International Joint Workshop on the Standard Model and Beyond 2024 & 3rd Gordon Godfrey Workshop on Astroparticle Physics

Report of Contributions

https://indico.global/e/12919

Contribution ID: **2** Type: **Contributed Talk**

A Beyond Standard Model Approach to Dark Energy and its multiple observational consequences

Thursday 12 December 2024 14:50 (20 minutes)

From the perspective of Particle Physics, Dark Energy is a low energy phenomenon. Thus, our expectation is that field theory in curved space time should be sufficient to understand the physics of Dark Energy. However, in the context of the Standard Model of Particle Physics obtaining fields with sufficiently low masses that can be protected technically and be relevant for Dark Energy physics is a challenge. Pseudo Nambu Goldstone Bosons tied to non-zero Neutrino masses provide an approach to the Dark Energy problem that is promising. This approach solves the traditional problems that Dark Energy was invented to solve and provides avenues to explore the connected areas of physics, cosmology and astrophysics. As examples of this, we will discuss the collapse of dark energy field configurations to form SMBHs (Super Massive Black Holes) with masses comparable to the masses at the centers of galaxies. Moreover, the gravitational waves produced by dark energy fields can explain the periodicity of the Ice Ages through the amplitude and frequency of the ellipticity variation of earth's orbit created by such Dark Energy Gravitational Waves. Further, the family structure of neutrinos leads to multiple phase transitions during the recent history of the Universe providing a mechanism for the production of Dark Energy Black Holes and Quasars at high redshifts as predicted by us earlier and recently observed by the James Webb Space Telescope (JWST). Finally, we discuss future directions and point out some of the exciting avenues that still need further exploration including the high energy consequences of the flavor symmetries that are responsible for the rich cosmological observations –these explorations will undoubtedly shape our ever expanding understanding of our Universe.

Author: Prof. SINGH, Anupam (LNMIIT)

Presenter: Prof. SINGH, Anupam (LNMIIT)

Session Classification: Cosmology

Contribution ID: **6** Type: **Contributed Talk**

Hunting Primordial Black Hole Dark Matter in Lyman-alpha forest

Tuesday 10 December 2024 15:10 (20 minutes)

The question that what constitutes Dark Matter (DM) is one of the most pressing ones in contemporary physics, and one that has not been answered to any degree so far. Primordial Black Holes (PBHs) are one of the most well-motivated dark matter candidates. PBHs which are light enough that the Hawking radiation is substantial have been constrained by either the non-detection of the radiation itself, or by the non-observation of any measurable effects of the radiation on astrophysical and cosmological observables. In this work, we constrain the existence of such PBHs by the effect their Hawking radiation would have had on the temperature of the intergalactic medium (IGM). We use the latest deductions of IGM's temperature from the Lyman-alpha forest observations. We put constraints on the fraction of dark matter that PBHs can constitute with masses in the range 5 x 10ˆ15 g –10ˆ17 g, separately for spinning and non-spinning black holes. We derive the constraints by dealing with the heating effects of the astrophysical reionization of the IGM in two ways. In one way, we completely neglect this heating due to astrophysical sources, thus giving us relatively weak constraints, but which are completely robust to the reionization history of the universe. In the second way, we use some modelling of the ionization and temperature history and use them to derive more stringent constraints. We find that for PBHs of mass 10ˆ16 g, the current measurements can constrain the PBH-density to be less than 0.1% of the total dark matter density, both for spinning and non-spinning black holes. Thus, we find that these constraints from the Lyman-alpha measurements are competitive, and hence provide a new observable to probe the nature of dark matter.

Author: SINGH, Abhijeet (Indian Institute of Science, Bengaluru)

Co-authors: KUMAR SAHA, Akash; Dr PARASHARI, Priyank (Indian Institute of Science); Dr LAHA, Ranjan (Indian Institute of science (IN))

Presenter: SINGH, Abhijeet (Indian Institute of Science, Bengaluru)

Session Classification: Cosmology

Contribution ID: **9** Type: **Contributed Talk**

Axion clumps, streams and voids

Thursday 12 December 2024 14:00 (30 minutes)

Axions are an increasingly popular dark matter candidate with a flourishing experimental campaign now poised to discover them if they exist. However, there is a potential crisis lurking within this model which could make a discovery impossible, even if the axion does turn out to be the correct dark matter candidate. In one of the general classes of cosmological production scenarios—namely the scenario in which the axion is born after inflation—it has been known for some time that dark matter is expected to inherit ultra-small-scale inhomogeneities from dynamics of the field taking place at the QCD scale. These inhomogeneities eventually collapse under gravity into small-scale structures called miniclusters or minihalos, which have potentially drastic consequences for experimental efforts to detect the axion on Earth. I will discuss recent and ongoing work which aims to address the degree of substructure in the axion dark matter distribution and attempt to quantify the extent to which prospects for discovering axions experimentally are hindered or potentially doomed altogether.

Author: O'HARE, Ciaran (Sydney)

Presenter: O'HARE, Ciaran (Sydney)

Session Classification: Light and ultralight physics

Contribution ID: **11** Type: **Contributed Talk**

Early supermassive black hole direct collapse with dark matter

Thursday 12 December 2024 14:00 (30 minutes)

One of the exciting mysteries uncovered by the James Webb Space Telescope is the discovery of very high redshift supermassive black holes (SMBH). Such early formation of SMBH challenges conventional formation mechanisms—one possible explanation is that these black holes formed from the direct collapse of massive dust clouds. However, it has long been understood that the onset of cooling from molecular hydrogen causes the cloud to fragment and prevent SMBH formation. But if the dust cloud had additional sources of heating, this molecular hydrogen cooling can be avoided. We show here that additional heating from a dark sector—in the form of evaporating black holes or decaying particles—can suppress the molecular hydrogen cooling and allow for the successful direct collapse of dust clouds to SMBH at arbitrarily early times.

Author: PICKER, ZACHARY

Co-authors: Prof. KUSENKO, Alexander (UCLA); Mr LU, Yifan (UCLA)

Presenter: PICKER, ZACHARY

Session Classification: Cosmology

Contribution ID: **12** Type: **Contributed Talk**

BelleII excess & Muon g-2 illuminating Light DM with Higgs Portal

Thursday 12 December 2024 14:00 (30 minutes)

The Belle II collaboration recently announced that they observed the B⟶ Kνν decay process for the first time. However, their result encounters a 2.7σ deviation from the Standard Model calculation. Additionally, Fermilab released new data on muon g − 2 away from the SM expectation with 5.1σ. In this talk, I would like to talk about the simplest UV-complete U(1)Lμ–Lτ-charged complex scalar Dark Matter model. Thanks to the existence of light dark Higgs boson and light dark photon, I can explain the observed relic density of DM and resolve the results reported by both Belle II and Fermilab experiments simultaneously. As a byproduct, the Hubble tension can be alleviated.

Authors: Mr HO, Shu-Yu (Tohoku University); Dr KIM, Jongkuk (Chung-Ang University); Prof. KO, Pyungwon (KIAS (Korea Institute for Advanced Study))

Presenter: Dr KIM, Jongkuk (Chung-Ang University)

Session Classification: Standard Model and Beyond

Contribution ID: **15** Type: **Contributed Talk**

Recent dark sector searches from the BABAR experiment

Tuesday 10 December 2024 16:50 (20 minutes)

High statistics data sets collected in the region of the $\Upsilon(4S)$ resonance can provide extremely powerful tests of possible physics beyond the standard model. Searches with the BABAR experiment at the SLAC PEP-II B factory have placed stringent constraints on possible dark-sector particles and interactions across a variety of models, for masses spanning the MeV - GeV range. Recent BABAR searches for low-mass dark sector particles will be described, and in particular, bounds are presented on B baryogenesis via $B \to \mathcal{B}\psi_D$, where $\mathcal{B}$ is a standard model baryon and ψ_D is a dark sector antibaryon. These searches substantially constrain the parameter space for couplings within these B baryogenesis models.

Author: ROBERTSON, Steven (IPP / University of Alberta)

Presenter: ROBERTSON, Steven (IPP / University of Alberta)

Session Classification: Standard Model and Beyond

Contribution ID: **16** Type: **Contributed Talk**

Evidence for Dark Matter Density Spikes Surrounding Black Holes

Tuesday 10 December 2024 14:50 (20 minutes)

It has been suggested for a long time that dark matter would form a density spike around a black hole. However, no promising evidence has been observed so far to verify this theoretical prediction. In this talk, I will report the evidence of showing the existence of a dark matter density spike surrounding each of the two nearby stellar-mass black holes (A0620-00 and XTE J1118+480) and in the supermassive black hole binary OJ287. The dynamical friction between dark matter and the companions can satisfactorily explain the observed orbital decays in the binaries. The spike index constrained is consistent with the theoretical prediction. The interplay between dark matter and black holes provides important information for constraining the properties of dark matter.

Author: CHAN, Man Ho

Presenter: CHAN, Man Ho

Session Classification: Dark Matter

Contribution ID: **17** Type: **Contributed Talk**

Prospects for Long Lived Particle searches with the MATHSULA experiment

Tuesday 10 December 2024 17:10 (20 minutes)

Long Lived Particles (LLPs) are predicted in many models of possible physics beyond the Standard Model which seek to explain key questions in modern physics. The MATHUSLA experiment is a proposed LLP detection experiment for the CERN Large Hadron Collider (LHC). Consisting of a large decay volume instrumented with layers of scintillator tracking detectors positioned on the surface approximately 100m from one of the LHC interaction points, MATHUSLA seeks to reconstruct the decay vertices of neutral LLPs which penetrate the LHC overburden to decay within the MATHUSLA detector volume. Planning is currently underway for a 10m x 10m x ˜16m demonstrator module, which may ultimately become the first of 16 such modules comprising a 40m x 40m detector (referred to as "MATHUSLA-40"). The physics motivation and expected sensitivity for this detector will be presented, and ongoing MATHUSLA detector development work will be summarized.

Author: ROBERTSON, Steven (IPP / University of Alberta)

Presenter: ROBERTSON, Steven (IPP / University of Alberta)

Session Classification: Standard Model and Beyond

Contribution ID: **18** Type: **Contributed Talk**

Implications of a new SU(2) flavour group in early-universe phase transitions

Tuesday 10 December 2024 14:00 (30 minutes)

Mounting evidence suggests that planned and present gravitational-wave detectors may be sensitive to signatures from first-order phase transitions in the early universe. Here, we investigate the influence of heavy vector-like fermions on the phase transition. Specifically, we consider the recently-proposed "flavour transfer" model, where the SM flavour structure is augmented by a new horizontal SU(2) flavour gauge group. For such a model, the new gauge symmetry is broken far above the electroweak scale and constraints are dominated by "flavour-transfer"operators rather than flavour-changing currents. We calculate the finite-temperature corrections to the effective potential and determine the critical temperature at which we expect a phase transition. We examine the parameters for which the phase transition is strongly first order, and estimate whether the corresponding peak frequency of the gravitational-wave lies within the sensitivity windows of upcoming detectors.

Authors: Prof. CORNELL, Alan Stanley (University of Johannesburg (ZA)); DEANDREA, Aldo (Centre National de la Recherche Scientifique (FR)); CHRYSOSTOMOU, Anna (University of Johannesburg (ZA)); DARME, Luc; Mr DEMARTINI, Thibault (IP2I)

Presenter: Prof. CORNELL, Alan Stanley (University of Johannesburg (ZA))

Session Classification: Early Universe

Contribution ID: **20** Type: **Contributed Talk**

Cosmological implications of radiative electroweak symmetry breaking theories

Thursday 12 December 2024 14:50 (20 minutes)

Radiative symmetry breaking (i.e. classically conformal) theories provide an appealing explanation for electroweak symmetry breaking and address the hierarchy problem. Such theories also imply one or more first-order phase transitions (FOPTs) in the early Universe, deeply affecting the thermal history and potentially providing novel solutions to puzzles of dark matter and baryon asymmetry. This talk performs a detailed analysis of this topic, which includes providing exact and analytical solutions for the vacuum structure and scalar interactions, classifying four patterns of cosmic thermal history, and calculating the supercooled FOPT dynamics and GWs. By combining future collider and gravitational wave experiments, we can probe the conformal symmetry breaking scales up to $10^5 - 10^8$ GeV.

Author: XIE, Kepan (Beihang University)

Presenter: XIE, Kepan (Beihang University)

Session Classification: Standard Model and Beyond

Contribution ID: **21** Type: **Contributed Talk**

A Full EFT Approach to Radiative Neutrino Mass

Tuesday 10 December 2024 14:50 (20 minutes)

The standard model (SM) prediction of massless neutrinos is experimentally inconsistent. Introducing new high-energy physics allows for neutrino masses to be generated via effective operators in the SM. Naturally, the SM is therefore regarded as an effective field theory (EFT), namely the SMEFT, and calls for a complete EFT implementation of the new physics. This is especially poignant for so called 'radiative' mass modes that generate neutrino masses at 1-loop, where only a full EFT approach can account for the quantum effects in the parameters of the theory as we run from the new physics scale, down to the electroweak scale and below where measurements are made. In particular, I consider the matching of the Zee model to the SMEFT, through a 2-Higgs-Doublet model, carrying out the calculation at 1-loop, where the neutrino mass is generated. I include running and demonstrate the significance of the quantum corrections to the low-energy neutrino mass that arise in this full EFT approach.

Author: VANDELEUR, James (University of New South Wales (UNSW))

Co-author: SCHMIDT, Michael (UNSW Sydney)

Presenter: VANDELEUR, James (University of New South Wales (UNSW))

Session Classification: Standard Model and Beyond

Contribution ID: **22** Type: **Contributed Talk**

Light mass window of inert doublet dark matter with lepton portal interaction

Tuesday 10 December 2024 17:30 (20 minutes)

We study phenomenology of a light scalar dark matter (DM). In the model, there are an inert doublet scalar and a singlet Dirac fermion ψ, both charged under a global Z_2 symmetry. The mass of the lightest inert scalar H can be lighter than 10 GeV by imposing appropriate relations between three scalar quartic couplings. The lightest Z_2 odd particle is stable and DM. In this paper, focusing on the parameter space where H is lighter than ψ and is DM, we discuss DM physics related to relic density, direct detection, indirect detection, collider searches and other cosmological observations. We clarify differences from the case where ψ is instead DM, which has been focused on in the previous works.

Authors: Mr HIGUCHI, Ryo (Kindai University); Dr OKAWA, Shohei (KEK); Dr IGURO, Syuhei (Nagoya U.); OMURA, Yuji (Kindai University)

Presenter: OMURA, Yuji (Kindai University)

Session Classification: Dark Matter

Contribution ID: **23** Type: **Contributed Talk**

Leptogenesis in the Zee Model

Tuesday 10 December 2024 15:30 (20 minutes)

Is it possible to get leptogenesis to work in the Zee Model? Come to this talk and find out!

Author: LACKNER, Adam

Co-authors: Dr FONG, Chee Sheng (Universidade de São Paulo); SCHMIDT, Michael (UNSW Sydney)

Presenter: LACKNER, Adam

Session Classification: Early Universe

Contribution ID: **24** Type: **Contributed Talk**

Status of singlet-doublet fermion dark matter

Tuesday 10 December 2024 16:20 (30 minutes)

Irrefutable evidences from galaxy rotation curve, gravitational lensing and large scale structure of the Universe suggest that the present Universe is dominantly filled by an invisible matter, popularly called dark matter. In fact, the satellite based experiment PLANCK predicted that the relic density of dark matter, expressed in terms of Ω_Dm hˆ2=0.12±0.0012. However, the dark matter component of the present Universe can not be explained by the current standard model (SM) of particle physics. This implies one has to explore physics beyond the SM. A SM singlet fermion DM (χ) has been explored extensively and found that it is over produced in order to be compatible with the current direct detection limit. On the other hand, an inert fermion doublet DM (ψ) is under produced in order to be compatible with the direct search constraint. However, a combination of a singlet and a doublet fermion with appropriate mixing give rise a good candidate of DM, which not only satisfy the current direct search constraints but also give the correct relic in a large parameter space. In a series of paper (1510.02760, 1704.03417, 1812.06505, 2009.00885,2112.06847, 2204.09671,2310.03721) we explored the compatibility of singlet-doublet fermion dark matter with neutrino mass, g-2 anomaly, W-mass anomaly and ΔN_eff. In this talk a summary of these results will be reported.

Author: Prof. SAHU, Narendra (Department of Physics IIT Hyderabad)

Presenter: Prof. SAHU, Narendra (Department of Physics IIT Hyderabad)

Session Classification: Dark Matter

Contribution ID: **25** Type: **Contributed Talk**

Dark gauge mediated supersymmetry breaking by a massless dark photon

Thursday 12 December 2024 14:30 (20 minutes)

The kinetic mixing can transfer the supersymmetry breaking from the hidden sector to the visible sector. We study dark gauge mediation supersymmetry breaking (dark GMSB) with large kinetic mixing. The massless dark photon allows such a large kinetic mixing, so the effect of the dark GMSB can become significant in the soft mass terms. For the neutralino sector, the dominant components in the dark photino-bino mixture state change along the size of the kinetic mixing. In the scalar sector, the mass spectrum is more sensitive to the kinetic mixing if the scalar particle has a large hypercharge. Such a distinguishable characteristic of the dark GMSB has a possibility to alter the phenomenology.

Authors: BATELL, Brian Thomas; LEE, Hye-Sung (KAIST); LEE, Jiheon (KAIST); KIM, Yechan (KAIST)

Presenter: KIM, Yechan (KAIST)

Session Classification: Standard Model and Beyond

Contribution ID: **26** Type: **not specified**

QED 5-loop on the lattice

Tuesday 10 December 2024 14:00 (30 minutes)

I report the progress in the 5-loop QED computation of g-2. Currently, there seems to be discrepancy in the 5-loop results obtained by two groups. I am trying to get an independent result by using the lattice simulation on the FUGAKU supercomputer.

Author: KITANO, Ryuichiro

Presenter: KITANO, Ryuichiro

Session Classification: Standard Model and Beyond

Contribution ID: **28** Type: **Contributed Talk**

Revisiting the phase transition of the flaton potential

Tuesday 10 December 2024 14:30 (20 minutes)

Recently, there has been a lot of attention given to cosmological first-order phase transitions in various contexts. To achieve a strong first-order phase transition a flat symmetry-breaking potential is commonly required. For instance, a classically scale invariant potential can provide such a flat potential, $V \sim \phi^4 \log \phi$, albeit with a large dilution factor and run-away bubbles. Another example of a flat potential can arise from supersymmetric theories, which can even forbid the existence of a tree-level quartic coupling for the 'flaton' field altogether, potentially modifying the predicted properties of the phase transition. In the past it has been argued that thermal fluctuations dominate over bubble nucleation in such models precluding a strong phase transition and therefore gravitational wave signals. We revisit the flaton potential and, with the aide of numerical simulations, determine the fate of the flaton potential during its phase transition.

Author: DUTKA, Tomasz (Korea Institute for Advanced Study)

Presenter: DUTKA, Tomasz (Korea Institute for Advanced Study)

Session Classification: Early Universe

Contribution ID: **29** Type: **not specified**

Constraining millicharged dark matter with gravitational positivity bounds

Thursday 12 December 2024 14:30 (20 minutes)

Positivity bound is one of the UV-IR consistency conditions which can be derived from fundamental principles such as unitarity and causality. Recently, it has been studied to incorporate gravity effects to the positivity constraints and apply them to various phenomenologies. In this talk, we study the implications of the gravitational positivity bound for dark matter. In particular, we focus on the millicharged dark matter and constrain their parameter spaces.

Author: KIM, Suro

Presenter: KIM, Suro

Session Classification: Dark Matter

Contribution ID: **31** Type: **Contributed Talk**

Dark matter limits from the tip of the red giant branch

Tuesday 10 December 2024 14:00 (30 minutes)

Capture and annihilation of WIMP-like dark matter in red giant stars can lead to faster-than-expected ignition of the helium core, and thus a lower tip of the red giant branch (TRGB) luminosity. We use Gaia data to place constraints on the dark matter-nucleon cross section using TRGB of 22 globular clusters with measured TRGB luminosities, and place projections on the sensitivity resulting from 161 clusters with full phase space distributions observed by Gaia. Although limits remain weaker than those from Earth-based direct detection experiments, they represent a constraint that is fully independent of dark matter properties in the Solar neighbourhood, probing its properties across the entire Milky Way galaxy, and help confirm the robustness of the TRGB as a standard candle.

Author: VINCENT, Aaron (Queen's University)

Presenter: VINCENT, Aaron (Queen's University)

Session Classification: Dark Matter

Contribution ID: **32** Type: **Contributed Talk**

Reconciling Cosmological Tensions with Inelastic Dark Matter and Dark Radiation in a $U(1)_D$ Framework

Thursday 12 December 2024 15:10 (20 minutes)

We propose a novel and comprehensive particle physics framework that addresses multiple cosmological tensions observed in recent measurements of the Hubble parameter, S_8, and Lyman-α forest data. Our model, termed '{\bf SIDR+z_t}' (Self Interacting Dark Radiation with transition redshift), is based on an inelastic dark matter (IDM) scenario coupled with dark radiation, governed by a $U(1)_D$ gauge symmetry. This framework naturally incorporates cold dark matter (DM), strongly interacting dark radiation (SIDR), and the interactions between these components. The fluid-like behavior of the dark radiation component which originates from the self-quartic coupling of the $U(1)_D$ breaking scalar, effectively mitigates both the Hubble and S_8 tensions by suppressing free-streaming effects. Simultaneously, the interacting DM-DR system attenuates the matter power spectrum at small scales, potentially reconciling discrepancies in Lyman-α (Ly-α) observations. The inelastic nature of DM provides a distinct temperature dependence for the DM-DR interaction rate determined by the mass-splitting between the inelastic dark fermions which is crucial for resolving the Ly-α discrepancies. We present a cosmologically consistent analysis of the model by solving the relevant Boltzmann equations to obtain the energy density and number density evolution of different species of the model. The DR undergoes two "steps" of increased energy density when the heavier dark species freeze out and become non-relativistic, transferring their entropy to the dark radiation and enhancing $\Delta N_{\rm eff}$. The analysis showcases the model's potential to uphold the Big Bang Nucleosynthesis (BBN) prediction of $\Delta N_{\rm eff}$ but dominantly producing additional contributions prior to recombination, while simultaneously achieving correct relic density of DM though an hybrid of freeze-in and non-thermal production.

Authors: Dr CHOI, Ki-Young (Sungkyunkwan University); MAHAPATRA, Satyabrata (Sungkyunkwan University); Mr CHO, Wonsub (Sungkyunkwan University)

Presenter: MAHAPATRA, Satyabrata (Sungkyunkwan University)

Session Classification: Cosmology

Contribution ID: **33** Type: **Contributed Talk**

Domain wall networks and their cosmological signatures

Tuesday 10 December 2024 16:20 (30 minutes)

Several unified models that embed the SM elegantly have the possibility of domain wall formation according to Kibble mechanism. In models based on supersymmetric and non-supersymmetric left-right symmetric models, we discuss the emergence of such walls in the early universe and their signature in gravitational waves and the links to leptogenesis and EDM searches.

References :

https://inspirehep.net/literature/2613355
Left-right symmetry breaking and gravitational waves: A tale of two phase transitions

https://inspirehep.net/literature/2638642
Gravitational wave signature of generic disappearance of Z_2-symmetry breaking domain walls

https://inspirehep.net/literature/1835770
Domain walls and CP violation with left right supersymmetry: implications for leptogenesis and electron EDM

Author: YAJNIK, Urjit

Co-authors: BANERJEE, Piyali; AHMED BORBORUAH, Zafri (IIT Bombay)

Presenter: YAJNIK, Urjit

Session Classification: Cosmology

Contribution ID: **34** Type: **not specified**

Halo as a key to indirect DM searches

Tuesday 10 December 2024 11:30 (30 minutes)

Author: HIROSHIMA, Nagisa (Yokohama National University)

Presenter: HIROSHIMA, Nagisa (Yokohama National University)

Session Classification: Plenary

Contribution ID: **35** Type: **Invited Talk**

muTRISTAN

Wednesday 11 December 2024 12:00 (30 minutes)

The ultra-cold muon technology developed for the muon g − 2 experiment at J-PARC provides a low-emittance mu+ beam which can be accelerated and used for realistic collider experiments. We consider the possibility of new collider experiments by accelerating the mu+ beam up to 1 TeV. Allowing the mu+ beam to collide with a high-intensity e− beam at the TRISTAN energy, 30 GeV, in a storage ring with the same size as TRISTAN (a circumference of 3 km), one can realize a collider experiment with the center-of-mass energy 346 GeV, which allows the production of Higgs bosons through vector boson fusion processes. We estimate the deliverable luminosity with existing accelerator technologies to be at the level of 5 x 10ˆ33 cmˆ−2 sˆ−1, with which the collider can be a good Higgs boson factory. mu+mu+ colliders up to $\sqrt{s} = 2$ TeV are also possible using the same storage ring. I will explain the design of this proposed collider briefly, and discuss the Higgs production and possible new physics searches.

Authors: Dr TAKAURA, Hiromasa; Prof. YOSHIDA, Mitsuhiro (KEK); KITANO, Ryuichiro; MATSUDO, Ryutaro; Dr HAMADA, Yu (DESY)

Presenter: MATSUDO, Ryutaro

Session Classification: Plenary

Contribution ID: **36** Type: **Invited Talk**

Theoretical developments in flavor physics

Monday 9 December 2024 14:30 (30 minutes)

I will give an overview of recent theoretical developments in flavor physics.

Author: ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

Presenter: ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

Session Classification: Plenary

Contribution ID: **37** Type: **Invited Talk**

Axion-like particle at the LHC

Wednesday 11 December 2024 11:30 (30 minutes)

The talk consists of two parts:
(i) The recent excess in a rare decay of the Higgs boson $H \to Z\gamma$ can be interpreted using a light axion-like particle (ALP) in the mass range of $0.05 - 0.1$ GeV. The dominant decay of such a light ALP is into a pair of collimated photons, whose decay is required to happen before reaching the ECAL detector, such that it mimics a single photon in the detector.

(ii) The sensitivities on the gauge-boson couplings $g_{aZZ}, g_{aZ\gamma}$ and g_{aWW} of an axion-like particle (ALP) are estimated at the LHC with $\sqrt{s} = 14$ TeV and integrated luminosities of 300 fb (current run) and 3000 fb (High-Luminosity LHC). We focus on the associated production processes of $pp \to Za \to (\ell^+\ell^-)(\gamma\gamma)$ and $pp \to W^\pm a \to (\ell^\pm\nu)(\gamma\gamma)$.

Author: CHEUNG, Kingman (National Tsing Hua University (TW))

Presenter: CHEUNG, Kingman (National Tsing Hua University (TW))

Session Classification: Plenary

Contribution ID: **38** Type: **not specified**

CMBubbles: Searching for the existence of a multiverse in Planck CMB

Tuesday 10 December 2024 17:30 (20 minutes)

The universe is a vast place, but what if this universe was just one of many embedded in a greater multiverse? How can we look for such a multiverse? In this paper, we develop our understanding of a multiverse and how bubble universes can exist. We discuss the existing literature on the topic and develop an understanding of the possibilities of other bubble universes colliding with our own universe. We discuss a theoretical thermal profile that mimics the mathematical structure of de Sitter - de Sitter bubble collisions, which we can use to look for bubble universe collisions in the Cosmic Microwave Background (CMB) sky. Through this paper, we develop a three part pipeline to look
for these signatures in the 2021 Planck CMB data. We first simulate a set of CMB maps consisting of the CMB 'backgrounds'and bubble collision signatures incorporated into them. We then carry out a Blob Detection algorithm on these maps, conducting a parameter sensitivity study to validate our pipeline outputs to establish a set of threshold requirements defining a collision signature. We also apply a Simple Statistical Model onto the simulated maps to see how well our algorithm can recreate input parameters. Lastly, we apply our detection algorithm and statistics model onto the Planck data to look for any regions in the sky that would match our threshold requirements to be counted as a bubble collision signature. We find no features in the Planck data that meet our threshold requirements, but we discuss in depth the detection of 14 maximal features and the possibilities of these being potential bubble collision signature candidates. We also discuss the need for further study with increased sensitivity, and comment on improvements for future works.

Author: Ms M, Jahanvi (UNSW)

Presenter: Ms M, Jahanvi (UNSW)

Session Classification: Cosmology

Contribution ID: **39** Type: **Invited Talk**

Precision Low-Energy Experiments to Search for signs of Quantum Gravity and Dark Matter Particles

Monday 9 December 2024 11:30 (30 minutes)

The Quantum Technologies and Dark Matter research laboratory at the University of Western Australia has a rich history of developing precision tools for testing fundamental physics at low energies. This includes the efforts to discover "Beyond Standard Model"physics, including the nature of Dark Matter and the unification of Quantum Mechanics with General Relativity to help uncover a unified theory of everything. In particular, our work includes searches for Lorentz invariance violations in the photon, phonon, and gravity sectors, possible variations in fundamental constants, searches for wave-like dark matter, tests of quantum gravity, and the determination of temporal geometric phases. This includes experiments that take advantage of axion-photon coupling and axion-spin coupling to search for axion dark matter. High acoustic Q phonon systems to search for Lorentz violations, high-frequency gravity waves, scalar dark matter, tests of quantum gravity from the possible modification of the Heisenberg uncertainty principle, and the new proposal to undertake a temporal Pound-Rebka experiment as gravitational Aharonov-Bohm effect.

Author: TOBAR, Michael (The University of Western Australia)

Presenter: TOBAR, Michael (The University of Western Australia)

Session Classification: Plenary

Contribution ID: **42** Type: **Invited Talk**

Calculating and Detecting Gravitational Waves from the Sound in Cosmological Phase Transitions

Wednesday 11 December 2024 10:00 (30 minutes)

Author: GUO, Huaike (UCAS)

Presenter: GUO, Huaike (UCAS)

Session Classification: Plenary

Contribution ID: **43** Type: **Contributed Talk**

Exploring light dark matter boosted by supernova neutrinos in the present and past Universe

Tuesday 10 December 2024 15:10 (20 minutes)

It has been recently proposed that the boosted dark matter (BDM) by supernova neutrinos (SNν) from SN1987a or from the next Galactic supernova (SN) can serve as a novel component to probe nonvanishing interaction between dark matter (DM) and the standard model leptons. In this talk, I will introduce the relevant concept and evaluate the present-day *diffuse* flux of SNν BDM originated from all galaxies at higher redshifts. We show that by considering this diffuse BDM (DBDM) component, the best sensitivity on the product of the energy-independent DM-ν and DM-electron cross sections, $\sqrt{\sigma_{\chi\nu}\sigma_{\chi e}} \simeq \mathcal{O}(10^{-37})$ cm^2 for sub-MeV DM, can be obtained with large-size neutrino experiments such as Super-Kamiokande or Hyper-Kamiokande, surpassing the estimated SNν BDM bound from SN1987a. We also examine the impact due to the presence of DM spikes around the supermassive black holes in galaxies on SNν BDM and DBDM. Our results suggest that both the DBDM and the SNν BDM probes are robust to the uncertain properties of DM spikes, unless the next Galactic SN happens to occur at a location extremely close to or right behind the Galactic Center along the SN line of sight.

Author: Dr LIN, Yen-Hsun (Institute of Physics, Academia Sinica, Taiwan)

Co-author: WU, Meng-Ru (Institute of Physics, Academia Sinica)

Presenter: Dr LIN, Yen-Hsun (Institute of Physics, Academia Sinica, Taiwan)

Session Classification: Dark Matter

Contribution ID: **44** Type: **Contributed Talk**

Model-independent Extraction of Form Factors and |V_{cb}| in B ->D l nu with hadronic tagging at BABAR

Tuesday 10 December 2024 16:20 (30 minutes)

BABAR performed the first two-dimensional unbinned angular analysis of the semileptonic decay $\bar{B} \to D\ell^- \bar{\nu}_\ell$ with the full data set, where ℓ is either an electron or a muon. The other B meson is tagged via hadronic reconstruction. A novel data-driven signal-background separation procedure with minimal dependence on simulation has been developed that preserves all multi-dimensional correlations present in the data.
Including input from recent lattice QCD calculations and previously available experimental data, we present a model-independent form factor analysis and the extraction of the CKM matrix element $|V_{cb}|$.

Author: Prof. EIGEN, Gerald (University of Goettingen/Caltech)

Presenter: Prof. EIGEN, Gerald (University of Goettingen/Caltech)

Session Classification: Standard Model and Beyond

Contribution ID: **45** Type: **Invited Talk**

Neutrino flavor oscillations in supernovae

Wednesday 11 December 2024 12:30 (30 minutes)

Neutrinos are known to play crucial roles in core-collapse supernova explosions. The anticipated large amount of supernova neutrinos events from the next galactic explosion as well as the upcoming unambiguous detection of the diffuse supernova neutrino background are also expected to be important messengers to probe various important issues in astrophysical, nuclear, and particle physics. However, accurate theory modeling for supernovae and their neutrino signals has been plagued by the poor understanding of the collective flavor oscillations of neutrinos that can happen inside the deep interior of a supernova. In this talk, I will review this challenging issue and the associated difficulties. I will then discuss recent progresses toward solving this long-standing problem.

Author: WU, Meng-Ru (Institute of Physics, Academia Sinica)

Presenter: WU, Meng-Ru (Institute of Physics, Academia Sinica)

Session Classification: Plenary

Contribution ID: **47** Type: **Contributed Talk**

Multi-Component Dark Matter from Minimal Flavor Violation

Tuesday 10 December 2024 16:50 (20 minutes)

Minimal Flavor Violation (MFV) offers an appealing framework for exploring physics beyond the Standard Model. Interestingly, within the MFV framework, a new colorless field that transforms non-trivially under a global $\mathrm{SU}(3)^3$ quark flavor group can naturally be stable. Such a new field is thus a promising dark matter candidate, provided it is electrically neutral. We extend the MFV framework for dark matter and demonstrate that dark matter can naturally be multi-component across a broad parameter space. For illustration, we consider a gauge singlet, flavor triplet scalar field and identify parameter spaces for multi-component dark matter, where only the lightest flavor component is absolutely stable and heavy flavor components are decaying with lifetimes sufficiently longer than the age of the universe. Phenomenological, cosmological and astrophysical aspects of multi-component flavored dark matter are briefly discussed.

Author: OKAWA, Shohei (KEK)

Co-authors: MESCIA, Federico (Laboratori Nazionali di Frascati); WU, Keyun (Universitat de Barcelona)

Presenter: OKAWA, Shohei (KEK)

Session Classification: Dark Matter

Contribution ID: **48** Type: **Contributed Talk**

Gravitational wave spectrum from expanding string loops on domain walls: Implication to nano-hertz pulsar timing array signal

Tuesday 10 December 2024 14:00 (30 minutes)

We analytically calculate the spectrum of stochastic gravitational waves (GWs) emitted by expanding string loops on domain walls in the scenario where domain walls decay by nucleation of string loops. By introducing macroscopic parameters characterizing the nucleation of the loops, the stochastic GW spectrum is derived in a way that is independent of the details of particle physics models. In contrast to GWs emitted from bubble collisions of the false vacuum decay, the string loops do radiate GWs even when they are perfectly circular before their collisions, resulting in that more and more contribution to the spectrum comes from the smaller and smaller loops compared to the typical size of the collided loops. Consequently, the spectrum is linearly proportional to the frequency at the high-frequency region, which is peculiar to this GW source. Furthermore, the results are compared with the recent nano-Hertz pulsar timing array signal, as well as the projected sensitivity curves of future gravitational wave observatories.

Authors: NAKANO, Wakutaka (KEK); Dr HAMADA, Yu

Presenter: NAKANO, Wakutaka (KEK)

Session Classification: Cosmology

Contribution ID: **50** Type: **Invited Talk**

Neutrino physics phenomenology

Thursday 12 December 2024 09:30 (30 minutes)

The observation of neutrino oscillations has shown that neutrinos are massive and hence that the Standard Model of particle physics has to be extended. In this talk I will discuss recent developments in neutrino theory which can guide experimental explorations of the neutrino sector.

Author: GEHRLEIN, Julia (Colorado State University (US))

Presenter: GEHRLEIN, Julia (Colorado State University (US))

Session Classification: Plenary

Contribution ID: **51** Type: **not specified**

Chiral Dark Matter and radiative neutrino mass generation from gauged □(□) symmetry

Tuesday 10 December 2024 17:10 (20 minutes)

We propose a class of dark matter models based on a chiral U(1) gauge symmetry acting on a dark sector. The chiral U(1) protects the masses of the dark sector fermions, and also guarantees the stability of the dark matter particle by virtue of an unbroken discrete Z_N gauge symmetry. We identify 38 such U(1) models which are descendants of a chiral SU(3)×SU(2) gauge symmetry, consisting of a minimal set of fermions with simple U(1) charge assignments. We show how these models can also be utilized to generate small Majorana neutrino masses radiatively via the scotogenic mechanism with the dark sector particles circulating inside loop diagrams. We further explore the phenomenology of the simplest model in this class, which admits a Majorana fermion, Dirac fermion or a scalar field to be the dark matter candidate, and show the consistency of various scenarios with constraints from relic density and direct detection experiments.

Authors: Prof. BABU, Kaladi (Oklahoma State University); Prof. CHAKDAR, Shreyashi (College of the Holy Cross); Dr P.K, Vishnu (University of Munster, Germany)

Presenter: Prof. CHAKDAR, Shreyashi (College of the Holy Cross)

Session Classification: Dark Matter

Contribution ID: **52** Type: **not specified**

Influence of the axion-nucleon interaction on the direct detection of dark matter

Thursday 12 December 2024 14:50 (20 minutes)

Axions and Axion-Like-Particles (ALPs) are theoretically well-motivated candidates for dark matter that, due to their large occupation number, can be described as oscillating classical fields. At low energies, canonical QCD axions have a model-independent quadratic interaction with nucleons that can be extended to gluon-coupled ALPs. Nucleon densities modify the axion's and ALP' s field dynamics, inducing a very interesting phenomenology. In this talk, I will treat in a general setting, how the Earth, as an object made out of mainly nucleons, modifies the sensitivities of direct detection experiments such as CASPEr. I will show the regions of the parameter space with noticeable effects, where current and future experimental sensitivities can be modified. I will also discuss the applicability of the results when the Earth's acceleration is taken into account. For this purpose, I will discuss the time dependence of the field and its relaxation times to stationary configurations.

Author: Mr GARCIA DEL CASTILLO, Yeray

Presenter: Mr GARCIA DEL CASTILLO, Yeray

Session Classification: Light and ultralight physics

Contribution ID: **53** Type: **not specified**

Weak mixing angle at direct detection

Tuesday 10 December 2024 14:30 (20 minutes)

Current ton-scale direct detection experiments have begun observing solar neutrinos. We probe the weak mixing angle using existing direct detection data. Leveraging recent measurements of ^{8}B solar neutrinos via coherent neutrino-nucleus scattering by PandaX-4T and XENONnT, we demonstrate that these experiments can probe the weak mixing angle in a region complementary to that of dedicated neutrino experiments. Furthermore, we show that the current XENONnT electron recoil data can probe the weak mixing angle through neutrino-electron scattering, in a momentum transfer region over an order of magnitude smaller than that explored by atomic parity violation experiments. Our findings reveal significant potential for probing a key Standard Model parameter in a completely new energy regime through the observation of neutrinos in future direct detection experiments.

Author: MAITY, Tarak Nath (The University of Sydney)

Co-author: Prof. BOEHM, Celine (The University of Sydney)

Presenter: MAITY, Tarak Nath (The University of Sydney)

Session Classification: Standard Model and Beyond

Contribution ID: **54** Type: **Contributed Talk**

Affleck-Dine Dirac Leptogenesis

Tuesday 10 December 2024 15:10 (20 minutes)

We present a minimal framework that realises successful Dirac Leptogenesis through the Affleck-Dine mechanism. A single right-handed neutrino and a neutrinophillic Higgs doublet are introduced to the Standard Model, which couple via a Yukawa interaction. The inflationary setting is induced by a combination of the two Higgs doublets, with their global symmetry violating interactions leading to a net charge generation via the Affleck-Dine mechanism. This simple Standard Model extension exhibits a unique and connected set of phenomenological implications including the resultant baryon asymmetry, inflationary predictions, cosmological implications, relic right-handed neutrinos, and its low energy phenomenology, while also being able to be embedded in various neutrino mass generating mechanisms.

Author: BARRIE, Neil

Presenter: BARRIE, Neil

Session Classification: Early Universe

Contribution ID: **55** Type: **Contributed Talk**

The QCD-Axion-Nucleon Coupling at Finite Density

Thursday 12 December 2024 14:30 (20 minutes)

As an elegant solution to the strong CP problem and promising dark matter candidate, the QCD axion is one of the best motivated particles beyond the SM. On the phenomenological side, it is extremely predictive as all its couplings to SM particles as well as its mass is determined by a single scale, the axion decay constant. The hunt for the QCD axion, both with terrestrial experiments as well as astrophysical observables, has exploded in the last years. As of today, astrophysical observations, such as neutron star cooling and energy loss from supernovae, place the strongest bounds.
In this talk, I will show that astrophysical bounds depend on a non-trivial momentum dependence of the axion-nucleon coupling in zero- as well as in finite density environments. This dependence is induced by one-loop corrections to the coupling that can be systematically calculated within the framework of chiral perturbation theory, both at zero density and in thermal field theory. As a consequence, the supernova bound is strengthened and the momentum dependence further allows us to constrain large parts of parameter space of the axion neutron coupling.
Additionally, I will talk about the model independent axion production mechanism in supernova, leading to a orders of magnitude stricter bound than in current literature, where the operator responsible for the dominant model independent contribution has been neglected so far.

Authors: WEILER, Andreas; SPRINGMANN, Konstantin; STADLBAUER, Michael; STELZL, Stefan

Presenter: STADLBAUER, Michael

Session Classification: Light and ultralight physics

Contribution ID: **57** Type: **Invited Talk**

Probing Seesaw Scale at a Cosmological Neutrino Collider

Thursday 12 December 2024 10:00 (30 minutes)

Probing Seesaw Scale at a Cosmological Neutrino Collider

Author: Prof. HAN, Chengcheng (SYSU)

Presenter: Prof. HAN, Chengcheng (SYSU)

Session Classification: Plenary

Contribution ID: **58** Type: **Contributed Talk**

Extending Global Fits of 4D Composite Higgs Models with Partially Composite Leptons

Tuesday 10 December 2024 15:30 (20 minutes)

Composite Higgs Models offer an attractive solution to the hierarchy problem. We extend previously examined models based on a SO(5) ⟶ SO(4) symmetry breaking pattern and 3rd generation quarks, with two representations of the τ and its neutrino. We conduct Bayesian global fits of these models using a wide array of constraints in order to find regions in the parameter volume that best fit experimental measurement. We then study the effects of including lepton parameters and constraints on the fit results for similar scans, as well as analyse the fine-tuning of each model by calculating the Kullback-Lieber divergence between their respective priors and posteriors, and the robustness of each scan. Both models were found to satisfy all constraints at the 3σ level and capable of predicting gluon-fusion produced Higgs signal strengths that are agreeable with the Standard Model order of unity. Additionally, we present the predicted leptons' experimental signatures for valid points in said models and discuss their potential phenomenology at future high-luminosity LHC runs.

Authors: Prof. WILLIAMS, Anthony (University of Adelaide); CARRAGHER, Ethan (University of Oxford); GOH, Kenn Shern; WHITE, Martin John (University of Adelaide (AU)); SU, Wei (Sun Yat-sen University)

Presenter: GOH, Kenn Shern

Session Classification: Standard Model and Beyond

Contribution ID: **59** Type: **Contributed Talk**

Capture, Thermalization and Annihilation of Dark Matter in Neutron Stars

Tuesday 10 December 2024 11:00 (30 minutes)

We consider the capture of dark matter in neutron stars, and the heating caused by the subsequent thermalization and annihilation of that dark matter. We find that most of the dark matter's kinetic energy is rapidly deposited in the star. We also discuss, for the first time, the annihilation of partially thermalized dark matter. We find that capture-annihilation equilibrium, and hence maximal annihilation heating, can be achieved without complete thermalization of the captured dark matter. Comparing projected neutron star sensitivities with limits from direct detection experiments, we find that neutron stars provide a possible means to probe dark matter interactions that would be difficult or impossible to observe in experiments on Earth.

Author: Prof. BELL, Nicole (The University of Melbourne)

Presenter: Prof. BELL, Nicole (The University of Melbourne)

Session Classification: Plenary

Contribution ID: **60** Type: **not specified**

Dark matter candidate emerging from 3-form gauge theory

Thursday 12 December 2024 14:50 (20 minutes)

Current astrophysical observations such as the rotational curves of galaxies, galaxy structure formation, gravitational lensing and the cosmic microwave background have all pointed towards the existence of a new type of matter, known as dark matter (DM). DM is believed to only interact appreciably through gravity alone and makes up around 85% of the known matter in our universe. The nature of this DM is unknown and a wide variety of candidates have been proposed, ranging from new hypothetical particles (such as WIMPs, axions and dark photons), primordial black holes and modified gravity theories.

In this work, I propose a novel approach to explaining DM through a 3-form gauge theory. A 3-form gauge field in vacuum only has a static solution that behaves like a cosmological constant. However, if we couple this 3-form gauge field to a cosmological medium, then through the Anderson-Higgs mechanism the gauge field gains an effective propagating degree of freedom. This results in a massive 3-form gauge field that can act as the role of DM.

We demonstrate that this coupling between the 3-form gauge field and the cosmological medium generates a mass source. We analyse the phenomenology of the theory assuming that the massive 3-form gauge field is dust-like and is the major source of cold dark matter in the Universe. We also show that in the very low coupling limit where the mass is very small, the dynamics of the 3-form gauge field becomes wave-like and becomes a possible candidate for warm dark matter. If this theory of DM were to be realised, it would imply that many of the current searches of DM may be unfeasible and new approaches to DM detection would need to be considered.

Author: CANETE, Christian Paolo

Presenter: CANETE, Christian Paolo

Session Classification: Dark Matter

Contribution ID: **61** Type: **Contributed Talk**

Absorption of dark matter particles in atoms via a Migdal-type effect

Thursday 12 December 2024 14:00 (30 minutes)

The Migdal effect describes the ionization rate of atoms during the scattering of heavy particles off atomic nuclei. It offers a new avenue for the search for dark matter particles with sub-GeV masses in liquid noble gas detectors. We propose a novel mechanism for atomic ionization, involving the complete absorption of dark matter particles upon interaction with atomic nuclei. Unlike inelastic dark matter scattering, this process transfers the particle's entire energy, including its rest mass (mc^2 term), to the electron. This approach enables the search for scalar dark matter particles with masses ranging from 1 to 100 keV using the same detectors, assuming these particles exhibit Yukawa-type interactions with nucleons.

Author: SAMSONOV, Igor (UNSW)

Presenter: SAMSONOV, Igor (UNSW)

Session Classification: Dark Matter

Contribution ID: **62** Type: **Contributed Talk**

Non-Holomorphic Modular $\mathcal{A}_4$ Symmetric Scotogenic Model

Thursday 12 December 2024 15:10 (20 minutes)

The present talk will cover an extension of a scotogenic and its modular $\mathcal{A}_4$ variation a step forward and demonstrates scotogenic modular $\mathcal{A}_4$ non-supersymmetric realization. To achieve this non-holomorphic modular symmetries come to rescue. Advantage of the current construction is the compactness of the model content and absence of the supersymmetric fields. Neutrino mass is generated through a canonical scotogenic mechanism. The allowed values of the VEV of the τ modulus are $\tau \simeq w$ and $\mathrm{Im}[\tau] \approx 2$. The non-holomorphic modular $\mathcal{A}_4$ symmetry leads to correlations among the neutrino observables.

Authors: Prof. OKADA, Hiroshi (Henan Normal University); Dr POPOV, Oleg (Shenzhen MSU-BIT University); Prof. NOMURA, Takaaki (Sichuan University)

Presenter: Dr POPOV, Oleg (Shenzhen MSU-BIT University)

Session Classification: Standard Model and Beyond

Contribution ID: **63** Type: **Contributed Talk**

CMB and 21cm constraints on Primordial Black Holes

Tuesday 10 December 2024 15:30 (20 minutes)

Post-recombination cosmological probes offer some of the most stringent constraints on the properties of Dark Matter. The Cosmic Microwave Background (CMB), within the ΛCDM framework, has provided precise measurements of the Dark Matter density and its properties. Similarly, with upcoming 21cm experiments, the 21cm signal is a promising late-time cosmological probe, particularly sensitive to exotic energy injections during the Cosmic Dawn. In this talk, I will discuss the constraints imposed on solar mass and heavier primordial black holes by these probes, addressing in detail the combined effects of radiation feedback in accretion and Dark Matter mini-halos on the bound. I will use this example to explain how cosmological probes can be used generically to constrain exotic energy injections from various Dark Matter candidates.

Author: AGIUS, Dominic (IFIC, University of Valencia)

Presenter: AGIUS, Dominic (IFIC, University of Valencia)

Session Classification: Cosmology

Contribution ID: **64** Type: **Contributed Talk**

Listening to Dark Sectors with Pulsar Timing Arrays

Tuesday 10 December 2024 14:30 (20 minutes)

We study gravitational wave (GW) signatures from dark sector phase transitions as an explanation of the stochastic GW signal in the nHz range reported by the NANOGrav, Parkes and European Pulsar Timing Array (PTA) experiments. In contrast to earlier works, which have focused on fitting the PTA results with phenomenological phase transition parameters, we perform a detailed analysis of the GW spectrum beginning from underlying dark sector models at the microscopic level. We find viable models that can fit the PTA results, while consistent with other cosmological constraints.

Authors: Dr BANIK, Amitayus (Chungbuk National University); Prof. CUI, Yanou (University of California, Riverside); TSAI, Yu-Dai (University of California, Irvine); TSAI, Yuhsin (University of Notre Dame)

Presenter: Dr BANIK, Amitayus (Chungbuk National University)

Session Classification: Cosmology

Contribution ID: **65** Type: **not specified**

Prediction of non-Gaussianity in CMB lensing with full-sky simulations

Tuesday 10 December 2024 17:10 (20 minutes)

The lensing convergence field describing the weak lensing effect of the Cosmic Microwave Background (CMB) radiation is expected to be subject to mild deviations from Gaussianity. Accurately predicting this non-Gaussianity requires precise numerical simulations. However, simulating CMB lensing, which involves lens structures all the way back to the last scattering surface, is computationally intensive. We present a full-sky CMB lensing simulation algorithm that addresses this challenge by combining the multi-plane method with hierarchical N-body simulations using adaptive box sizes for generating lens shells. This method achieves high angular resolution (up to $\ell \sim 3000$) and full-sky coverage while maintaining manageable computational demands. Our results demonstrate that high-redshift coverage in numerical simulations, up to $z \sim 10$, is essential for capturing non-Gaussian features in the lensing field. Incorporating non-Gaussian information in the analysis improves constraints on cosmological parameters. This work provides precise predictions for non-Gaussianity in CMB lensing data, which will be important for CMB lensing analysis in future CMB experiments. Additionally, the algorithm can be adapted for use in galaxy weak lensing simulations by adjusting the source redshift, allowing for its application in a broader range of cosmological studies.

Authors: HAMANN, Jan (The University of New South Wales); KANG, Yuqi

Presenter: KANG, Yuqi

Session Classification: Cosmology

Contribution ID: **66** Type: **Contributed Talk**

Early Universe phase transitions in a Scale Invariant Standard Model

Tuesday 10 December 2024 14:50 (20 minutes)

The mass hierarchy problem is concerned with the large differences in scale present in our universe, namely between the Higgs mass (125 GeV) and the Planck mass (10^{19} GeV). The Standard Model currently offers no explanation for this difference which prompts the investigation of other fundamental theories. It has been argued that scale invariance of physical laws may be a solution to hierarchy problem. In this theory, physical laws are invariant under mass, energy or length scalings and it is only through quantum mechanical effects that scales and the hierarchy of scales emerge. A general cosmological consequence of this theory is that electroweak symmetry breaking doesn't occur until later in the universe's evolution, at lower temperatures. Here, it is triggered by chiral symmetry breaking, when the unbound quarks of the universe cool and condense into bound hadron states. This change in conditions results in the electroweak symmetry breaking occurring via a first-order phase transition. In this talk, I present preliminary estimates for the peak frequency and amplitude of the gravitational waves that would be produced by such a transition, along with the peak mass and abundance of primordial black holes that would be produced.

Author: CESCA, Joshua

Presenter: CESCA, Joshua

Session Classification: Early Universe

Contribution ID: **67** Type: **not specified**

Scale Dependence of Neutrino Mixing Parameters in the Scotogenic Model

Tuesday 10 December 2024 15:10 (20 minutes)

Quantum corrections to neutrino mixing parameters introduce a scale dependence through running of the renormalization group. We discuss this scale dependence of the neutrino mass matrix in a modified scotogenic model under the framework of an effective field theory below the electroweak scale.

Authors: LACKNER, Adam; SCHMIDT, Michael (UNSW Sydney); ZHANG, Weihang

Presenter: ZHANG, Weihang

Session Classification: Standard Model and Beyond

Contribution ID: **69** Type: **Contributed Talk**

Revisiting Metastable Cosmic String Breaking

Tuesday 10 December 2024 16:50 (20 minutes)

Metastable cosmic strings are gathering attention as potential progenitors of stochastic gravitational wave background. They result from a two-step symmetry breaking $G \to H \to 1$ with $\pi_1(G) = 0$ and $\pi_1(H) \neq 0$, and decay via internal monopole-antimonopole pair creation.
Conventionally, the breaking rate has been estimated by an infinitely thin string approximation, which requires a large hierarchy between the symmetry breaking scales.
We numerically constructed a tunneling path and thus obtained a robust lower limit on the tunneling factor e^{-S} even for mild scale hierarchy. In particular, it is relevant to the cosmic string interpretation of the gravitational wave signals recently reported by pulsar timing array experiments.

Authors: CHITOSE, Akifumi (Institute for Cosmic Ray Research, University of Tokyo); WATANABE, Keiichi; IBE, Masahiro (Institute for Cosmic Ray Research, University of Tokyo); SHIRAI, Satoshi (Kavli IPMU); Mr NAKAYAMA, Yuhei (The University of Tokyo)

Presenter: CHITOSE, Akifumi (Institute for Cosmic Ray Research, University of Tokyo)

Session Classification: Cosmology

Contribution ID: **70** Type: **Invited Talk**

Spin-2 Scattering Amplitudes and Gravitational Portal Dark Matter

Friday 13 December 2024 11:30 (1 hour)

The diffeomorphism invariance of a compactified five-dimensional theory of gravity is spontaneously broken by the background space-time geometry. In this talk we discuss the surprising properties of the scattering amplitudes of the massive spin-2 Kaluza-Klein modes of these theories, and explain the origin of these properties in terms of underlying hidden symmetries.

We revisit dark-matter (DM) models within radius stabilized Randall-Sundrum models. Specifically we consider models where the dark matter candidates are Standard Model (SM) singlets confined on the TeV brane, and interact with the SM via the spin-2 Kaluza-Klein (KK) modes and through spin-0 Goldberger-Wise modes. By taking into account relic-density, latest collider constraints and direct detection into account, we show that the spin-2 KK portal DM models are highly constrained. In particular we show that within the usual thermal freeze-out scenario, scalar and fermion dark matter models are ruled out, while vector dark matter models are still viable for a certain region of parameter space. We point out the relevance of the massive radion in these models, and show that radion mediated annihilation play a significant role in evading the constraints.

Presenters: SIMMONS, Elizabeth (University of California, San Diego); CHIVUKULA, R. Sekhar (UC San Diego)

Session Classification: Plenary

Contribution ID: **71** Type: **Invited Talk**

New results in axion physics

Monday 9 December 2024 14:00 (30 minutes)

Presenter: GHERGHETTA, Tony

Session Classification: Plenary

Contribution ID: **72** Type: **not specified**

Hot dark matter in N-body simulations

Tuesday 10 December 2024 14:30 (20 minutes)

We generalise the SuperEasy linear response method, originally developed to describe massive neutrinos in cosmological N-body simulations, to any hot dark matter (HDM) species with arbitrary momentum distributions. The method, implemented in a Particle-Mesh simulation code, is able to predict the total matter spectrum to sub-percent level accuracy relative to particle HDM (neutrino) simulations. Applying the method to cosmologies with mixed neutrinos+thermal QCD axions and neutrinos+generic thermal bosons, we find that non-standard HDM cosmologies have no intrinsically different non-linear signature in the total matter power spectrum from standard neutrino cosmologies. However, because they predict different time dependencies even at the linear level and the differences are augmented by non-linear evolution, it remains a possibility that observations at multiple redshifts may help distinguish between them.

Presenter: PIEROBON, Giovanni

Session Classification: Dark Matter

Contribution ID: **73** Type: **Invited Talk**

The minimal cosmological standard model

Monday 9 December 2024 17:00 (30 minutes)

A minimal scenario for the BSM physics, dubbed as the minimal cosmological standard model, will be introduced, and its key cosmological aspects will be discussed.

Presenter: PARK, Wanil (JBNU)

Session Classification: Plenary

Contribution ID: **74** Type: **Invited Talk**

The symmetries of extra-dimensional gravitational theories and their consequences

The diffeomorphism invariance of a compactified five-dimensional theory of gravity is spontaneously broken by the background space-time geometry. In this talk we discuss the surprising properties of the scattering amplitudes of the massive spin-2 Kaluza-Klein modes of these theories, and explain the origin of these properties in terms of underlying hidden symmetries.

Presenter: SIMMONS, Elizabeth (University of California, San Diego)

Session Classification: Plenary

Contribution ID: **75** Type: **Invited Talk**

Neutrino Mass and Mass Ordering with Cosmic Gravitational Focusing

Friday 13 December 2024 09:30 (30 minutes)

The cosmic gravitational focusing (CGF) is the 3rd cosmological way of measuring the neutrino masses. Different from the existing methods with CMB and large scale structure that have linear dependence on the neutrino mass sum, CGF is sensitive to the fourth power of the neutrino masses and hence can provide an independent measurement of the neutrino mass. We thoroughly explore the cosmic gravitational focusing of cosmic neutrino fluid (CνF) by dark matter (DM) halo using both general relativity for a point source of gravitational potential and Boltzmann equations for continuous overdensities. Derived in the general way for both relativistic and non-relativistic neutrinos, our results show that the effect has fourth power dependence on the neutrino mass and temperature. We take DESI as an example to illustrate that the projected sensitivity as well as its synergy with existing terrestrial neutrino oscillation experiments and other cosmological observations can significantly improve the neutrino mass and mass ordering measurements.

Author: Prof. GE, Shao-Feng (TDLI-SJTU)

Presenter: Prof. GE, Shao-Feng (TDLI-SJTU)

Session Classification: Plenary

Contribution ID: **77** Type: **Invited Talk**

Gravitational Waves and Dark Matter in Gauged Two-Higgs Doublet Model

Thursday 12 December 2024 16:20 (30 minutes)

Presenter: YUAN, tc (IOP Academia Sinica)

Session Classification: Plenary

Contribution ID: **78** Type: **Invited Talk**

Cogenesis by Majoron

Wednesday 11 December 2024 09:00 (30 minutes)

We propose a scenario for cogenesis of baryon asymmetry and dark matter driven by Majoron. It can be achieved assuming either an initial kinetic motion or a conventional misalignment with symmetry non-restoration.

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

Session Classification: Plenary

Contribution ID: **79** Type: **Invited Talk**

Lessons from the by-gone anomalies: From Data to Models to Theories

Thursday 12 December 2024 17:20 (30 minutes)

During the last few decades, many experimental anomalies were reported and then most of them eventually disappeared. Very often they employ simplified or phenomenological models in order to interpret anomalous data. I will show a few examples where this common approach largely fails, and emphasize that it is important to interpret the anomalous data in mathematically consistent models.

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

Session Classification: Plenary

Contribution ID: **80** Type: **Invited Talk**

Interplay between (g-2)_{e_a} anomalies and lepton flavor violating decays in models beyond the Standard Model with inverse seesaw neutrinos

Thursday 12 December 2024 16:50 (30 minutes)

We will discuss the models beyond the Standard Model (BSM) consisting of inverse seesaw (ISS) neutrinos and singly charged Higgs bosons, which accommodate all the data of neutrino oscillation, the (g-2)_{e_a} anomalies of muon and electron, and the lepton flavor violating (LFV) decays. We will show that one-loop contribution related to ISS neutrino exchanges can lead to large LFV decay rates of the decays e_b-> e_a gamma and h,Z-> e_be_a in the regions satisfying the (g-2)_ea data. Moreover, the allowed regions of the parameter space that satisfy all data require complicated destructive correlations among one-loop contributions to LFV amplitudes so that all decay rates can be consistent with experimental constraints.

Presenter: LE, Tho Hue (Science and Technology Advanced Institute, Van Lang University, Ho Chi Minh City, Vietnam)

Session Classification: Plenary

Contribution ID: **81** Type: **Invited Talk**

Consequences of phase transitions occurred during inflation

Thursday 12 December 2024 11:00 (30 minutes)

In slow-roll inflationary models, the inflaton can undergo excursions on the order of the Planck scale, leading to significant changes in the properties of fields coupled to the inflaton, referred to as spectator fields. These changes may result in transitions between weakly and strongly interacting regimes, or even alterations in mass squared within the spectator field sector during inflation. Such dynamics can induce phase transitions, which have profound implications for the early Universe. In this talk, I will explore the phenomenological consequences of these phase transitions, focusing on the production of gravitational waves, curvature perturbations, non-Gaussianities, dark matter, and baryon number. I will also demonstrate how gravitational waves generated by scalar perturbations induced by phase transitions may potentially explain the alleged gravitational wave signals observed in recent pulsar timing array studies.

Presenter: AN, Haipeng

Session Classification: Plenary

Contribution ID: **82** Type: **Invited Talk**

Classical Backgrounds as Coherent States and Canonical Quantization of General Relativity

Monday 9 December 2024 11:00 (30 minutes)

Presenter: BEREZHIANI, Lasha (Max Planck Institute for Physics)

Session Classification: Plenary

Contribution ID: **83** Type: **Invited Talk**

Extreme energy cosmic rays: where do they all come from?

Tuesday 10 December 2024 12:00 (30 minutes)

I discuss paradoxical situation in detection of the highest energy cosmic rays by Telescope Array and Pierre Auger experiments, in particular, a strong discrepancy between their results for cosmic ray fluxes at energies above the GZK cutoff. I also discuss ideas of new BSM physics and dark matter identity which could naturally resolve these paradoxes.

Presenter: BEREZHIANI, Zurab (Univ. L'Aquila)

Session Classification: Plenary

Contribution ID: **84** Type: **Invited Talk**

Impacts of the ALP on dark photon searches

Thursday 12 December 2024 11:30 (30 minutes)

Presenter: CHEN, Chuan-Ren (National Taiwan Normal University)

Session Classification: Plenary

Contribution ID: **85** Type: **Invited Talk**

Light dark matter detection

Tuesday 10 December 2024 09:30 (30 minutes)

Presenter: Dr COX, Peter (The University of Melbourne)

Session Classification: Plenary

Contribution ID: **86** Type: **Invited Talk**

Lessons from the Seiberg-Witten axion

Monday 9 December 2024 09:30 (30 minutes)

Presenter: CSAKI, Csaba (Cornell University)

Session Classification: Plenary

Contribution ID: **87** Type: **Invited Talk**

Hyper-Kamiokande: Towards New Discoveries in (Astro)Particle Physics

Thursday 12 December 2024 09:00 (30 minutes)

The Hyper-Kamiokande project in Japan envisions a broad experimental program, including the discovery of charge-parity violation in neutrino oscillation, the search for nucleon decay and (indirectly) dark matter, and supernova neutrinos. This talk will describe the current status and efforts towards realizing this next generation experiment.

Presenter: DE PERIO, Patrick (Kavli IPMU, University of Tokyo)

Session Classification: Plenary

Contribution ID: **88** Type: **Invited Talk**

Saturons

Tuesday 10 December 2024 09:00 (30 minutes)

Presenter: DVALI, Gia

Session Classification: Plenary

Contribution ID: **89** Type: **not specified**

Axions beyond the QCD axion

Wednesday 11 December 2024 11:00 (30 minutes)

Presenter: GORI, Stefania (UC Santa Cruz)

Session Classification: Plenary

Contribution ID: **90** Type: **Invited Talk**

Baryon Asymmetry of the Universe and New Physics

Wednesday 11 December 2024 09:30 (30 minutes)

Presenter: IPEK, Seyda

Session Classification: Plenary

Contribution ID: **92** Type: **Invited Talk**

Axion DM from Inflation-driven Quantum Phase Transition

Thursday 12 December 2024 12:00 (30 minutes)

Presenter: LEE, Seung J. (Korea University)

Session Classification: Plenary

Contribution ID: **93** Type: **Invited Talk**

Our Universe in Simulation

Monday 9 December 2024 17:30 (30 minutes)

We are expecting high-precision observations from upcoming CMB surveys, such as the Simons Observatory, CMB-S4, and LiteBIRD, as well as from surveys of the large-scale structure, such as Rubin LSST, Euclid, DESI, PSF, SPHEREx, and Roman. Most of the observables from these independent surveys will be correlated due to their sky and redshift overlaps. Joint analysis of these surveys will be key to transformative discoveries in fundamental physics ——inflation, dark energy, dark matter, and neutrino mass. In this talk, I will discuss paths to simulate correlated CMB and LSS observables to achieve these goals.

Presenter: LIU, Jia (IPMU)

Session Classification: Plenary

Contribution ID: **95** Type: **Invited Talk**

Blazar-boosted dark matter: a cosmic accelerator for Sub-GeV dark matter particle detection

Tuesday 10 December 2024 10:00 (30 minutes)

The search for dark matter (DM) remains one of the most pressing challenges in modern physics. Detecting sub-GeV DM particles poses significant challenges for traditional Earth-based detectors due to their low collision energies. This talk presents a novel approach to overcome these limitations: blazar-boosted dark matter (BBDM). I will explore how active galactic nuclei (AGN) with jets oriented towards Earth, known as blazars, can serve as cosmic particle accelerators for DM. Through interactions with hadronic matter in blazar jets, DM particles in the host galaxy's halo can be significantly accelerated, potentially reaching Earth with kinetic energies high enough for detection.

This presentation will cover the theoretical framework of BBDM, including blazar selection, modeling, and the upscattering mechanism in the DM halo. Notably, this is the first work that brings together experimental particle physicists, astrophysicists, and theoretical physicists, representing a cross-section of different disciplines. This approach allows us to explore the potential of BBDM, potentially opening new avenues for DM research.

Presenter: MANENTI, Laura (University of Sydney)

Session Classification: Plenary

Contribution ID: **96** Type: **Invited Talk**

New developments in effective field theory

Monday 9 December 2024 15:00 (30 minutes)

Presenter: PAGÈS, Julie

Session Classification: Plenary

Contribution ID: **97** Type: **Invited Talk**

False vacuum decay in and out of equilibrium

Friday 13 December 2024 10:00 (30 minutes)

False vacuum decay plays an important role in many branches of physics. In many systems, the initial state is in local thermodynamic equilibrium around the metastable minimum. For such systems the Euclidean path integral is a powerful tool to compute the decay rate or the shape of the true vacuum bubble. On the other hand, the Euclidean approach does not capture real-time dynamics of the phase transition such as the bubble formation and growth, clustering of the bubbles, etc. Furthremore, it is, in general, inapplicable to the decay in out-of-equilibrium states which occur ubiquitously in the universe (preheating, black holes, etc.). Other methods are needed to address these questions and to test the predictions of the Euclidean theory. I will review these methods and recent studies of vacuum decay. I will give two examples emphasizing the role of non-equilibrium effects. The first is the decay catalyzed by a black hole in the Unruh vacuum. The second is the decay from the thermal metastable state in the regime when equilibrium is violated during the bubble nucleation process. I will show that in both cases the decay rate is significantly suppressed compared to the predictions of the standard thermal theory.

Presenter: SHKERIN, Andrey

Session Classification: Plenary

Contribution ID: **98** Type: **Contributed Talk**

New 511 keV Line Data Provide Strongest Sub-GeV Dark Matter Constraints

Thursday 12 December 2024 15:30 (20 minutes)

We explore the 511˜keV emission associated to sub-GeV dark matter (DM) particles that can produce electron-positron pairs and form positronium after thermalizing. We use $\sim$ 16˜yr of SPI data from INTEGRAL to constrain DM properties, including the full positron propagation and losses, and the free electron density suppression away from the Galactic plane. We show that the predicted longitude and latitude profiles vary significantly for different DM masses, unlike previous assumptions, and obtain the strongest limits on sub-GeV DM (from the MeV to a few GeV) so far, excluding cross-sections down to $\langle\sigma v\rangle$
$lesssim10^{-32}$ cm^3 s^{-1} for $m_\chi \sim 1$ MeV and $\langle\sigma v\rangle$
$lesssim10^{-26}$ cm^3 s^{-1} for $m_\chi \sim 5$ GeV and lifetimes up to τ
$gtrsim10^{29}$ s for $m_\chi \sim 1$ MeV and τ
$gtrsim10^{27}$ s for $m_\chi \sim 5$˜GeV for the typical Navarro-Frenk-White DM profile. Our derived limits are robust within a factor of a few due to systematic uncertainties.

Presenter: BALAJI, Shyam (LPTHE)

Session Classification: Light and ultralight physics

Contribution ID: **99** Type: **Invited Talk**

Gravitational relics from topological defects

Monday 9 December 2024 16:30 (30 minutes)

Presenter: KITAJIMA, Naoya

Session Classification: Plenary

Contribution ID: **100** Type: **not specified**

Unitarity, Causality, and Solar System Bounds, Significantly Limit Using Gravitational Waves to Test General Relativity

Friday 13 December 2024 11:00 (30 minutes)

The prospect of detecting/constraining deviations from general relativity by studying gravitational waves (GWs) from merging black holes has been one of the primary motivations of GW interferometers like LIGO/Virgo. Within pure gravity, the only possible way deviations can arise is from the existence of higher order derivative corrections, namely higher powers of the Riemann curvature tensor, in the effective action. Any observational bounds imply constraints on the corresponding Wilson coefficients. At the level of the action, one can imagine the coefficients are sufficiently large so as to be in principle detectable. However, from the point of view of some fundamental principles, namely causality and unitarity, this is much less clear, as we examine here. We begin by reviewing certain known bounds on these coefficients, which together imply a low cut off on the effective theory. We then consider a possible mechanism to generate such terms, namely in the form of many minimally coupled light scalars that can be integrated out to give these higher order operators. We show that a by product of this is the generation of quantum corrections to Newton's potential, whose observable consequences are already ruled out by solar system tests. We point out that over 7 orders of magnitude of improvement in interferometer sensitivity would be required to avoid such solar system constraints.

Presenter: HERTZBERG, Mark (Tufts University)

Session Classification: Plenary

Contribution ID: **102** Type: **Invited Talk**

Weak supervision techniques in collider physics

Friday 13 December 2024 09:00 (30 minutes)

Presenter: Prof. CHIANG, Cheng-Wei (National Taiwan University)

Session Classification: Plenary

Contribution ID: **103** Type: **not specified**

Closing remarks

Friday 13 December 2024 12:30 (5 minutes)

Session Classification: Plenary

Contribution ID: **104** Type: **not specified**

Opening

Monday 9 December 2024 09:15 (15 minutes)

Session Classification: Plenary

Contribution ID: **106** Type: **Contributed Talk**

Detecting Dark Matter Coherent Scattering via a Novel Torsion Balance Experiment

Thursday 12 December 2024 15:10 (20 minutes)

Dark matter with mass in the crossover range between wave dark matter and particle dark matter, around $(10^{-3}, 10^{3})$ eV, remains relatively unexplored by terrestrial experiments. In this mass regime, dark matter scatters coherently with macroscopic objects. The effect of the coherent scattering greatly enhances the accelerations of the targets that the dark matter collisions cause by a factor of $\sim 10^{23}$. We propose a novel torsion balance experiment with test bodies of different geometric sizes to detect such dark matter-induced acceleration. This method provides the strongest constraints on the scattering cross-section between the dark matter and a nucleon in the mass range $(10^{-5}, 10^{3})$ eV.

Presenter: SHENG, Jie (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Session Classification: Light and ultralight physics

Contribution ID: **107** Type: **Invited Talk**

θ-vacua, quantum gravity and particles spectrum

Monday 9 December 2024 10:00 (30 minutes)

In this talk, I will argue that the consistency of non-perturbative θ-vacua in gauge theories and gravity predicts the presence of axion-like particles (ALPs) in the particle spectrum. This prediction also necessitates additional structures in these theories. Specifically, General Relativity incorporates Eguchi-Hanson instantons, which generate gravitational θ-vacua. The S-matrix formulation of gravity requires the elimination of these θ-vacua, leading to the formulation of the Gravity-CP problem. The only viable solution to this problem is spontaneously broken supergravity, which predicts an ALP that acquires mass exclusively from gravitational θ-vacua. Consequently, these particles exhibit a correlated mass with the gravitino. Their appearance is due to consistency, making them promising candidates for dark matter.

Furthermore, the electroweak sector of the Standard Model possesses its own θ-vacua, which are removed via $B + L$ symmetry. I will argue that this symmetry should be realized non-linearly, leading to the emergence of a composite ultra-light particle, η_w, within the Standard Model. I will also examine the scenario where $B + L$ symmetry is explicitly broken. Using gravitational arguments, I will discuss the necessity of its exactness and/or the existence of an external ALP coupled with the aforementioned θ-vacuum structure, thereby making predictions about the existence of the η_w particle rigorous and strict.\\

The talk is based on:

2406.18402 [hep-th], 2408.07535 [hep-th].

Presenter: Dr SAKHELASHVILI, Otari (Sydney University)

Session Classification: Plenary

Contribution ID: **108** Type: **Contributed Talk**

Dark matter in stabilised warped extra-dimensional model with heavy radion

Thursday 12 December 2024 15:30 (20 minutes)

Presenter: SANAMYAN, George

Session Classification: Dark Matter

Contribution ID: **109** Type: **Contributed Talk**

Bayesian Optimisation for Bayesian Evidence (BOBE)

Thursday 12 December 2024 15:30 (20 minutes)

Presenter: COHEN, Nathan

Session Classification: Cosmology

Contribution ID: **110** Type: **Contributed Talk**

Delicate Cancellations in Kaluza-Klein Dark Matter Calculations

Thursday 12 December 2024 15:10 (20 minutes)

Presenter: GILL, Joshua

Session Classification: Dark Matter

Contribution ID: **111** Type: **not specified**

Proton decay from the bottom up

Monday 9 December 2024 15:30 (30 minutes)

In this talk I will present a general study of nucleon decay based on the SMEFT up to dimension 7. Our analysis takes into account RGE effects, and includes limits on the scale underlying each operator, an assessment of the possibility of flat directions, and correlations between decay modes assuming single-operator dominance. The talk is mainly based on 2312.13361.

Presenter: GARGALIONIS, John (IFIC)

Session Classification: Plenary

Contribution ID: **112** Type: **not specified**

Constraints on Antiquark Nuggets from Collisions with the Earth

Tuesday 10 December 2024 15:30 (20 minutes)

Antiquark nuggets are hypothetical composite objects composed of antimatter, proposed as candidates for a significant fraction of dark matter in the Universe. This talk explores the parameter space of antiquark nuggets, considering constraints from the observed neutrino flux from the Sun and Earth, alongside the non-observation of seismic events indicative of dark matter interactions.

Presenter: VONG, Garry

Session Classification: Dark Matter

Contribution ID: **113** Type: **not specified**

Astrometry, gravitational waves and synergies with Pulsar Timing Arrays

Tuesday 10 December 2024 14:50 (20 minutes)

Several Pulsar Timing Array (PTA) collaboratiosn have recently announced strong evidence for a stochastic gravitational background (SGWB) at nanohertz frequencies. In the same frequency range, high precision astrometry with surveys like Gaia can offer complimentary constraints on SGWB by tracking the positions of a large number of distant sources. We review the astrometric response to SGWB and discuss the potential of PTA-Astrometry cross-correlations to improve upon the SGWB constraints coming from PTA data alone. We show that such cross-correlations can enhance the overall sensitivity to SGWB, even when the constraining power of the astrometric data alone is low.

Presenter: MALHOTRA, Ameek (Swansea University)

Session Classification: Cosmology

Contribution ID: **114** Type: **Contributed Talk**

Axion Quality, Clockwork & Extra Dimensions

Thursday 12 December 2024 15:30 (20 minutes)

The Strong CP Problem is solved elegantly and economically by endowing the Standard Model of Particle Physics with a new complex scalar, and a spontaneously broken, anomalous global Peccei-Quinn (PQ) symmetry whose Goldstone boson is called the axion. Unfortunately, this solution may be spoiled by the global symmetry-breaking effects generically expected to arise in any effective theory of quantum gravity. This is known as the Axion Quality Problem, and it presents a highly non-trivial constraint on axion model-building. In this presentation, we will formulate a novel no-go theorem for any 3+1D model in which PQ symmetry arises residually from the spontaneous breaking of some larger (compact, connected) symmetry group: in a word, one cannot suppress gravitational corrections without also inadvertently suppressing the anomalous axion potential, in which case there is no relative protection to axion quality. As a motivating example, we will consider how this issue manifests in a so-called clockwork model, where the nearest-neighbour interactions of a field-space lattice of complex scalars can be used to exponentially suppress the axion coupling to gravity. However, drawing inspiration from the link between clockwork models and the deconstruction of higher-dimensional theories in curved spacetime, we will explore how the situation is fundamentally different in 4+1D, where the additional anomaly structure provided by the 5D Chern-Simons term may be a way past our 3+1D no-go result.

Author: BEOCANIN, Marko (University of New South Wales)

Presenter: BEOCANIN, Marko (University of New South Wales)

Session Classification: Standard Model and Beyond

Contribution ID: **115** Type: **not specified**

Self-interacting scalar field distributions around Schwarzschild black holes

Thursday 12 December 2024 14:30 (20 minutes)

Long-lived configurations of massive scalar fields around black holes may form if the coupling between the mass of the scalar field and the mass of the black hole is very small. In this work, we analyse the effect of self-interaction in the distribution of the long-lived cloud surrounding a stationary black hole. We consider both attractive and repulsive self-interactions.

Presenter: Mr AGUILAR NIETO, Alejandro

Session Classification: Cosmology

Contribution ID: **116** Type: **not specified**

Natural supersymmetry without cancellations in the quiver supersymmetric standard model

Tuesday 10 December 2024 17:30 (20 minutes)

Supersymmetry (SUSY) remains a leading candidate for physics beyond the Standard Model (SM). However, thus far, the LHC has not found any evidence of supersymmetry. The lower bound of the gluino mass exceeds 2 TeV and around 1 TeV for the stop in the bulk of parameter space. The fine-tuning of the electroweak symmetry breaking (EWSB) in the Minimal Supersymmetric Standard Model (MSSM) is almost below a percent level. Now the curse of the MSSM is the radiative electroweak symmetry breaking, which mixes the gaugino and stop masses with the Higgs mass via the renormalization group running. Furthermore, the inevitable separation between the mediation scale and the soft SUSY breaking mass, at least a loop factor, further complicates the situation. In order to ameliorate these issues, we investigate the potential of the quiver supersymmetric standard model. Instead of introducing intricate cancellations among different contributions, we double the SM gauge group and the top sector and separate the SUSY braking and the original SM gauge/Yukawa interaction between the two sectors, which are combined into the SM around the TeV scale to minimize the corrections to the Higgs mass. We present the results of our phenomenological analysis on the model.

Presenter: Dr OKUMURA, Kenichi (Iwate Medical University)

Session Classification: Standard Model and Beyond

Contribution ID: **117** Type: **not specified**

Announcement - parallel sessions

Tuesday 10 December 2024 10:30 (1 minute)

Session Classification: Plenary

Contribution ID: **118** Type: **not specified**

Beyond the Standard Model with Geometric Quantization

Tuesday 10 December 2024 17:50 (20 minutes)

Presenter: MCCLAIN, Tom

Session Classification: Standard Model and Beyond

Contribution ID: **119** Type: **not specified**

Announcement

Thursday 12 December 2024 12:30 (1 minute)

Session Classification: Plenary