PBHs + Higgs stability

+ ...

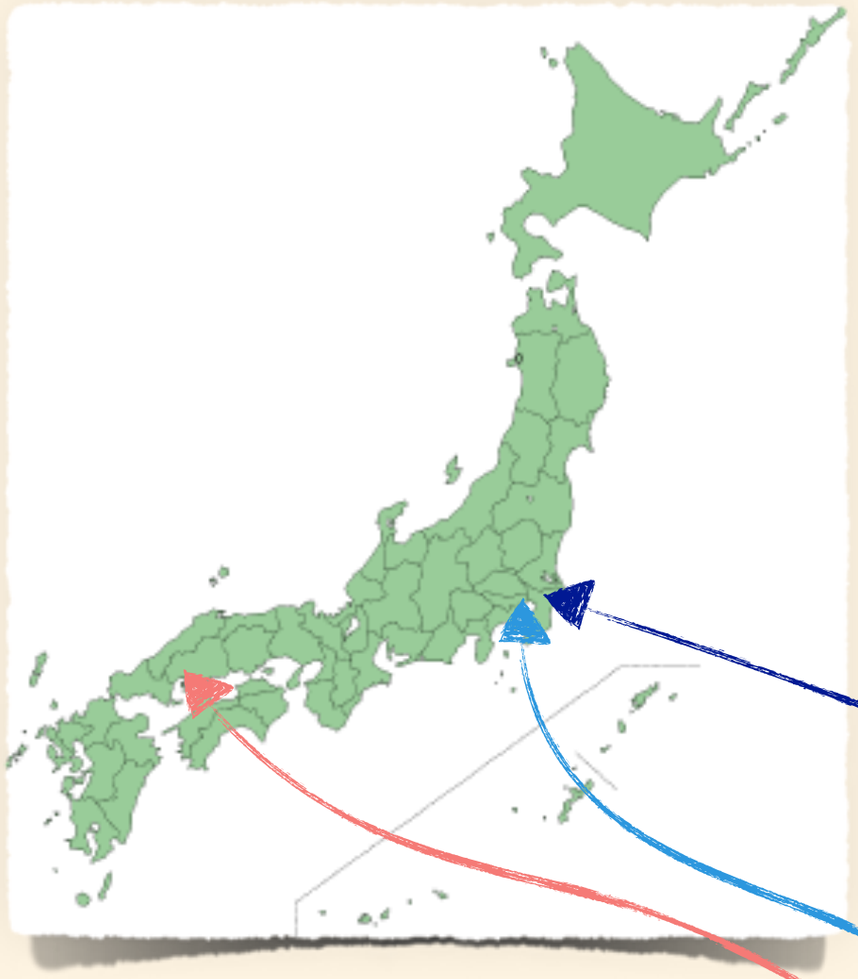
Kyohei Mukaida

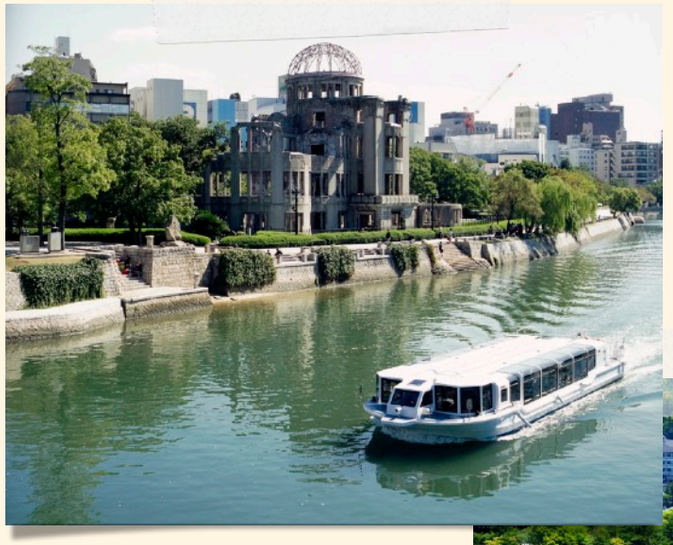
Room: 208a, Building 2a

DESY: Fellow's meeting 2018 @ Feb.27

About myself

Mukaida, Kyohei (向田 享平)





[Pictures in Hiroshima: www.hiroshima-kankou.com]

- Born on 27.4.1987 in Hiroshima
- Ph.D. Physics @ Univ. of Tokyo; 3.2015, supervised by **Koichi Hamaguchi**
- 1st Postdoc @ Kavli IPMU; 4.2015-9.2017
- **2nd Postdoc @ DESY; 10.2017**

My Interests

Interplay between **Particle Physics** & **Cosmology**

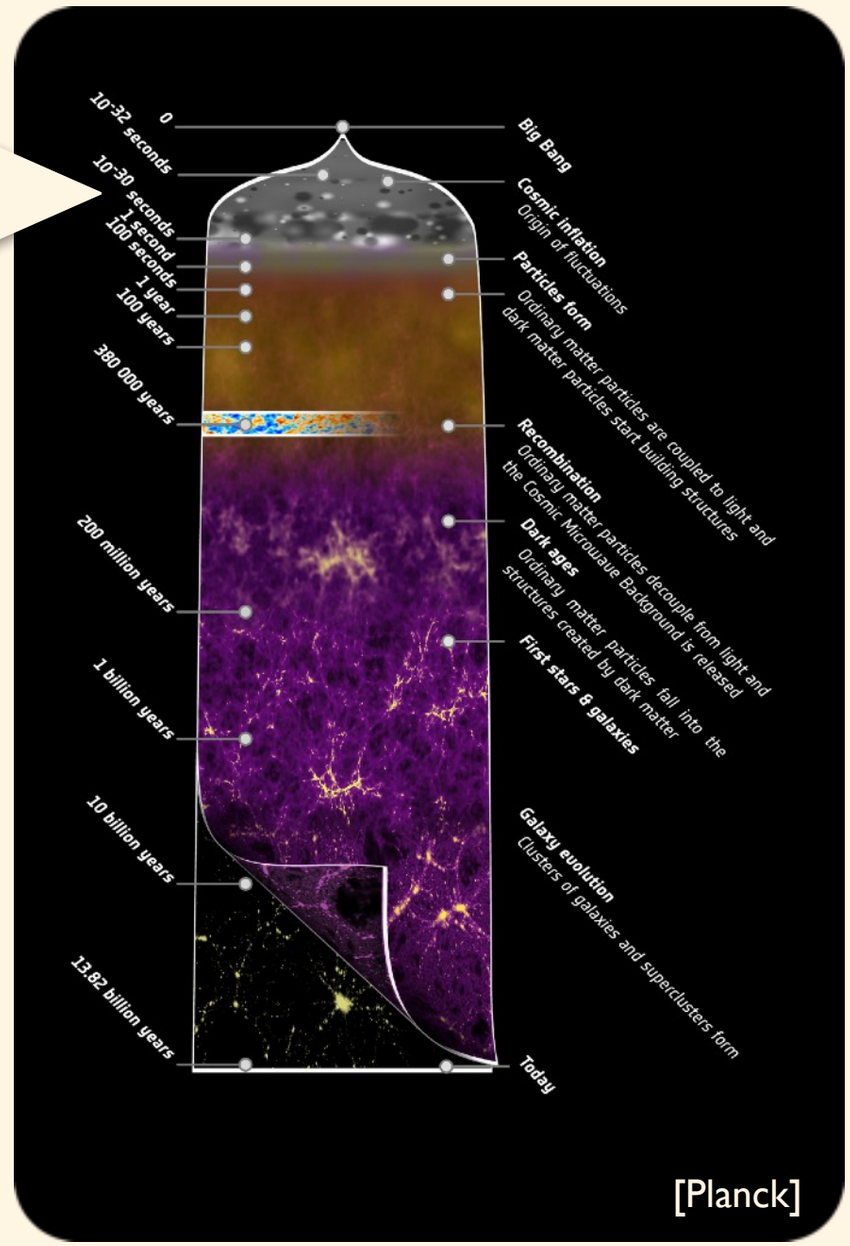
Dynamics of Early Universe from the viewpoint of Quantum Fields under extreme conditions.

Mostly before BBN... t < 1s

- Inflation, (P)Reheating, Thermalization
- Dark Matter production
- Baryon asymmetry of Universe
- Phase transition, classical lumps

- **Primordial Black Holes (PBHs)**
- **Higgs stability**

Revisit the old ideas… Suppose that BSM is far away from us.



Primordial Black Holes

What is "**Primordial**" Black Hole?

- Black Hole formed **BEFORE** any astrophysical objects exist (even in **RD** era!).

↪ Need **special mechanisms** for **Gravity > Pressure**. (i.e., need large density perturb ~ 0.5)

Why is it interesting?

- **Non-particle** candidate of DM
- Candidate of gravitational waves observed by **LIGO**
- Can constrain **other** DM candidates even if PBHs are subdominant.
- …

My interests → Implication on Particle Physics

- PBHs from **Inflation**: concrete models; **Can we probe them?**

  [Inomata, Kawasaki, **KM**, Tada, Yanagida; 1611.06130; Inomata, Kawasaki, **KM**, Yanagida; 1711.06129; cf) 1711.08956]

- Coexistence of other DM candidates for subdominant PBHs.
- Are there other **novel mechanisms** (more) closely tied with BSM?

Higgs stability

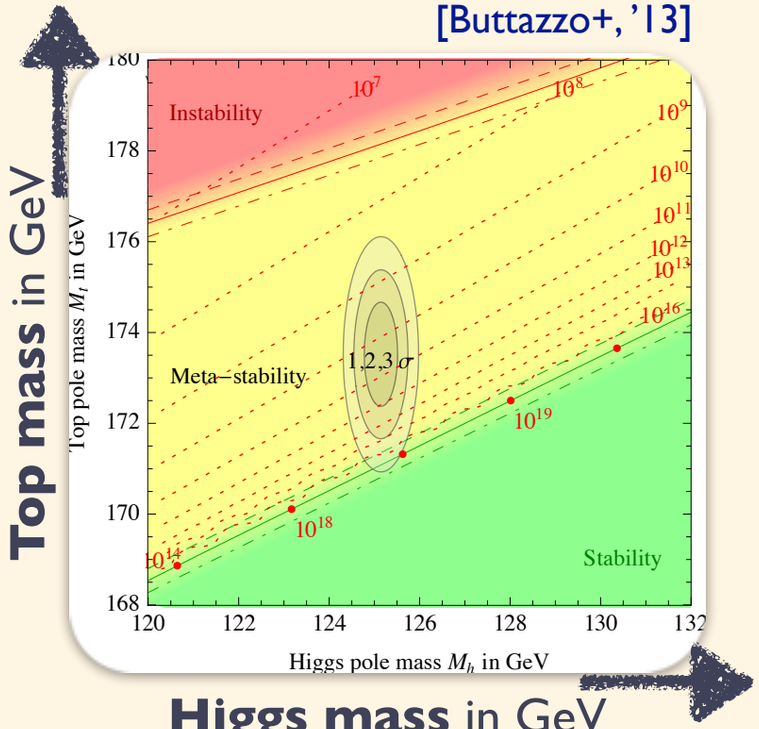
Suppose **new physics** is far away…

- Run the SM up to, say, Planck scale.

↪ Our Electroweak Vacuum tends to be **metastable**!

✤ Life time @ **vacuum** » Current age of Universe

[Buttazzo+, '13]



v.s. **Cosmological** environment

Can we live in the metastable vacuum? If not, we need BSM below the instability scale.

- v.s. High temperature plasma → reduce the allowed region, but still viable @ best fit.

[e.g. Espinosa+, '08; Rose+, '15]

- v.s. **Inflation** (w/ inflaton mass & scale » instability scale)

↪ Need a (tiny) Higgs-inflaton coupling to stabilize the Vacuum **during inflation**. [Westphal+; Espinosa+]

↪ However, this very coupling may **destabilize it after inflation**! (via preheating)

[Ema, **KM**, Nakayama; 1602.00483, 1706.08920]

- Are there other interesting cosmological environment?
  - **Evaporating Black Holes**? [**KM**, Yamada; 1706.04523]
  - What happens in a more generic non-equil. dist., say from the end of inflation to thermalization?