What is dark matter?

Comprehensive study of the huge discovery space in dark matter

PI: Hitoshi Murayama（Kavli IPMU、Berkeley）

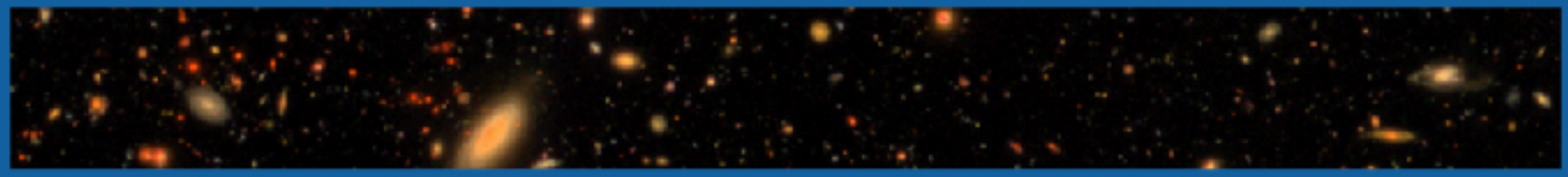
March 7, 2023

Grant-in-Aid for Transformative Research Areas

東京大学 THE UNIVERSITY OF TOKYO

BERKELEY LAB

KAVLI IPMU



FY2022 "What is dark matter? - Comprehensive study of the huge discovery space in dark matter"

7-9 March 2023
Kavli IPMU
Asia/Tokyo timezone

Overview
Timetable
Timetable (Indico style)
Contribution List
Speaker List
My Conference
My Contributions
Registration
Participant List

Contact
seminar@ipmu.jp

69 contributions!

Timetable

Tue 07/03 | Wed 08/03 | Thu 09/03 | All days

Print | PDF | Full screen | Detailed view | Filter

Session legend

B04 | B06 | Contributed Talks | Opening & A01

10:00
Opening Remark — *Hitoshi Murayama*
Lecture Hall, Kavli IPMU 10:00 - 10:15

Invited talk: "Aspects of Light Scalar Dark Matter" — *Mark Hertzberg*
Lecture Hall, Kavli IPMU 10:15 - 10:45

Research summary of A01 group — *Fuminobu Takahashi*
Lecture Hall, Kavli IPMU 10:45 - 10:50

Cascades of high-energy particles and non-thermal DM production in the pre-thermal phase — *Masaki Yamada*
11:00
Lecture Hall, Kavli IPMU 10:50 - 11:10

Production of light dark photon dark matter in the early universe — *Naoya Kitajima*
Lecture Hall, Kavli IPMU 11:10 - 11:30

Dark Higgs early dark energy by axion-induced trapping effect — *Shota Nakagawa*
Lecture Hall, Kavli IPMU 11:30 - 11:50

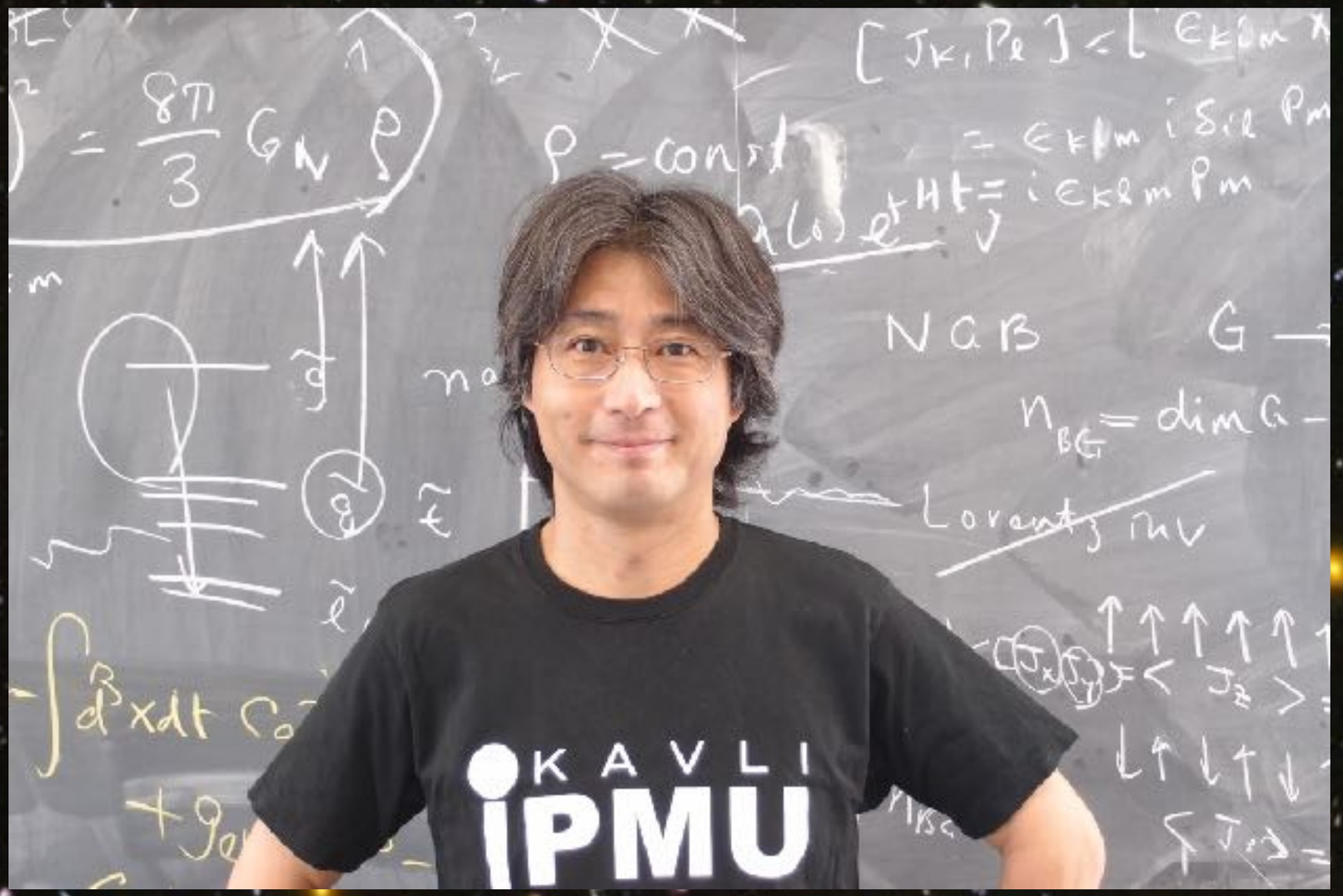
Isotropic cosmic birefringence from early dark energy — *Kai Murai*
12:00
Lecture Hall, Kavli IPMU 11:50 - 12:10

Lunch
13:00
Lecture Hall, Kavli IPMU 12:10 - 13:30

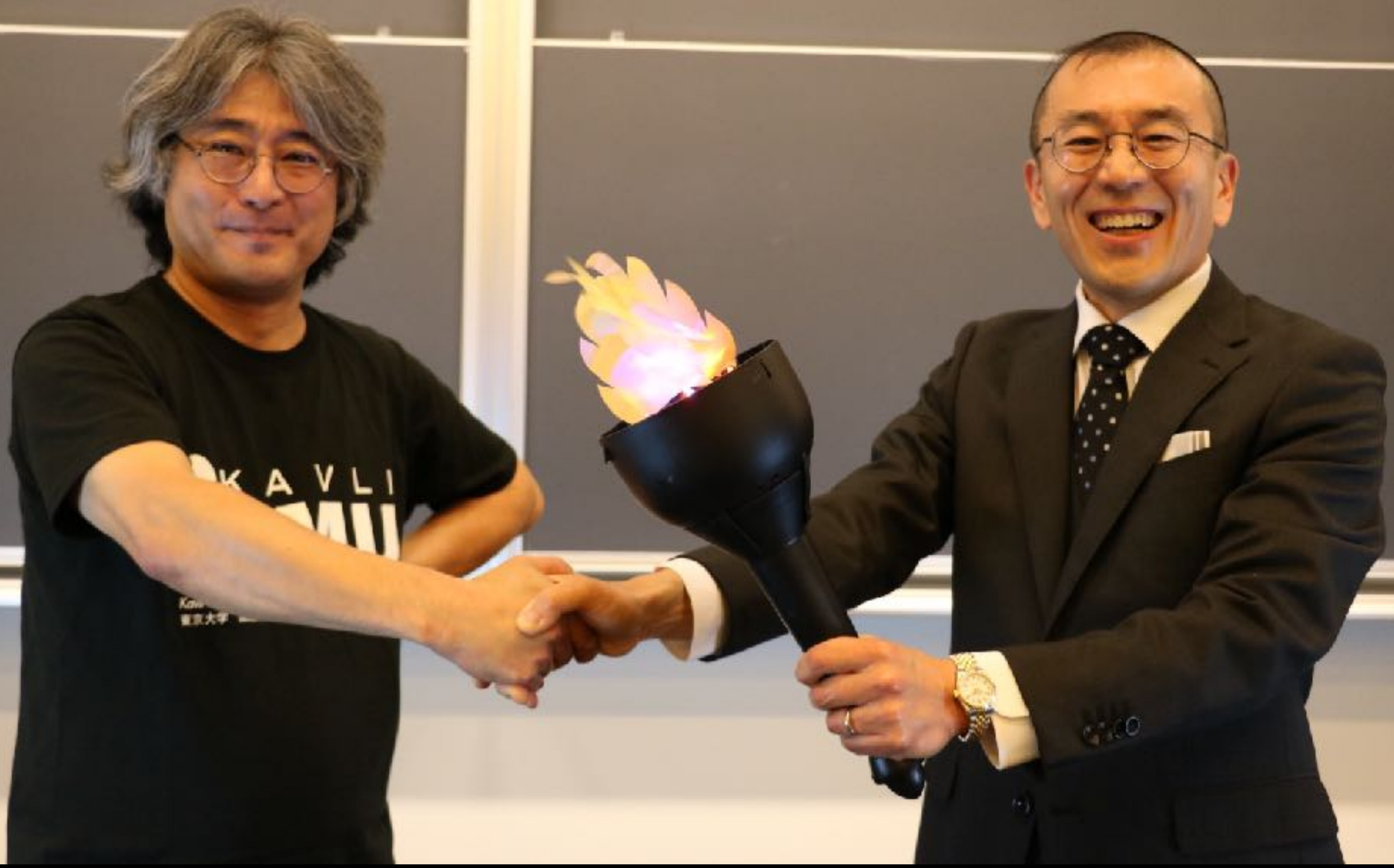
Wow!

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

Director of the Kavli Institute for the Physics and Mathematics of the Universe



Director of the Universe



proton mosquito Earth

neutrino electron bacteria human Mt. Fuji Sun

mass of dark matter [GeV/c^2]

10^{-40} 10^{-30} 10^{-20} 10^{-10} 10^{0} 10^{10} 10^{20} 10^{30} 10^{40} 10^{50} 10^{60} 10^{70}

doesn't fit inside galaxies | wave | light | WIMP | heavy | composite or macroscopic | excluded by CMB

X-ray X-ray CMB neutrinos X-ray CMB

laser interferometer e^+e^- cosmic ray gravitational lensing

Subaru imaging/spectroscopic surveys Subaru spectroscopy

bottom up

[X00] 総括班 村山 (KIPMU)	[A01]軽いDM 高橋 (東北大)	[A02]重いDM 村瀬 (PSU)	[A03]マクロDM 柳 (名古屋大)	[C02]宇宙構造形成理論 安藤 (アムステルダム大)
[B01] レーザー干渉計 道村 (東大)	axion, dilaton (円偏光)	背景重力波 (相転移など)	背景重力波 (inflationなど)	
[B02] すばる分光 高田 (KIPMU)	fuzzy DM, SIDM 3D DM地図	矮小銀河内の対消滅 3D DM地図	PBH, UCMH, DM subhalo, 3D DM地図	
[B03] イメージング 宮崎 (NAOJ)	DM subhalo DM地図	DM subhalo DM地図	PBH, UCMH (重力マイクロレンズ)	
[B04] X線 山崎(典) (ISAS)	sterile neutrino moduli (輝線、連続光)	ダークマター崩壊 (輝線、連続光)	PBH蒸発 (X線背景放射)	
[B05] e^+e^-加速器 西田 (KEK)	dark photon SIMP	高エネルギーの間接検証 (余剰次元、Higgs)	高エネルギーの間接検証 (余剰次元、Higgs)	
[B06] CMB 小松 (MPA)	axion (CMB偏光)	宇宙初期の対消滅 $N_{\rm eff}$	PBH (τ)	
[C01]量子重力理論 山崎(雅) (KIPMU)				

laser interferometer

Subaru spectroscopy

Subaru imaging

X-ray satellite

e^+e^- collider

CMB

top down

structure formation theory

quantum gravity

Exciting

- great enthusiasm and excitement about this program
  - the timing was right to launch new directions
- Lots of new ideas, theories, observations, experiments
  - Many many papers
  - solicited research were also great!
- Great to see leadership of young scientists
- Now 10^{-22} to 10^{-10} eV excluded? (Neal, Elisa)
  - 90 orders of magnitude shrank to 78
  - 7 more grants will close the entire range!

Good progress

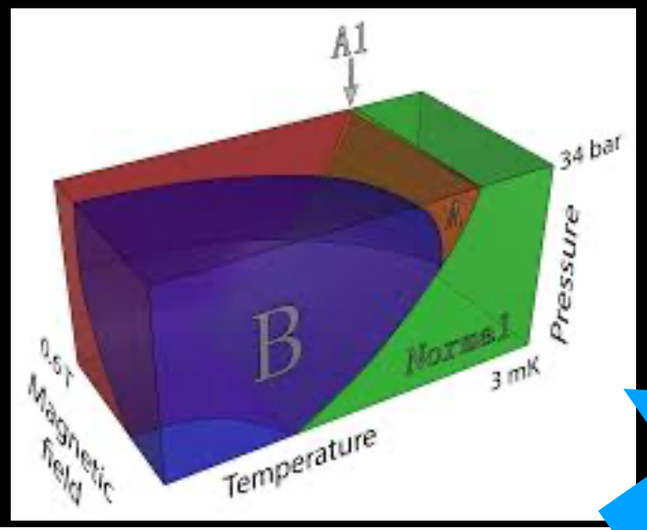
- Major projects are making good progress
  - PFS
  - XRISM (H2)
  - DANCE, KAGRA (polarizer already in!)
  - Belle II
  - ^{57}Fe x 2
  - CMB: case for birefringence thickens

Disk

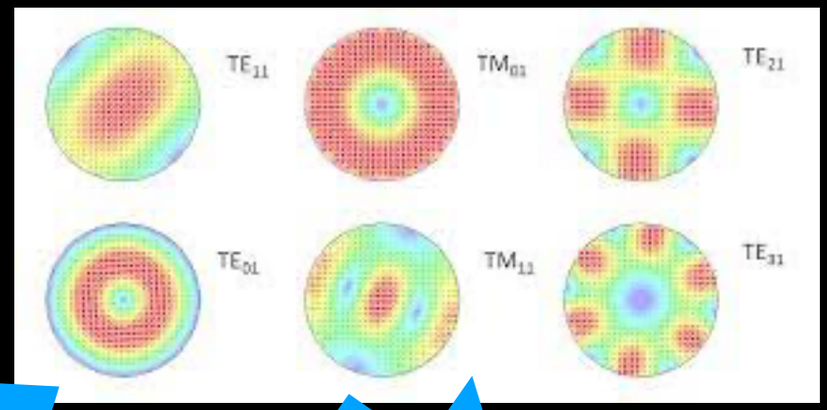
Dark matter
Axion

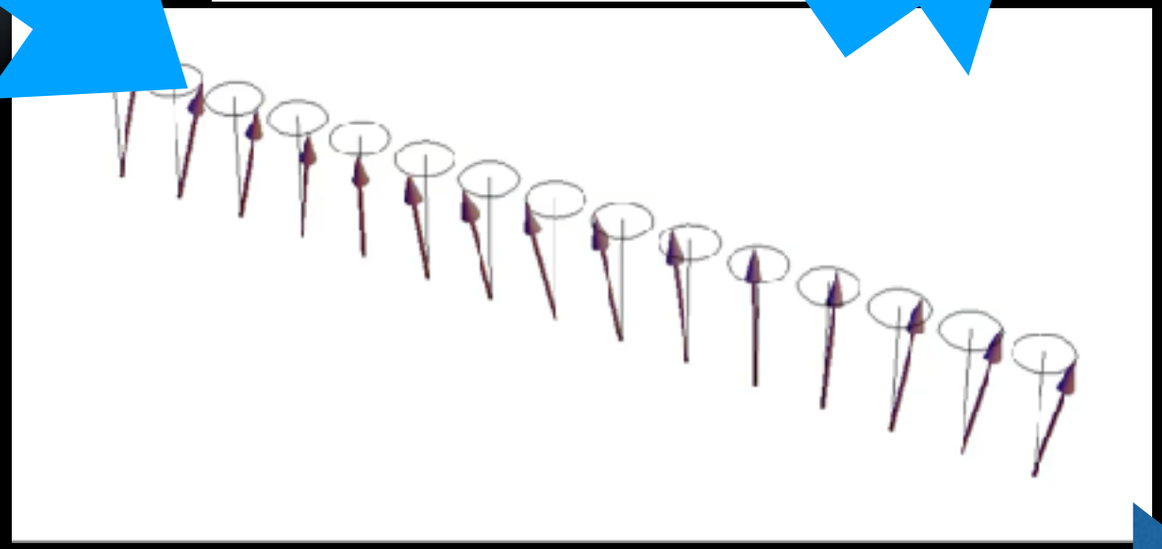
$$H = \frac{1}{f_a}\vec{\nabla}a \cdot \vec{s}_n$$

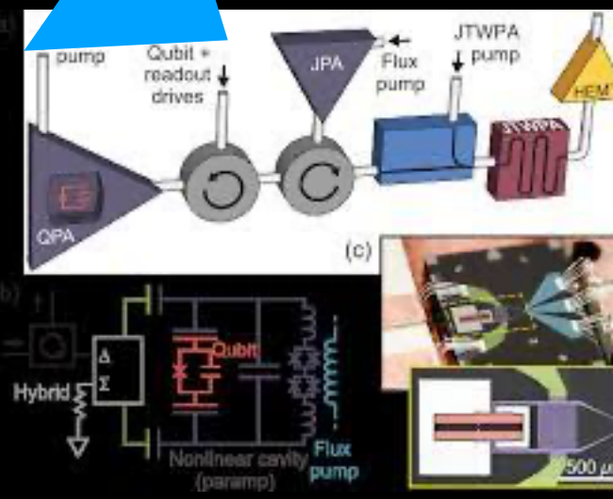
Superfluid ^{3}He A1 phase



Resonant cavity







Josephson amplifier

Yuta Michimura

Go beyond SQL

IPMU Murayama Group
Dan Kondo, Risshin Okabe
So Chigusa（Berkeley）

FoPM

ISSP Oka Group
Hiroyuki Sudo

Astrophysics　Particle physics　Condensed matter　Quantum information

Keep it up!

- Collaboration among different groups
- Solicited and core programs
- Joint workshops
- Brainstorming
- Think outside the box!
  - Cosmic rays with HSC, muscovites, …

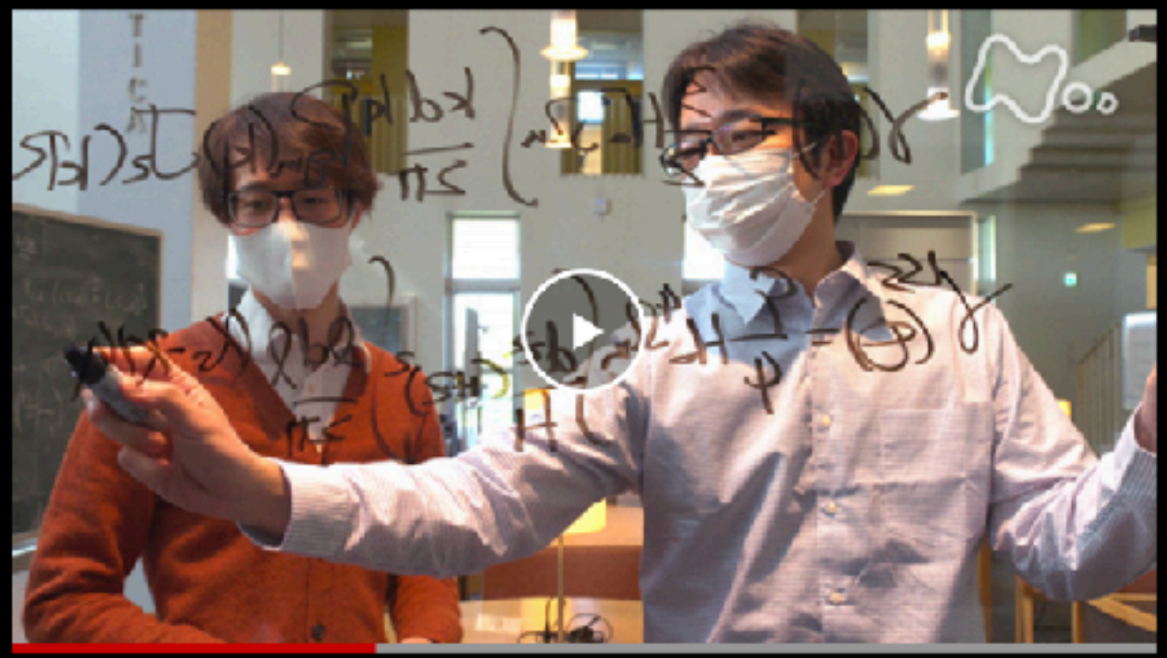
Need your help

- We are heading to a mid-term review this June
  - Need to write a big report
  - Must demonstrate we are more than sum of the parts
- We will be asking for information on
  - publications, results
  - emphasis on cross-group collaborations
  - Successful career of young scientists
  - Outreach, publicity, press releases
  - https://www.nhk-ondemand.jp/goods/G2021114366SA000/

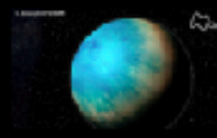
NHKオンデマンド　マイページ | ログアウト | NHKオンデマンドとは？ | 配信中番組一覧 | 配信予定　詳細検索

NHKオンデマンドのサービス向上のためにアンケートを実施しています。ご協力をお願いします。　アンケートページはこちら

ホーム　大河ドラマ　連続テレビ小説　NHKスペシャル　ジャンル　放送日でみる　無料番組



いま人気の番組



コズミック　フロント　生命の可能性は？　系外惑星探査最前線

2023年放送

本編：59分　字幕　HD　※iOS、Chromecastは字幕非対応

配信：2023年5月31日まで

コズミック　フロント　「原始ブラックホール　宇宙創成のマスターキー」

シリーズ　コズミック　フロント

★ お気に入りに登録　シェアする　?

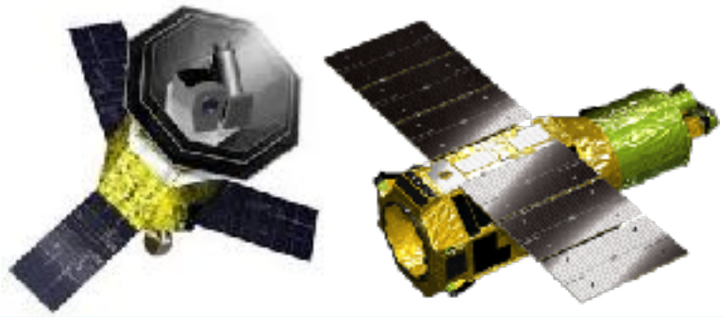
原始ブラックホールは、宇宙誕生後１秒の間に大小さまざま、無数に誕生したという。光さえも飲み込み、暗黒であるが故に観測は難しく、極小なものは私たちの体をすり抜けても気がつくことはない。そんな不思議な天体が、誕生メカニズムがわかっていない超巨大ブラックホールそのものだったり、宇宙の２割以上を占めるとされるダークマターだったり、さらには、中性子星と衝突することで、大量の金を生み出す可能性まであるという。

語り　坂井真紀 、井上二郎

声　金光宣明 、宗矢樹頼

NHK TV “Primordial Black Hole: master key to the creation of the Universe”

space



theory

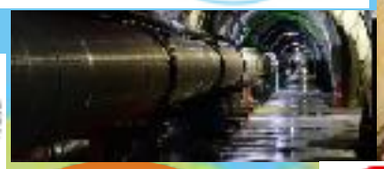
light DM
heavy DM
macroDM

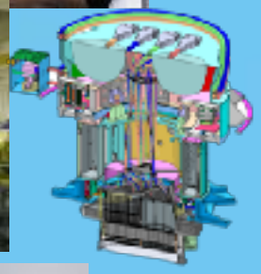
expts

laser interferometry
Subaru imaging & spectroscopy
-ray, colliders
CMB

quantum gravity
structure formation

ultimate





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New community

Looking forward

to seeing

even more progress!

Have a safe trip home!