

2025 CAU-IBS Beyond the Standard Model Workshop



Report of Contributions

Contribution ID: 1

Type: **not specified**

Astrophysical Probes of Dark Matter

Monday 17 February 2025 09:30 (1 hour)

Presenter: YU, Hai-Bo (University of California Riverside)

Session Classification: DM

Contribution ID: 2

Type: **not specified**

Connecting the baryons to the dark matter of the Universe

Monday 17 February 2025 11:00 (40 minutes)

Presenter: IBARRA, Alejandro (Technical University of Munich)

Session Classification: DM

Contribution ID: 3

Type: **not specified**

Status of Boosted Dark Matter

Monday 17 February 2025 11:40 (40 minutes)

Presenter: Prof. PARK, Jong-Chul (Chungnam National University (KR))

Session Classification: DM

Contribution ID: 4

Type: **not specified**

Recent research results of Center for Underground Physics

Monday 17 February 2025 14:00 (40 minutes)

Presenter: Prof. KIM, Yeongduk (Institute for Basic Science (IBS), South Korea)

Session Classification: Neutrino

Contribution ID: 5

Type: **not specified**

Searching for Neutrinoless double beta decay with PandaX

Monday 17 February 2025 14:40 (40 minutes)

Presenter: Prof. HAN, Ke (Shanghai Jiao Tong University)

Session Classification: Neutrino

Contribution ID: 6

Type: **not specified**

Phenomenology of Dirac neutrino EFT

Monday 17 February 2025 15:50 (40 minutes)

Presenter: CHUN, Eung Jin (Korea Institute for Advanced Study)

Session Classification: Neutrino & DM

Contribution ID: 7

Type: **not specified**

Reactor antineutrinos through the neutrino inelastic scattering of ^{13}C

Monday 17 February 2025 16:30 (30 minutes)

Presenter: Prof. SHIN, Seodong (Jeonbuk National University)

Session Classification: Neutrino & DM

Contribution ID: 8

Type: **not specified**

New physics decaying into metastable particles: impact on cosmic neutrinos

Monday 17 February 2025 17:00 (20 minutes)

Presenter: Dr AKITA, Kensuke (Institute for Basic Science, Center for Theoretical Physics of the Universe)

Session Classification: Neutrino & DM

Contribution ID: 9

Type: **not specified**

Indirect dark matter searches with the CTAO telescope

Friday 21 February 2025 16:20 (20 minutes)

The dark matter problem is one of the most elusive problems of modern physics and several extensions of the Standard Model have been proposed to address this puzzle. One of the relevant hypotheses is known as “Weakly Interacting Massive Particles”: massive particles in the GeV-TeV scale with a weak coupling to the SM sector. One of the detection approaches for WIMPs is the indirect detection method: DM particles may self-annihilate in astrophysical objects and produce an excess in the fluxes of SM particles, which can propagate and reach observatories on Earth. Gamma rays are particularly interesting among these messengers because they do not suffer propagation effects. One of the most important future gamma-ray telescopes is the Cherenkov Telescope Array Observatory (CTAO). The CTAO will increase the sensitivity of the current experiments by one order of magnitude and probe masses for thermal DM in the (0.1 - 10) TeV range, being a fundamental test for the WIMP paradigm in the future. In this talk, I will present the most important characteristics and strategies of DM indirect searches with the CTAO and the expected limits for some specific BSM theories.

Presenter: RADICCE JUSTINO, Lucca**Session Classification:** DM

Contribution ID: **10**

Type: **not specified**

Generalized Symmetries in Particle Physics

Tuesday 18 February 2025 09:30 (1 hour)

Presenter: CRAIG, Nathaniel (UCSB)

Session Classification: Higgs & DM

Contribution ID: **11**

Type: **not specified**

Gravitational Wave with Domain Wall Dominance

Tuesday 18 February 2025 11:00 (40 minutes)

Presenter: Prof. HONG, Sungwoo (KAIST)

Session Classification: Axion

Contribution ID: 12

Type: **not specified**

Pseudo NG bosons from finite modular symmetry

Tuesday 18 February 2025 11:40 (30 minutes)

Pseudo Nambu-Goldstone (pNG) bosons can play important roles in particle physics, such as being a light dark matter (DM), the QCD axion to solve the strong CP problem, and so on. I point out that such a pNG boson is naturally realized by the finite modular symmetry, which may originate from the geometry of extra dimensions in the superstring models. An accidental global $U(1)$ symmetry arises due to the residual Z_N symmetry, when the modulus is stabilized near a fixed point of the finite modular symmetry. To illustrate, I will show the realization of the KSVZ axion model to solve the strong CP problem, where the modulus is stabilized by the radiative potential generated by the vector-like quarks, based on arXiv:2402.02071 (JHEP) and 2405.03996 (JHEP). Since the finite modular symmetries were originally used to explain the flavor structure, this observation suggests that there are non-trivial connections between the pNG mode, which may be the DM, and flavor physics. If time permits, I will discuss the existence of such pNG mode in other stabilization mechanisms and possible applications to particle physics based on 2409.19261 and 2412.18

Presenter: Dr KAWAMURA, Junichiro (Institute for Basic Science, Keio University)

Session Classification: Axion

Contribution ID: 13

Type: **not specified**

Axion search - where are we?

Tuesday 18 February 2025 14:00 (40 minutes)

Presenter: YOUN, SungWoo (IBS-CAP)

Session Classification: Axion

Contribution ID: 14

Type: **not specified**

Aspects of axion dark matter

Tuesday 18 February 2025 14:40 (30 minutes)

Presenter: HONG, deog-ki (pusan national university)

Session Classification: Axion

Contribution ID: 15

Type: **not specified**

Searches for Power-law Warped Extra Dimensions

Tuesday 18 February 2025 15:10 (30 minutes)

Presenter: Dr IM, Sang Hui (IBS CTPU)

Session Classification: Axion

Contribution ID: **16**

Type: **not specified**

Higgs and BSM at FCC-ee

Wednesday 19 February 2025 11:00 (40 minutes)

Presenter: YOU, Tevong (King's College London)

Session Classification: Higgs & DM

Contribution ID: 17

Type: **not specified**

New physics searches with unconventional signatures at the LHC

Tuesday 18 February 2025 16:10 (40 minutes)

Presenter: MOON, Chang-Seong (Kyungpook National University (KR))

Session Classification: Higgs & DM

Contribution ID: **18**

Type: **not specified**

Hybrid quantum-classical approach for combinatorial problems at hadron colliders

Wednesday 19 February 2025 11:40 (30 minutes)

Presenter: Prof. PARK, Myeonghun (Seoultech)

Session Classification: Higgs & DM

Contribution ID: **19**

Type: **not specified**

Light Dark Matter: showcases from cosmology, astrophysics and experiment

Wednesday 19 February 2025 09:30 (1 hour)

Presenter: PRADLER, Josef (University of Vienna & Austrian Academy of Sciences (AT))

Session Classification: DM

Contribution ID: 20

Type: **not specified**

Celestial bodies as WIMP detectors

Tuesday 18 February 2025 16:50 (30 minutes)

Celestial bodies can catalyze WIMP annihilations, providing a promising way to detect them. Moreover, celestial bodies and direct detection probe the same WIMP-nucleus scattering process in a complementary way, allowing to remove the uncertainty on the velocity distribution. Thanks to their gravitational acceleration celestial bodies also allow to extend the experimental sensitivity to a larger parameter space because WIMPs scatter off nuclear targets at a larger speed compared to terrestrial detectors.

Presenter: SCOPEL, Stefano (Sogang University)**Session Classification:** Higgs & DM

Contribution ID: 21

Type: **not specified**

Dark Photons can Prevent Core-Collapse Supernova Explosions

Thursday 20 February 2025 15:00 (30 minutes)

During the accretion phase of a core-collapse supernova (SN), dark-photon (DP) cooling can be largest in the gain layer below the stalled shock wave. In this way, it could counter-act the usual shock rejuvenation by neutrino energy deposition and thus prevent the explosion. This peculiar energy-loss profile derives from the resonant nature of DP production. The largest cooling and thus strongest constraints obtain for DP masses of 0.1–0.4 MeV, a range corresponding to the photon plasma mass in the gain region. Electron-capture SNe, once observationally unambiguously identified, could provide strong bounds even down to nearly 0.01 MeV. For a coupling strength so small that neutrino-driven explosions are expected to survive, the DP cooling of the core is too small to modify the neutrino signal, i.e., our new argument supersedes the traditional SN1987A cooling bound.

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

Contribution ID: 22

Type: **not specified**

Primordial black holes from an interrupted phase transition

Wednesday 19 February 2025 14:00 (30 minutes)

Presenter: Dr JUNG, Tae Hyun (IBS-CTPU)

Session Classification: Phase transitions

Contribution ID: 23

Type: **not specified**

Gravitational Waves from a First-Order Phase Transition of the Inflaton

Wednesday 19 February 2025 14:30 (30 minutes)

Presenter: KERSTEN, Joern (University of Bergen)

Session Classification: Phase transitions

Contribution ID: 24

Type: **not specified**

Bubble wall dynamics at the electroweak phase transition

Wednesday 19 February 2025 15:00 (30 minutes)

The early Universe provides a unique environment to explore fundamental physics, offering extreme conditions that allow theoretical models to be tested, and opening the possibility to probe particle physics at energy scales far beyond the reach of current and future accelerators. In this respect, among the various cosmological phenomena of interest, first-order phase transitions play a prominent role, as they may have left a variety of experimentally accessible signatures. A first order phase transition proceeds through a process of nucleation, growth and merger of bubbles of true vacuum in a false vacuum background. The dynamics of this process is governed by the density perturbations and the non-trivial spatial profiles generated by the propagation of the bubble wall in the false vacuum sea. The determination of the wall expansion velocity is crucial to assess the experimental signatures of the transition. In this talk, I will report on recent advances in the quantitative theoretical description of bubble dynamics, and present numerical results for the bubble wall velocity and the plasma and fields profiles that describe the phase transition dynamics.

Presenter: Dr BRANCHINA, Carlo (Chung-Ang University)

Session Classification: Phase transitions

Contribution ID: 25

Type: **not specified**

Recent Highlights from Belle II and Belle Physics

Wednesday 19 February 2025 16:00 (40 minutes)

Presenter: KWON, Youngjoon

Session Classification: Flavor & Neutrino

Contribution ID: 26

Type: **not specified**

Effects of NSI on neutrino oscillation

Wednesday 19 February 2025 16:40 (20 minutes)

In this talk, I will explore Non-Standard Neutrino Interactions (NSIs) and their effects on neutrino oscillation parameters. I will discuss the LMA-Dark solution and the degeneracies induced by NSIs in the measurement of δ_{CP} . Additionally, I will examine the impact of NSIs on solar and atmospheric neutrinos.

Presenter: BAKHTI, Pouya (JBNU)**Session Classification:** Flavor & Neutrino

Contribution ID: 27

Type: **not specified**

Radiative corrections to the QCD θ parameter at the two-loop level

Wednesday 19 February 2025 17:00 (20 minutes)

Radiative corrections to the QCD θ parameter have been evaluated in terms of the imaginary part of the radiative quark mass phase, e.g. using the Fujikawa method. We have evaluated the radiative correction to the QCD θ at the 2-loop level by direct calculation of the Feynman diagram using a toy model with CP-violating Yukawa coupling. We show that the diagrammatic method is consistent with the low energy effective field theory approach and includes the contributions not coming from the quark mass phase. We also show that in some cases the Fujikawa method may not be sufficient to evaluate the QCD θ . This talk is based on JHEP 02 (2024) 195.

Presenter: BANNO, Tatsuya (Nogoya Univ)

Session Classification: Flavor & Neutrino

Contribution ID: 28

Type: **not specified**

Dark Matter from Inflation and Reheating

Thursday 20 February 2025 09:30 (1 hour)

Presenter: Prof. GARCIA GARCIA, Marcos A. (Instituto de Fisica, UNAM)

Session Classification: Inflation & GW

Contribution ID: 29

Type: **not specified**

Probing Dark Matter with Gravitational-Wave Detectors in Space

Thursday 20 February 2025 11:00 (40 minutes)

Presenter: Dr TANG, Yong (University of Chinese Academy of Sciences)

Session Classification: Inflation & GW

Contribution ID: **30**

Type: **not specified**

Quantum aspects of inflationary gravitational waves

Thursday 20 February 2025 11:40 (40 minutes)

Presenter: GONG, Jinn-Ouk

Session Classification: Inflation & GW

Contribution ID: 31

Type: **not specified**

Heavy dark matter and the evolution of the early universe

Thursday 20 February 2025 14:00 (40 minutes)

Presenter: SHIN, Chang Sub (Institute for Basic Science)

Session Classification: DM

Contribution ID: 32

Type: **not specified**

Probing heavy dark matter with red giants

Thursday 20 February 2025 14:40 (20 minutes)

Astrophysical objects provide an alternative way to probe the properties of dark matter. As dark matter particles transit a star, they can be captured by losing energy through scattering with the nuclei in the star. The accumulation of dark matter particles and their interaction with the nuclei can change the evolution of the star. We focus on the red giants which are in the late phase of stellar evolution after hydrogen is exhausted in the core. During the main sequence phase and red giant phase, if a large amount of dark matter particles can be captured by the star, the scattering between dark matter particles and the helium core of the red giant can lead to temperature increase, which can significantly change the fusion rate of helium and therefore the evolution of the red giant. We derive the condition for the ignition of the red giant core due to such heating effect from dark matter and discuss the constraints on the parameter space of heavy dark matter.

Presenter: Dr HE, Minxi**Session Classification:** DM

Contribution ID: 33

Type: **not specified**

Reconciling cosmological tensions with inelastic dark matter and dark radiation

Thursday 20 February 2025 16:40 (20 minutes)

In this talk I will introduce a novel particle physics framework addressing multiple cosmological tensions, including discrepancies in the Hubble parameter, $S8$, and Lyman- α forest data. This model, SIDR+z_t (Self-Interacting Dark Radiation with transition redshift), features an inelastic dark matter (IDM) scenario coupled with dark radiation under a dark gauge symmetry. The model incorporates cold dark matter, strongly interacting dark radiation, and their interactions, suppressing free-streaming effects and attenuating the matter power spectrum at small scales. The inelastic nature of dark matter introduces a distinct temperature-dependent interaction rate, crucial for resolving Lyman- α discrepancies. Solving the relevant Boltzmann equations, we explore the model's consistency with Big Bang Nucleosynthesis and its ability to produce additional contributions prior to recombination while achieving the correct dark matter relic density.

Presenter: MAHAPATRA, SATYABRATA (Sungkyunkwan University)

Session Classification: Inflation & GW

Contribution ID: 34

Type: **not specified**

Gravitational production in the early Universe

Thursday 20 February 2025 16:00 (40 minutes)

Presenter: MAMBRINI, Yann

Session Classification: Inflation & GW

Contribution ID: 35

Type: **not specified**

Is leptogenesis during gravitational reheating flavourful?

Thursday 20 February 2025 17:00 (20 minutes)

Presenter: DATTA, ARGHYAJIT

Session Classification: Inflation & GW

Contribution ID: 36

Type: **not specified**

UV Freeze-In Dark Matter in General Reheating Scenarios

The dynamics of cosmic reheating, that is, on how the energy stored in the inflaton is transferred to the standard model (SM) thermal bath, is largely unknown. In this work, we show that the phenomenology of the nonbaryonic dark matter (DM) ultraviolet freeze-in production strongly depends on the dynamics of the cosmic-reheating era. Using a general parametrization for the Hubble expansion rate and SM temperature, we thoroughly investigate DM production during reheating, not only recovering earlier findings that focused on specific cases, but also exploring alternative scenarios. Additionally, we derive a generalized framework for DM production via inflaton decays and identify the viable parameter space, while simultaneously addressing constraints from CMB observations. As illustrative examples, we explore gravitational DM production through scatterings of SM particles or inflatons, deriving well-defined parameter regions for these scenarios.

Presenter: Dr DEKA, Kuldeep (New York University Abu Dhabi)

Session Classification: Inflation & GW

Contribution ID: 37

Type: **not specified**

Vector dark matter at low reheat temperature Including decay

Friday 21 February 2025 15:50 (30 minutes)

Presenter: KHAN, Sarif (Goettingen University)

Session Classification: DM

Contribution ID: 38

Type: **not specified**

Cosmological Collider Physics

Friday 21 February 2025 09:30 (1 hour)

Presenter: YAMAGUCHI, Masahide (Tokyo Institute of Technology)

Session Classification: Inflation & GW

Contribution ID: 39

Type: **not specified**

Quintessence Inflaton

Friday 21 February 2025 11:00 (40 minutes)

Presenter: Prof. PARK, Seong Chan (Yonsei University)

Session Classification: Inflation & GW

Contribution ID: 40

Type: **not specified**

Model building aspects of cosmological collider

Friday 21 February 2025 11:40 (30 minutes)

The cosmological collider program, which aims to extract direct information about heavy particles during inflation via primordial non-Gaussianity, has attracted attention as it offers a window into high-energy physics beyond the reach of terrestrial experiments. However, analyses based on concrete particle physics models remain limited, and it is still unclear under what conditions a large cosmological collider signal can be generated. In this talk, we investigate the criteria for achieving a large signal in a generic framework, focusing on tree-level massive scalar exchange. We further confirm our findings explicitly using several multifield R^2 inflation models.

Presenter: AOKI, Shuntaro**Session Classification:** Inflation & GW

Contribution ID: 41

Type: **not specified**

A few topics in dark matter physics with RHN portals

Friday 21 February 2025 14:00 (40 minutes)

Presenter: Prof. KO, Pyungwon (KIAS (Korea Institute for Advanced Study))

Session Classification: DM

Contribution ID: 42

Type: **not specified**

Self-interacting dark matter from simulation and astrophysics

In an era characterized by a wide range of astrophysical and cosmological observations, the synergy of data with sophisticated simulations has enabled us to probe interesting phenomenological paradigms of particulate dark matter (DM). Self-scattering of particulate DM within the dark sector can contribute to the thermalization of the central region of a galactic halo. The self-interaction strength of DM has a significant impact on the position and velocities of DM within these thermalised regions. We conduct rigorous DM only N-body simulations of spherical isolated haloes of $(10^{10}-10^{15}) M_{\odot}$ and study their matter and velocity distributions. We also report conservative bounds on the self-interaction cross-section.

Presenter: SARKAR, Sambo (Indian Institute of Technology Kharagpur)

Session Classification: DM

Contribution ID: 43

Type: **not specified**

Kinetic mixing in $SO(10)$, gravitational waves and PTA data

We discuss an $SO(10)$ model where a dimension five operator induces kinetic mixing between the abelian subgroups at the unification scale. We discuss gauge coupling unification and proton decay in this model, as well as the appearance of superheavy quasistable strings, which can explain the PTA data.

Presenter: Dr MAJI, RINKU (Center for Theoretical Physics of the Universe, Institute for Basic Science)

Session Classification: DM

Contribution ID: 44

Type: **not specified**

Dark gauge-mediated supersymmetry breaking with a massless dark photon

Friday 21 February 2025 14:40 (20 minutes)

The kinetic mixing with dark $U(1)$ gauge can mediate the supersymmetry breaking with significant distortions of the mass spectrum and distinct phenomenology. This talk is based on our recent paper (arXiv: 2412.17777).

Presenter: KIM, Yechan (KAIST)

Session Classification: DM

Contribution ID: 45

Type: **not specified**

Late-time Cosmology without Dark Sector but with Closed String Massless Sector

Friday 21 February 2025 16:40 (20 minutes)

We explore the possibility of solving the dark energy and the coincidence problems by postulating the massless sector of closed strings. This sector constitutes the gravitational multiplet of string theory and, when applied to four-dimensional cosmology, predicts that \textit{the expansion of an open Universe defined in string frame is readily accelerating}. We confront the prediction with the late-time cosmological data of Type Ia supernovae and quasar absorption spectrum, which probe the evolutions of the Hubble parameter and possibly the fine-structure constant. We report that these observations are in admirable agreement with the prediction without any dark sector or coincidence problem. We estimate the Hubble constant, 71.2 km/s/Mpc.

Presenter: Dr LEE, Hocheol (Sogang Univ)**Session Classification:** DM

Contribution ID: 46

Type: **not specified**

Dark matter from simulations and astrophysics

Monday 17 February 2025 17:20 (20 minutes)

In an era characterized by a wide range of astrophysical and cosmological observations, the synergy of data with sophisticated simulations has enabled us to probe interesting phenomenological paradigms of particulate dark matter (DM). Self-scattering of particulate DM within the dark sector can contribute to the thermalization of the central region of a galactic halo. The self-interaction strength of DM has a significant impact on the position and velocities of DM within these thermalised regions. We conduct rigorous DM only N-body simulations of spherical isolated haloes of $(10^4\text{--}10^{15}) M_\odot$ and study their matter and velocity distributions. We also report conservative bounds on the self-interaction cross-section.

Presenter: Dr SARKAR, Sambo (Jeonbuk National University)

Session Classification: Neutrino & DM

Contribution ID: 47

Type: **not specified**

Modern Computational Approaches to Early Universe Modeling

Thursday 20 February 2025 17:20 (20 minutes)

In physics, while analytical calculations remain appealing, there are situations where the use of computers becomes indispensable. A straightforward example is the three-body problem, where even the interactions of just three bodies are challenging to solve analytically. This necessity is similarly evident in studies of the early universe. Understanding the dynamics of the inflaton requires numerical analysis through lattice simulations in this context. Accessing high-performance computing (HPC) used to be difficult, but it is now widely available and significantly more powerful. We apply numerical results obtained through HPC to various physical problems, including the dark matter problem. However, practical constraints still hinder our ability to fully simulate the early universe, so we are exploring machine learning as a means to overcome these challenges.

Presenter: YOON, Jong-Hyun**Session Classification:** Inflation & GW

Contribution ID: 48

Type: **not specified**

Heavy Dark Photon Cosmological and Astrophysical Bounds revised

Friday 21 February 2025 15:00 (20 minutes)

Presenter: PARK, Jaeyoung

Session Classification: DM

Contribution ID: 49

Type: **not specified**

Revisiting the decoupling limit of the Georgi-Machacek model with a scalar singlet

Tuesday 18 February 2025 17:20 (20 minutes)

Presenter: Dr PADHAN, ROJALIN (Chung-Ang University)

Session Classification: Higgs & DM