# Axions, Weyl and Beyond


# Report of Contributions

https://indico.cern.ch/e/axion_weyl_beyond

Contribution ID: **1** Type: **not specified**

# Recent progress in Weyl and topological semimetals

*Thursday 31 August 2023 14:00 (45 minutes)*

Wey semimetal is an interesting class of topological materials that harbors chiral fermions as the low energy excitations. In this talk, I will give a comprehensive review of the Weyl semimetallic phase. Starting from exotic transport and experimental phenomena of such matter, I will discuss the dimensional hierarchy and the relation with the topological insulator phase in higher-dimensions. Finally, I will introduce the recent progress in the fields of topological semimetals that attempt to generalize the concept of Weyl fermions.

**Presenter:** Prof. PARK, Moon Jip (Hanyang University)

Contribution ID: **2** Type: **not specified**

# A Review of Axion Physics

*Thursday 31 August 2023 14:45 (45 minutes)*

Axion is one of the most compelling candidate particles for new physics beyond the Standard model. It is ubiquitous in a variety of well-motivated new physics scenarios and can address conundrums in the Standard Model, e.g., the strong CP problem. Indeed, research on axions is actively ongoing worldwide. In this talk, I will briefly overview axion physics and the current status of phenomenological research on axions. If I have enough time, I will introduce my recent work on 'Axion magnetic resonance'.

**Primary author:** Dr YUN, Seokhoon (University of Padova)

**Presenter:** Dr YUN, Seokhoon (University of Padova)

Contribution ID: **3** Type: **not specified**

# Exploring the nontrivial topology of topological metals using electrical and thermal transport

*Thursday 31 August 2023 16:00 (45 minutes)*

Experimental techniques to reveal the topology of materials and related properties are limited. Angle-resolved photoemission spectroscopy (ARPES) is a direct way to probe the band structure, but it cannot detect novel transport phenomena in a topological material. Electrical and thermal characterization techniques are therefore useful and necessary. In this talk, I will review experimental characterization methods based on electrical and thermal transports, and present some examples to show how these techniques reveal the nontrivial topological properties of materials. I will specifically emphasize the use of AC transport techniques, which can be used to investigate both the equilibrium properties of a system and the nonequilibrium steady state driven by AC perturbations. The discussions in this talk will demonstrate the power and usefulness of electrical and thermal transport measurements in revealing the topology of materials.

**Presenter:** Prof. KIM, Heon-Jung (Daegu University)

Contribution ID: **4** Type: **not specified**

# Review on Axion search experiment

*Thursday 31 August 2023 17:00 (45 minutes)*

The axion is a hypothetical particle motivated from the Peccei-Quinn solution to the strong CP problem. Light axions, particularly those with masses below meV, exhibit feeble interactions with the standard model particles, rendering them compelling candidates for cold dark matter. Despite their flimsy interactions, numerous innovative methodologies have been proposed and implemented to directly detect their existence. In this presentation, we examine the physics of axions and introduce a range of proposed experimental approaches for dark matter axion searches.

**Presenter:** Dr JEONG, Junu (CAPP, IBS)

Contribution ID: **5** Type: **not specified**

# Detecting axion dark matter with chiral magnetic effects

*Thursday 31 August 2023 20:00 (45 minutes)*

We show that dark matter axions or axion-like particles (ALP) induce spontaneously alternating electric currents in conductors along the external magnetic fields due to the (medium) axial anomaly, realizing the chiral magnetic effects. We propose a new experiment to measure this current to detect the dark matter axions or ALP. These induced currents are the electron medium effects, directly proportional to the axion or ALP coupling to electrons, which depends on their microscopic physics, and also suppressed by the Fermi velocity.

**Presenter:** Dr IHM, Sang Hui (CTPU, IBS)

Contribution ID: **6** Type: **not specified**

# Brain Storming Discussions

*Thursday 31 August 2023 21:00 (1 hour)*

Discussions on axions and Weyl metal

**Co-authors:** HONG, Deog Ki (Pusan National University (KR)); Prof. KIM, Ki-Seok (POSTECH)

**Presenters:** HONG, Deog Ki (Pusan National University (KR)); Prof. KIM, Ki-Seok (POSTECH)

Contribution ID: **7** Type: **not specified**

# Topological Fermi-liquid theory: Dynamics of collective modes and their instabilities in Weyl metals (Role of emergent axions in interacting Weyl metals)

*Friday 1 September 2023 09:00 (45 minutes)*

1. Introduction of topological classification of electronic band structure based on historical perspectives: Paper reviews 2.Emergent axions in ferromagnetic Weyl metals, antiferromagnetic topological insulators, and superconducting Weyl metals: From microscopic lattice models to effective field theories with symmetry breaking ⊠ Novel non-equilibrium phase transitions
2. Introduction of Berry curvature into Landau's Fermi-liquid theory = Topological Fermi-liquid theory (Haldane): Dynamics of l=1 & l=2 collective modes and their instabilities in interacting Weyl metals
3. Role of effective axion dynamics in potential instabilities of topological Fermi liquid theory: Generalization of composite Fermion theory in two spatial dimensions (From EM CS + gravitational CS + Wen-Zee CS to EM theta + gravitational theta + mixed anomaly theta terms)

**Presenter:** Prof. KIM, Ki-Seok (POSTECH)

Contribution ID: **8** Type: **not specified**

# Generalized Global Symmetries of Axion

*Friday 1 September 2023 11:00 (45 minutes)*

In this talk, I will describe various generalized global symmetries of axion-Maxwell theory.
This includes 0-, 1-, and 2-form symmetries, non-invertible symmetries and 3-group symmetry.
If time permits, I will briefly mention how the symmetry structure changes for axion-YM and axion-QCD theory.

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

Contribution ID: **9** Type: **not specified**

# A Short Review of Time-Resolved and Angle-Resolved PES Studies on a few Weyl Systems

*Friday 1 September 2023 09:45 (45 minutes)*

In this short review presentation, I would like to talk about the basic concept of time-resolved photoemission and angle-resolved photoemission spectroscopy as the fittest observation tool for Dirac/Weyl systems, and present a few prototypical successful examples in chronological order to observe Dirac/Weyl quasi-particles in condensed matter systems via TR-/ARPES, expecting vivid discussion for the future research direction.

**Presenter:** Prof. NOH, Han-Jin (Chonnam National University)

Contribution ID: **10** Type: **not specified**

# Weyl Fermion in holography and the fate of the topology under the presence of the strong interaction.

*Friday 1 September 2023 14:00 (45 minutes)*

We examine how to realize the Weyl Fermion in holography, which describe a strongly interacting system. We then study whether the topology of the Weyl Fermion realized in holographic set up to answer the question whether it remains in the presence of the interaction. Finally, we try to understand the topology as a consequence of the symmetry breaking.

**Co-author:** Prof. SIN, Sang-Jin (Hanyang University)

**Presenter:** Prof. SIN, Sang-Jin (Hanyang University)

Contribution ID: **11** Type: **not specified**

# Axions and atomic spectra

*Friday 1 September 2023 14:45 (45 minutes)*

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

Contribution ID: **12** Type: **not specified**

# Brain storming discussions

*Friday 1 September 2023 16:00 (1 hour)*

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

Contribution ID: **13** Type: **not specified**

# Brain Storming discussions

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