

Short Introduction to 学術変革 ダークマター (Transformative Research Area "Dark Matter")

Yuta Michimura

Department of Physics, University of Tokyo

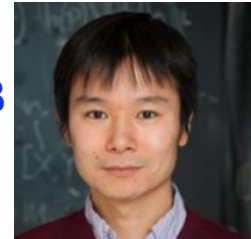
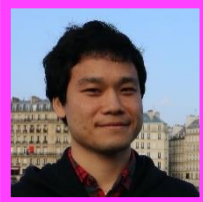
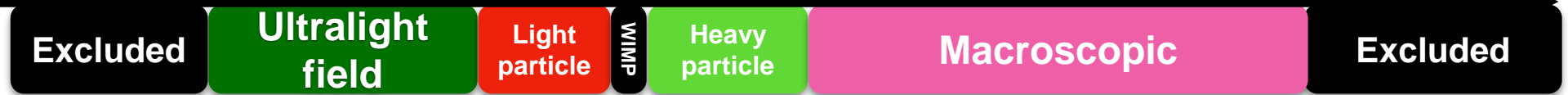
学術変革 ダークマター

- From November 2020 to March 2025
- <https://member.ipmu.jp/DarkMatter/>

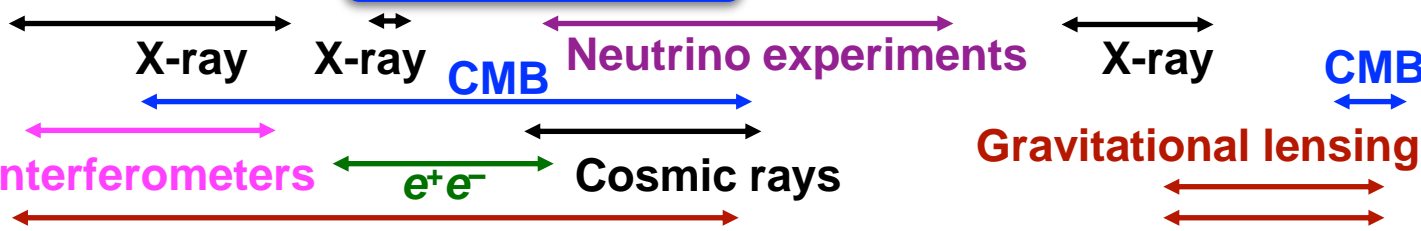


Dark matter mass [GeV/c^2]

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

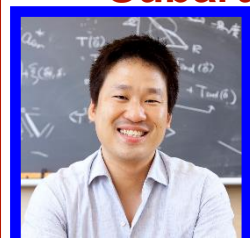
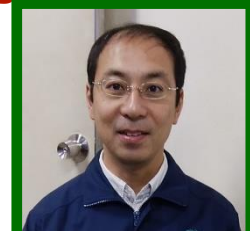


Particle



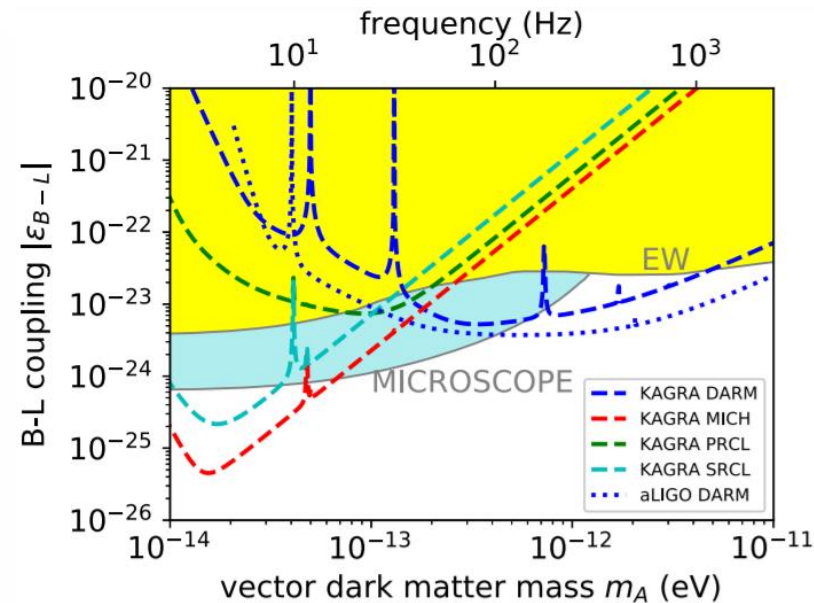
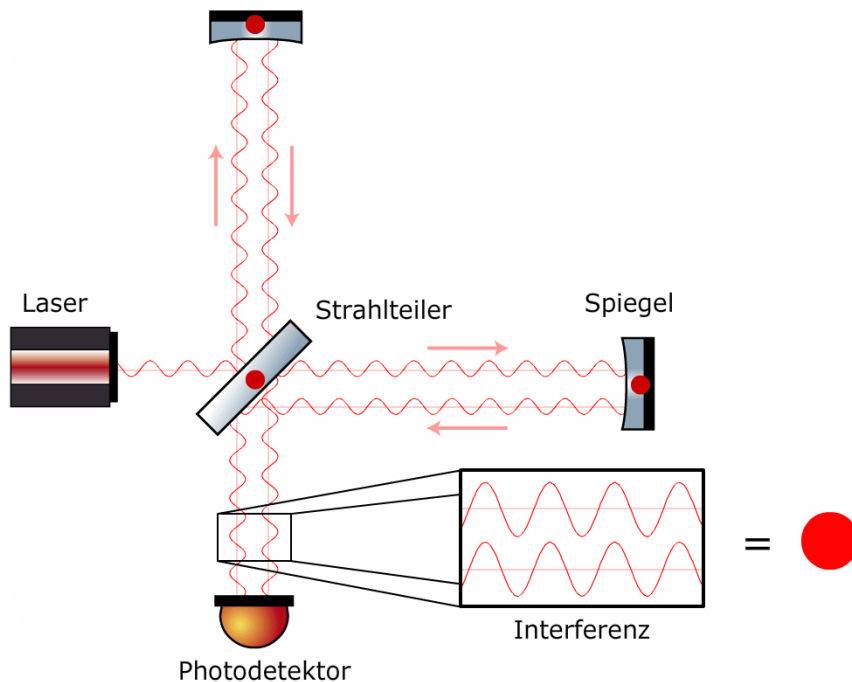
Subaru imaging / spectroscopy

Subaru spectroscopy



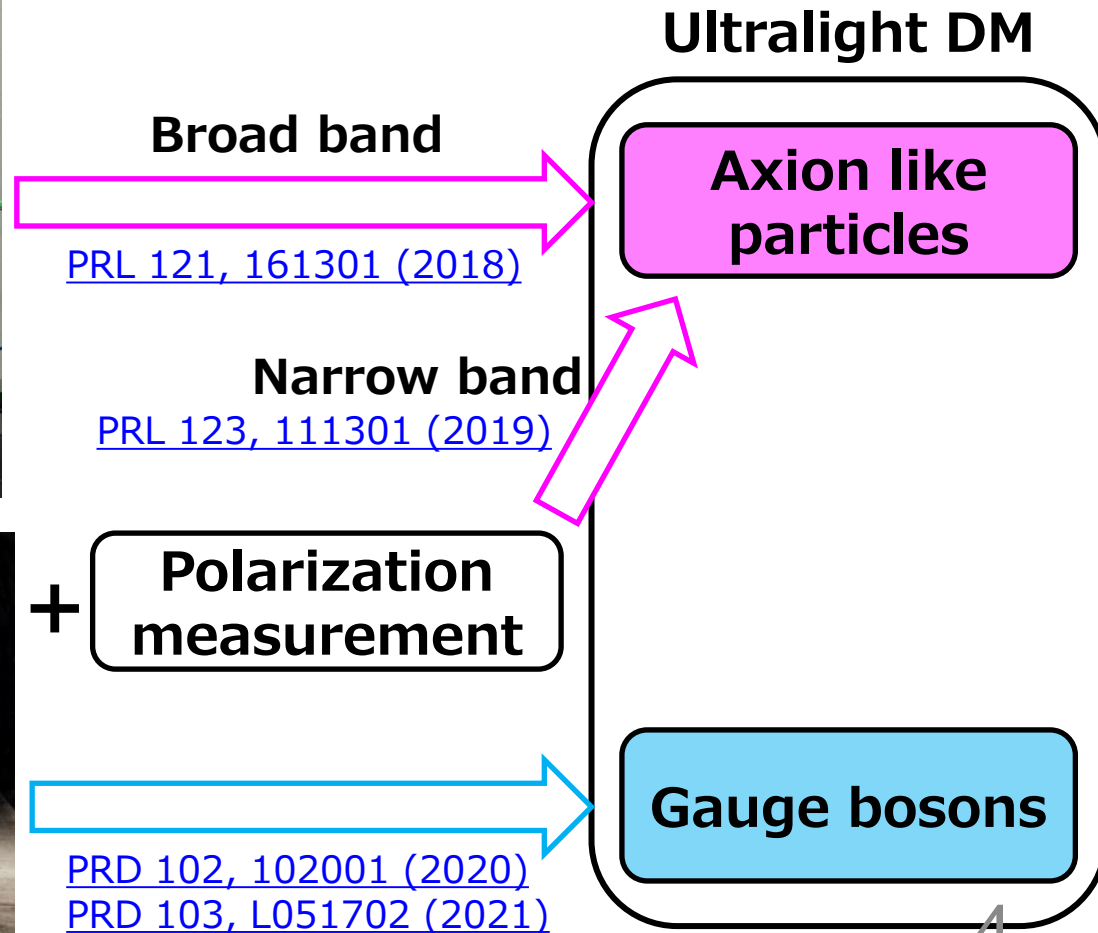
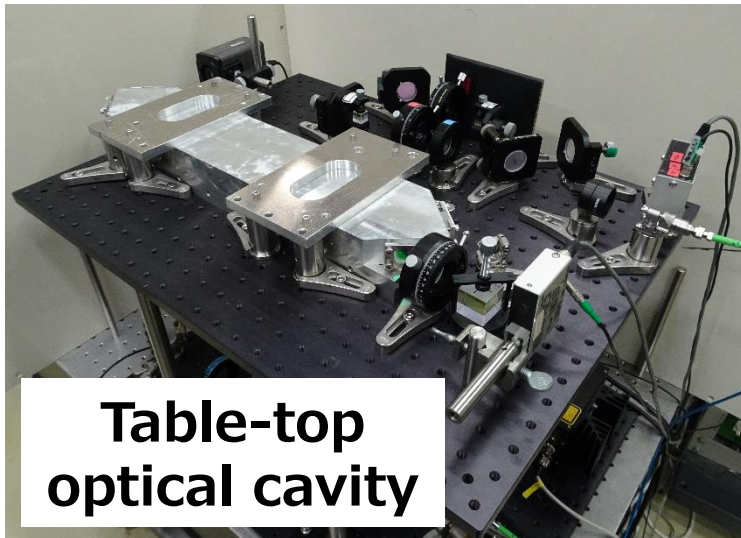
Ultralight Dark Matter

- Ultralight DM ($\lesssim 1$ eV) behaves as classical wave fields
- $$f = 242 \text{ Hz} \left(\frac{m_{\text{DM}}}{10^{-12} \text{ eV}} \right)$$
- Laser interferometers are sensitive to tiny length changes from such oscillations



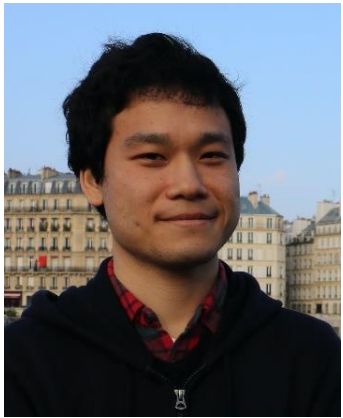
Our Strategy

- Use both **table-top** optical cavities and **large-scale** laser interferometric gravitational wave detectors



Our Team

※Non-LVK member



PI: Yuta Michimura
(道村唯太, UTokyo)

Experiment

Yuka Oshima
Hiroki Fujimoto
Koji Nagano



Co-I: Tomohiro Fujita
(藤田智弘, ICRR)

**Theory
& Data analysis**

Ippei Obata
Hiromasa Nakatsuka
Soichiro Morisaki
Jun'ya Kume
Atsushi Nishizawa



東京大学
THE UNIVERSITY OF TOKYO

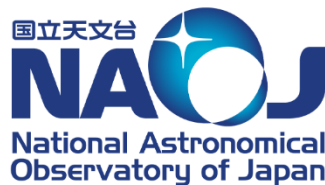


MAX-PLANCK-GESELLSCHAFT

... and more to come!



Co-I: Matteo Leonardi
(マテオ・レオナルディ, NAOJ)
Optical characterization



Co-I: Shinji Miyoki
(三代木伸二, ICRR)
KAGRA

The Budget

- 1.49M JPY (~1.37M USD) in total
 - from November 2020 to March 2025
- Roughly half is planned be used for KAGRA
 - Already spent some to buy optics etc. for KAGRA
 - Improving the sensitivity to GW
will improve the sensitivity to DM
- 1 Project Researcher will join us from July 2021
 - Will work on birefringence studies and other interferometer simulations for KAGRA
- By the way, we are also looking for another Project Researcher working on the data analysis

Past Presentations/Publications

- On axion search by Koji Nagano **at F2F April 2019**
(Poster Award)
- On DM searches by Tomohiro Fujita and Yuta Michimura **at KIW7 Dec 2020**
- Y. Michimura+, [Phys. Rev. D 102, 102001 \(2020\)](#)
- Submitted through CPC
- S. Morisaki+. [Phys. Rev. D 103, L051702 \(2021\)](#)
- Presented at LVK Dark Matter call on Oct. 28, 2020

Expected LVK Publications

- **Gauge boson** dark matter search using O3GK KAGRA data
 - On-going
 - New approach to use MICH/PRCL data (Unique to KAGRA since we use sapphire)
- **Axion** dark matter search using O4 KAGRA data
 - Using polarization optics
- Updated **gauge boson** dark matter search using O4 KAGRA data
 - Hopefully do better than LIGO DARM
- Also, some short author papers discussing the data analysis pipelines and experimental proposals