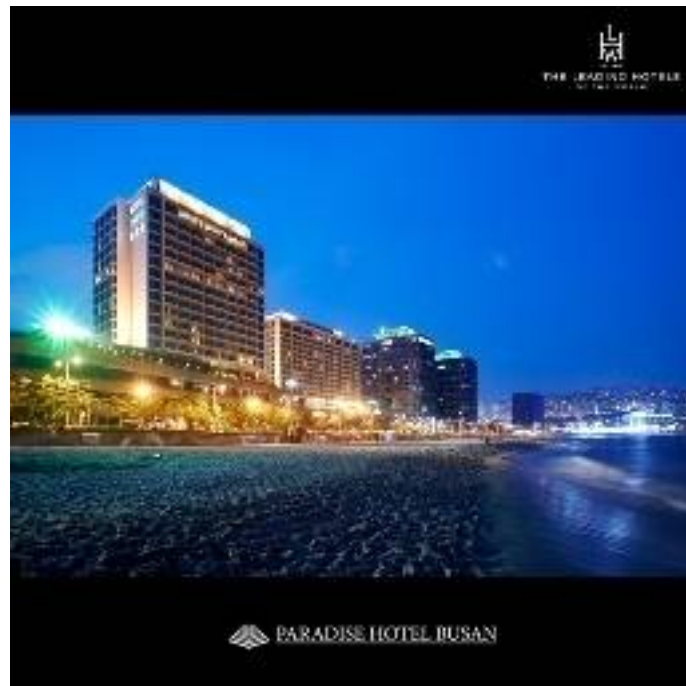


# **PNU-IBS workshop on Axion Physics : Search for axions**



## **Report of Contributions**

Contribution ID: 1

Type: **not specified**

## Coffee Break

*Tuesday 5 December 2023 16:00 (30 minutes)*

Coffee Break

Contribution ID: 2

Type: **not specified**

## **Uncovering the axion and BSM CP violation with electric dipole moments**

*Tuesday 5 December 2023 14:30 (45 minutes)*

**Primary author:** Prof. CHOI, Kiwoon (CTPU-IBS)

**Presenter:** Prof. CHOI, Kiwoon (CTPU-IBS)

**Session Classification:** Afternoon Session 1

Contribution ID: 3

Type: **not specified**

## Spectral distortions of astrophysical blackbodies as axion probes

*Tuesday 5 December 2023 15:15 (45 minutes)*

Recent studies reveal that more than a dozen of white dwarfs displaying near-perfect blackbody spectra in the optical range have been lurking in the Sloan Digital Sky Survey catalog. We point out that, in a way analogous to the cosmic microwave background, these stars serve as excellent test beds for new physics. Specifically, we show how their observed lack of spectral distortions translates into limits on the parameter space of axions with electromagnetic coupling. The prospects for future improvements are also discussed.

**Primary author:** Dr CHANG, Jae Hyeok (Fermi Lab and UIC)

**Presenter:** Dr CHANG, Jae Hyeok (Fermi Lab and UIC)

**Session Classification:** Afternoon Session 1

Contribution ID: 4

Type: **not specified**

## Effective Theory Approach for Axion Wormholes

*Tuesday 5 December 2023 16:30 (45 minutes)*

We employ the effective field theory approach to analyze the characteristics of Euclidean wormholes within axion theories. Using this approach, we obtain non-perturbative instantons in various complex scalar models with and without a non-minimal coupling to gravity, as well as models featuring the  $R^2$  term for a range of coupling values. This yields a series of analytical expressions for the axion wormhole action, shedding light on the model parameters and field dependencies of contributions in both the ultraviolet and infrared domains. Consequently, model-dependent local operators that disrupt axion shift symmetries are generated at lower energy levels. This, in turn, provides crucial insights into the gravitational influences on the axion quality problem.

**Primary author:** Prof. SHIN, Chang Sub (CNU)

**Presenter:** Prof. SHIN, Chang Sub (CNU)

**Session Classification:** Afternoon Session 2

Contribution ID: 5

Type: **not specified**

## Search for axion dark matter in the laboratory and in the cosmos

*Tuesday 5 December 2023 17:15 (45 minutes)*

I would like to present a new experimental proposal, called LACME, to search for axion dark matter in the laboratory. If axions or axion-like particles are the main component of dark matter, they will modify the transport property of electrons and also the atomic spectra, which will give a new way of detecting axions or axion-like particles. Finally I will discuss a topological soliton made of axions and discuss its observational consequences in the cosmos.

**Primary author:** HONG, Deog Ki (Pusan National University (KR))

**Presenter:** HONG, Deog Ki (Pusan National University (KR))

**Session Classification:** Afternoon Session 2

Contribution ID: 6

Type: **not specified**

## **DE source from a new confining force**

*Wednesday 6 December 2023 09:30 (45 minutes)*

**Primary author:** Prof. KIM, Jihn (SNU/KHU)

**Presenter:** Prof. KIM, Jihn (SNU/KHU)

**Session Classification:** Morning Session 1

Contribution ID: 7

Type: **not specified**

## Light Axion Dark Matter Search with Nitrogen-Vacancy Centers in Diamonds

*Wednesday 6 December 2023 10:45 (45 minutes)*

We propose new ideas to directly search for light axion dark matter by using magnetometry with nitrogen-vacancy centers in diamonds. If the axion dark matter couples to the electron spin, it affects the evolution of the Bloch vectors consisting of the spin-triplet states, which may be detected through several magnetometry techniques. We give several concrete examples with the use of dc and ac magnetometry and estimate the sensitivity on dark matter couplings.

**Primary author:** Dr CHIGUSA, So (LBNL/UC Berkeley)

**Presenter:** Dr CHIGUSA, So (LBNL/UC Berkeley)

**Session Classification:** Morning Session 2



Contribution ID: 8

Type: **not specified**

## **Global efforts to search for invisible axions**

*Wednesday 6 December 2023 11:30 (45 minutes)*

**Primary author:** Dr YOUN, SungWoo (CAP-IBS)

**Presenter:** Dr YOUN, SungWoo (CAP-IBS)

**Session Classification:** Morning Session 2

Contribution ID: 9

Type: **not specified**

## **Probing axion coupling to electrons by Chiral Magnetic Effects**

*Wednesday 6 December 2023 15:15 (45 minutes)*

**Primary author:** Dr IM, Sang Hui (CTPU-IBS)

**Presenter:** Dr IM, Sang Hui (CTPU-IBS)

**Session Classification:** Afternoon Session 3

Contribution ID: **10**

Type: **not specified**

**TBA**

*Wednesday 6 December 2023 14:30 (45 minutes)*

**Primary author:** FOSTER, Joshua (MIT)

**Presenter:** FOSTER, Joshua (MIT)

**Session Classification:** Afternoon Session 3

Contribution ID: 11

Type: **not specified**

## CAPP's High Mass Axion Searches and Heterodyne-Base Variance Method

*Wednesday 6 December 2023 16:30 (45 minutes)*

The cavity haloscope is a highly sensitive technique for detecting dark matter axions within the microwave region. The Center for Axion and Precision Physics Research at the Institute for Basic Science (IBS-CAPP) has ingeniously developed cavity designs specifically tailored for high-mass axions, such as multiple-cell cavities, a wheel tuning mechanism, and tunable photonic crystal cavities. Furthermore, we have recently proposed a horn antenna array haloscope optimized for an even higher frequency range, spanning from tens to hundreds of GHz. Additionally, a new detection scheme employing heterodyne interferometry has been proposed to amplify and detect the variance of weak signals when knowing their coherence time. This presentation provides an overview of CAPP's efforts on high-mass dark matter axion searches and introduces the variance method.

**Primary author:** Dr JEONG, Junu (CAP-IBS)

**Presenter:** Dr JEONG, Junu (CAP-IBS)

**Session Classification:** Afternoon Session 4

Contribution ID: 12

Type: **not specified**

## Axionic and Phonon Polaritons for Axion Dark Matter Detection (via Zoom)

*Wednesday 6 December 2023 17:15 (45 minutes)*

Zoom link: <https://pusan.zoom.us/j/86275799785pwd=EK6wqm0UJV8aZDqvvpmaE3UMHXsbVo.1>  
(ID : 862 7579 9785, Code secret: 335557)

In this talk I will describe how one can use collective effects in materials to detect axion dark matter (DM). I will first discuss topological magnetic insulators which can host axion quasiparticles (AQs). The AQs can resonantly mix with DM axions and photons leading to an enhanced DM signal in a photon detector. As a second example I discuss how one can utilize crystal lattice phonon excitations to search for axion DM. The DM signal calculation takes into account boundary effects and material losses. A central element in our calculation plays the effective refractive index, which in principle can be measured with transmission spectroscopy.

**Primary author:** Dr SCHUTTE-ENGEL, Jan (UC Berkeley/Riken)

**Presenter:** Dr SCHUTTE-ENGEL, Jan (UC Berkeley/Riken)

**Session Classification:** Afternoon Session 4

Contribution ID: 13

Type: **not specified**

## Looking in the Axion Mirror (via zoom)

*Thursday 7 December 2023 09:30 (45 minutes)*

<https://pusan.zoom.us/j/85641446219?pwd=KI4Z5tkyAIncbVsVV5npyDjbpqrXtb.1>  
(ID : 856 4144 6219, Code secret: 650333)

In the presence of radiation from bright astrophysical sources at radio frequencies, axion dark matter can undergo stimulated decay to two nearly back-to-back photons, meaning that bright sources could have faint counterimages in other parts of the sky. The counterimages will be spectrally distinct from backgrounds, taking the form of a narrow radio line centered at half the axion mass with a spectral width determined by Doppler broadening in the dark matter halo. In essence, axions behave as an imperfect monochromatic mirror. The morphology of the induced images can be nontrivial, with blurring due to the geometry of the source and image as well as spatial smearing due to the galactic kinematics of axion dark matter. I will show that the axion decay-induced counterimages of galactic sources may be bright enough to be detectable with archival data from CHIME and other ongoing or planned radio surveys. CHIME therefore can run as a competitive axion experiment simultaneously with other science objectives, requiring no new hardware.

**Primary author:** Prof. SCHUTZ, Katelin (McGill U.)

**Presenter:** Prof. SCHUTZ, Katelin (McGill U.)

**Session Classification:** Morning Session 1

Contribution ID: 14

Type: **not specified**

## Polarized Signatures of Axions at Magnetic White Dwarfs

*Thursday 7 December 2023 10:45 (45 minutes)*

I will discuss a novel search for axions using spectropolarimetric observations of magnetic white dwarfs (MWDs). Photons produced as thermal radiation at the MWD surface may convert into an axion as they traverse the magnetosphere, but only the component polarized parallel to the MWD magnetic field. Therefore the MWD radiation at Earth is linearly polarized perpendicular to the magnetic field direction. I overview the analysis of archival linear polarization spectra of a nearby MWD, and then discuss the prospects for discovery in ongoing searches using dedicated data at the Lick and Keck Observatories.

**Primary author:** DESSERT, Chris (Flatiron Institute/NYU)

**Presenter:** DESSERT, Chris (Flatiron Institute/NYU)

**Session Classification:** Morning Session 2

Contribution ID: 15

Type: **not specified**

## Cosmological Solitons

*Thursday 7 December 2023 11:30 (45 minutes)*

The study of localised stable solitons in 3+1 dimensional field theory often hinges on a loophole to Derrick's theorem that states that stable localised solutions may exist if they are periodic in time, such as in the case of a time dependent complex phase. The possible presence and influence of such dynamic solitons may have important consequences for the evolution of the early universe in structure formation or in the present universe as dark matter candidates. This talk will discuss a number of examples in soliton theory. Firstly, on large Q-balls and the simulation of their collisions including gravitational effects and secondly, on possible solitons in axion electrodynamics in the presence of a time dependent axion field.

**Primary author:** Dr LONSDALE, Stephen (PNU)

**Presenter:** Dr LONSDALE, Stephen (PNU)

**Session Classification:** Morning Session 2



Contribution ID: **16**

Type: **not specified**

**TBA**

*Thursday 7 December 2023 14:30 (45 minutes)*

**Primary author:** Prof. SON, Minho (KAIST)

**Presenter:** Prof. SON, Minho (KAIST)

**Session Classification:** Afternoon Session 3

Contribution ID: 17

Type: **not specified**

**TBA**

*Thursday 7 December 2023 15:15 (45 minutes)*

**Primary author:** Dr YUN, Seokhoon (CTPU-IBS)

**Presenter:** Dr YUN, Seokhoon (CTPU-IBS)

**Session Classification:** Afternoon Session 3

Contribution ID: **18**

Type: **not specified**

## **Probing cosmic sterile neutrino background with beta decay experiment**

*Thursday 7 December 2023 16:30 (45 minutes)*

**Primary author:** Prof. CHOI, Ki-Young (SKKU)

**Presenter:** Prof. CHOI, Ki-Young (SKKU)

**Session Classification:** Afternoon Session 4

Contribution ID: 19

Type: **not specified**

## **Selected highlights in axion cosmology (via zoom)**

*Thursday 7 December 2023 17:15 (45 minutes)*

<https://pusan.zoom.us/j/86061341145?pwd=ofYF9LIMw9rfV54TCC9sbsr3Nle22M.1>  
(ID : 860 6134 1145, Code secret: 615519)

**Primary author:** SERVANT, Geraldine (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** SERVANT, Geraldine (Deutsches Elektronen-Synchrotron (DE))

**Session Classification:** Afternoon Session 4

Contribution ID: 20

Type: **not specified**

## **Cosmological Implications of Axion Rotations (via zoom)**

*Friday 8 December 2023 09:30 (45 minutes)*

<https://pusan.zoom.us/j/88351724378?pwd=p0mnAOQCvPQHYNHm0K3qpiIzs1kyJH.1>  
(ID : 883 5172 4378, Code secret: 744378)

**Primary author:** Prof. CO, Raymond (Indiana U.)

**Presenter:** Prof. CO, Raymond (Indiana U.)

**Session Classification:** Morning Session 1

Contribution ID: 21

Type: **not specified**

## Glimmers from the Axiverse

*Friday 8 December 2023 10:45 (45 minutes)*

We study axion-photon couplings in compactifications of type IIB string theory. We find that these couplings are systematically suppressed compared to the inverse axion periodicity, as a result of two effects. First, couplings to the QED theta angle are suppressed for axion mass eigenstates that are light compared to the mass scale set by stringy instantons on the cycle supporting QED. Second, in compactifications with many axions the intersection matrix is sparse, making kinetic mixing weak. We study the resulting phenomenology in an ensemble of explicit models constructed from the Kreuzer-Skarke database up to the maximum number of axions, 491. We also explore the general features of this axiverse and give a simple geometric model for some of its properties.

**Primary author:** Dr GENDLER, Naomi (Harvard)

**Presenter:** Dr GENDLER, Naomi (Harvard)

**Session Classification:** Morning Session 2

Contribution ID: 22

Type: **not specified**

# Axion Domain Walls, Small Instantons, and Non-Invertible Symmetry Breaking

*Friday 8 December 2023 11:30 (45 minutes)*

Non-invertible global symmetry often predicts degeneracy in axion potentials and carries important information about the global form of the gauge group. When these symmetries are spontaneously broken they can lead to the formation of stable axion domain wall networks which support topological degrees of freedom on their worldvolume. Such non-invertible symmetries can be broken by embedding into appropriate larger UV gauge groups where small instanton contributions lift the vacuum degeneracy, and provide a possible solution to the domain wall problem. We explain these ideas in simple illustrative examples and then apply them to the Standard Model, whose gauge algebra and matter content are consistent with several possible global structures. Each possible global structure leads to different selection rules on the axion couplings, and various UV completions of the Standard Model lead to more specific relations. As a proof of principle, we also present an example of a UV embedding of the Standard Model which can solve the axion domain wall problem.

**Primary author:** Prof. HONG, Sungwoo (KAIST)

**Presenter:** Prof. HONG, Sungwoo (KAIST)

**Session Classification:** Morning Session 2

Contribution ID: 23

Type: **not specified**

# Peccei-Quinn Inflation at the Pole and Axion Kinetic Misalignment

*Friday 8 December 2023 14:30 (45 minutes)*

We propose a minimal extension of the Standard Model with the Peccei-Quinn (PQ) scalar field and explain the relic density of the QCD axion through the kinetic misalignment with a relatively small axion decay constant. To this purpose, we consider a slow-roll inflation from the radial component of the PQ field with the PQ conserving potential near the pole of its kinetic term and investigate the post-inflationary dynamics of the PQ field for reheating. The angular mode of the PQ field, identified with the QCD axion, receives a nonzero velocity during inflation due to the PQ violating potential, evolving with an approximately conserved Noether PQ charge. We determine the reheating temperature from the perturbative decays and scattering processes of the inflaton and obtain dark radiation from the axions produced from the inflaton scattering at a testable level in the future Cosmic Microwave Background experiments. We show the correlation between the reheating temperature, the initial velocity of the axion and the axion decay constant, realizing the axion kinetic misalignment for the correct relic density.

Ref. <https://arxiv.org/abs/2310.17710>**Primary author:** LEE, Hyun Min (CAU - Chung-Ang University (KR))**Presenter:** LEE, Hyun Min (CAU - Chung-Ang University (KR))**Session Classification:** Afternoon Session 3



Contribution ID: 24

Type: **not specified**

## Addressing the Strong CP problem in Composite Higgs/ RS model

*Friday 8 December 2023 15:15 (45 minutes)*

**Primary author:** LEE, Seung J. (Korea University)

**Presenter:** LEE, Seung J. (Korea University)

**Session Classification:** Afternoon Session 3

Contribution ID: 25

Type: **not specified**

## Studies of missing-energy final states from Belle II, including $B \rightarrow K \nu \bar{\nu}$

*Friday 8 December 2023 16:30 (45 minutes)*

With the Belle II and Belle experiments, we have a cleanly defined  $e^+e^-$  initial state and a nearly hermetic detector of almost  $4\pi$  solid-angle coverage. This is a great advantage for studying final states that include missing particles where we use the information from missing energy and momentum. In this talk, we show some of the recent results from Belle II involving missing-energy final states. In particular, we present the updated  $B \rightarrow K \nu \bar{\nu}$  result which was first presented in August, 2023 (arXiv:2311.14647).

**Primary author:** Prof. KWON, Youngjoon (Yonsei University)

**Presenter:** Prof. KWON, Youngjoon (Yonsei University)

**Session Classification:** Afternoon Session 4

Contribution ID: 26

Type: **not specified**

## Hunting ALP-like particle through Higgs boson exotic decays at the LHC

*Friday 8 December 2023 17:15 (45 minutes)*

**Primary author:** Prof. PARK, Myeonghun (Seoultech)

**Presenter:** Prof. PARK, Myeonghun (Seoultech)

**Session Classification:** Afternoon Session 4