TYL-FJPPL, HEP-04

Cosmological tests of Fundamental Physics

Kaz Kohri

郡　和範

KEK and Sokendai

Members

France:

- Vivian Poulin (PI, LUPM) : Neutrino cosmology, Atroparticle physics
- Pasquale Serpico (ex-PI, LAPTh) : Neutrino cosmology, Atroparticle physics
- and two more students

Japan:

- Kazunori Kohri (PI, KEK) : Inflation, Dark Matter, Neutrino Cosmology
- Satoshi Iso (KEK) : Superstring, Higgs, Baryogenesis, Inflation, Dark Energy
- Nagisa Hiroshima (Riken) Dark Mater, High-energy astrophysics
- and two more student and postdoc

Past common articles within 3 years

- 1) Spectral Distortions of the CMB as a Probe of Inflation, Recombination, Structure Formation and Particle Physics By J. Chluba et al., arXiv:1903.04218 [astro-ph.CO].

- 2) CMB bounds on disk-accreting massive primordial black holes By Vivian Poulin, Pasquale D. Serpico, Francesca Calore, Sebastien Clesse, Kazunori Kohri, Phys. Rev. D96 (2017) no.8, 083524.

more than 60 citations in 2 yrs

- 3) QCD-Electroweak First-Order Phase Transition in a Supercooled Universe, By Satoshi Iso, Pasquale D. Serpico, Kengo Shimada, Phys. Rev. Lett. 119 (2017) no.14, 141301.

So successful!

Funding Requests

Funding Request from France				
Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to:**
Travel expenses	2000	2 travels	4000	FJPPL
Lodging expenses + per diem	160/day	15 days	2400	FJPPL
Total			6400	

Funding Request from KEK				
Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Travel expenses	200	3 travel	600	KEK
Lodging expenses + per diem	21/day	18 days	378	KEK
Total			978	

Summary of the projects

We study the following subjects in the Universe

(1) The origin of baryon asymmetry (visible-matter asymmetry)

(2) The origin of neutrino masses

(3) The nature of dark matter (invisible matter)

(4) The nature of the inflaton field which induces the inflationary Universe

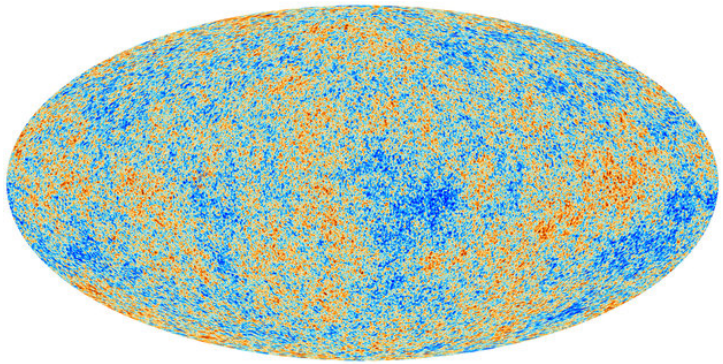
(5) The nature of dark energy

(6) The Higgs stabilization problem

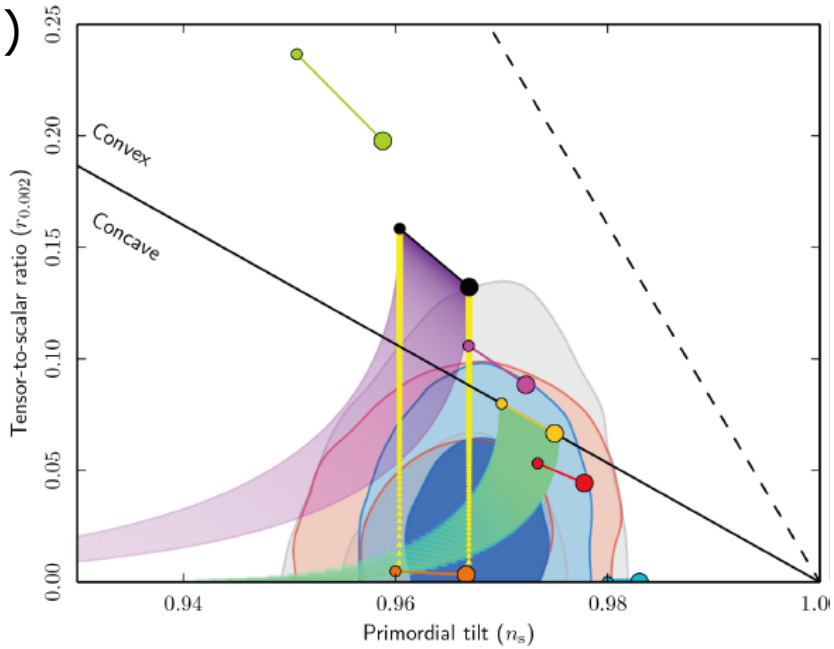
(4) Inflation and (3) Dark Matter

[and (1) baryon#, (5)dark energy,...]

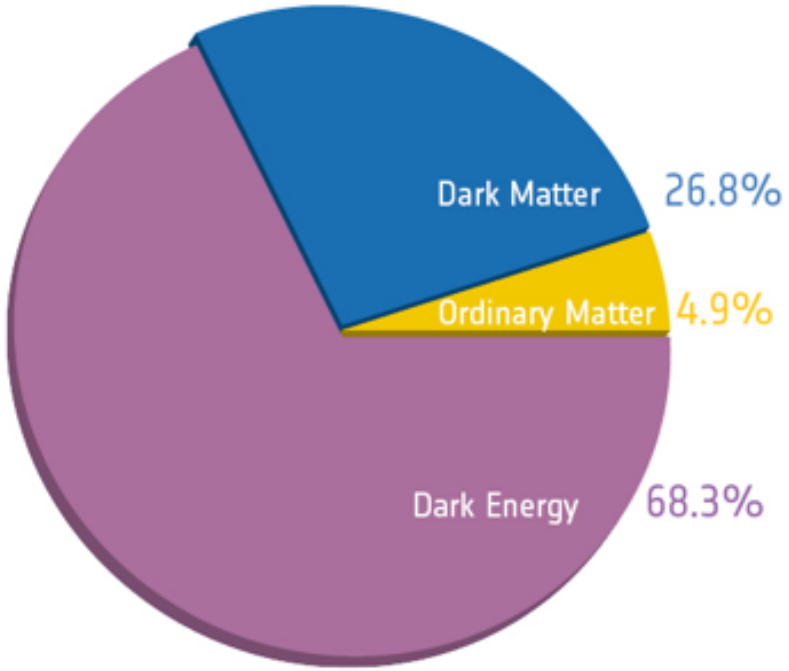
CMB Temperature fluctuation (4)



Gravitational wave/Scalar fluctuation (4)



Dark Matter(3)



Bary on# (1)

Dark Energy (5)

Planck 2015 results. XX. Constraints on inflation

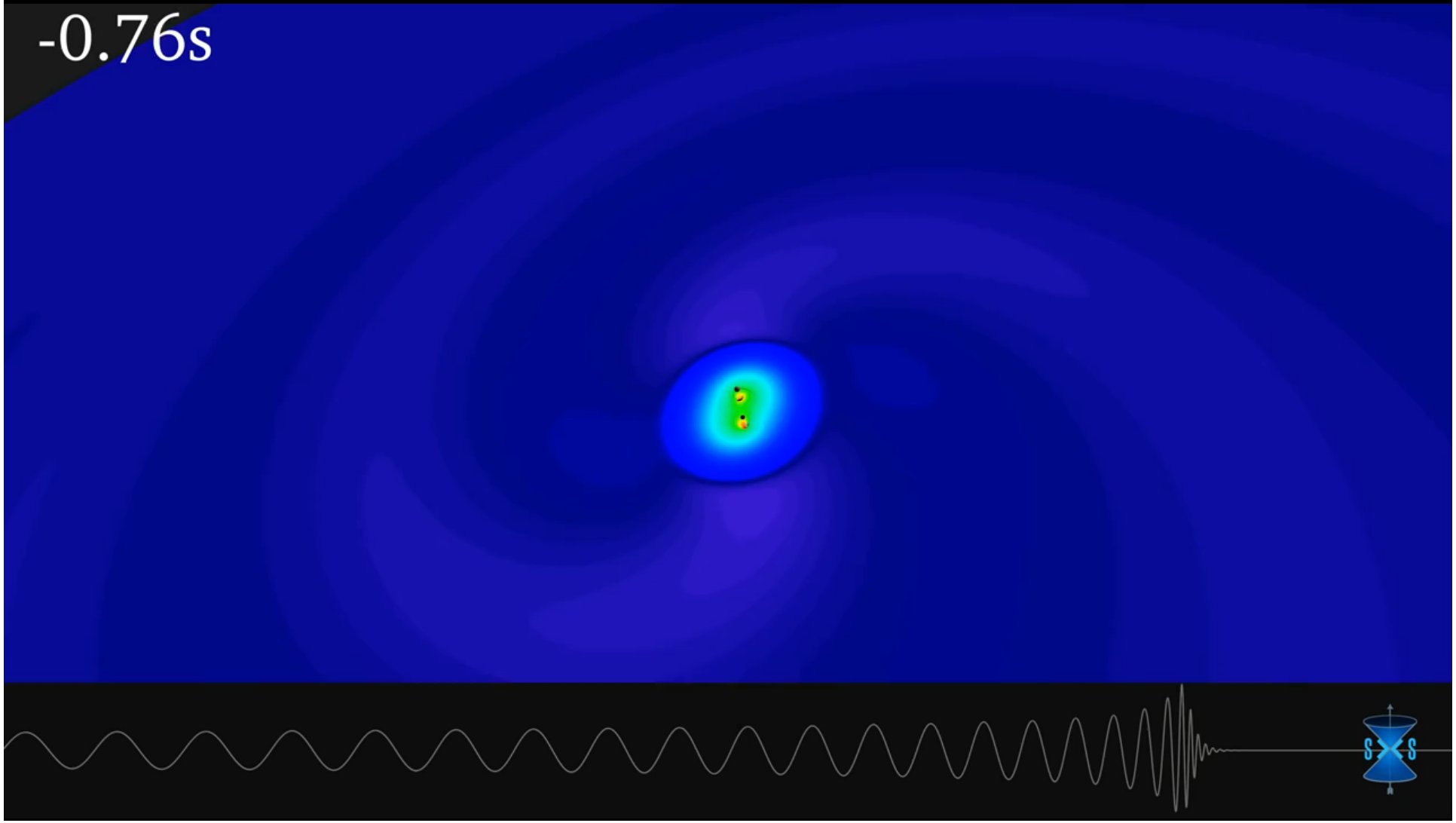
Main theme in this fiscal year

Primordial Black Holes (PBHs)

To understand Higgs and Inflation

Binary PBHs can produce GWs

https://www.youtube.com/watch?v=1agm33iEAuo

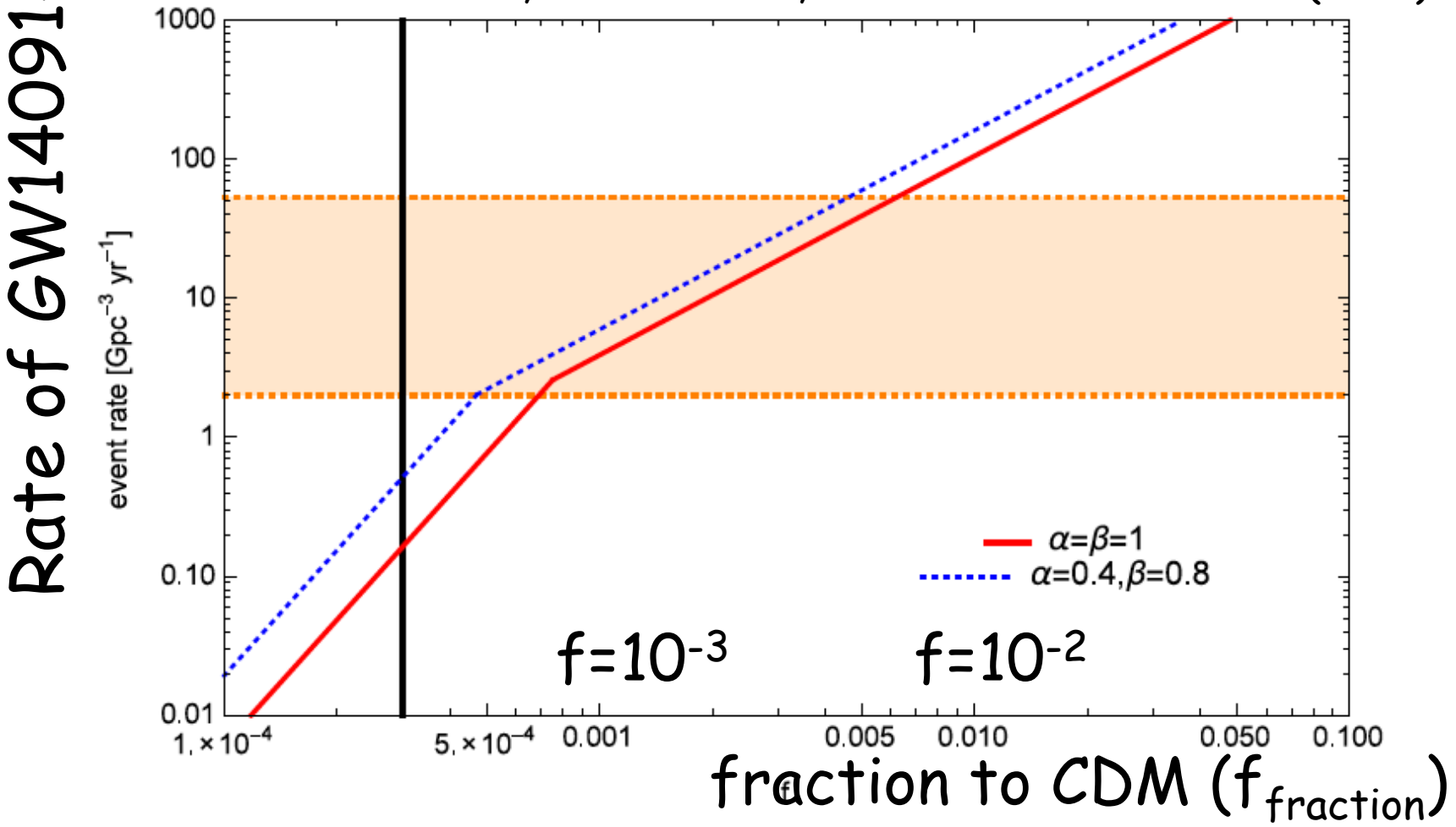


GW150914 and its merger rate

M. Sasaki, T. Suyama, T. Tanaka and S. Yokoyama (2016).

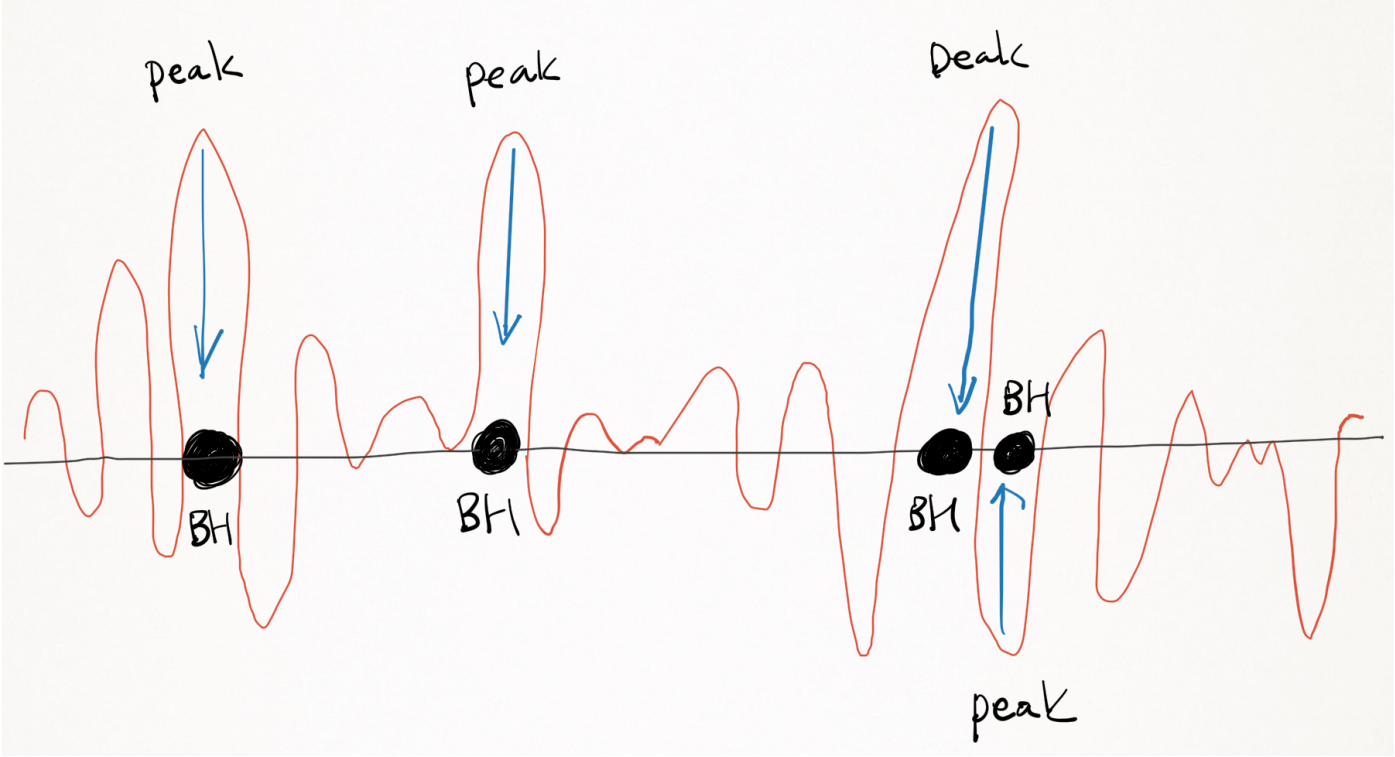
3-body is important for the BBH formations

See also, Ali-Haimound, Kovetz and Kamionkowski (2017)



Primordial Black Holes (PBH) can be sources of GWs, SMBHs, 100%, and dark matter

- At a smaller scale, the density perturbation produced by inflation can have a high peak



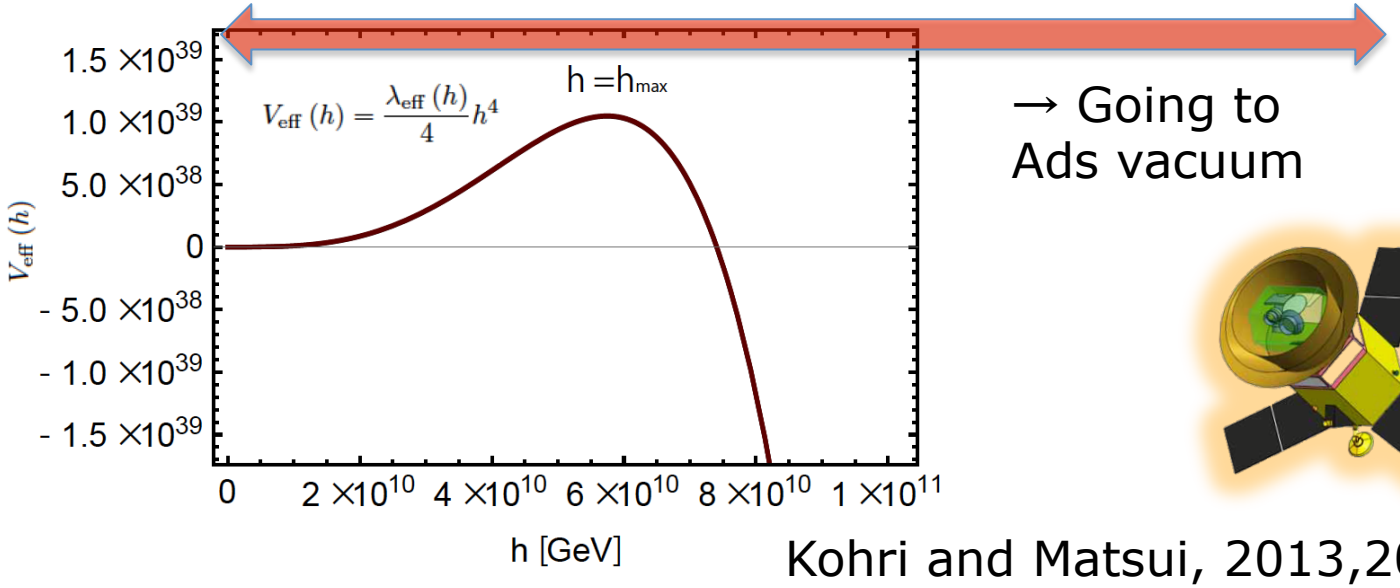
Destabilized Higgs vev by de Sitter fluctuation during Inflation

$$m_t = 173.21 \pm 0.51 \pm 0.71 \text{ GeV (PDG2015)}$$
$$m_h = 125.09 \pm 0.24 \text{GeV (PDG2015)}$$

$$\delta h_{\text{HIggs}} \sim \frac{H_{\text{Hubble}}}{2\pi} \sim 10^{13}\,\text{GeV}\ ?$$

LiteBIRD will detect B-mode within 10 years

δh



→ Going to Ads vacuum

Kohri and Matsui, 2013,2015

$V_{\text{Inflation}}^{1/4} << 10^{15}\,\text{GeV}$ < GUT scale ($\sim 10^{16}\,\text{GeV}$)

Event Horizon Telescope

- Observed M87 has the mass $M_{BH} \sim 7\times10^{9}\, M_{solar}$
- Schwarzschild Radius $R_{Sch}=2\, M_{BH}\sim2\times10^{10}$ km
- Photon sphere $R_{photon}=3\sqrt{3}\, M_{BH} \sim 2.6\, R_{Sch}\sim5\times10^{10}$ km

PBH?

Open Question:

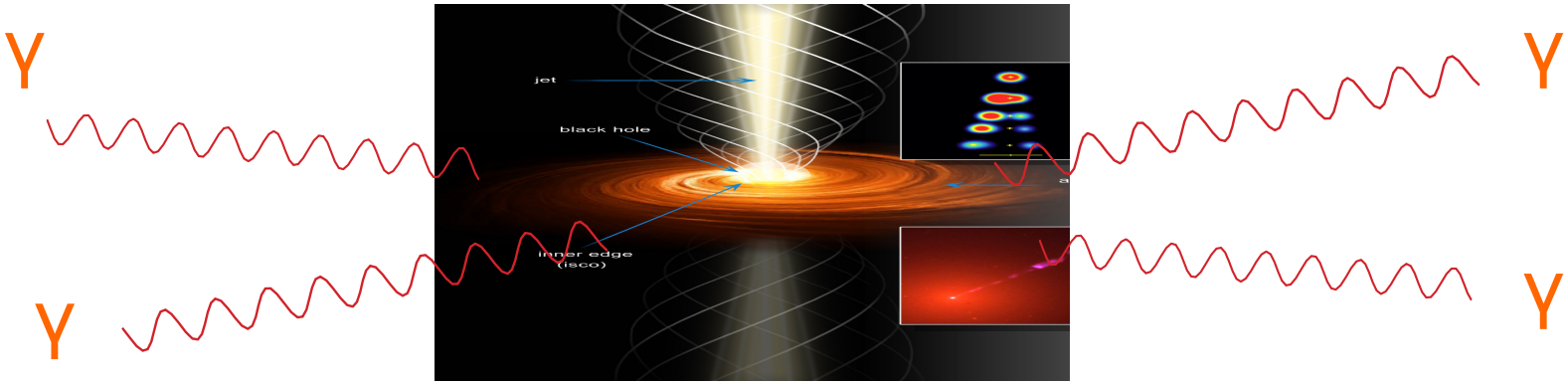
How to produce such a SMBH with $O(10^{9})M_{solar}$?

How to explain the GW events, dark matter, and Super-Massive BHs?

PBH!

- Inflation (quantum fluctuation as a seed)
- Binary formation (GW event rates)
- Baryonic accretion (increasing masses)

Cosmological Accretion on to PBHs



- A completely new subject in cosmology
- How baryon can accrete on PBHs at $z_{redshift} < 100$?
- Future CMB and 21cm can constrain scenarios

Projects in this year

I. Super Massive Black Hole, dark matter and PBHs:

Baryonic matter can accrete on to PBHs inevitably in the Early Universe, which can solve problems in dark matter and a origins of Super Massive Black Hole

II. CMB and 21cm line constraints on PBHs

21cm line (EDGES and SKA) and CMB polarization (LiteBIRD and CMB-S4) observations can constrain histories of accretions onto PBHs.

Common Articles Expected

1) Authors: Nagisa Hiroshima (Riken), Kazunori Kohri (KEK), Viviaon Poulin (LUPM), and Pasquale Serpico (LAPTH)

   Title: ``Evolutions of PBH masses by accretions on to systems of PBHs and CDM halos ”

2) Authors: G. F. Abellan, Viviaon Poulin (LUPM), Kazunori Kohri (KEK) , Pasquale Serpico (LAPTH), and Nagisa Hiroshima (Riken)

   Title :“Constraining PBH with EDGES and future 21cm experiment.”