The Mitchell Conference on Collider, Dark Matter, and Neutrino Physics 2023

Report of Contributions

https://indico.cern.ch/e/1252762

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

Energy-peak based method to measure top quark mass via B-hadron decay lengths

Wednesday 17 May 2023 16:15 (25 minutes)

We develop a method for the determination of the top quark mass using the distribution of the decay length of the B-hadrons originating from its decay. This technique is based on our earlier observation regarding the location of the peak of the b quark energy distribution. Such "energy-peak" methods enjoy a greater degree of model-independence with respect to the kinematics of top quark production compared to earlier proposals. The CMS experiment has implemented the energy-peak method using associated b-jet energy as an approximation for b quark energy. The new method uses B-hadron decay lengths, which are related to b quark energies by convolution. The advantage of the new decay length method is that it can be applied in a way that evades jet-energy scale (JES) uncertainties. Indeed, CMS has measured the top quark mass using B-hadron decay lengths, but they did not incorporate the energy-peak method. Therefore, mismodeling of top quark transverse momentum remains a large uncertainty in their result. We demonstrate that, using energy-peak methods, this systematic uncertainty can become negligible. We show that with the current LHC data set, a sub-GeV statistical uncertainty on the top quark mass can be attained with this method. To achieve a comparable systematic uncertainty as is true for many methods based on exclusive or semi-inclusive observables using hadrons, we find that the quark-hadron transition needs to be described significantly better than is the case with current fragmentation functions and hadronization models.

Primary author: AGASHE, Kaustubh

Co-authors: SATHYAN, Deepak; KIM, Doojin; INCANDELA, Joseph (Univ. of California Santa Barbara (US)); FRANCESCHINI, Roberto (Rome 3 U.); AIREN, Sagar

Presenter: AGASHE, Kaustubh

Session Classification: Collider

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

Dark Matter and Baryogenesis from Long-Lived Particles in the Visible Sector

Friday 19 May 2023 11:40 (25 minutes)

A minimal extension of the standard model is presented that includes a long-lived fermion with weak-scale mass and an O(GeV) fermionic dark matter candidate. Decays of a TeV-scale colored scalar in a radiation-dominated phase bring the former to a thermal abundance while also producing dark matter. The long-lived fermion then drives a period of early matter domination and decays to reheat the universe and also generates a baryon asymmetry. The allowed parameter space of this model can be probed by proposed long-lived particle searches as well as next-generation neutron-antineutron oscillation experiments.

Primary author: ALLAHVERDI, Rouzbeh (University of New Mexico)

Presenter: ALLAHVERDI, Rouzbeh (University of New Mexico)

Session Classification: Cosmology

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

Blazar constraints on the dark matter - neutrino cross section

Wednesday 17 May 2023 09:30 (25 minutes)

The flux of high energy neutrinos and photons produced in a blazar could get attenuated when they propagate through the dark matter spike around the central black hole and the halo of the host galaxy. Using the observation by IceCube of a few high-energy neutrino events from TXS 0506+056, and their coincident gamma ray events, we obtain new constraints on the dark matter-neutrino and dark matter-photon scattering cross sections. Our constraints are orders of magnitude more stringent than those derived from considering the attenuation through the intergalactic medium and the Milky Way dark matter halo. When the cross-section increases with energy, our constraints are also stronger than those derived from the CMB and large-scale structure.

Primary author: FERRER ESCURSELL, Francesc

Presenter: FERRER ESCURSELL, Francesc

Session Classification: Dark matter

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

Understanding Jet Charge

Wednesday 17 May 2023 16:40 (25 minutes)

The jet charge is an old observable that has proven uniquely useful for discrimination of jets initiated by different flavors of light quarks, for example. In this talk, I propose an approach to understanding the jet charge by establishing simple, robust assumptions that hold to good approximation non-perturbatively, such as isospin conservation and large particle multiplicity in the jets, forgoing any attempt at a perturbative analysis. From these assumptions, the jet charge distribution with fixed particle multiplicity takes the form of a Gaussian by the central limit theorem and whose mean and variance are related to fractional-power moments of single particle energy distributions. These results make several concrete predictions for the scaling of the jet charge with the multiplicity, explaining many of the results already in the literature, and new results we validate in Monte Carlo simulation.

Primary author: LARKOSKI, Andrew (UCLA)

Presenter: LARKOSKI, Andrew (UCLA)

Session Classification: Collider

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

Parity solution to the strong CP problem and leptogenesis

Tuesday 16 May 2023 09:30 (25 minutes)

I discuss parity solutions to the strong CP problem which do not need an axion. It is implemented within the context of left-right symmetric models with minimal Higgs content and the universal seesaw mechanism using vector like fermions to generate quark and lepton masses. I discuss a way to understand the origin of matter-anti-matter asymmetry in these models using Affleck-Dine (AD) mechanism. The model has Dirac neutrinos whose small masses arise via the Dirac seesaw. I discuss some phenomenological implications of the model.

Primary author: MOHAPATRA, Rabindra

Presenter: MOHAPATRA, Rabindra

Session Classification: Cosmology

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

First FASER Physics Results

Tuesday 16 May 2023 14:55 (25 minutes)

This talk will present the first physics results of the FASER experiment, where we were the first to directly observe neutrino interactions at a particle collider experiment and also probed previously unconstrained phase space of the dark photon with couplings 10^{-5}—10^{-4} and masses ~10 MeV - 100 MeV. FASER is an experiment dedicated to searching for light, extremely weakly-interacting particles that are produced in the very forward direction of high-energy pp collisions at CERN's Large Hadron Collider (LHC). The detector is placed 480 m downstream of the ATLAS interaction point, aligned with the beam collisions axis, and consists of both active electronic components intended to search for BSM physics and a passive tungsten emulsion target intended for neutrino physics. The results presented in this talk were obtained using a dataset collected at center-of-mass energy $\sqrt{s}$=13.6 TeV in 2022 during LHC Run 3.

Primary author: FELLERS, Deion Elgin (University of Oregon (US))

Presenter: FELLERS, Deion Elgin (University of Oregon (US))

Session Classification: Collider

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

Dark matter physics: from the early universe to near-field cosmology

Thursday 18 May 2023 11:15 (25 minutes)

Cosmological observables, from the CMB anisotropy to the census of galaxies in the local universe, offer the most direct and broad tests for the nature of dark matter, including a number of scenarios that are challenging or even impossible to test in a laboratory setting. I will review the status of the recent early-universe and late-universe searches for the identity of dark matter, summarizing the best current limits on scattering between dark matter and baryons, the non-thermal production mechanisms for sterile neutrinos, and mass bounds on thermal-relic dark matter. I will highlight the interplay between complementary probes of dark matter physics, focusing especially on the substructure in the Milky Way and its potential to resolve cosmological tensions. Finally, I will discuss the prospects for unveiling the physics of dark matter in the coming decade.

Primary author: Prof. GLUSCEVIC, Vera (University of Southern California)

Presenter: Prof. GLUSCEVIC, Vera (University of Southern California)

Session Classification: Dark matter

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

Effective field theory approach for radiative corrections in neutron beta decay

Friday 19 May 2023 09:55 (25 minutes)

We study radiative corrections to the neutron beta decay within the top-down effective field theory approach. First, we match the Standard Model to the four-fermion effective field theory specifying the scheme dependence of the Wilson coefficients. To evaluate radiative corrections at scales of the neutron decay, we perform matching to the heavy-baryon chiral perturbation theory for the vector coupling constant. We find an agreement with traditional current-algebra approach at one-loop level and perform detailed evaluation in renormalization-group-improved perturbation theory.

Primary authors: MEREGHETTI, Emanuele (Los Alamos National Laboratory); TOMALAK, Oleksandr; CIRIGLIANO, Vincenzo (UW); DEKENS, Wouter (UW)

Presenter: TOMALAK, Oleksandr

Session Classification: Nuclear physics

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

Stepped Partially Acoustic Dark Matter (SPartAcous)

Tuesday 16 May 2023 17:30 (25 minutes)

In this talk, we present a new interacting dark sector model, Stepped Partially Acoustic Dark Matter (SPartAcous), that can tackle two major issues in current cosmological data, namely the H_0 and S_8 problems. Similar to Partially Acoustic Dark Matter (PAcDM), this model involves a part of dark matter that interacts with dark radiation at high temperatures, resulting in a decrease in the formation of structure at small scales and thus, solving the S_8 problem. However, in the SPartAcous model, the dark radiation comprises a light component that becomes non-relativistic near the time of matter-radiation equality. As this light component annihilates, the remaining dark radiation warms up, leading to a step-like increase in the relative energy density in dark radiation. This step-like increase significantly mitigates the H_0 tension. Moreover, dark matter and dark radiation become decoupled, ensuring that the power spectrum at larger scales is similar to that of ΛCDM.

Primary author: YOUN, Taewook (University of Texas at Austin)

Presenter: YOUN, Taewook (University of Texas at Austin)

Session Classification: Collider

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

Anomalous Triple Gauge Couplings in Electroweak Dilepton Tails at the LHC and Interference Resurrection

Wednesday 17 May 2023 17:30 (25 minutes)

We will discuss about the electroweak dilepton production with two forward jets at the LHC, aiming to measure the anomalous triple gauge couplings in the Effective Field Theory (EFT) approach. This process provides a new example where the interference between Standard Model (SM) and beyond the SM is resurrected in the inclusive cross section of the full amplitude, including two forward jets. As a concrete illustration, we will show the detailed analytic and numerical study of the interference using a simpler toy process. Finally, we will talk about the sensitivity to anomalous triple gauge couplings at the LHC and the high luminosity LHC.

Primary author: SON, Minho

Presenter: SON, Minho

Session Classification: Collider

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

Jet SIFT-ing: a new scale-invariant jet clustering algorithm for the substructure era

Wednesday 17 May 2023 17:05 (25 minutes)

We describe a new jet clustering algorithm named SIFT (Scale-Invariant Filtered Tree) that maintains the resolution of substructure for collimated decay products at large boosts. The scale-invariant measure combines properties of kT and anti-kT by preferring early association of soft radiation with a resilient hard axis, while avoiding the specification of a fixed cone size. Integrated filtering and variable-radius isolation criteria block assimilation of soft wide-angle radiation and provide a halting condition. Mutually hard structures are preserved to the end of clustering, automatically generating a tree of subjet axis candidates. Excellent object identification and kinematic reconstruction for multi-pronged resonances are realized across more than an order of magnitude in transverse energy. The clustering measure history facilitates high-performance substructure tagging, which we quantify with the aid of supervised machine learning. These properties suggest that SIFT may prove to be a useful tool for the continuing study of jet substructure.

Primary authors: LARKOSKI, Andrew (UCLA); RATHJENS, Denis (Texas A & M University (US)); VEATCH, Jason Robert (California State University (US)); Prof. WALKER, Joel (Sam Houston State University)

Presenter: Prof. WALKER, Joel (Sam Houston State University)

Session Classification: Collider

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

Leptogenesis triggered by a first-order phase transition

Tuesday 16 May 2023 09:55 (25 minutes)

In this talk, I will present a new scenario of leptogenesis, which is triggered by a first-order phase transition (FOPT). The right-handed neutrinos (RHNs) are massless in the old vacuum, while they acquire a mass in the new vacuum bubbles, and the mass gap is huge compared with the FOPT temperature. The ultra-relativistic bubble walls sweep the RHNs into the bubbles, where the RHNs experience fast decay and generate the lepton asymmetry, which is further converted to the baryon asymmetry of the Universe (BAU). Since the RHNs are out of equilibrium inside the bubble, the generated BAU does not suffer from the thermal bath washout. I will first discuss the general feature of such a FOPT leptogenesis mechanism, and then realize it in an extended B–L model.

Primary author: HUANG, Peisi

Presenter: HUANG, Peisi

Session Classification: Cosmology

Contribution ID: **14** Type: **not specified**

Entanglement and Bell's Inequalities with boosted top quark pairs

Wednesday 17 May 2023 15:20 (25 minutes)

The Large Hadron Collider provides a unique environment to study quantum entanglement and violation of Bell's inequalities at the highest energy available today. In this talk, we will discuss the possible observation of these quantum correlations with top quark pair production, which represents a system of two-qubits. Our study focus on the semi-leptonic top pair channel. They indicate that the observation of entanglement is possible with the current dataset and the violation of Bell's inequalities can be probed at 3-σ level at the HL-LHC.

Primary author: GONÇALVES, Dorival (Oklahoma State University)

Presenter: GONÇALVES, Dorival (Oklahoma State University)

Session Classification: Collider

Contribution ID: **15** Type: **not specified**

Probing Lepton Number Violation at the LHC

Wednesday 17 May 2023 14:55 (25 minutes)

Observation of lepton number (L) violation by two units at colliders would provide evidence for the Majorana nature of neutrinos. We study signals of L-violation in the context of two popular models of neutrino masses, the type-II seesaw model and the Zee model, wherein small neutrino masses arise at the tree-level and one-loop level, respectively. We focus on L-violation signals at the LHC arising through the process $pp \to \ell^{\pm}\ell'^{\pm}$ + jets within these frameworks. We obtain sensitivity to L-violation in the type-II seesaw model for triplet scalar masses up to 700 GeV and in the Zee model for charged scalar masses up to 4.8 TeV at the high-luminosity LHC with an integrated luminosity of 3 ab−1.

Primary author: BABU, Kaladi

Presenter: BABU, Kaladi

Session Classification: Collider

Contribution ID: **16** Type: **not specified**

Highlights of Search for New Particles (Vector-like Quarks/Leptoquark/W'/Z')

Wednesday 17 May 2023 14:05 (25 minutes)

Many physics models beyond the Standard Model predict heavy new particles preferentially decaying to at least one top quark. This talk will present searches for Leptoquark/Vector-like quark/new resonances decaying into at least one top quark in pp collision at a center-of-mass energy of 13 TeV at the CMS and ATLAS detectors at the LHC.

The searches use the data set collected with the CMS or ATLAS detectors in 2016-2018, which corresponds to an integrated luminosity of 138 fb−1. Novel machine learning techniques and reconstruction techniques are used to optimize discrimination of top quarks with high Lorentz boosts, which requires the use of non isolated leptons and jet substructure techniques, as well as allowing for a significant improvement of the analysis sensitivity compared with earlier results. No significant excess of events relative to the expected yield from standard model processes is observed. The most stringent limits to date are obtained from these searches.

Primary author: PATHAK, Atanu (Purdue University Northwest (US))

Presenter: PATHAK, Atanu (Purdue University Northwest (US))

Session Classification: Collider

Contribution ID: **17** Type: **not specified**

Composite Dark Matter Through the Neutrino Portal

Thursday 18 May 2023 11:40 (25 minutes)

I will discuss a model where dark matter is a composite state in a hidden sector, interacting with the Standard Model via the neutrino portal. The composite states in the hidden sector interpolated by the portal act as singlet neutrinos, which can naturally explain the existence of small but nonzero neutrino masses via the inverse seesaw mechanism. I will describe the existing constraints on this model, and estimate the reach of future experiments, not just for the singlet neutrinos which are the first particles in the hidden sector to be directly produced, but for the dark matter particle as well.

Primary authors: AHMED, Aqeel (Max-Planck-Institut für Kernphysik, Heidelberg); CHACKO, Zackaria (University of Maryland); DESAI, Niral (UT Austin); DOSHI, Sanket (University of Maryland); KILIC, Can; NAJJARI, Saereh

Presenter: KILIC, Can

Session Classification: Dark matter

Contribution ID: **18** Type: **not specified**

First Constraints on ALP-photon Couplings from Multimessenger Studies of the Neutron Star Merger GW170817

Thursday 18 May 2023 14:30 (25 minutes)

We use multimessenger observations of the neutron star merger event GW170817 to derive the first merger constraints on axion-like particles (ALPs) coupling to photons. ALP production from Primakoff and photon coalescence processes is calculated; then, the region of parameter space where ALPs can escape the remnant and decay back into two photons is considered. This gives rise to an ALP-induced photon signal approximately along the line-of-sight to the merger event. The spectral and temporal behavior of the ALP-induced photon signal as a function of the ALP mass and coupling is studied, with particular care to the decay geometry which is the main source of the temporal dependence. Fermi-LAT observations of GW170817 in the time window 1153 – 2027 s after the arrival of the GW signal is then employed to impose an upper bound on the ALP-induced photon signal flux, and hence the first merger constraints on the ALP-photon coupling. We then investigate the prospects of future MeV gamma-ray missions to constrain ALPs using a combination of temporal and spectral information. Taking the spectral coverage of AMEGO-X as an example, and assuming that data is obtained concurrently with the GW signal and up to times when the ALP-induced emission diminishes, we show that AMEGO-X will constrain new regions of ALP parameter space.

Primary author: SINHA, Kuver (University of Oklahoma)

Presenter: SINHA, Kuver (University of Oklahoma)

Session Classification: Astrophysics

Contribution ID: **19** Type: **not specified**

Multi-photon decays of the Higgs boson at the LHC

Tuesday 16 May 2023 14:30 (25 minutes)

Many new physics scenarios predict multi-photon Higgs resonances. One such scenario is the dark axion portal model. The primary decay chain that we study is the Higgs to dark photon (γ_D) pairs that subsequently decay into a photon (γ) and an axion-like particle (a). The axion-like particles then decay into photon pairs. Hence, the signal is a six-photon Higgs decay: $h \to \gamma_D\,\gamma_D \to 2\,\gamma 2\,a \to 6\gamma$. However, depending on the relevant kinematics, the photons can become well-collimated and appear as photon-jets (multiple photons that appear as a single photon in the detector) or ξ-jets (non-isolated multi-photon signals that do not pass the isolation criterion). These effects cause the true six-photon resonance to appear as other multi-photon signals, such as two and four photons. We classify the mass regions where two, four, and six-photon resonances dominate. The four-photon signal is particularly interesting. These events mainly occur when the photons from the axion-like particles are collimated into photon-jets. The decay of the dark photon is then $\gamma_D \to \gamma a \to \gamma + \gamma$-jet, which is an apparent violation of the Landau-Yang theorem. We show that current measurements of $h \to 2\gamma$ and searches for $h \to 4\gamma$ at the Large Hadron Collider (LHC) can limit $\mathrm{BR}(h \to \gamma_D\gamma_D) < 10^{-3}$. This model also motivates new searches for Higgs decays into six isolated photons or ξ-jets at the LHC. While there are currently no dedicated searches, we show that many of the Higgs to six isolated photons or ξ-jet events could pass two or three-photon triggers. That is, new physics could be found by reanalyzing existing data. These multi-photon signals provide excellent footing to explore new physics at the LHC and beyond.

Primary authors: LEE, Hye-Sung (KAIST); LEWIS, Ian (The University of Kansas); LANE, Samuel (KAIST)

Presenter: LEWIS, Ian (The University of Kansas)

Session Classification: Collider

Contribution ID: **20** Type: **not specified**

Detecting Axion-Like Particles with Primordial Black Holes

Thursday 18 May 2023 10:20 (25 minutes)

Asteroid-mass primordial black holes (PBH) can make up a fraction or all of dark matter. Their Hawking radiation process offers a novel channel to produce new particles, which is especially interesting if these particles are mostly secluded from the Standard Model sector. Future MeV gamma-ray telescopes provide exciting prospects for detecting the Hawking radiation signal from asteroid-mass PBHs. In this talk, I will first introduce the indirect detection searches for PBHs, and discuss how to distinguish the signal from PBH-produced axion-like particles in the gamma-ray spectrum.

Primary authors: Prof. DUTTA, Bhaskar; CHANG, Jae Hyeok (JHU/UMD); AGASHE, Kaustubh; CLARK, Steven (Brown University); XU, Tao (The University of Oklahoma); TSAI, Yuhsin (University of Notre Dame)

Presenter: XU, Tao (The University of Oklahoma)

Session Classification: Axion

Contribution ID: **21** Type: **not specified**

Milli-Magnetic Monopole Dark Matter and the Survival of Galactic Magnetic Fields

Wednesday 17 May 2023 10:20 (25 minutes)

Dark sectors with Abelian gauge symmetries can interact with ordinary matter via kinetic mixing. In such scenarios, magnetic monopoles of a broken dark U (1) will appear in our sector as confined milli-magnetically charged objects under ordinary electromagnetism. If these states contribute sizably to the local dark matter density, they extract significant energy from the galactic magnetic field. We revise and extend this "Parker Bound"on galactic magnetic energy loss to milli-magnetic monopoles which leads to the strongest existing constraints on these states, over a wide range of magnetic monopole masses

Primary author: GRAESSER, Michael

Presenter: GRAESSER, Michael

Session Classification: Dark matter

Contribution ID: **22** Type: **not specified**

Probing the Early Universe with Dark Matter Annihilation

Tuesday 16 May 2023 10:20 (25 minutes)

As remnants of the earliest stages of structure formation, the smallest dark matter halos provide a unique probe of the evolution of the Universe prior to the onset of Big Bang nucleosynthesis (BBN). I will discuss how the pre-BBN expansion history can enhance the microhalo population, thereby boosting the dark matter annihilation rate if dark matter is a thermal relic. The amplitude of this boost is highly sensitive to the size of the smallest halos, which provides an additional window into the dynamics and particle content of the early Universe. It is therefore possible to use astronomical observations to learn about the origins of dark matter and the evolution of the Universe during its first second. Specifically, observations of the isotropic gamma-ray background restrict dark matter production during an early matter-dominated era or a period of kination.

Primary author: ERICKCEK, Adrienne

Presenter: ERICKCEK, Adrienne

Session Classification: Cosmology

Contribution ID: **24** Type: **not specified**

Building non-vanilla QCD axion models

Thursday 18 May 2023 09:55 (25 minutes)

In [1] and [2], my co-authors and I revisit the the field theory of axion model building from two separate perspectives. We first considered [1] the effects of small-size instantons arising from enlarged color gauge groups on the QCD axion mass, reaffirming earlier results that QCD axion masses can be parametrically heavier than vanilla models when the confinement effects of the extended color group symmetry contribute to the Peccei-Quinn (PQ) breaking. Notably, we discuss an improvement of the vanilla chiral Lagrangian that readily incorporates non-vanilla ‘t Hooft determinantal operators. In [2], we present the “Anarchic Axion” model where a possible soft-breaking of PQ symmetry is included in the scalar potential. Depending on the phase and magnitude of the soft-breaking term, an arbitrarily light QCD axion remains to solve the strong CP problem, albeit at the expense of increasing fine tuning. Besides expanding the axion parameter space beyond the vanilla QCD axion band, we have also discussed the phenomenology of axion-like particle effective field theories when the Standard Model is extended to include a gauged baryon number symmetry, offering new collider signatures for ALPs and Z’ bosons [3].

[1] Kivel, Laux, FY, [JHEP 11(2022) 088, arXiv:2207.08740]
[2] Elahi, Elor, Kivel, Laux, Najjari, FY [arXiv:2301.08760]
[3] Kivel, Laux, FY [JHEP 03 (2023) 078, arXiv:2211.12155]

Primary author: YU, Felix (Johannes Gutenberg University Mainz)

Presenter: YU, Felix (Johannes Gutenberg University Mainz)

Session Classification: Axion

Contribution ID: **25** Type: **not specified**

Gravitational Wave Signatures of Reheating

Thursday 18 May 2023 14:55 (25 minutes)

We initiate a study of the gravitational wave signatures of a phase transition that occurs as the Universe's temperature increases during reheating. The gravitational wave signatures of a heating phase transition are different from those of a cooling phase transition and observation of them would allow us to probe reheating. In the lucky case that the gravitational wave signatures from both the heating and cooling phase transitions were observed, information about reheating could in principle be obtained utilizing the correlations between the two transitions. Frictional effects leading to a constant bubble wall speed in one case will instead accelerate the bubble wall, often into a runaway, in the other case. The efficiencies, strength of the phase transition and duration of the phase transitions will be similarly correlated in a reheating dependent manner.

Primary authors: HOOK, Anson (University of Maryland); CHANG, Jae Hyeok (JHU/UMD); BUEN-ABAD, Manuel (Brown University)

Presenter: CHANG, Jae Hyeok (JHU/UMD)

Session Classification: Astrophysics

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

Nuclear decay anomalies as a signature of axion dark matter

Friday 19 May 2023 10:20 (25 minutes)

A number of nuclear decay anomalies have been reported in the literature, which purport to show periodic variations in the decay rates of certain radioisotopes. If these reports reflect reality, they would necessitate a seismic shift in our understanding of fundamental physics. We provide the first mechanism to explain these findings, via the misalignment mechanism of QCD axion dark matter, wherein oscillations of the effective θ angle induce periodic variation in nuclear binding energies and hence decay rates. As we expect this effect to be most pronounced in low-Q systems, we analyse 12 years of tritium decay data ($Q \simeq 18.6$ keV) taken at the European Commission's Joint Research Centre. Finding no statistically significant excess, we exclude axion decay constants below $9.4\times10^{12}-1.8\times10^{10}$ GeV (95 \% confidence level) for masses in the $1.7\times10^{-23}-8.7\times10^{-21}$ eV range.

Primary author: LI, Tianjun

Presenter: LI, Tianjun

Session Classification: Nuclear physics

Contribution ID: **27** Type: **not specified**

A Novel Beam Dump Experiment at CMS

Tuesday 16 May 2023 15:20 (25 minutes)

Despite the current standard model of particle physics has been highly successful, there are still unanswered questions surrounding dark matter. This suggests that new physics beyond the standard model may be discovered at the Large Hadron Collider. In my talk, I will focus on the search for the dark sector using a novel concept of beam dump experiments at the CMS experiment. While this approach has great potential to find new physics, it also poses significant challenges. I will discuss the challenges and highlight opportunities to overcome them using machine learning techniques and other methods to expand our potential for discovery in the near future.

Primary author: KIM, Hyunyong (Texas A & M University (US))

Co-authors: Prof. DUTTA, Bhaskar; KIM, Doojin

Presenter: KIM, Hyunyong (Texas A & M University (US))

Session Classification: Collider

Contribution ID: **28** Type: **not specified**

Determining the Neutrino Lifetime from Cosmology

Thursday 18 May 2023 16:15 (25 minutes)

I discuss the cosmological signals of theories in which the neutrinos decay into invisible dark radiation after becoming nonrelativistic. I show that, in this scenario, near-future large-scale structure measurements from the Euclid satellite, when combined with cosmic microwave background data from Planck, may allow an independent determination of both the lifetime of the neutrinos and the sum of their masses.

Primary author: CHACKO, Zackaria (University of Maryland, College Park)

Co-authors: DEV, Abhish; DU, Peizhi; POULIN, Vivian; TSAI, Yuhsin

Presenter: CHACKO, Zackaria (University of Maryland, College Park)

Session Classification: Neutrino

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

Dark Matter Misalignment Through the Higgs Portal

Thursday 18 May 2023 12:05 (25 minutes)

A light singlet scalar field feebly coupled through the super-renormalizable Higgs portal provides a minimal and well-motivated realization of ultra-light bosonic dark matter. We study the cosmological production of dark matter in this model by elucidating the dynamics of two sources of scalar field misalignment generated during the radiation era. For relatively large masses, dark matter is produced through thermal misalignment, by which the scalar field is driven towards large field values as a result of the finite-temperature effective potential. The dominance of thermal misalignment in this mass range leads to a sharp relic abundance prediction which is, to a significant extent, insensitive to the initial conditions of the scalar field. On the other hand, for low mass scalars, dark matter is produced via VEV misalignment, which is caused by the induced scalar field vacuum expectation value triggered by the electroweak phase transition. We show that the relic abundance in this low mass range is sensitive to the scalar field initial conditions. We compare the relic abundance predictions with constraints and projections from various experimental and observational tests.

Primary author: BATELL, Brian Thomas

Presenter: BATELL, Brian Thomas

Session Classification: Dark matter

Contribution ID: **30** Type: **not specified**

Heavy neutral leptons at muon colliders

Wednesday 17 May 2023 12:15 (25 minutes)

The future high-energy muon colliders, featuring both high energy and low background, could play a critical role in our searches for new physics. The smallness of neutrino mass is a puzzle of particle physics. Broad classes of solutions to the neutrino puzzles can be best tested by seeking the partners of SM light neutrinos, dubbed as heavy neutral leptons (HNLs), at muon colliders.
We can parametrize HNLs in terms of the mass m_N and the mixing angle with ℓ-flavor U_ℓ. In this work, we focus on the regime $m_N > O(100)$ GeV and study the projected sensitivities on the $|U_\ell|^2 - m_N$ plane with the full-reconstructable HNL decay into a hadronic W and a charged lepton. The projected reach in $|U_\ell|^2$ leads to the best sensitivities in the TeV realm.

Primary author: LIU, Zhen (University of Minnesota (US))

Presenter: LIU, Zhen (University of Minnesota (US))

Session Classification: Collider

Contribution ID: **31** Type: **not specified**

Coherent elastic neutrino nucleus scattering: experimental efforts at SNS and reactor-site

Friday 19 May 2023 09:30 (25 minutes)

Coherent elastic neutrino nucleus scattering (CEνNS) is a standard-model interaction in which the neutrino interacts with the nucleus as a whole. It was first measured by the COHERENT collaboration in 2017 decades after its prediction.
A coherent interaction is only possible at neutrino energies of a few tens of MeV or below, which makes the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory an ideal source for this kind of experiments. The COHERENT experiment located at SNS employs a variety of detectors of different target materials. I will give an overview on the experiment, latest efforts and the physics potential beyond CEνNS.
Another source of neutrinos at the lower end of the coherent energy regime are nuclear reactors and I will discuss the recent results from the reactor-based CONUS experiment as well.

Primary author: HAKENMÜLLER, Janina (Duke University)

Presenter: HAKENMÜLLER, Janina (Duke University)

Session Classification: Nuclear physics

Contribution ID: **32** Type: **not specified**

Precise SM measurements as BSM probes: a new purpose for the W mass measurement

Wednesday 17 May 2023 11:50 (25 minutes)

The precise measurement of the Standard Model parameters is not only a consistency check of the SM itself, but it also represents a powerful probe for New Physics. This is well known in the case of heavy new physics, that might show-up indirectly by modifying the relations among the SM parameters.
On different lines, we argue that precise SM measurements can also be repurposed to constrain light new physics that can be directly produced, distorting the kinematic distributions.
We explore this paradigm revisiting the W mass measurement. For example, invisible new physics might pollute the leptonic decay of the W, modifying the MET and consequently the kinematic distributions exploited to extract the W mass. The precise measurements of CDF, ATLAS and LHCB guarantee great control on these new physics effects, so that, as byproduct, we have competitive probes for New Physics.

Primary authors: SATHYAN, Deepak; Dr KIM, Doojin (Texas A & M University (US)); AGASHE, Kaustubh; RICCI, Lorenzo; FRANCESCHINI, Roberto (Rome 3 U.); AIREN, Sagar

Presenter: RICCI, Lorenzo

Session Classification: Collider

Contribution ID: **33** Type: **not specified**

Atmospheric Neutrinos in the Future

Thursday 18 May 2023 17:05 (25 minutes)

I will discuss atmospheric neutrino measurements in DUNE and HK. I will discuss sub-GeV atmospheric neutrinos and how they can be used to measure δ_{CP}; Earth tomography measurements, and the impact of solar cycles in the time modulation of atmospheric neutrinos.

Most will be based on 1904.02751, 2110.00003, and 2304.04689.

Primary author: MACHADO, Pedro (Fermilab)

Presenter: MACHADO, Pedro (Fermilab)

Session Classification: Neutrino

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

A multi-messenger probe of the nature of neutrino mass

Wednesday 17 May 2023 09:55 (25 minutes)

Whether neutrinos are Majorana or Dirac particles is an open question. Theoretically, it is also possible that neutrinos are pseudo-Dirac, which are fundamentally Majorana fermions, but essentially act like Dirac fermions in most experimental settings, due to extremely small active-sterile mass splitting. Such small values of mass splitting can only be accessed via active-sterile oscillations over an astrophysical baseline. We show that the recent identification of high energy neutrino sources by the IceCube Neutrino Observatory provides us with such an astrophysical baseline, thus improving the reach of terrestrial experiments by up to a billion for the active-sterile mass-squared difference.

Primary author: DEV, Bhupal (Washington University in St. Louis)

Presenter: DEV, Bhupal (Washington University in St. Louis)

Session Classification: Dark matter

Contribution ID: **35** Type: **not specified**

DAMSA, A Dark Sector Particle Search Experiment at Fermilab PIP-II LINAC

Tuesday 16 May 2023 11:15 (35 minutes)

The neutrino oscillation needs parameters to be measured precisely to provide essential information for a modification of the Standard Model. Accomplishing this novel goal in future neutrino experiments requires high flux neutrino beams and powerful combination of near and far detectors. Fermilab's PIP-II LINAC is an essential element in providing high flux protons to the Long Baseline Neutrino Facility (LBNF) for the neutrino experiments. The PIP-II LINAC can provide 2mA of proton current with 800MeV to 1GeV. The Dump produced Aboriginal Matter Search at Accelerators (DAMSA) proposes to take advantage of this large proton flux at just the right energy in search of dark sector particles (DSP). In this talk, I will discuss the DAMSA experiment and its sensitivity reach in the Axion-Like Particle search using the high intensity PIP-II LINAC.

Primary author: Prof. YU, Jae (University of Texas at Arlington (US))

Co-authors: KIM, Doojin; KIM, Doojin (University of Florida); JANG, Wooyoung (The University of Texas at Arlington); JANG, Wooyoung (University of Texas at Arlington); Mr BOGENSCHUETZ, jacob (university of Texas at Arlington)

Presenter: Prof. YU, Jae (University of Texas at Arlington (US))

Session Classification: Dark sector

Contribution ID: **36** Type: **not specified**

Prospects and Current Status of the ICARUS Experiment

Thursday 18 May 2023 16:40 (25 minutes)

The ICARUS T600 LArTPC detector successfully ran for three years at the underground LNGS laboratories, providing a first sensitive search for LSND-like anomalous electron neutrino appearance in the CNGS beam. After a significant overhauling at CERN, the T600 detector has been placed in its experimental hall at Fermilab, fully commissioned, and the first events observed with full detector readout. Regular data taking began in May 2021 with neutrinos from the Booster Neutrino Beam (BNB) and the Neutrinos at the Main Injector (NuMI) off-axis beam. As the far detector of the Short-Baseline Neutrino (SBN) Program, the ICARUS experiment's capability in searching for both muon neutrino disappearance and electron neutrino appearance will allow for unprecedented sensitivity to light sterile neutrinos with eV-scale mass. Exposure to both the BNB and NuMI beams provides a broad program of neutrino interaction measurements and searches for physics beyond the Standard Model. This talk will summarize the current status and prospects of the ICARUS experiment.

Primary author: MUELLER, Justin

Presenter: MUELLER, Justin

Session Classification: Neutrino

Contribution ID: **37** Type: **not specified**

Status and Prospect of Search for Dark Matter

Tuesday 16 May 2023 14:05 (25 minutes)

Primary author: KAR, Deepak (University of the Witwatersrand (ZA))

Presenter: KAR, Deepak (University of the Witwatersrand (ZA))

Session Classification: Collider

Contribution ID: **39** Type: **not specified**

Recurrent Axinovae and their Cosmological Constraints

Thursday 18 May 2023 09:30 (25 minutes)

Axion-like dark matter whose symmetry breaking occurs after the end of inflation predicts enhanced primordial density fluctuations at small scales. This leads to dense axion minihalos (or miniclusters) forming early in the history of the Universe. Condensation of axions in the minihalos leads to the formation and subsequent growth of axion stars at the cores of these halos. If, like the QCD axion, the axion-like particle has attractive self-interactions there is a maximal mass for these stars, above which the star rapidly shrinks and converts an O(1) fraction of its mass into unbound relativistic axions. This process would leave a similar (although in principle distinct) signature in cosmological observables as a decaying dark matter fraction, and thus is strongly constrained. I will discuss such constraints.

Primary author: FOX, Patrick James

Presenter: FOX, Patrick James

Session Classification: Axion

Contribution ID: **40** Type: **not specified**

Dark Sector Signals at Neutrino Experiments

Tuesday 16 May 2023 11:50 (25 minutes)

Neutrino experiments will have leading sensitivity to several dark matter and dark sector models. I discuss signals from a range of different dark sector models, from induced nucleon decay in mesogenesis models to production, scattering, and decay of dark sector states in neutrino beams. I present simulation tools for boosted dark matter and induced nucleon decay signals. I discuss some challenges with developing simulation and analyses to achieve a comprehensive program at the SBN and DUNE experiments.

Primary author: BERGER, Joshua (Colorado State University)

Presenter: BERGER, Joshua (Colorado State University)

Session Classification: Dark sector

Contribution ID: **41** Type: **not specified**

Ringdown beyond Kerr

Thursday 18 May 2023 14:05 (25 minutes)

The final phase of gravitational radiation from black hole binaries is the ringdown of the merged black holes, which occurs at a characteristic set of frequencies. Measurements of the ringdown spectrum can provide especially clean tests of the nature of the final black hole, potentially revealing violations of the famous "no-hair" theorem. The large number of gravitational wave observations that will be made in the coming years together with recent advances in the analysis of ringdown indicate that precision tests will be possible in the near future. Going beyond null tests, however, requires predictions of the ringdown spectrum in theories beyond GR and in spacetimes beyond Kerr. In this talk I will outline a flexible approach for calculating the ringdown spectrum of spinning black holes in theories where deviations from GR are small, and discuss future prospects for precision ringdown tests.

Primary author: ZIMMERMAN, Aaron

Presenter: ZIMMERMAN, Aaron

Session Classification: Astrophysics

Contribution ID: **42** Type: **not specified**

Parity solution to the strong CP problem and leptogenesis

Session Classification: Cosmology

Contribution ID: **43** Type: **not specified**

TBA

Primary author: SHOEMAKER, Ian (Virginia Tech)

Presenter: SHOEMAKER, Ian (Virginia Tech)

Session Classification: Dark sector

Contribution ID: **44** Type: **not specified**

Searching for Higgs boson pairs at the Large Hadron Collider

Tuesday 16 May 2023 16:15 (25 minutes)

Presenter: VEATCH, Jason Robert (California State University (US))

Session Classification: Collider

Contribution ID: **45** Type: **not specified**

Charged Higgs Boson Search via e+e- -> H+H– -> cb(bar) c(bar)b at Linear Colliders

Tuesday 16 May 2023 16:40 (25 minutes)

We study charged Higgs boson search via $e^+e^- \to H^+H^- \to c\bar{b}\bar{c}b$ at the 500 GeV ILC. In a general two Higgs doublet model without Z_2 symmetry, extra Yukawa couplings ρ_{tt} and ρ_{tc} can drive baryogenesis, but searches at the HL-LHC may still go empty-handed if the couplings are relatively weak. Taking $m_{H^+} \simeq m_H \simeq m_A \sim 200$ GeV, with ρ_{tt}, $\rho_{tc} \sim 0.1$ and no $h(125)$-H mixing, $H^+ \to c\bar{b}$ decay is dominant, and the $c\bar{b}\bar{c}b$ final state is likely overwhelmed by QCD background at the LHC. We show that the electroweak production of H^+H^- at the ILC is discoverable with integrated luminosity of 1 ab^{-1}. We show further that m_{H^+} can be extracted by requiring the two pairs of b and light jets be roughly equal in mass, without assuming the mass value. Thus, ILC can probe low mass Higgs bosons in multijet final states to complement HL-LHC in the future.

Primary author: HOU, George (National Taiwan University (TW))

Presenter: HOU, George (National Taiwan University (TW))

Session Classification: Collider

Contribution ID: **46** Type: **not specified**

Higgs couplings to fermions

Tuesday 16 May 2023 17:05 (25 minutes)

The mechanism of fermion mass generation via the Higgs Yukawa interactions remains to be mysterious because of the large mass hierarchies, many free parameters, and their arbitrary flavor mixing patterns. Scrutinizing the fermionic sector associated with the Higgs properties is of high priority. In this talk, I reiterate the fermion mass and flavor puzzles. I propose some experimental studies to probe the Yukawa couplings for the second-generation fermions at hadron and lepton colliders, such as the High-Luminosity LHC and a future muon collider.

Presenter: HAN, Tao

Session Classification: Collider

Contribution ID: **47** Type: **not specified**

ΛCDM tensions and new physics

Thursday 18 May 2023 15:20 (25 minutes)

In the last few years increased precision of experimental data led to challenges to ΛCDM. The dynamics of the expansion and the statistics of the growth of structure appear to be in tension between local measurements and inference from the CMB. I will discuss the H0 and S8 tensions and discuss new physics solutions in the context of dark matter/energy and quantum gravity.

Primary authors: KOUSHIAPPAS, Savvas; KOUSHIAPPAS, Savvas (Brown University)

Presenters: KOUSHIAPPAS, Savvas; KOUSHIAPPAS, Savvas (Brown University)

Session Classification: Astrophysics

Contribution ID: **48** Type: **not specified**

Status and Prospect of Search for Long-Lived Particles

Wednesday 17 May 2023 14:30 (25 minutes)

Presenter: Mr GOSWAMI, Soumyananda (Oklahoma State University (US))

Session Classification: Collider

Contribution ID: **49** Type: **not specified**

The CDF W Boson Mass Measurement

Wednesday 17 May 2023 11:15 (20 minutes)

Presenter: KOTWAL, Ashutosh (Duke University (US))

Session Classification: Collider

Contribution ID: **50** Type: **not specified**

Neutrino oscillation as a probe of new physics

Thursday 18 May 2023 17:30 (25 minutes)

While the standard 3-flavor neutrino oscillation scenario is well-established, the mechanism behind neutrino mass is not yet pinned down experimentally. In fact, some new physics (related or not related to new physics behind neutrino mass) can modify the standard 3-flavor neutrino oscillation paradigm. We introduce an analytical solution for n-flavor neutrino oscillation in an arbitrary matter potential, which allows us to study effects beyond the standard paradigm. In particular, we highlight the difference between low-scale "nonunitary" scenario and nonstandard neutrino interactions. This solution is implemented in a public code NuProbe.

Primary author: FONG, Chee Sheng (Universidade Federal do ABC)

Presenter: FONG, Chee Sheng (Universidade Federal do ABC)

Session Classification: Neutrino

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

TBA

Presenter: DIENES, Keith (University of Arizona)

Session Classification: Cosmology

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

Stasis in an Expanding Universe: Overview, Concrete Realizations, and Observational Consequences

Friday 19 May 2023 11:15 (25 minutes)

Presenter: THOMAS, Brooks

Session Classification: Cosmology

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

One man's thoughts a year after the CDF W Mass Announcement

Wednesday 17 May 2023 11:35 (15 minutes)

Presenter: TOBACK, David (Texas A & M University (US))

Session Classification: Collider