2026 Spring Postdoc Mini-Symposium

Report of Contributions

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

Probing axion-like particles via laser-plasma wakefields and coherent photon regeneration

Tuesday, 12 May 2026 15:55 (15 minutes)

We propose a novel Light-Shining-Through-a-Wall (LSW) scheme that utilizes the ultra-strong electromagnetic fields of laser-driven plasma wakefields for highly efficient, in situ axion generation. Moreover, by injecting a coherent seed field into the regeneration region, the axion-induced photon signal is coherently amplified via constructive interference, offering a pathway to probe axion-photon couplings at the $g_{a\gamma\gamma} \sim 10^{-12}\text{GeV}^{-1}$ level without requiring resonant cavities.

Primary author: AN, Xiangyan (Tsung-Dao Lee Institute, Shanghai Jiao Tong University, China)

Co-authors: LIU, Jianglai (Shanghai Jiao Tong University); CHEN, Min (Shanghai Jiao Tong University)

Presenter: AN, Xiangyan (Tsung-Dao Lee Institute, Shanghai Jiao Tong University, China)

Session Classification: DM+Axion+early universe

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

Deep-learning boosted hadronic Higgs precise measurements at future e+e− Higgs factories

Tuesday, 12 May 2026 13:35 (15 minutes)

Precise measurements of Higgs decays into quarks and gluons are essential
for probing the Yukawa couplings of the Higgs boson and testing the flavor structure of the Standard Model. We investigate the process e+e− ⟶ ZH at √s = 240 GeV at a future e+e− Higgs factory, taking the CEPC design as a benchmark. Jet flavor is identified using state-of-the-art particle-level deep neural network taggers, whose per-jet outputs are combined with global event observables in a two-stage analysis to separate the Higgs hadronic decay modes from the backgrounds. Assuming an integrated luminosity of 20 ab−1, we present a quantitative sensitivity estimation corresponding to a statistical significance of about 1.3σ for H ⟶ s¯s. These results highlight the potential of deep-learning-based jet flavor tagging for precision studies of Higgs decays at future e+e− Higgs factories.

Primary author: ZHU, Yifan

Presenter: ZHU, Yifan

Session Classification: Session 1: Collider+DM+Neutrino

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

Confinement and Chiral Phase Transitions: The Role of Polyakov Loop Kinetics Terms

Tuesday, 12 May 2026 16:40 (15 minutes)

We studied a crucial but often oversimplified ingredient in predicting gravitational-wave signals from QCD-type phase transitions: the kinetic term of the Polyakov loop. For the first time, we derive this term from first principles in finite-temperature pure SU(3) Yang-Mills theory, incorporating a field-dependent renormalization factor—a calculation we also extend to theories with more colors. Employing this derived kinetic term alongside three commonly-used effective potentials (the Haar-measure, polynomial, and quasi-particle models), we demonstrate that it substantially modifies the predicted GW energy spectrum from confinement transitions by 1-2 orders of magnitude. Based on this, we provide the first complete analysis of the chiral transition within the Polyakov–Nambu–Jona-Lasinio (PNJL) framework, described by the quark condensate. Our results reveal a clear dichotomy: while the Polyakov-loop kinetic term critically shapes GWs from confinement transitions, it has a negligible impact on the dynamics of the chiral transition, which is dominated by fermion condensation effects.

Primary author: Dr ZHU, Jiang (TDLi institution)

Presenter: Dr ZHU, Jiang (TDLi institution)

Session Classification: DM+Axion+early universe

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

Abelian-Higgs vortices in the oscillating axion background

Tuesday, 12 May 2026 15:40 (15 minutes)

Axion is one of the well-motivated candidates for dark matter and there have been many attempts for axion dark matter search. In this talk, we show novel aspects of the axion dark matter, which significantly modify the physics of vortex in the Abelian-Higgs model. Due to the axion-photon conversion, electromagnetic fields are induced in the magnetic core of the vortex. In numerical simulations, we find that the induced electromagnetic field is confined and resonantly enhanced in the vortex, which implies that the vortex acts as a cylindrical cavity. We also focus on the interaction of two vortices in the oscillating axion background, resulting in attractive or repulsive forces, even in the case with the BPS limit. These new features open up a new possibility for the axion dark matter search using superconducting devices.

Primary author: NAKAGAWA, Shota (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Presenter: NAKAGAWA, Shota (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Session Classification: DM+Axion+early universe

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

Dark Matter Inelastic Scattering with Nuclei

Tuesday, 12 May 2026 15:25 (15 minutes)

The talk is devoted to the role of excited final nuclear states in WIMP-nucleus scattering. I will describe the basic formalism of non-relativistic effective field theory (NR EFT) and its generalization for excited nuclear states. The effect on expected event rates in direct detection experiments will be discussed, with the focus on xenon-based detectors.

Primary author: Dr TITOV, Oleg (TDLI-SJTU)

Presenter: Dr TITOV, Oleg (TDLI-SJTU)

Session Classification: DM+Axion+early universe

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

Addressing the Inverse Problem: Spin Identification of Exotic Charged Particles at Future e^+e^- Collider

Tuesday, 12 May 2026 13:50 (15 minutes)

Despite its remarkable success, the Standard Model fails to explain phenomena such as neutrino masses, dark matter, and the matter–antimatter asymmetry, motivating a wide range of Beyond the Standard Model (BSM) scenarios. A major challenge in this context is the inverse problem, where different models produce overlapping signatures; hence, identifying the underlying BSM scenario becomes difficult.

In this talk, I address this issue by investigating how the spin of exotic charged particles, and the dark matter candidates, can be determined at future colliders. Focusing on models with a stable neutral particle (C^0) and charged partners ($C^\pm$) decaying via a $W^\pm$ boson, we study the process $e^+e^- \to C^+C^- \to C^0C^0W^+W^-$, considering the Inert Doublet Model and the Minimal Supersymmetric Standard Model as representative examples of scalar and fermionic charged states, respectively. Using beam polarization at a future e^+e^- collider, we demonstrate that the distributions of angular variables of the visible final-state particles provide an effective way to determine the spin of these exotic particles.

Primary author: BARIK, Anjan (TDLI)

Presenter: BARIK, Anjan (TDLI)

Session Classification: Session 1: Collider+DM+Neutrino

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

Dynamics and Emissions of Accreting Axion Clouds

Tuesday, 12 May 2026 16:10 (15 minutes)

Ultralight axion fields can form gravitational atoms around compact objects, in which self-interactions drive the relaxation of axion waves into bound states that grow exponentially. Once the field amplitude approaches the axion decay constant, nonlinear dynamics become essential. We identify two distinct regimes of late-time evolution, determined by the gravitational fine-structure constant and the cloud growth rate: a Bosenova regime, characterized by collapse accompanied by explosive axion bursts, and a weak-saturation regime, in which the outward axion flux induced by self-interactions balances the relaxation pump. In the saturation regime, the resulting axion radiation exhibits discrete spectral lines at odd multiples of the bound-state energy, directly reflecting the structure of the axion self-interaction potential. We show that axions with a pure cosine potential and those with a QCD axion-like potential predict distinct emission spectra, enabling terrestrial detection of the axion flux to discriminate between ultraviolet axion models.

Primary authors: LI (李), Ximeng (西蒙) (Institute of High Energy Physics); CHEN, Yifan (TDLI)

Co-author: ZHONG, Zhen

Presenter: LI (李), Ximeng (西蒙) (Institute of High Energy Physics)

Session Classification: DM+Axion+early universe

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

Towards Precision Measurements of boldsymbolH$_0$ with Multi-band Gravitational Waves

Tuesday, 12 May 2026 16:25 (15 minutes)

In this talk, I will explore the potential of multi-band gravitational wave (GW) observations to constrain uncertainties in the Hubble parameter (H_0), using primordial black holes (PBHs) as astrophysical sources. I will present a framework that combines scalar-induced and merger-induced GW signals and discuss forecasts for joint observations with the Square Kilometre Array (SKA) and the Einstein Telescope (ET), enabling a multi-band analysis. I will then show how statistical forecasts of PBH parameters, $M_{\rm PBH}$ and $f_{\rm PBH}$, based on signal-to-noise ratio (SNR) and Fisher matrix techniques, allow us to identify the accessible parameter space and propagate uncertainties to H_0. For $\delta\theta_i/\theta_i \leq 0.1$, with $\theta_i \equiv M_{\rm PBH}(f_{\rm PBH})$, we obtain $\delta H_0 \leq 2\ {\rm km, s^{-1}, Mpc^{-1}}$, improving to $\delta H_0 \leq \mathcal{O}(0.1)\ {\rm km, s^{-1}, Mpc^{-1}}$ for $\delta\theta_i/\theta_i \leq 0.01$. Finally, I will highlight that these results are largely insensitive to the fiducial value of H_0, with only moderate dependence on the PBH collapse efficiency, demonstrating that multi-band GW observations provide a complementary, cosmic distance ladder-independent probe of the Hubble parameter.

Reference: e-Print: 2604.22731

Primary author: HAQUE, Md Riajul (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Presenter: HAQUE, Md Riajul (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Session Classification: DM+Axion+early universe

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

[PhD results] Implementation of the Matrix Element Method at NLO for the measurement of the Higgs self coupling

Tuesday, 12 May 2026 14:05 (15 minutes)

Following the discovery of the Higgs boson, one of the next major achievement at LHC is to observe the production of Higgs pairs and to measure the Higgs tri-linear coupling λ_{3H}.

Due to the rarity of di-Higgs production, measuring λ_{3H} has proven to be highly challenging.
The MEM is a statistically optimal multivariate method that maximizes the utilization of both the experimental and theoretical information available to an analysis. Most MEM studies have been limited to leading-order (LO) accuracy, with extensions to next-to-leading-order (NLO) explored only in specific cases due to the additional complexities introduced by virtual and real contributions.
To contribute to the measurement of λ_{3H} from LHC data in the $gg \to HH \to b\bar{b}\gamma\gamma$ channel, we developed a MEM framework during my PhD by working on a new NLO implementation.

If time allows, I will also link my PhD work to the one I aim to develop during my Post-doc position at TDLI (3 ATLAS analysis, and phenomenology of the Higgs boson).

Primary author: TARTARIN, Matthias (TDLI/SJTU)

Presenter: TARTARIN, Matthias (TDLI/SJTU)

Session Classification: Session 1: Collider+DM+Neutrino

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

Ionization-only analysis for low energy signals in PandaX-4T

Tuesday, 12 May 2026 14:35 (15 minutes)

In the PandaX-4T experiment, the nuclear recoil energy threshold is above 1keV in the conventional search window requiring paired scintillation and ionization signals. This constrains detection sensitivity for low energy signals, such as solar B8 neutrinos and sub-GeV dark matter. By exploiting ionization-only events, we successfully reduce the detection threshold down to 0.33 keV, enabling enhanced sensitivity for low-energy signal detection. Within this low-energy window, two types of instrumental backgrounds are dominate and constitute the primary obstacle for ionization-only analysis. Based on 259 days of data from PandaX-4T, we establish accurate modeling and effective suppression strategies for the two background components. With this optimized low-energy analysis framework, PandaX-4T has achieved breakthrough in searching for solar B8 neutrinos and light dark matter.

Primary author: ZHANG, Minzhen (SJTU)

Presenter: ZHANG, Minzhen (SJTU)

Session Classification: Session 1: Collider+DM+Neutrino

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

Detector R&D of Cold Liquid Scintillator Veto for the PandaX-xT Experiment

Tuesday, 12 May 2026 14:20 (15 minutes)

The PandaX-xT experiment is a next-generation multi-tonne liquid xenon time projection chamber (TPC) located at the China Jinping Underground Laboratory, designed for ultra-sensitive direct detection of dark matter. As the experiment approaches the neutrino floor, background rejection becomes a critical limiting factor for discovery sensitivity. In particular, cosmogenic neutrons, secondary neutrons, and external gamma radiation remain significant residual backgrounds that are challenging to suppress using passive shielding and fiducialization alone, thereby motivating the development of a high efficiency active veto system. A Cold Liquid Scintillator (CLS) active veto offers an attractive solution, with the additional benefit of reducing thermal gradients and potentially enabling a thinner liquid xenon cryostat.

We have initiated a dedicated detector R&D program based on a 1-liter CLS prototype operated at temperatures below -100 ℃, for the PandaX-xT experiment. The CLS concept combines high scintillation yield, fast decay time, favorable emission spectrum, quenching behavior, viscosity and adequate optical transparency under cryogenic conditions. These properties enable efficient detection and tagging of backgrounds before they reach the xenon target. The detector is instrumented with silicon photomultipliers (SiPMs) coupled to wavelength-shifting (WLS) optical fibers, providing high photon-collection efficiency, low-noise operation, and excellent timing resolution for precise event-by-event correlation with the xenon target.

The primary objective is a systematic characterization of detector performance as a function of temperature, with particular emphasis on charge response, photoelectron yield, energy resolution, and intrinsic noise. Specifically, we investigate the temperature dependence of scintillation light yield. We also study photon transport and attenuation in wavelength-shifting fibers, SiPM gain stability and breakdown voltage, and dark count rate suppression. In addition, we characterize correlated noise processes, including afterpulsing and optical crosstalk, under cryogenic conditions.

Complementary Geant4-based Monte Carlo simulations are employed to model scintillation photon production, optical transport, optimized WLS fiber geometries, and the full detector response within the PandaX-xT detector geometry. These simulations further quantify the rejection power against dominant background sources and guide the optimization of the CLS veto design for next-generation rare-event searches.

Primary author: DEY, Roni (TDLI,SJTU)

Presenter: DEY, Roni (TDLI,SJTU)

Session Classification: Session 1: Collider+DM+Neutrino

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

Design and Upgrade of the JUNO DAQ Readout System

Tuesday, 12 May 2026 14:50 (15 minutes)

The Jiangmen Underground Neutrino Observatory (JUNO) aims to determine the neutrino mass ordering and precisely measure neutrino oscillation parameters. Its Data Acquisition (DAQ) system is required to read out, assemble, process online, and store over 40 GB/s of physical data from the front-end electronics. As the first stage of the dataflow software, the readout module's primary tasks include network readout of raw data, data checking, packetization, and first-level assembly.

To simultaneously accommodate triggered and triggerless data assembly, the readout module adopts a preprocessing scheme based on data timestamps, which segments different data types into fixed-duration time fragments. This allows data from the same time fragment to be assembled into full-channel time fragment data for online processing. However, in real-world environments, the fixed-duration time fragment strategy may result in some time fragments containing an excessive number of events, leading to processing timeouts or even memory overflow. To address this issue, a time fragment management(TFM) module capable of global dynamic time fragmentation decisions has been added. Furthermore, a new two-stage processing architecture based on an event bus has been designed and implemented for the readout module. In the new design, the front-end processing stage extracts timing information and sends it to the time fragment management module for centralized dynamic length determination, while the back-end processing stage performs fragmentation and first-level assembly based on the decisions received. Additionally, to handle anomalous channels and further improve software high availability, a channel management module has also been introduced, providing consistent internal and external interfaces for adding and deleting channels, thereby enabling dynamic removal and recovery of faulty channels.

The readout module under the new architecture has been released and deployed for physics data taking at the JUNO site. Compared to the previous version, its dynamic time fragmentation strategy brings significantly higher stability to the system.

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Presenter: CHEN, chao (TDLI)

Session Classification: Session 1: Collider+DM+Neutrino