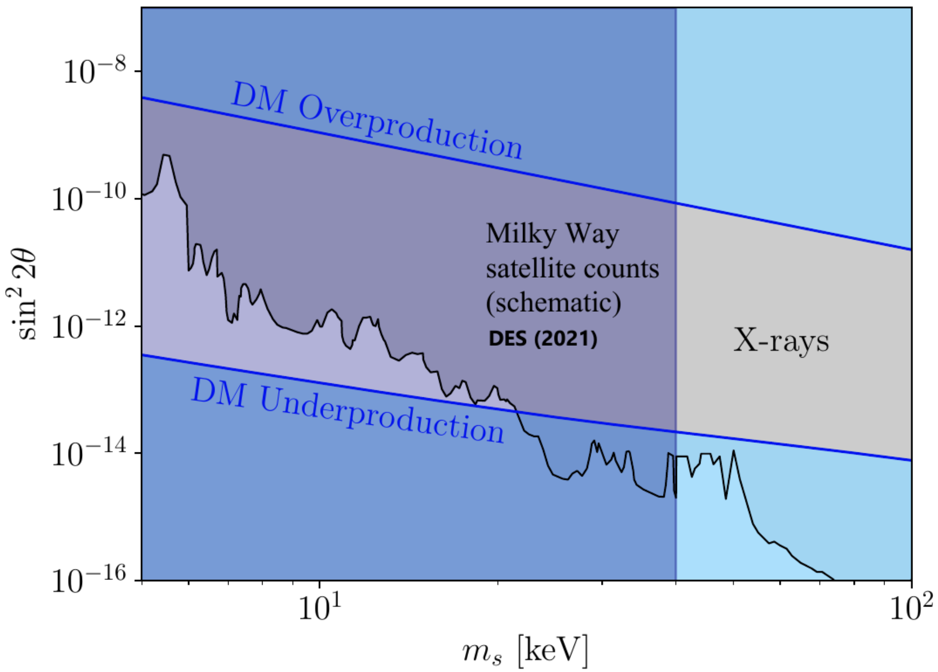
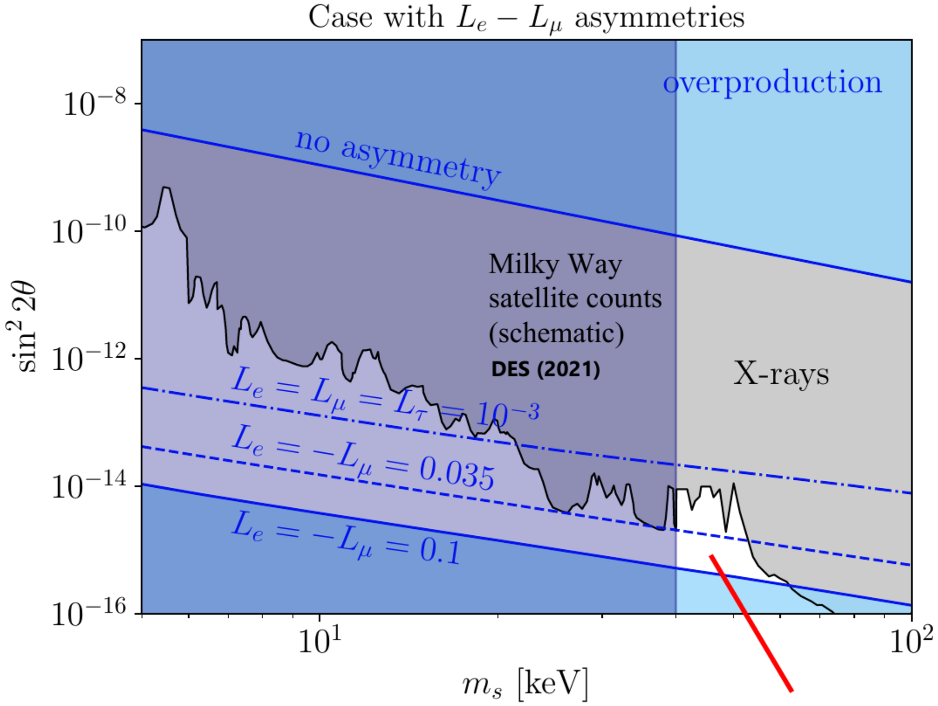
①

Maximal Parameter Space of Sterile Neutrino Dark Matter with Lepton Asymmetries

K. Akita, K. Hamaguchi, M. Ovchynnikov, Phys. Rev. Lett. 136 (2026) 11, 111001 [2507.20659].



Adapted form DES collaboration [arXiv:2008.00022]



Newly opened space may be testable by future X-ray, structure formation and CMB searches!

- Some simple models of sterile neutrino dark matter are (almost) excluded…
- We showed large lepton flavor asymmetries with vanishing total lepton asymmetry open a new parameter space as in the right figure!

② # Extended natural inflation and the trans-Planckian censorship conjecture

What is the physical mechanism of the origin of the Universe?
The University of Tokyo, Hongo campus, Koshiba Hall, July 7 - 8, 2026

Reference: Phys. Dark Univ. 49, 101990 (2025)

Fukushima University

Presenter : **Kazuharu Bamba (*Fukushima University*)**

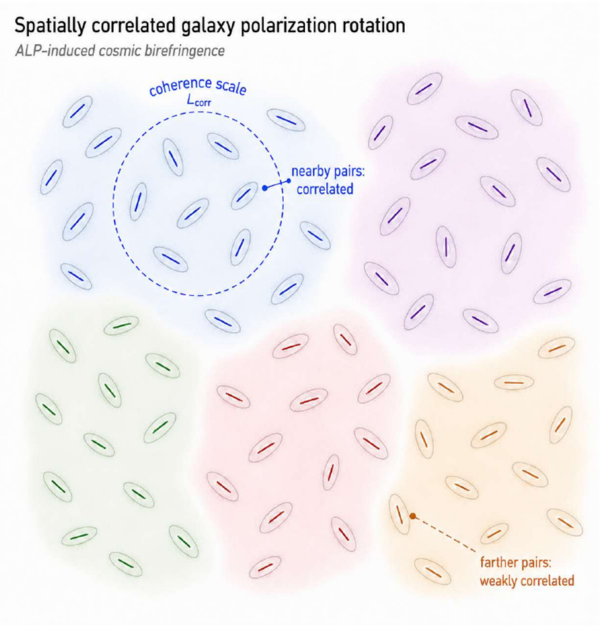
Collaborators: **Behnoush Afshar, Hooman Moradpour (*University of Maragheh*), Marziyeh Peyravi (*Ferdowsi University of Mashhad*)**

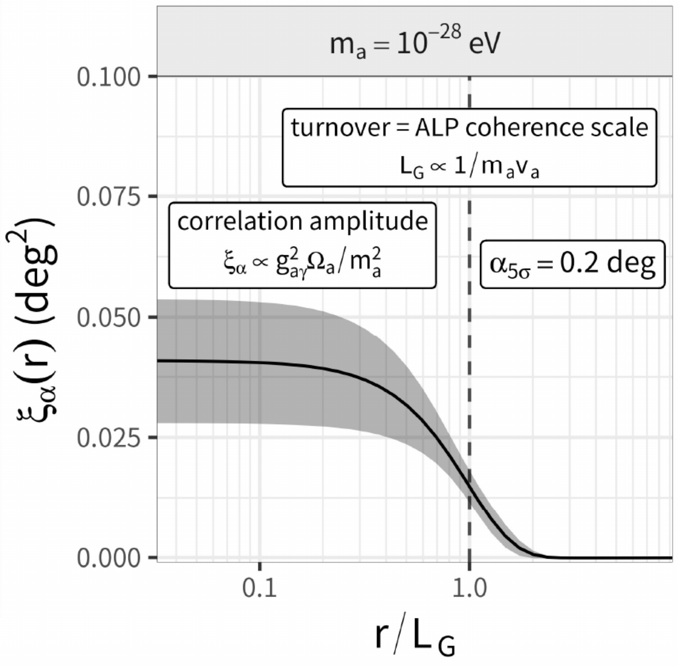
- We explore an extended version of the original natural inflation model with the double Sine-Gordon potential.
- We demonstrate that in the extended natural inflation model, the spectral index of scalar perturbations n_s and the tensor-to-scalar ratio r can be consistent with the Planck 2018 and the BICEP2/Keck 2018 observations by depicting $n_s - r$ diagram explicitly.
- We also discuss the realization of the reheating stage with the reheating temperature (up to around 10^{14} GeV) and the trans-Planckian censorship conjecture for the present inflation model.

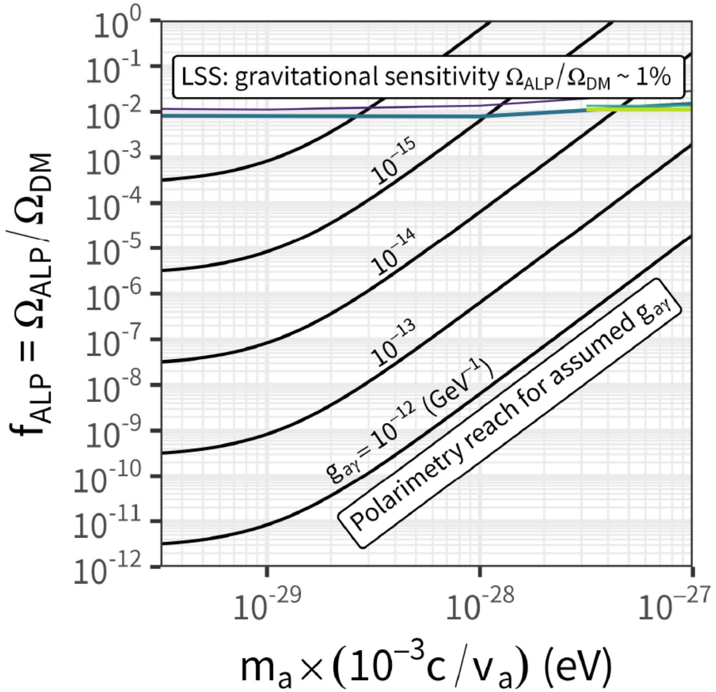
3

Galaxy polarization correlations: a 3D probe of ultralight-ALP coherence

— Search for a spatially correlated rotationfield across millions of galaxies—







Forecast: 10^6galaxies, $z \leq 2$, f_{sky} =0.25, $\sigma_\theta = 10°$

Outcome: detect correlated birefringence and measure its turnover $\Rightarrow m_a v_a$; complementary to LSS.

Poster: ”A Geometric Probe of Ultralight Axion-Like Particles from Galaxy Polarization Correlations” (Y. Doi)

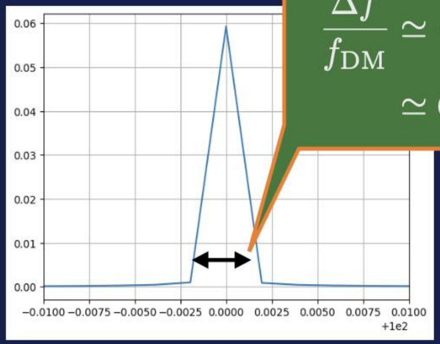
4

Identification of the UltraLight Dark Matter signal origin for the search with GW detectors

Takumi Fujimori[1] **Collaborators**: Jun'ya Kume[A], Soichiro Morisaki[B]

[1]Osaka Metropolitan Univ. [A]Univ. of Helsinki, [B]Institute of Cosmic-ray Research(ICRR), U. Tokyo

Osaka Metropolitan University



$$\frac{\Delta f}{f_{\mathrm{DM}}} \simeq \frac{v^2}{2} \simeq \mathcal{O}(10^{-6})$$

The spectrum of ULDM signal

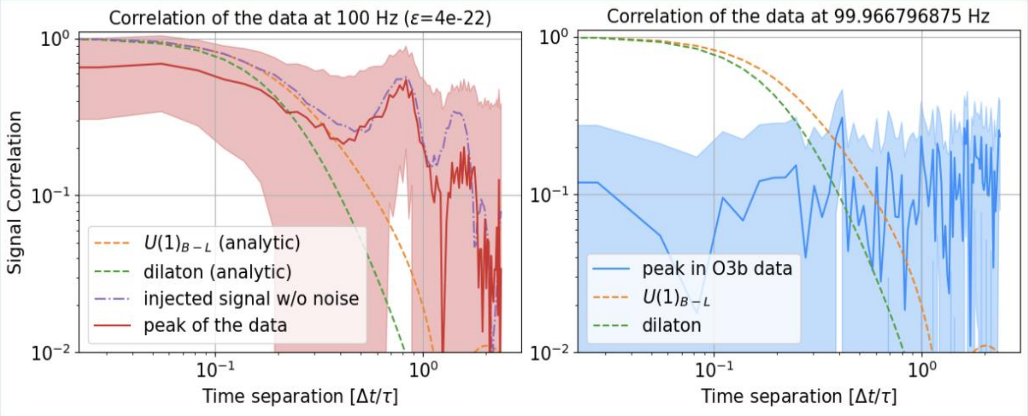
Problem:

Existing searches detect candidates but **fail to verify their physical nature**

The autocorrelation function to distinguish the signal origin

$$\mathcal{H}_{ft_i,f't_j} \equiv \langle \tilde{h}(f;t_i)\tilde{h}^*(f';t_j)\rangle$$

The analysis results with real data



The autocorrelation of the injected signal (right) & noise (left) is easy to distinguish

Gamma-Ray Signatures of Thermal Misalignment Dark Matter

Ryoichiro Hayakawa, Koichi Hamaguchi, Hiroki Takahashi [arXiv:2604.05326]

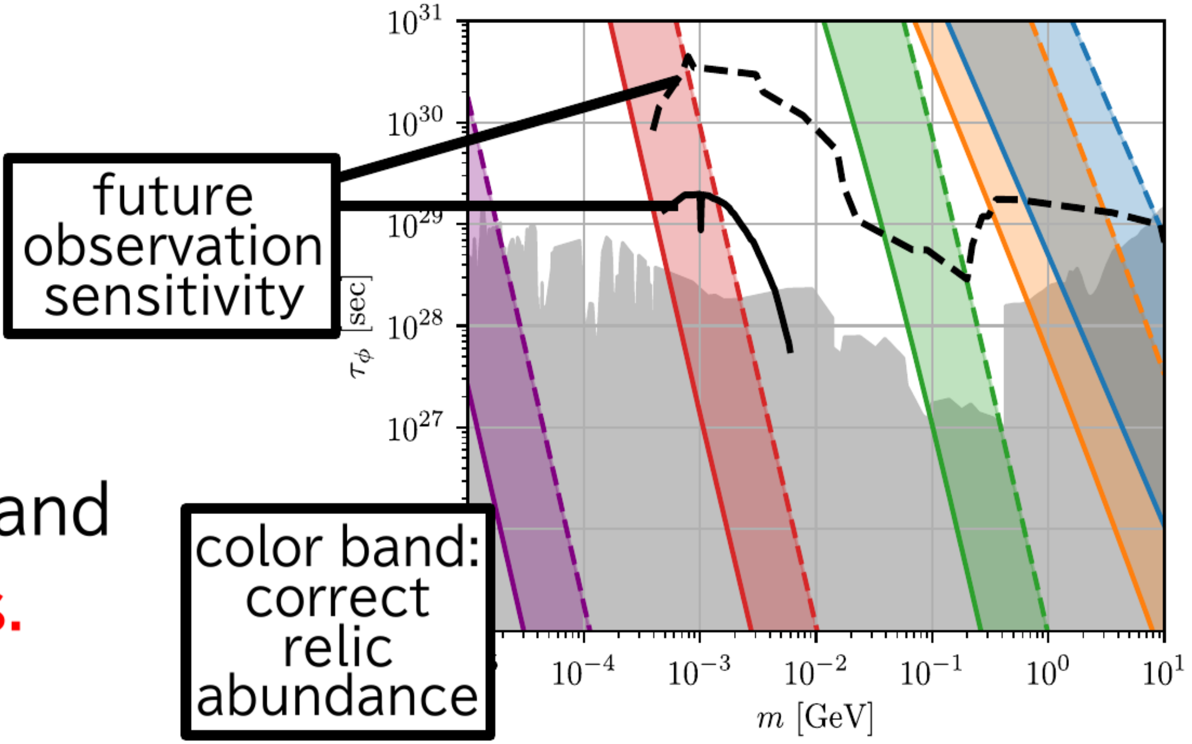
▶DM coupled to SM field in thermal equilibrium effectively acquires temperature-dependent potential

▶Through such potential, sufficient amount of DM is generated in the early universe (Thermal misalignment)

▶The model: scalar singlet ϕ with coupling $\dfrac{\phi F^{\mu\nu} F_{\mu\nu}}{M}$

($F^{\mu\nu}$:strength of EM field)

▶ Such ϕ decays into photons and be a target of gamma-ray obs.

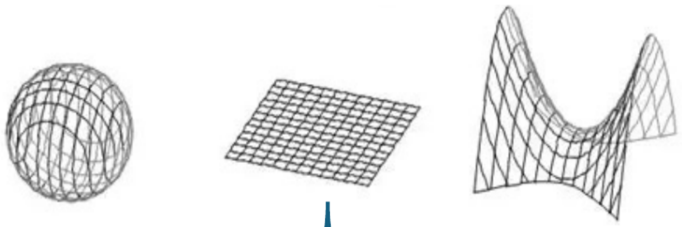


6

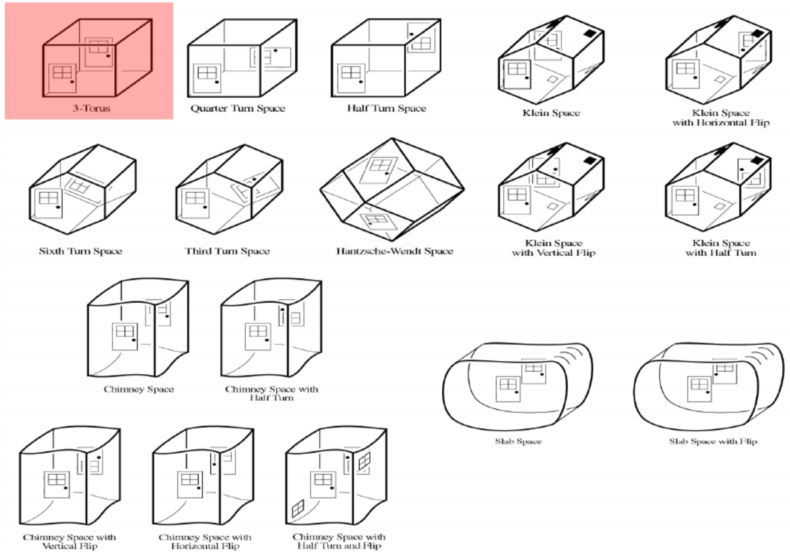
Probing Cosmic Topology Including CMB B-mode Polarization

Is the Universe infinite?

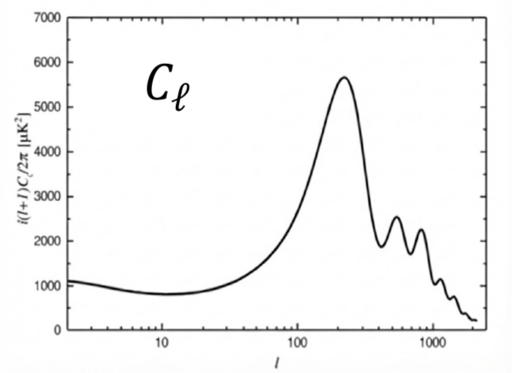
・Flat 3D space admits 18 possible topologies.



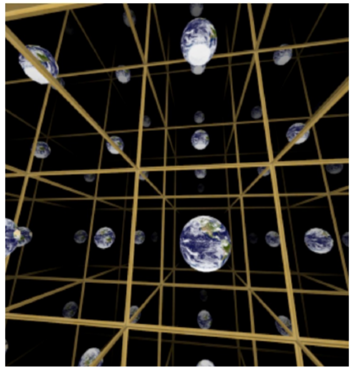
Our research

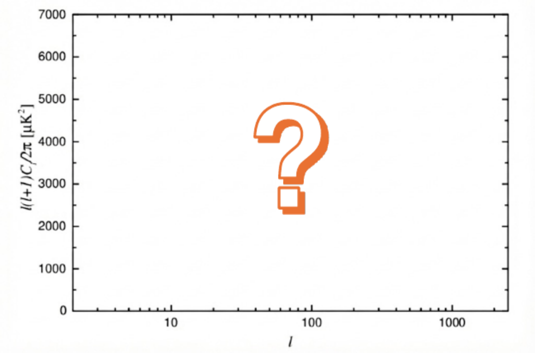


・Standard infinite universe



・Our research





・Cosmic topology may be imprinted in the CMB

→We calculate topology-induced CMB covariance

8 Testing pseudo-Nambu Goldstone dark matter via a two-component scenario

Takumi Ishikawa, Tomohiro Abe (Tokyo Univ. of Science)

Motivation

- pNGDM naturally evades direct detection
- This makes the model difficult to test

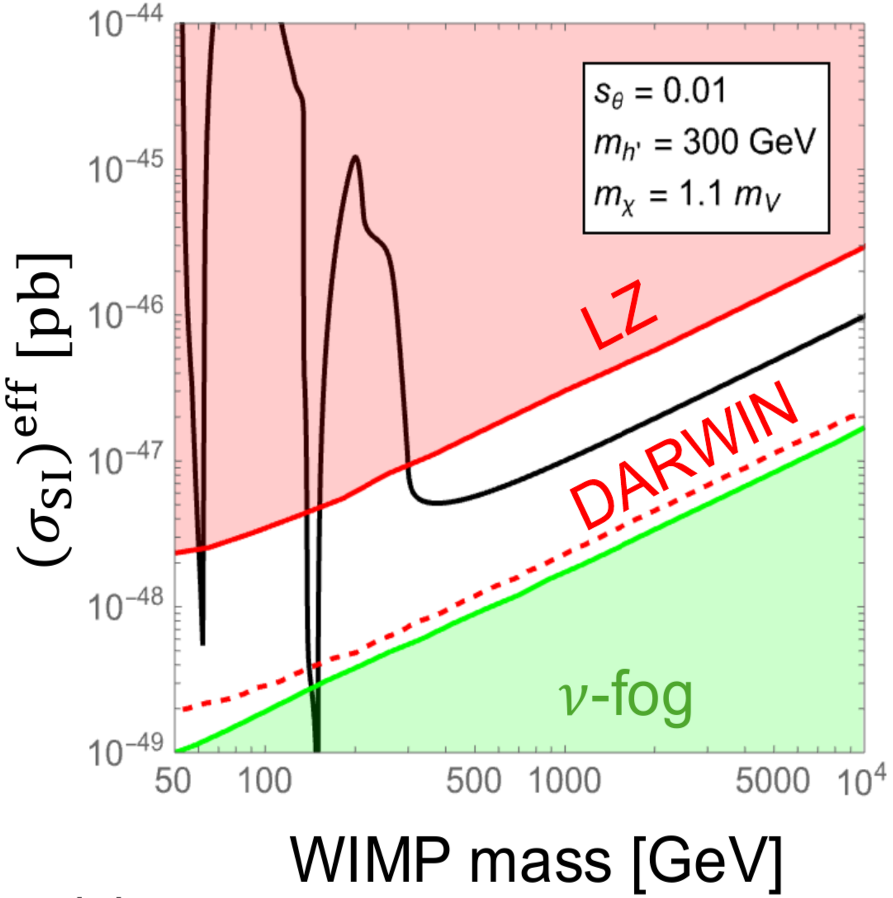
Idea

(pNGDM + WIMP)

- Many pNGDM models can realize two-component scenario
- The WIMP component may give detectable signals

Result

- DARWIN experiment can probe wide parameter regions
- Two-component scenario improves the testability of pNGDM model

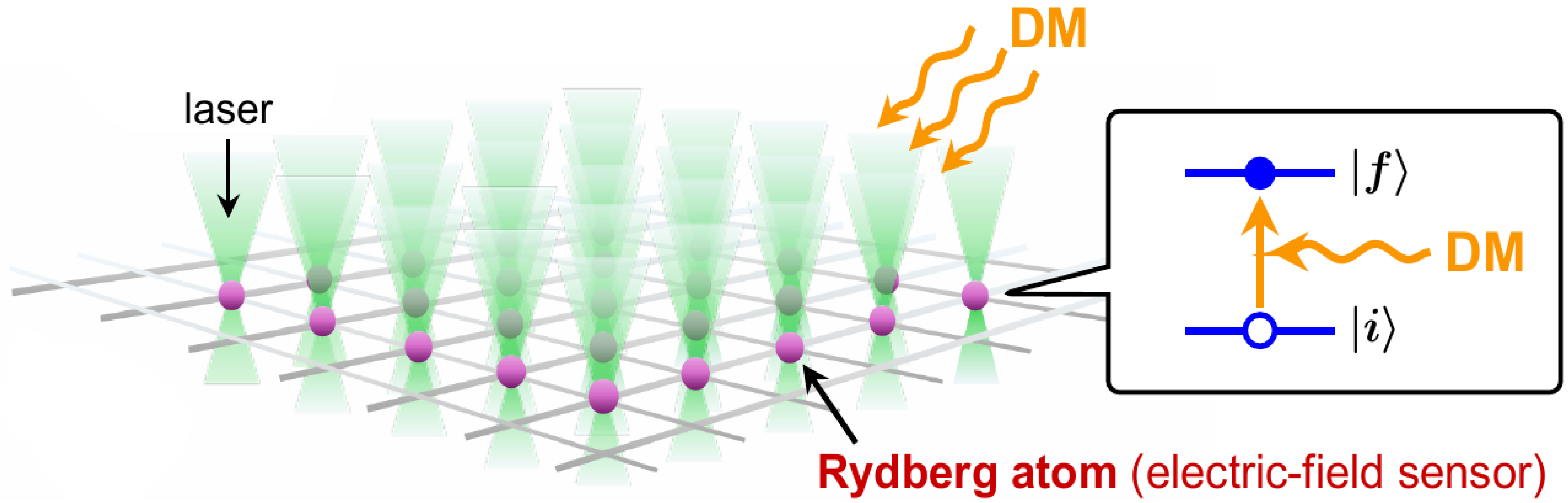


9 ★

Detecting dark matter using optically trapped Rydberg atom tweezer arrays

Taiyo Kasamaki (UTokyo)

with So Chigusa, Toshi Kusano, Takeo Moroi, Kazunori Nakayama, Naoya Ozawa, Yoshiro Takahashi, Atsuhiro Umemoto, Amar Vutha



We can probe previously unexplored parameter space of dark photon DM!

10

Search for Ultra-light Axion Dark Matter with KAGRA

Kenzaburo Kawaguchi[1,2], Hinata Takidera[1], Takumi Fujimori[3], Jun'ya Kume[4], Soichiro Morisaki[5], Tomohiro Fujita[6,7], Ippei Obata[7,8], Hiroki Fujimoto[9], Yuta Michimura[1,2,7], for the KAGRA Collaboration

[1]The University of Tokyo [2]RESCEU [3]Osaka Metropolitan University [4]University of Helsinki [5]Institute for Cosmic Ray Research, The University of Tokyo [6]Ochanomizu University [7]Kavli IPMU [8]KEK [9]National Astronomical Observatory of Japan

1 Axion detection via polarization rotation

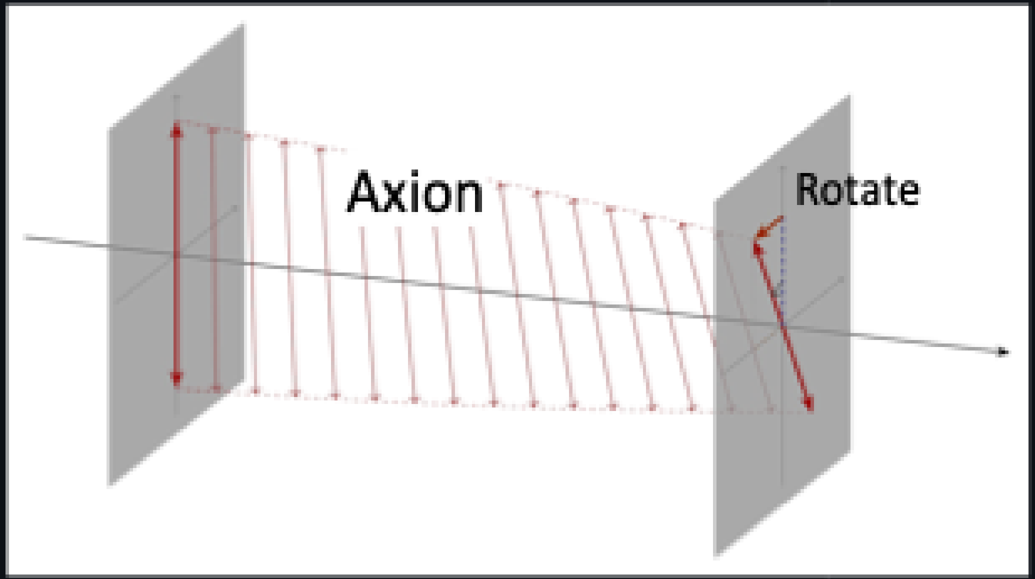
Axion-photon coupling rotates laser polarization.
KAGRA works as a sensitive polarimeter.

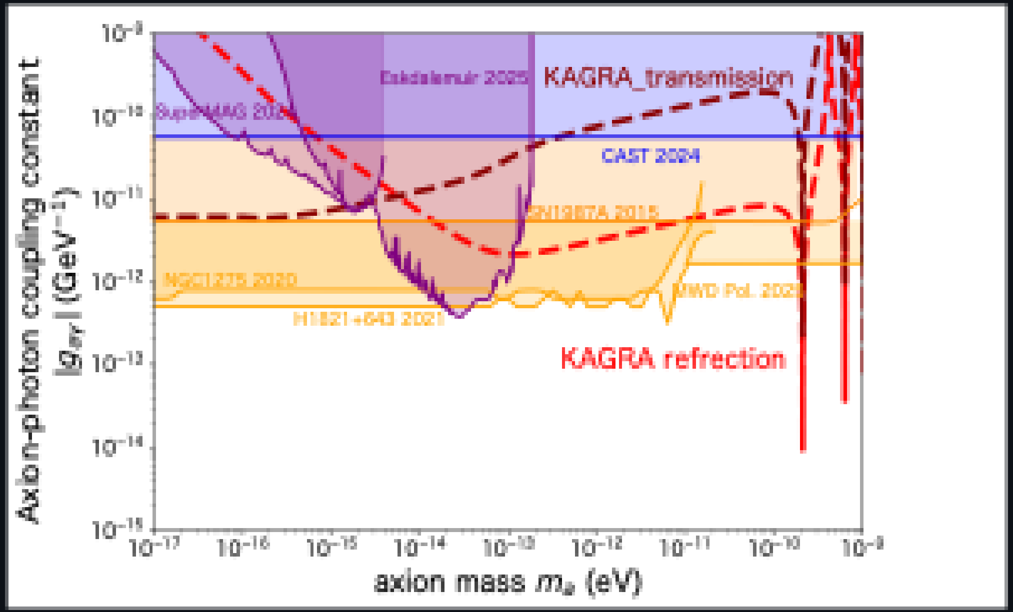
2 Simultaneous observation with GW

Signal frequency follows $f_a \propto m_a$
Runs together with GW observation.

3 Opening the high-frequency band

New data logger opens the high-frequency band.





Existing limits on axion-photon coupling and projected KAGRA sensitivity

Come to Poster 10

11

Mimimal Majoron Dark Matter

arXiv: 2605.12946

Haruto Kitagawa, in collaboration with K. Akita, K. Hamaguchi, T. Yokoyama

UTokyo

- Majoron : pNG boson from global $U(1)_{B-L}$ breaking (c.f. RHN mass)

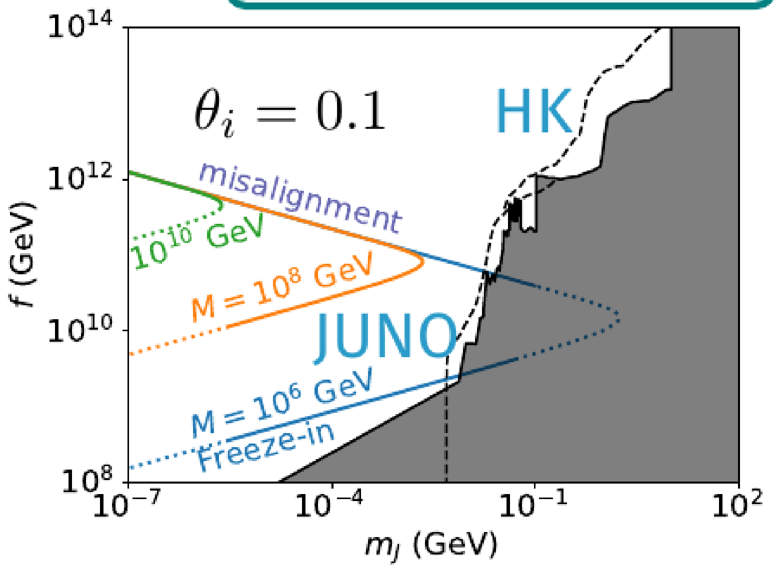
↑ Motivation

$$\mathcal{L} \supset i\bar{N}_i \not{\partial} N_i + |\partial_\mu \sigma|^2 - V(\sigma)$$
$$- \left[\frac{1}{2} g_i \sigma \bar{N_i}^c N_i + y_{\alpha i} \bar{L}_\alpha \tilde{H} N_i + \text{h.c.} \right]$$

Seesaw

- neutrino mass
- Baryon assymmetry (Leptogenesis)

- Production via freeze-in and misalignment for Majoron DM
- Constraints from ν, q, l, γ
- JUNO and HK can probe our model.
- Consistency with leptogenesis



12

Quantum Algorithm for the Fokker–Planck Equation in Cosmology

Hou Heng Leong (SOKENDAI, KEK) · Koichi Miyamoto (UOsaka) · Pankaj Saha (KEK) · Yuko Urakawa (SOKENDAI, KEK)

1 PROBLEM

- Fokker-Planck equation describes inflaton's probability distribution
- Classical solvers suffer from curse of dimensionality

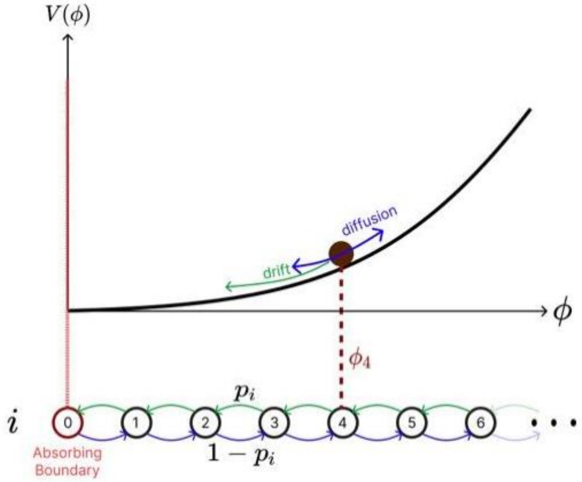
2 METHOD

- Bacteria model: branching random walk ⇨ Linear system of equations
- QSVT solver: construct a history state. SWAP test: outputs expected number of absorbed bacteria

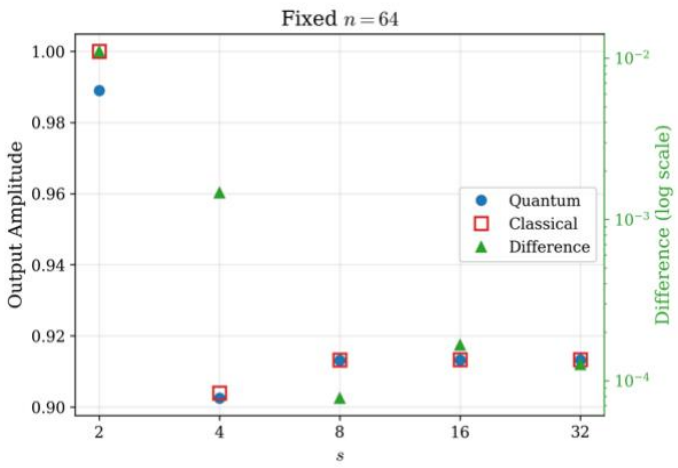
[Creminelli et al., JHEP '08, Gilyén et al., STOC '19]

3 RESULT

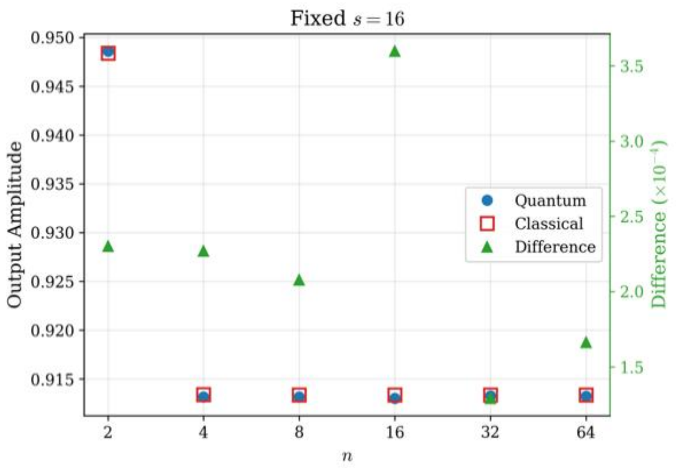
- End-to-end example of application on eternal inflation
- Numerical simulation to validate algorithm's results



Bacteria model: branching random walk on a one-dimensional grid



Comparison between classical method and quantum algorithm for n = 64 vs s



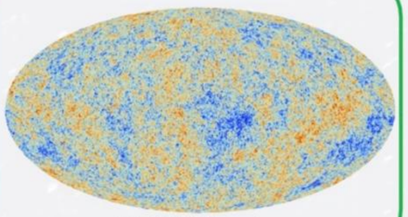
Comparison between classical method and quantum algorithm for s = 16 vs n

Generation of CMB V-mode Polarization by Dark Photons

Saki Matsuda (Ochanomizu U), Tomohiro Fujita (Ochanomizu U), Takashi Hiramatsu (Nihon U), Ippei Obata (KEK)

Everyone focuses on…

T-mode

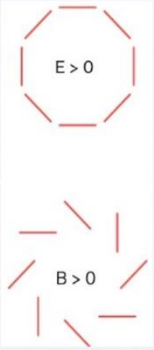


©ESA/Planck

E-mode

D.Baumann et al. (2009)

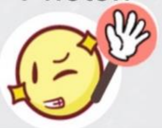
B-mode



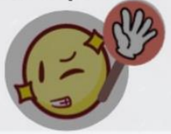
D.Baumann et al. (2009)

Photon-dark photon conversion

Photon



Dark photon



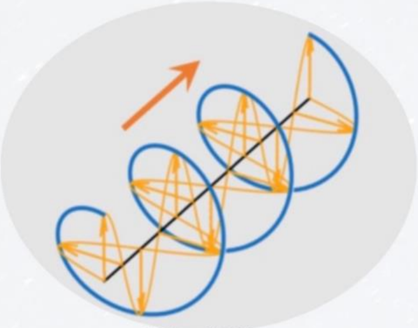
Let's generate V-mode !

Don’t forget V-mode !

V-mode

Standard cosmology predicts V-mode ~ 0

V-mode is often overlooked…



©Ryuji Mineta.

Is it really zero ?

14

Primordial Non-Gaussianity or Systematics?

-- Interpreting Galaxy Clustering To Probe the Origin of the Universe--

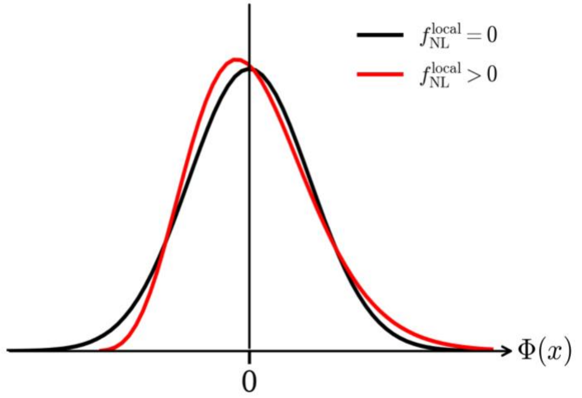
Shintaro Nakano (D2), Masahiro Takada, Toshiki Kurita, Ryo Terasawa

UTokyo

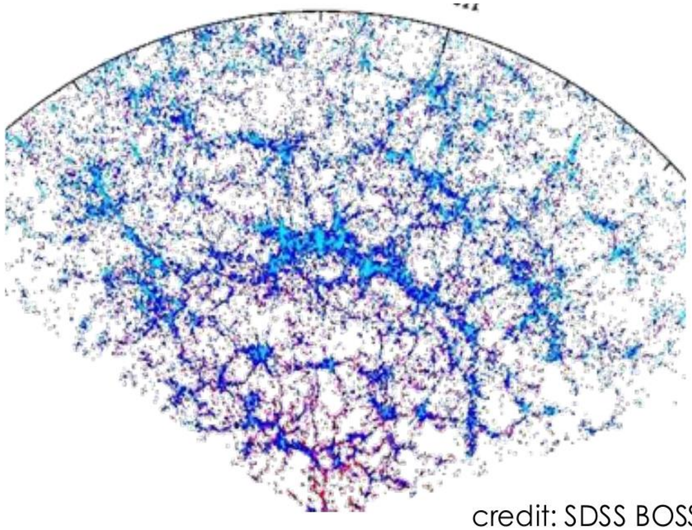
KAVLI IPMU

Background

Some inflation models predict **primordial non-Gaussianity (PNG)**

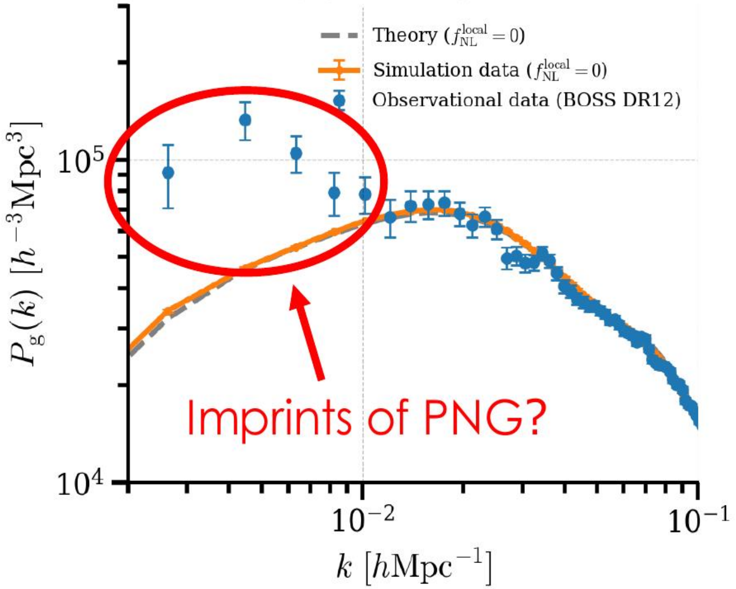


3D distribution of galaxies



credit: SDSS BOSS

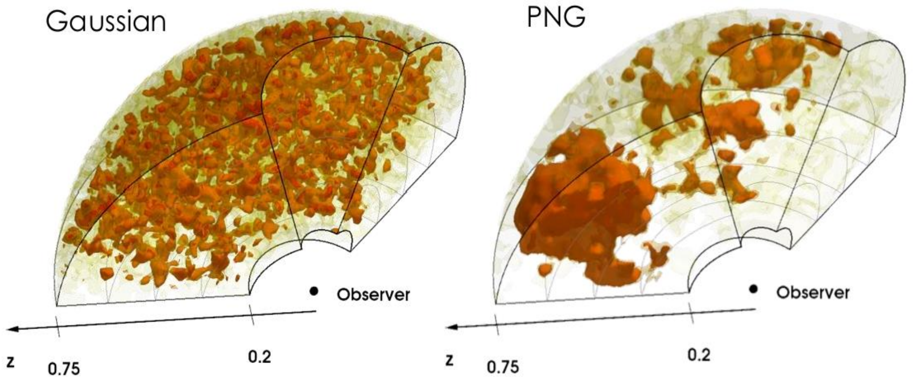
Galaxy power spectrum



What we did

1. Investigated the impact of **angular observational systematics** on the galaxy power spectrum

2. Generated ***linear perturbation theory-based simulations*** to see how PNG couples to the survey geometry and others

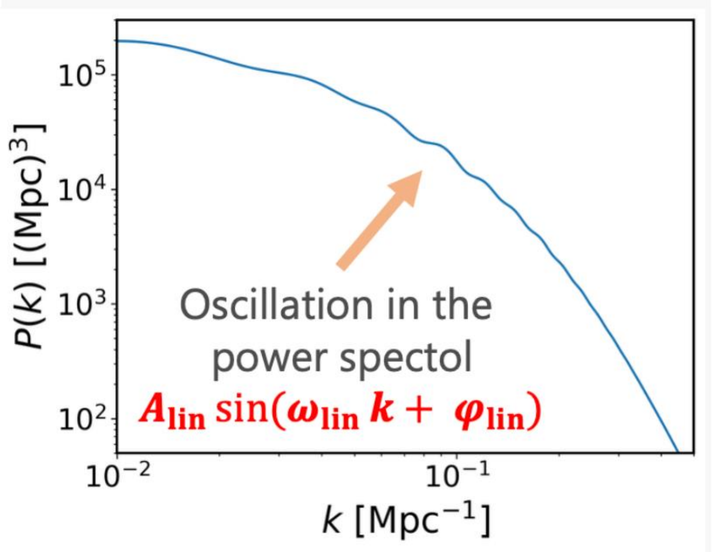


15

Forecasting Constraints on Primordial Features with DESI Y5

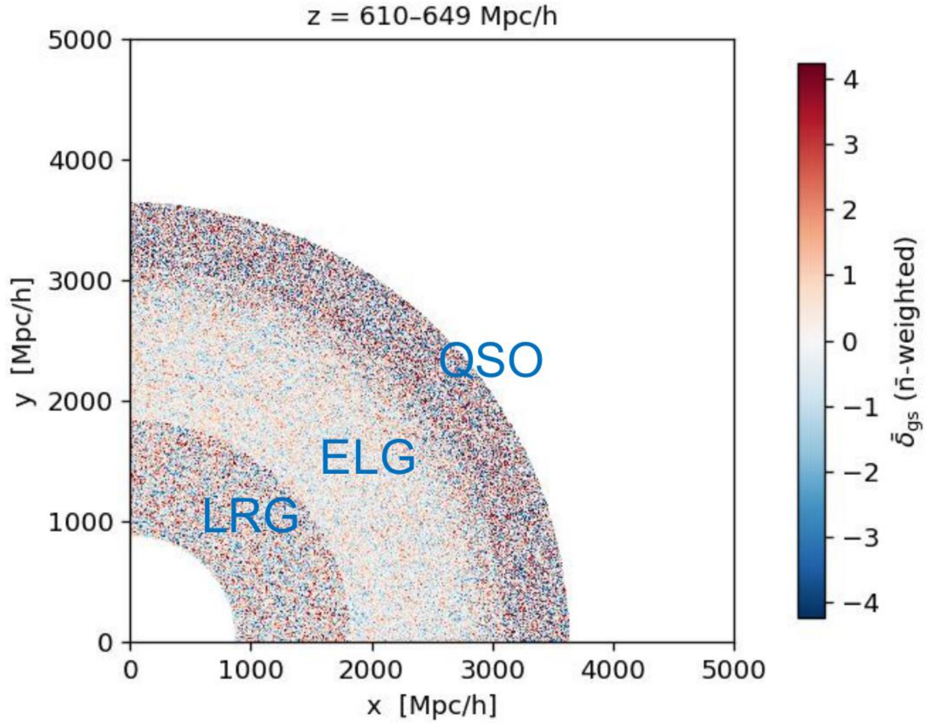
Shota Ogawa et al.
The University of Tokyo, Kavli IPMU

Inflation may have produced **oscillatory features**. We forecast how tightly the feature amplitude can be constrained using the large volume and high number density of **DESI Y5**.



Generate the density fluctuation field as a Gaussian field

Fisher forecast using the covariance estimated from the mocks



17

Decoherence of Primordial Perturbations in the View of a Local Observer

Fumiya Sano (UTokyo). Based on **2504.10472** with Junsei Tokuda (McGill Univ. / Nagoya Univ.).

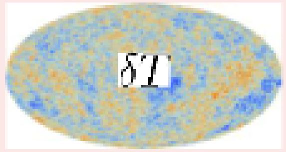
UTokyo

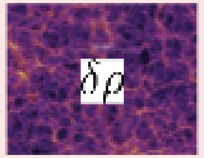
◆ Quantum-to-classical transition of cosmological perturbations

$$g_{ij} = (ae^{\zeta})^2 \delta_{ij}$$

Quantum during inflation

Decoherence etc.





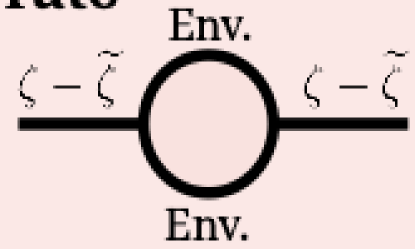
Classical in late time universe

◆ Reduced density matrix for CMB mode

$$\rho_{\rm S}[\zeta_{k_{\rm CMB}}, \tilde{\zeta}_{k_{\rm CMB}}] = \langle \zeta_{k_{\rm CMB}} | \hat{\rho}_{\rm S} | \tilde{\zeta}_{k_{\rm CMB}} \rangle \xrightarrow[\zeta \neq \tilde{\zeta}]{} \exp\left[-\Gamma_{\text{off-diag}} (\zeta_{k_{\rm CMB}} - \tilde{\zeta}_{k_{\rm CMB}})^2 \right]$$

Decoherence rate

$$\Gamma_{\text{off-diag}} \simeq$$



$$\sim \frac{H^2}{M_{\rm pl}^2} \left[\frac{1}{\epsilon^2} \left(\frac{aH}{k_{\rm S}} \right)^6 \left(1 + \log \frac{k_{\rm IR}}{k_{\rm S}} \right) + \left(\frac{\Lambda_{\rm phys}}{H} \right)^{\#} \right]$$

◆ Renormalization vs. artefacts of observables

IR

Absorbing IR mode to metric

$$a^2 e^{2\zeta_{\rm L}} dx^i dx^j \simeq a^2 dx^i_{\rm F} dx^j_{\rm F}$$

UV

$$\int^{\Lambda} k^{\#} dk \to \Lambda^{\#}$$

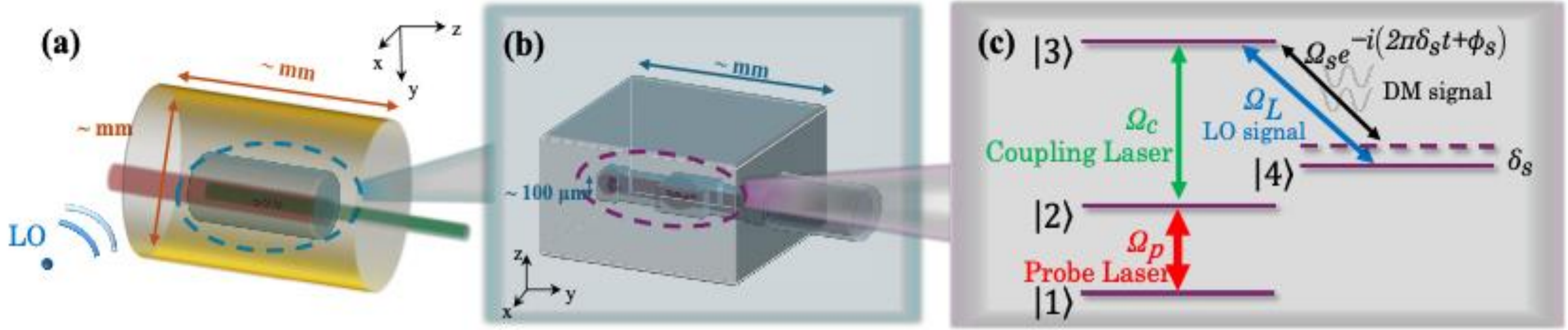
Time averaging

$$\frac{1}{|\tau_1 - \tau_2|^{\#}}$$ Renormalized

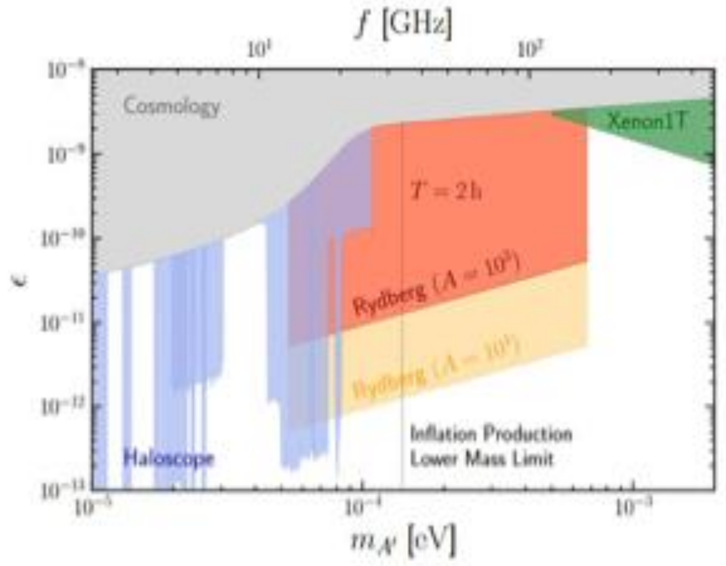
$$\frac{e^{-ik(\tau_1 - \tau_2)}}{|\tau_1 - \tau_2|^{\#}}$$ Averaged out

Rydberg-Atom Superheterodyne Detection of Inflationary Hidden-Photon Dark Matter

By Xiaochen Li, Bo Gao, Shigeki Matsumoto, J.S., Chuan-Yang Xing, and Hong Ding
From Tsung-Dao Lee Institute, Kavli IPMU, University of Tokyo, China University of Petroleum



By combining (a) a millimeter-scale cavity, (b) a chip-scale Rydberg-atom vapor cell, and (c) superheterodyne readout, we can probe high-frequency hidden-photon dark matter in a mass range inaccessible to haloscopes.

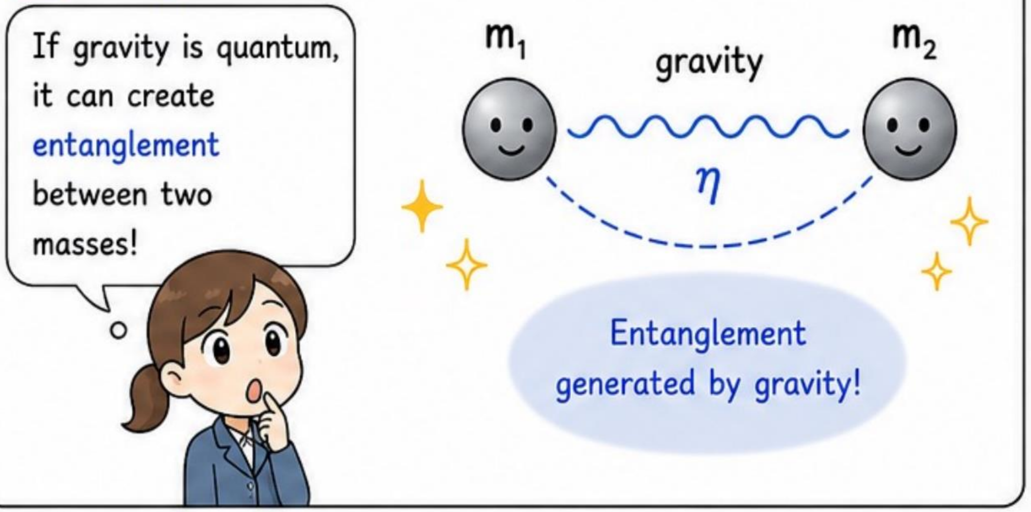


19

Squeezed Reservoir Control Toward Detecting Gravity-Induced Entanglement

Yuka Shiomatsu Master's Student, Ochanomizu University
(with Y. Kaku, A. Matsumura & T. Fujita)

1 Why does it matter?

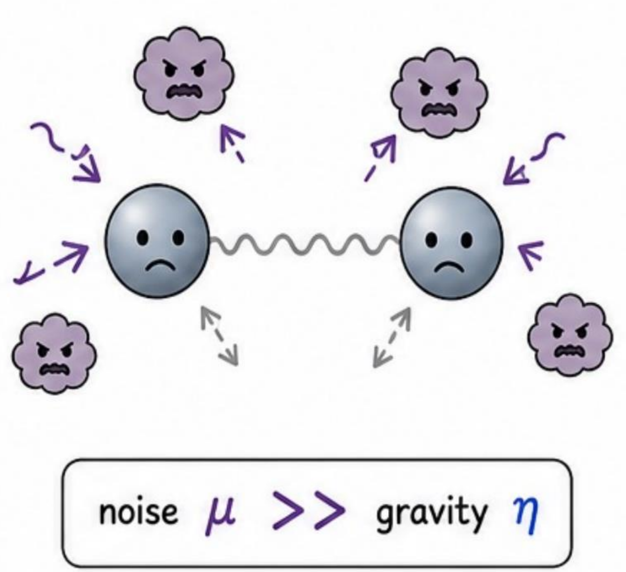


2 The problem

In realistic setups, environmental noise is usually much stronger than gravity.

↓

The entanglement signal is easily destroyed...



3 Our idea

We control the system with a squeezed reservoir.

Run two controlled cases:

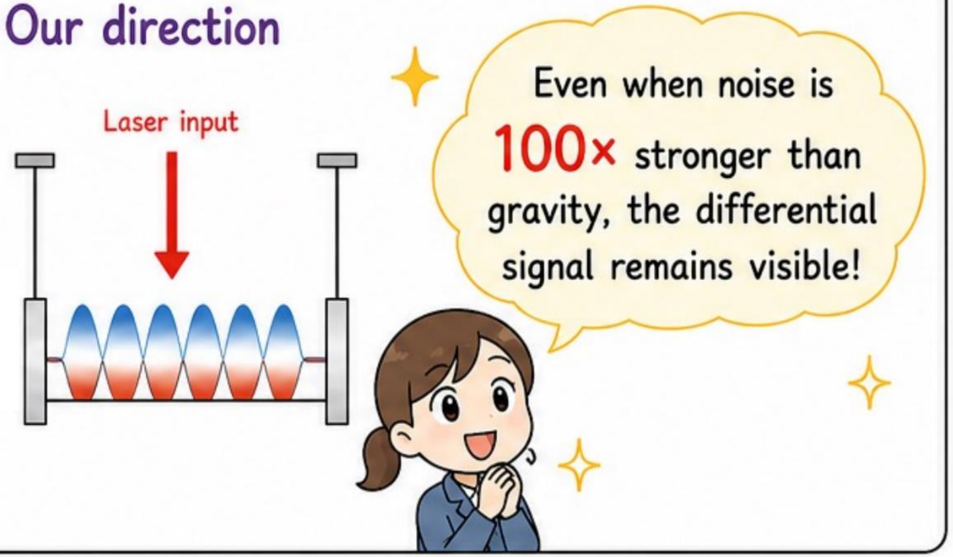
gravity η	gravity $\eta+\Delta\eta$

Subtract →

Take the difference in entanglement:

$$\Delta E_N = E_N(\eta+\Delta\eta) - E_N(\eta)$$

4 Our direction

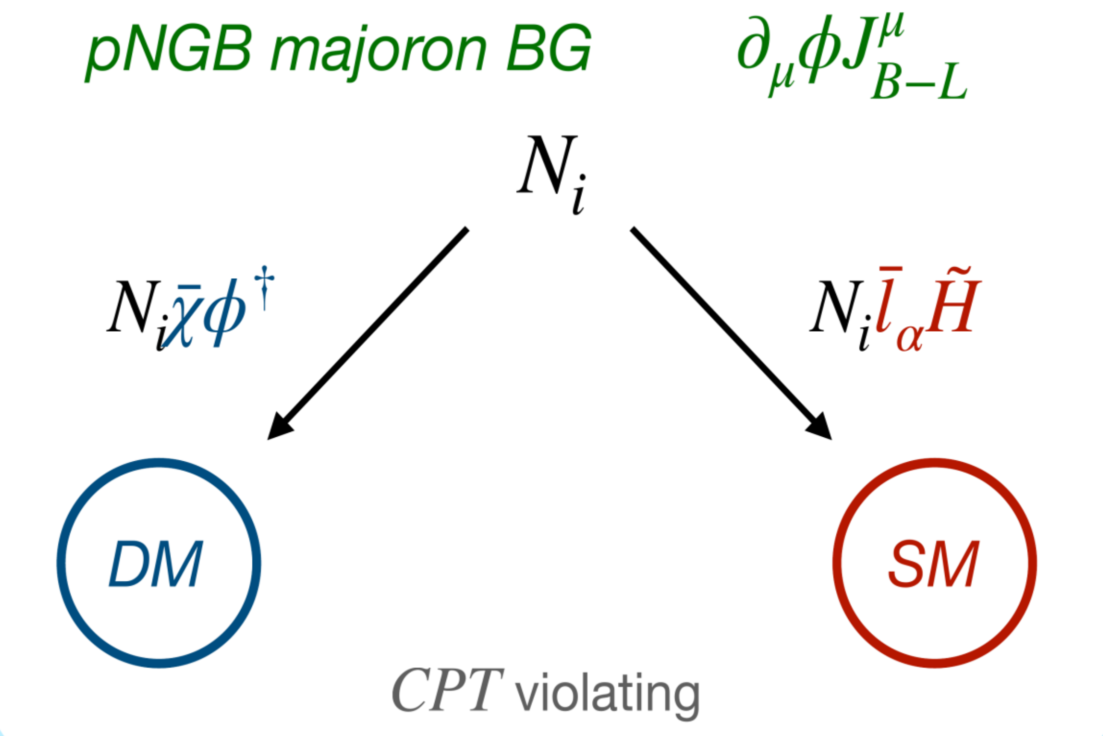


20

Asymmetric Dark Matter from Low-Scale Spontaneous Leptogenesis

Hiroki Takahashi (Univ. of Tokyo)

HT and Juntaro Wada, arXiv:2601.05326



Asymmetric dark matter model in the $\mathrm{U(1)}_{B-L}$ extended see-saw featuring **spontaneous leptogenesis**

- Asymmetry generation
- DM mass prediction
- Phenomenology

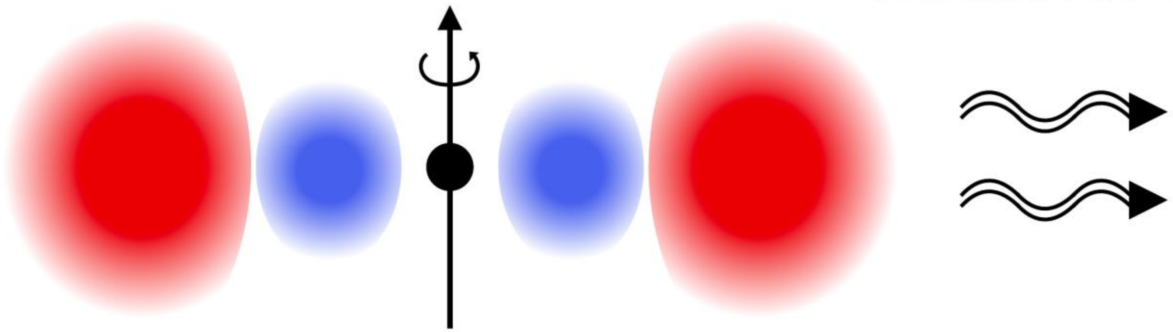
21

Relativistic frequency shifts in gravitational waves from axion clouds

Takuya Takahashi (RESCEU, U of Tokyo) [arXiv:2604.21239]

Axion clouds are naturally formed via black hole superradiance, which extracts rotational energy from the black hole.

Continuous GWs



- Targets for LVK and next generation detectors
- Axion searches: constraints on the mass and self-interaction

Accurate modeling of the GW phase evolution is essential.

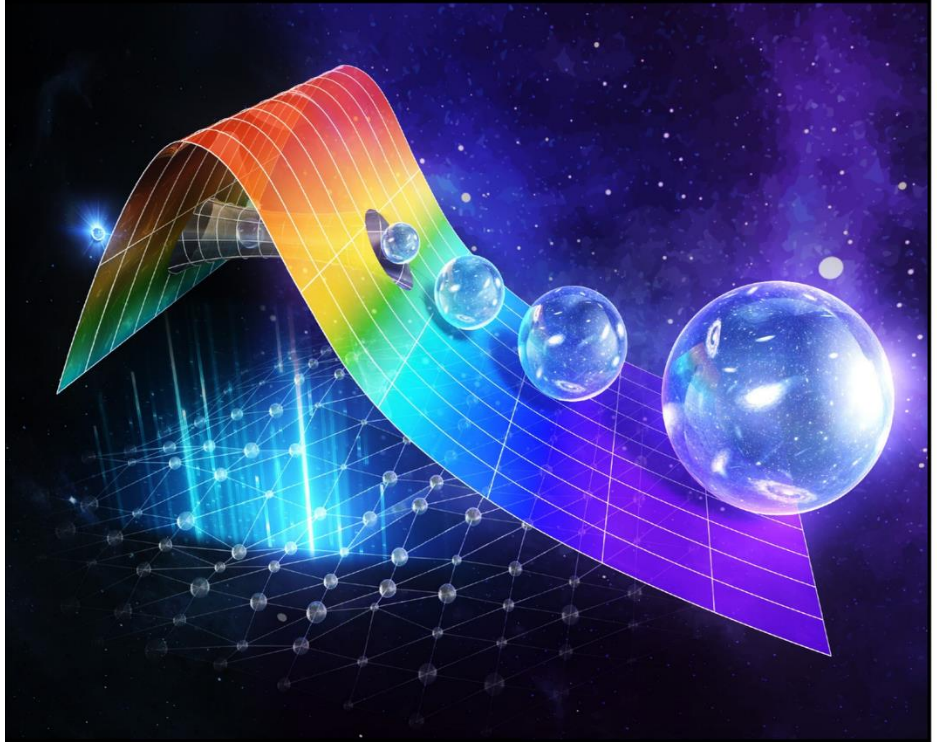
→ Calculation of the frequency shifts

Relativistic perturbation theory

$$\delta\omega_i = \frac{i\langle\langle F_i, \delta H F_i\rangle\rangle}{\langle\langle F_i, F_i\rangle\rangle}$$

The theoretical framework for continuous GW waveform modeling is now in place for data analysis.

Lorentzian Quantum Cosmology in D Dimensions



Honda, Matsui, Numajiri, Okabayashi, and Terada, 26XX.XXXXX [gr-qc].

Initial condition (~wave functional) of the Universe

$$\Psi[h_{ij}(t,x)] = \langle h_{ij}(t,x) | \Psi \rangle$$

$$\sim \int^{h_{ij}} \mathscr{D}h'_{ij} \exp[\pm I] \ ?$$

Tunneling vs No-boundary proposals; Controversial

$$\sim \int^{h_{ij}} \mathscr{D}h'_{ij} \exp[iS] \ ?$$

Lorentzian approach (**Picard-Lefschetz** and **resurgence** theories) *uniquely* fixes the wave function.

4D GR → Tunneling

[Feldbrugge, Lehners, & Turok, 1703.02076]
[Honda, Matsui, Okabayashi, & Terada, 2402.09981]

2D JT → No-boundary

[Honda, Matsui, Numajiri, & Okabayashi, 2412.20398]

We study the dependence on spacetime **dimensions** D.

We find the **tunneling** wave function in D-dim. Einstein Gravity, showing both **universality** and **limitations**.

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Host–Galaxy Identification of Binary Black Hole Mergers with Future Gravitational–Wave Observations

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◆ GW detectors do not take images → Broad sky localization!

- Future GW detector networks may localize some BBH mergers to their host galaxies.
- Forecast the expected rate of host–galaxy identifiable BBH events.

◆ IDEAS WANTED: Physics with well–localized GW events

- BBH population studies with the host–galaxy identified events
- Cross–correlation studies with galaxy catalogs / large–scale structure