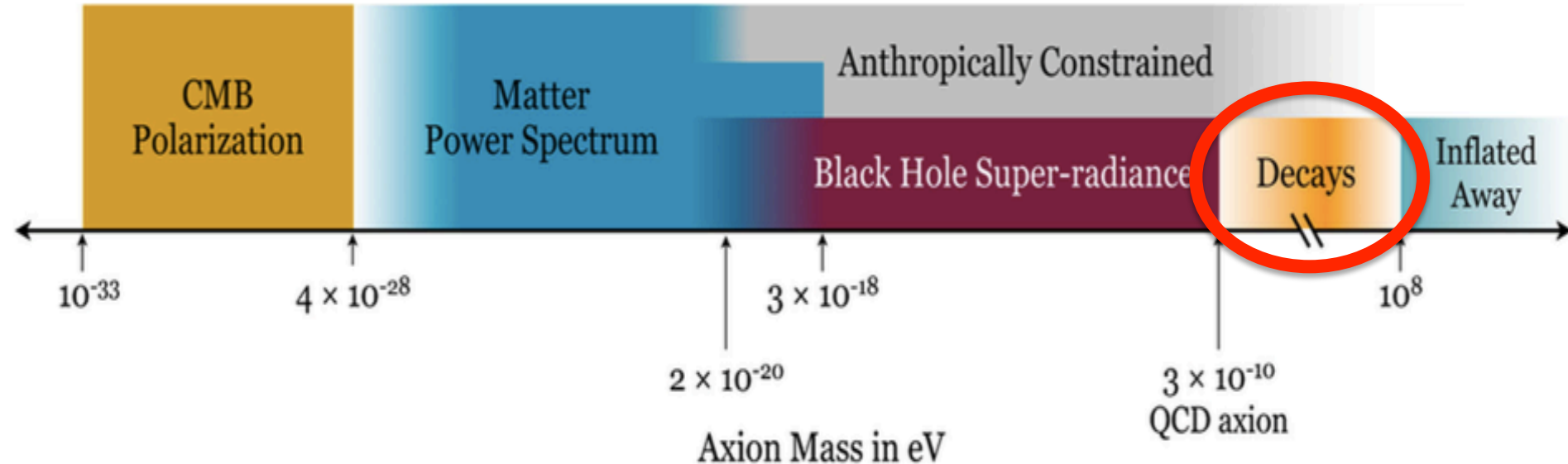


2017/03/08

Plural pNGBs in the wide mass range can be a test of string-based theories ?

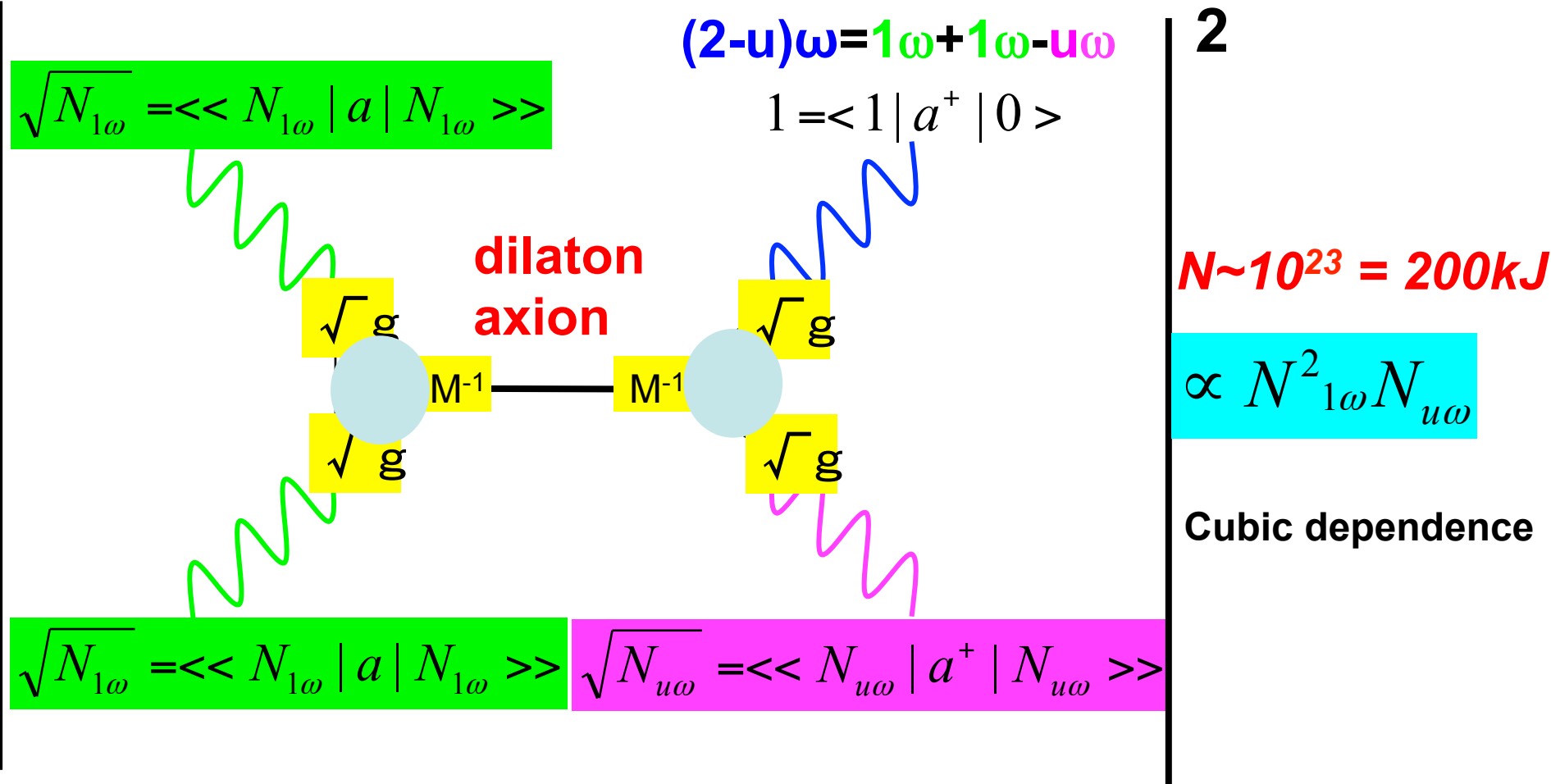
ASIMINA ARVANITAKI *et al.*

PHYSICAL REVIEW D **81**, 123530 (2010)

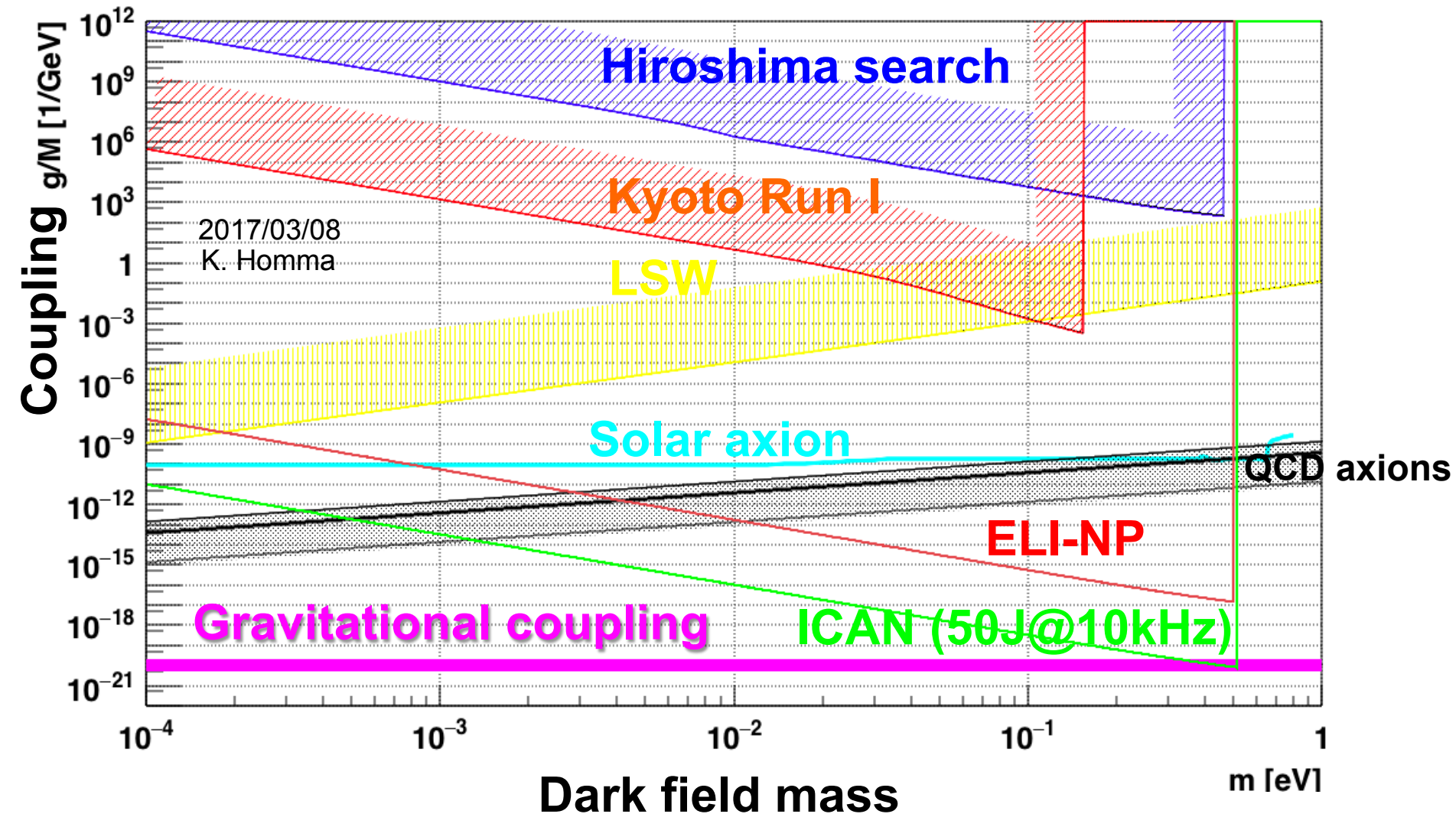


Stimulated photon-photon collider

- four-wave mixing process in vacuum -

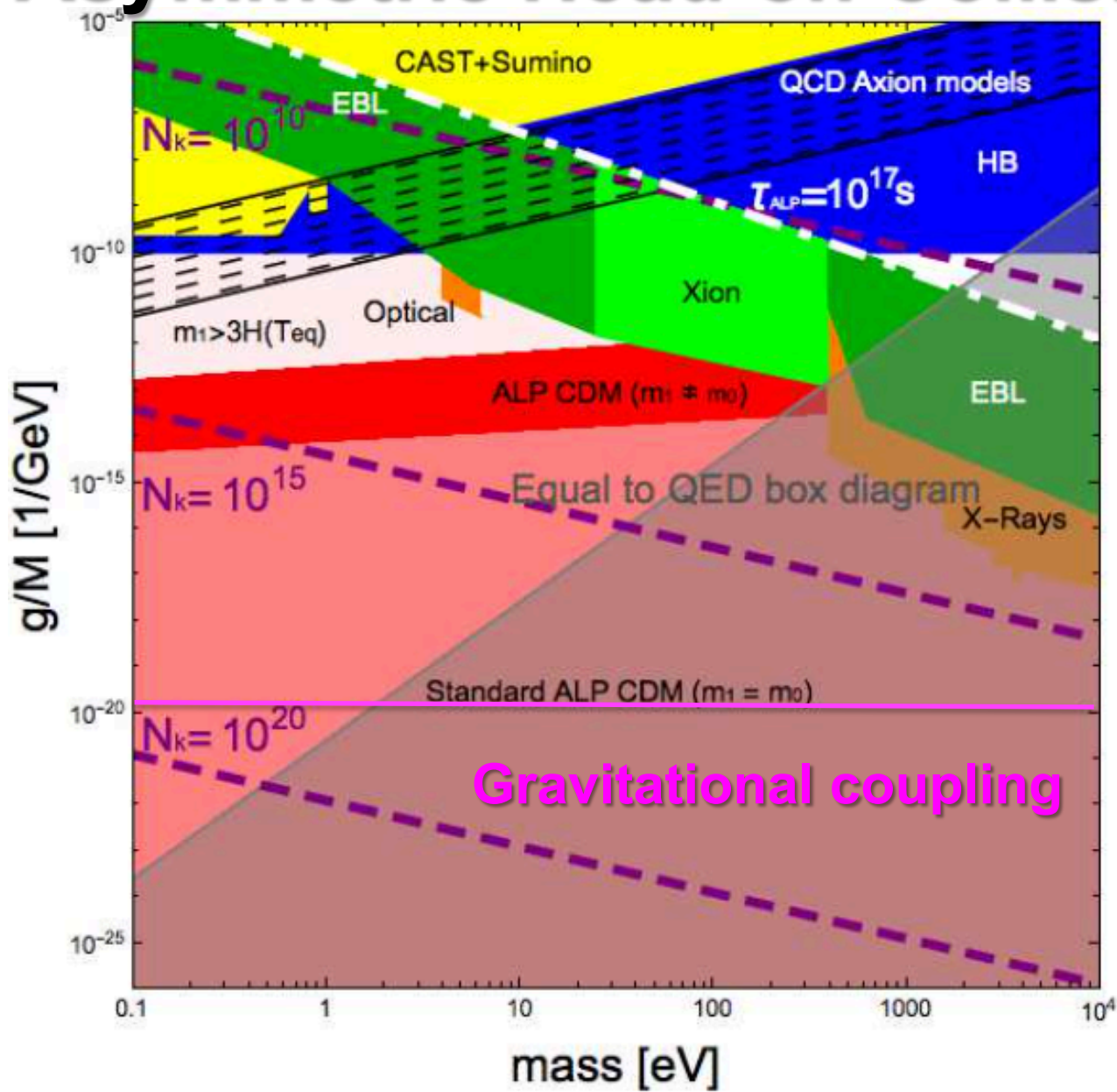


Sensitivity below sub-eV mass domain in Quasi-Parallel-Collision

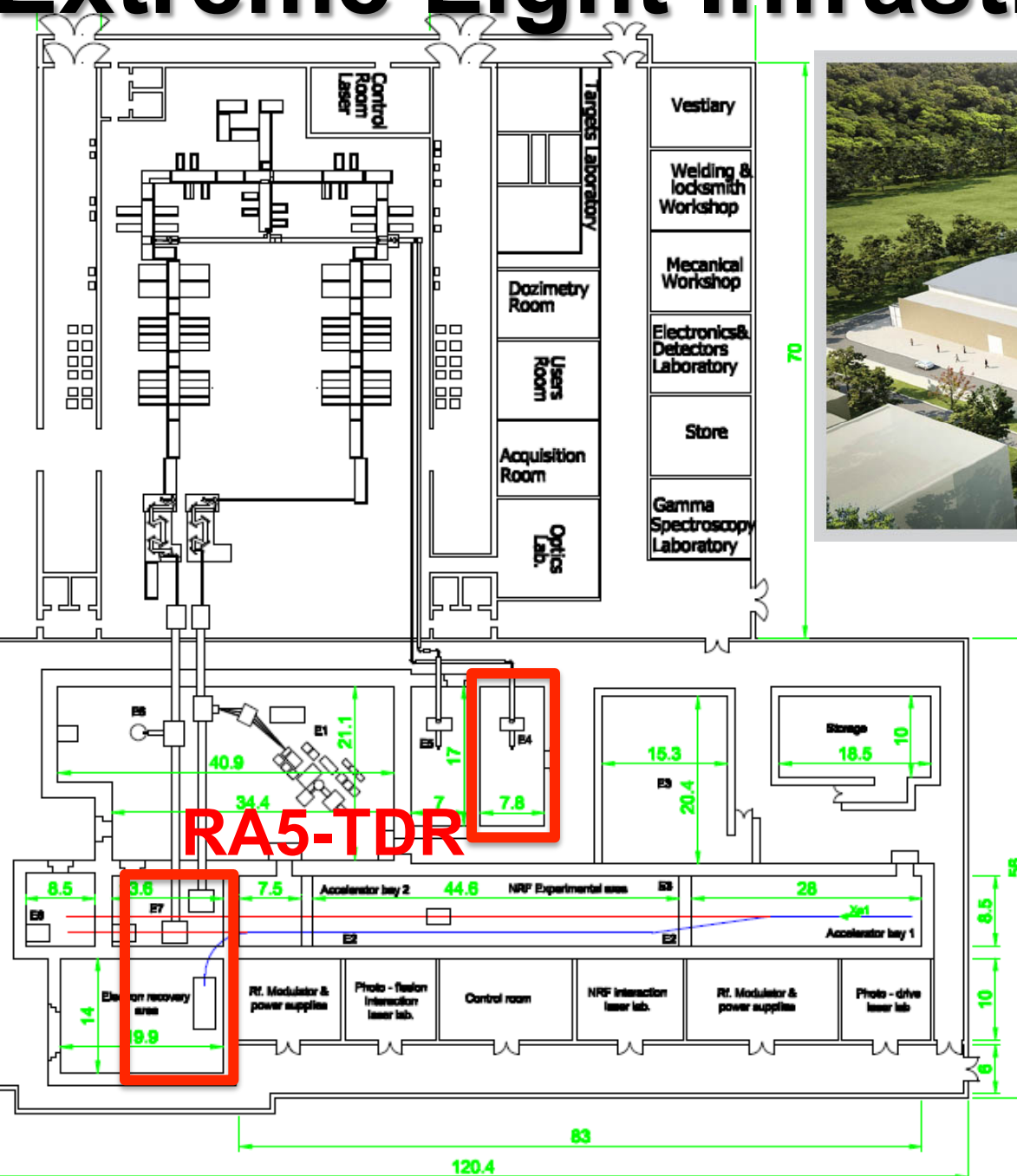


Sensitivity in sub-eV–10 keV mass domain in Asymmetric Head-on Collision

arXiv:1701.04282v1 [hep-ph] 16 Jan 2017



Extreme Light Infrastructure in EU



ELI-NP facility (280M€)

Exp. start from 2019

2 x 10PW

2 x 1 PW

2 x 0.1 PW

**0.2-19.5 MeV gamma
beam produced by
~700 MeV e⁻ + laser⁶**

POLARBEAR-2 Receiver system

Daisuke Kaneko, IPMU, UTokyo



B-mode polarization in CMB by primordial gravitational wave is a strong evident for the inflation at the early universe.

POLARBEAR experiment

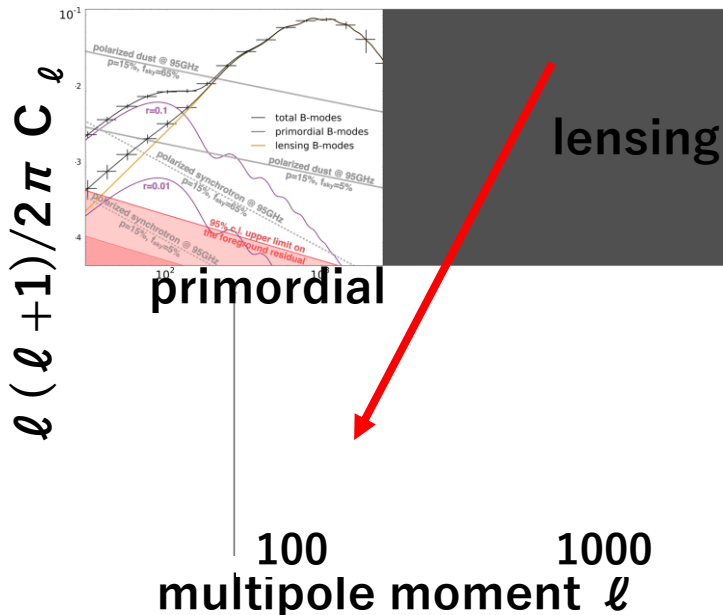
is searching for **B-mode polarization** in CMB at Atacama in Chile.

has already **found** the high- ℓ B-mode which is made by **gravitational lensing** by large scale structure.

will be **upgraded to POLARBEAR-2**
with 6 times more numbers of element sensors (TES),

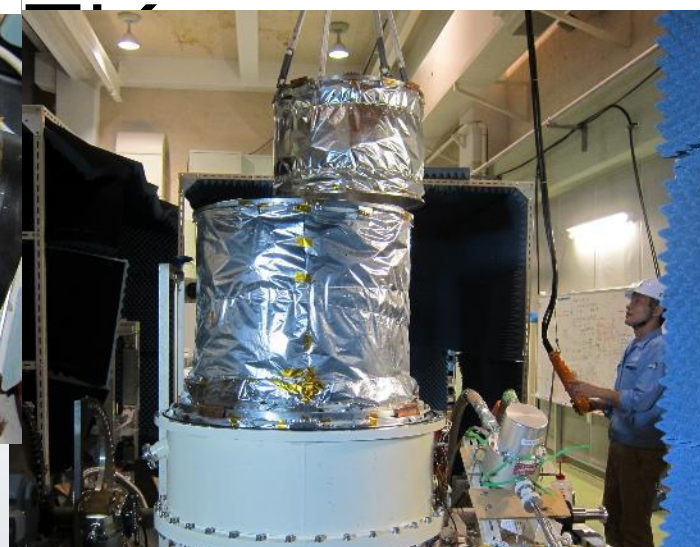
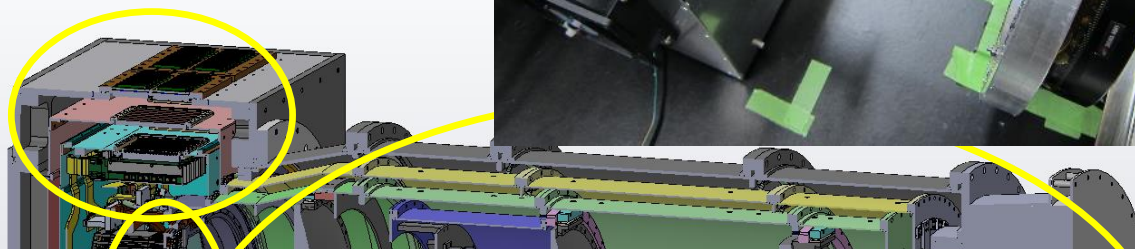
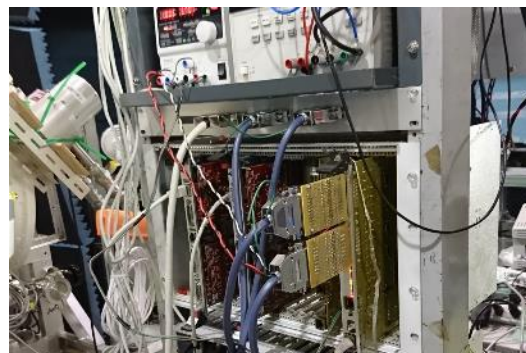
and then, extended to Simons Array of three PB-2 type receivers.

aiming at **r resolution less than 0.01.**

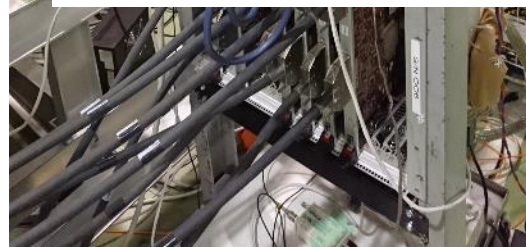


PB-2 Receiver Development

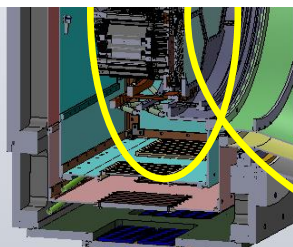
calibration tool R&D



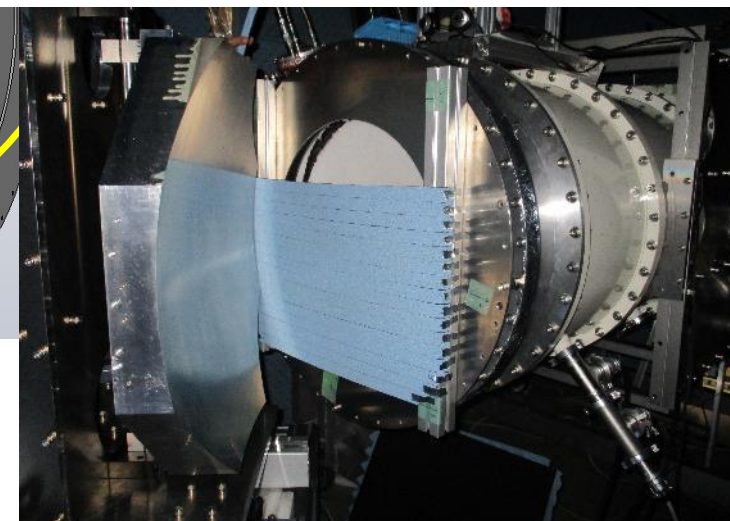
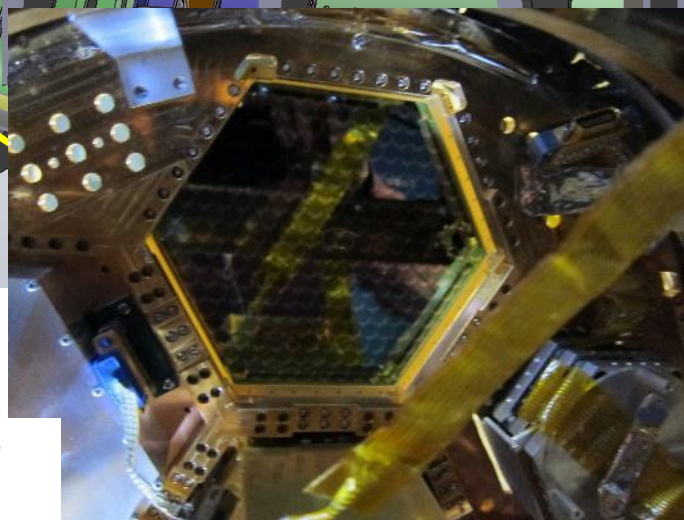
Development is on final stage for shipment to Chile in this year!



Readout integration test



TES (sensor) wafer
characteristic test



receiver beam measurement