The Mitchell Conference on Collider, Dark Matter, and Neutrino Physics 2022

Report of Contributions

https://indico.cern.ch/e/1125426

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

Energy-Dependent Neutrino Mixing Parameters at Oscillation Experiments

Thursday, 26 May 2022 16:59 (23 minutes)

One of the most important achievements in the field of particle physics was the discovery of neutrino oscillations.
Despite already awarded Nobel Prize, neutrino oscillation experiments still have a lot to offer, primarily the discovery
of CP violation in the lepton sector is anticipated. The expression for neutrino oscillation probabilities is composed
of neutrino mixing parameters and mass squared differences. In this seminar, we argue that mixing parameters at the scale of
neutrino production and detection do not necessarily need to coincide since such parameters are subject to
renormalization group evolution and the two processes occur at different energies.
We discuss this in the frame of a particular UV compete realization and demonstrate that quantum effects
can yield relevant observable effects at various neutrino experiments. As an example, we consider high-energy
astrophysical neutrinos at IceCube and show that neutron decay production mechanism, that is considered to be
strongly disfavored by present data, becomes viable if significant renormalization group effects are present.
We also scrutinize terrestrial experiments and show that the mismatch between neutrino parameters at production and
detection can induce large effects at T2K and NOvA.

Primary author: BRDAR, Vedran (MPIK Heidelberg)

Presenter: BRDAR, Vedran (MPIK Heidelberg)

Session Classification: Neutrino

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

Exploring CEvNS with the NUCLEUS experiment

Tuesday, 24 May 2022 08:53 (23 minutes)

The detection of coherent-neutrino nucleus scattering (CEvNS) opens a new window to study the fundamental properties of neutrinos and to probe physics beyond the Standard Model of Particle Physics. NUCLEUS is a novel cryogenic neutrino experiment at a nuclear power reactor which allows for precision measurements of CEvNS at unprecedentedly low energies. It is based on recently demonstrated ultra-low threshold cryogenic detectors with nuclear-recoil energy thresholds in the 10eV regime. Accessing these energies enables to fully exploit the strongly enhanced cross section of CEvNS which leads to a miniaturization of neutrino detectors. NUCLEUS is fully funded and will be installed at a new experimental site in between the two 4GW reactor cores of the CHOOZ nuclear power plant in France. In this talk I will present recent results from a prototype detector and discuss the experimental strategy as well as the extensive physics program of NUCLEUS.

Primary author: STRAUSS, Raimund

Presenter: STRAUSS, Raimund

Session Classification: Neutrino

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

Early Matter Domination from Long-Lived Particles in the Visible Sector

Tuesday, 24 May 2022 11:13 (23 minutes)

I show that a nonstandard cosmological history with a period of early matter domination driven by a sub-TeV visible-sector particle can arise rather naturally. This scenario involves a long-lived standard model singlet that acquires a thermal abundance at high temperatures from decays and inverse decays of a parent particle with SM charge(s), and subsequently dominates the energy density of the universe. Entropy generation at the end of early matter domination dilutes the abundance of dangerous relics (such as gravitinos) by a factor as large as 10ˆ4. The scenario can accommodate the correct dark matter relic abundance for a broad range of annihilation cross section. More importantly, the allowed parameter space can be directly probed by proposed searches for neutral long-lived particles at the energy frontier, allowing us to use particle physics experiments to reconstruct the cosmological history just prior to big bang nucleosynthesis.

Primary authors: OSINSKI, Jacek; ALLAHVERDI, Rouzbeh (University of New Mexico)

Presenter: ALLAHVERDI, Rouzbeh (University of New Mexico)

Session Classification: Cosmology, Dark Matter

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

Fast and Faithful Generation of Calorimeter Showers with Deep Generative Models: CaloFlow.

Wednesday, 25 May 2022 08:53 (23 minutes)

Simulation of particle interactions with detector material, especially in the calorimeters are very time-consuming and resource intensive. In the upcoming LHC runs, these could provide a bottleneck that severely limits our analysis capabilities.
In recent years, approaches based on deep generative models have provided a fresh alternative to "classical" fast simulation. In this talk, I present CaloFlow, a fast detector simulation framework based on normalizing flows. Besides the usual histograms of physical features and images of calorimeter showers, I will introduce a new metric for judging the quality of generative modeling: the performance of a classifier trained to differentiate real from generated images. I will show that images generated from CaloFlow are able to fool the classifier much of the time, while images generated by other deep generative models, such as GANs, can be identified by the classifier with 100% accuracy. Using a technique called Probability Density Distillation, originally developed for speech synthesis in the ML literature, CaloFlow generates the showers a factor of 10ˆ4 faster than GEANT4, matching or surpassing all other state-of-the-art deep generative models for calorimeter shower simulation.

Primary authors: Dr KRAUSE, Claudius (Rutgers University); SHIH, David

Presenter: Dr KRAUSE, Claudius (Rutgers University)

Session Classification: Machine Learning, Neutrino

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

CrystaLiZe: Pushing Dark Matter Detection to the Limit with Solid Xenon

Thursday, 26 May 2022 08:30 (23 minutes)

The liquid xenon time projection chamber (LXe TPC) is a well-established particle detection technology commonly used in rare event searches such as dark matter (DM) direct detection. LZ is a LXe TPC expected to improve on the current best WIMP sensitivity by almost two orders of magnitude by the time its nominal data-taking finishes around 2027. If DM lies beyond LZ's detection capabilities, further improvement by an order of magnitude will be required to either claim a discovery or reach the point where solar neutrinos become the dominant, irreducible background (the "neutrino fog"), stymieing progress. Continuing the paradigm of building larger detectors beyond LZ would be costly, and may not be effective at reaching the neutrino floor due to a less exotic but more prevalent background, radon emitted from internal detector components. We propose to address this through crystallizing the xenon. Once solid, the xenon will no longer admit external Rn into the bulk, allowing existing Rn to decay away. These decays can also be efficiently vetoed using the time structure of the decay sequence and the fixed position of daughter isotopes. In this talk, I will present recent results from a crystalline/vapor two phase TPC test stand which establish the viability of this new detector technology, and suggest its implementation as a possible future upgrade to LZ.

Primary author: KRAVITZ, Scott

Presenter: KRAVITZ, Scott

Session Classification: Dark matter

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

Probing the B anomalies at a Muon Collider

Thursday, 26 May 2022 11:13 (23 minutes)

For several years, various experimental results on B meson decays show persistent discrepancies with respect to Standard Model expectations. Discrepancies are observed in branching ratios, angular distributions, and lepton flavor universality ratios. I will review the status of the discrepancies, discuss possible new physics explanations, and outline how a high-energy muon collider could test the new physics explanations.

Primary author: ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

Presenter: ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

Session Classification: Collider

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

The Primordial Black Holes Variations

Thursday, 26 May 2022 13:30 (23 minutes)

In the age of gravitational wave astronomy, the possibility that some of the black holes in the universe have a primordial, rather than stellar origin, and that they might be a non-negligible fraction of the cosmological dark matter, is quite intriguing. I will review the status of the field, and comment on search strategies and future prospects for detection across many decades in black hole mass. I will also discuss how light primordial black holes could seed both baryonic and particle dark matter in the very early universe.

Primary author: PROFUMO, Stefano

Presenter: PROFUMO, Stefano

Session Classification: Astrophysics

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

Double Higgs Production at the HL-LHC

Wednesday, 25 May 2022 09:39 (23 minutes)

The Higgs potential is vital to understand the electroweak symmetry breaking mechanism, and probing the Higgs self-interaction is arguably one of the most important physics targets at current and upcoming collider experiments. In particular, the triple Higgs coupling may be accessible at the HL-LHC by combining results in multiple channels, which motivates to study all possible decay modes for the double Higgs production. In this paper, we revisit the double Higgs production at the HL-LHC in the final state with two b-tagged jets, two leptons and missing transverse momentum. We focus on the performance of various neural network architectures with different input features: low-level (four momenta), high-level (kinematic variables) and image-based. We find it possible to bring a modest increase in the signal sensitivity over existing results via careful optimization of machine learning algorithms making a full use of novel kinematic variables.

Primary authors: HUANG, Li; KANG, Su-beom; KIM, Jeong Han; KIM, Minho; KONG, K.C.; MATCHEV, Konstantin; Mr PARK, Myeonghun; PI, Jun Seung

Presenter: KONG, K.C.

Session Classification: Machine Learning, Neutrino

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

Probing the Supersymmetric Grand Unified Theories at the Future Proton-Proton Colliders and Hyper-Kamiokande Experiment

Wednesday, 25 May 2022 11:59 (23 minutes)

Gauge coupling unification in the Supersymmetric Standard Models strongly implies the Grand Unified Theories (GUTs). With the grand desert hypothesis, we show that the supersymmetric GUTs can be probed at the future proton-proton (pp) colliders and Hyper-Kamiokande experiment. For the GUTs with the GUT scale $M_{GUT} \leq 1.0 \times 10^{16}$ GeV, we can probe the dimension-six proton decay via heavy gauge boson exchange at the Hyper-Kamiokande experiment. Moreover, for the GUTs with $M_{GUT} \geq 1.0 \times 10^{16}$ GeV, we for the first time study the upper bounds on the gaugino and sfermion masses. We show that the GUTs with anomaly and gauge mediated supersymmetry breakings are well within the reaches of the future 100 TeV pp colliders such as the $\mathrm{FCC_{hh}}$ and SppC, and the supersymmetric GUTs with gravity mediated supersymmetry breaking can be probed at the future 160 TeV pp collider.

Primary author: Prof. LI, Tianjun

Co-author: LI, Tianjun

Presenter: LI, Tianjun

Session Classification: Collider

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

Astrophysical signatures of axion-like-particle clumps

Tuesday, 24 May 2022 14:39 (23 minutes)

Axion-like-particles frequently appear in extensions of the Standard Model and could be a principal component of the dark matter in the universe. We review several astrophysical effects that could be due to inhomogeneous axion distributions. Such clumps could have been present at early stages of the evolution of the universe giving rise to the formation of black holes; or they could exist in the present dark matter distribution and be related to the observed Fast Radio Bursts and contribute to the so called Gegenschein emission.

Primary author: FERRER ESCURSELL, Francesc

Presenter: FERRER ESCURSELL, Francesc

Session Classification: Dark Matter

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

Explaining lepton-flavor non-universality and self-interacting dark matter with L_mu - L_tau

Experimental hints for lepton-flavor universality violation in the muon's magnetic moment as well as neutral- and charged-current B-meson decays require Standard-Model extensions by particles such as leptoquarks that generically lead to unacceptably fast rates of charged lepton flavor violation and proton decay. We propose a model based on a gauged $U(1)_{L_\mu - L_\tau}$ that eliminates all these unwanted decays by symmetry rather than finetuning and efficiently explains $(g-2)_\mu$, $R_{K^{(*)}}$, $R_{D^{(*)}}$, and neutrino masses. The $U(1)_{L_\mu - L_\tau}$ furthermore acts as a stabilizing symmetry for dark matter and the light Z' gauge boson mediates velocity-dependent dark-matter self-interactions that resolve the small-scale structure problems. Lastly, even the Hubble tension can be ameliorated via the light Z' contribution to the relativistic degrees of freedom.

Primary authors: THAPA, Anil; HEECK, Julian

Presenter: HEECK, Julian

Session Classification: Collider: W mass/QCD, Electroweak

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

Classifying Anomalies THrough Outer Density Estimation

Wednesday, 25 May 2022 09:16 (23 minutes)

Despite countless searches at the Large Hadron Collider (LHC), new physics remains elusive. The majority of these searches are highly model specific, requiring both background and signal simulation. In recent years, many anomaly detection methods have been proposed that use machine learning to enhance resonance searches without specifying a particular signal hypothesis. In this talk, I will present CATHODE (Classifying Anomalies THrough Outer Density Estimation), a novel model agnostic anomaly detection method built on the combination of neural density estimation and classification. I will show that it significantly outperforms all previous approaches aiming to enhance bump hunt searches, and that it achieves the best possible performance on the well-studied LHC Olympics R&D dataset. CATHODE represents a major step forward in the field of anomaly detection for high energy physics and will significantly enhance the breadth and sensitivity of searches at the LHC and beyond.

Primary author: HALLIN, Anna

Co-authors: ISAACSON, Joshua; SOMMERHALDER, Manuel (Hamburg University (DE)); SHIH, David; SCHLAFFER, Matthias; QUADFASEL, Tobias (Hamburg University (DE)); NACHMAN, Ben (Lawrence Berkeley National Lab. (US)); KRAUSE, Claudius (Rutgers University); KASIECZKA, Gregor (Hamburg University (DE))

Presenter: HALLIN, Anna

Session Classification: Machine Learning, Neutrino

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

Robustness of neutrino mass ordering determination

Thursday, 26 May 2022 17:22 (23 minutes)

In neutrino oscillation physics numerous exact degeneracies exist under the name LMA-Dark. These degeneracies make it impossible to determine the sign of Δm^2_{31} known as the atmospheric mass ordering with oscillation experiments alone in the presence of new neutrino interactions. We discuss the status of these degeneracies and show that recent data has lifted the LMA-Dark degeneracy in the ν_e sector, however it can still be restored in the ν_μ and ν_τ sector or with very specific couplings to up and down quarks, and we speculate on a path forward.

Primary author: GEHRLEIN, Julia

Co-author: DENTON, Peter (Brookhaven National Laboratory)

Presenter: GEHRLEIN, Julia

Session Classification: Neutrino

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

The Migdal effect in liquid noble dark matter experiments

Tuesday, 24 May 2022 13:53 (23 minutes)

Dark matter direct detection experiments have spurred interest in the Migdal effect, where it is employed to extend their sensitivity to lower dark matter masses. The calculation of the signal is subject to large theoretical uncertainties, therefore a calibration of the Migdal effect and the experimental response to a potential dark matter signal is needed. In this talk I'll show the results of proof-of-concept calculations for such a calibration using low-energy neutrons and neutrinos.

Primary author: NEWSTEAD, Jayden

Presenter: NEWSTEAD, Jayden

Session Classification: Dark Matter

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

Memory-triggered supernova neutrino detection

Friday, 27 May 2022 10:50 (23 minutes)

When a burst of neutrinos from a core-collapse supernova (CCSN) passes by the Earth, it causes a permanent change in the local space-time metric, called the gravitational wave (GW) memory. Long considered unobservable, this effect will be detectable in the near future, at deci-Hertz GW interferometers. I will present a novel idea, where observations of the neutrino GW memory from CCSNe will enable time-triggered searches of supernova neutrinos at megaton (Mt) scale detectors. This combination of a deci-Hz GW detector and a Mt neutrino detector will allow the latter to surpass its current sensitivity limits to detect a nearly background-free sample of ˜ 3 - 30 supernova neutrino events per Mt per decade of operation, from large distances (˜ 10 - 100 Mpc), which will open a new avenue to studying supernova neutrinos.

Primary authors: MUKHOPADHYAY, Mainak (Arizona State University); LUNARDINI, Cecilia (Arizona State University); Dr LIN, Zidu (Department of Physics and Astronomy, University of Tennessee, Knoxville)

Presenter: MUKHOPADHYAY, Mainak (Arizona State University)

Session Classification: Neutrino, Dark Matter, String

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

The nCTEQ Project: revealing the fundamental character of the QCD strong force

Wednesday, 25 May 2022 14:16 (23 minutes)

Science is entering a new era in the investigation of nuclear matter, driven by a wealth of precision data from the JLab, HERA, RHIC, & LHC experiments. The nCTEQ project employs advanced theoretical techniques to analyze these data sets comprehensively. While this analysis is performed within the framework of the QCD parton model, we leverage methods and results from Lattice QCD, Machine Learning, as well as other techniques. This work also forms the foundation for discoveries at the future Electron-Ion Collider (EIC), which will address fundamental questions about nuclei's mass, spin, and internal structure. The culmination of these efforts will produce the most detailed picture to date of nuclei, and advance the opportunity to possibly "solve"the underlying QCD theory of strong interactions.

Primary author: OLNESS, Fred (Southern Methodist University (US))

Presenter: OLNESS, Fred (Southern Methodist University (US))

Session Classification: Collider: W mass/QCD, Electroweak

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

New Proton Beam Dump Experiments at Fermilab: PIP2-BD and SBN-BD

Wednesday, 25 May 2022 16:13 (23 minutes)

The PIP-II complex at Fermilab is slated for operation later this decade and can support MW-class proton fixed-target programs at both O(1 GeV) and O(10 GeV) in addition to the beam required for DUNE. In this talk we outline new opportunities for BSM searches at O(1 GeV) and O(10 GeV) proton beam dump facilities at Fermilab using existing and proposed neutrino detectors.

Primary author: TOUPS, Matthew

Presenter: TOUPS, Matthew

Session Classification: Electroweak, Neutrino

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

Status and Prospect of Search for LFUV (ATLAS and CMS)

Thursday, 26 May 2022 10:50 (23 minutes)

Lepton flavour universality violation (LFUV) continues to be indicated by results in the B-meson sector. Especially LHCb's measurement of the charged channel R(D) & R(D*), as well as neutral channel R(K) & R(K*)* anomalies hint at the existence of BSM physics explaining this LFUV.
This talk covers a variety of searches of the ATLAS and CMS collaborations at $\sqrt{s} = 13$ TeV that have been interpreted in models relevant to the B-anomalies. Prospects of further and ongoing searches will also be discussed.

Primary author: Dr RATHJENS, Denis (Texas A & M University (US))

Presenter: Dr RATHJENS, Denis (Texas A & M University (US))

Session Classification: Collider

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

The viability of ultralight bosonic dark matter in dwarf galaxies

Thursday, 26 May 2022 13:53 (23 minutes)

The dark matter distribution in dwarf galaxies holds a wealth of information on the fundamental properties and interactions of the dark matter particle. We study whether ultralight boson dark matter is consistent with the gravitational potential extracted from stellar kinematics. We use velocity dispersion measurements from six classical dwarf galaxies to show that axion-like particles with masses of order $m \approx 10^{-22}\mathrm{eV}$ are inconsistent with the potential distribution in classical dwarf galaxies unless the hierarchical assembly of the Milky Way did not trace the mean evolution of Milky Way size halos.

Primary author: GOLDSTEIN, Isabelle (Brown University)

Co-authors: Dr KOUSHIAPPAS, Savvas (Brown University); Dr WALKER, Matthew (Carnegie Mellon University)

Presenter: GOLDSTEIN, Isabelle (Brown University)

Session Classification: Astrophysics

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

Recent Results from NOvA

Thursday, 26 May 2022 16:13 (23 minutes)

NOvA is a long-baseline neutrino oscillation experiment designed to observe electron neutrino appearance in a muon neutrino beam. It consists of a near detector at Fermilab and a 14-kt far detector 810 km away in northern Minnesota, both exposed to the NuMI beam. In this talk, I will review recent results from NOvA, including measurements of the neutrino oscillation parameters based on a combined fit to neutrino and antineutrino data.

Primary author: KOERNER, Lisa (University of Houston (US))

Presenter: KOERNER, Lisa (University of Houston (US))

Session Classification: Neutrino

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

CP Violating Top Yukawa Coupling at the Future Muon Collider

Thursday, 26 May 2022 11:36 (23 minutes)

We study the CP-violating top Yukawa coupling at a future muon collider with energies of 1, 3, 10, and 30 TeV. The processes under consideration are $t\bar{t}h$, $t\bar{t}h\nu\bar{\nu}$, and $tbh\nu\mu$. As we will show, at different energies the different processes dominate. Additionally, each process has a different dependence on the CP-violating top Yukawa. We will project 2σ exclusion and 5σ discovery limits for the CP-violation.

Primary authors: LEWIS, Ian (The University of Kansas); KONG, K.C.; CASSIDY, Morgan (University of Washington (US)); ZHENG, Ya-Juan; ZHANG, Yanzhe (University of Kansas); DONG, Zhongtian (University of Kansas)

Presenter: LEWIS, Ian (The University of Kansas)

Session Classification: Collider

Contribution ID: **23** Type: **not specified**

A New Idea for Relic Neutrino Detection

Thursday, 26 May 2022 15:50 (23 minutes)

The detection of the cosmic neutrino background (CvB) is an outstanding problem in particle physics and cosmology. We propose a new way to detect CvB via resonant scattering against cosmogenic GZK neutrinos, which leads to an attenuation of the GZK neutrino flux. However, to have any observable effect, we need significant CvB overdensity along the line-of-sight. This might be feasible in certain astrophysical environments and/or if neutrinos have a large self-interaction.

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

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

Session Classification: Neutrino

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

Deep learning the astrometric signature of dark matter substructure

I will discuss the application of machine learning techniques for the detection of the astrometric signature of dark matter substructure. In this simple proof of principle example, a population of dark matter subhalos in the Milky Way act as lenses for sources of extragalactic origin. We show that machine learning applied to an SKA -like survey can be used to probe the substructure content of the Milky Way.

Primary author: Prof. KOUSHIAPPAS, Savvas (Brown University)

Presenter: Prof. KOUSHIAPPAS, Savvas (Brown University)

Session Classification: Astrophysics

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

The Search for Dark Matter in the Ultra-high-energy Sky

The nature of dark matter (DM) —the cold, neutral entity comprising roughly 85% of all matter content in the universe —is one of the biggest open problems in modern astrophysics. One plausible class of candidate DM particles, from beyond the Standard Model of physics, are Weakly Interacting Massive Particles (WIMPs), ranging in masses between ˜GeV to hundreds of TeV. Such DM particles may annihilate or decay in astrophysical environments to produce photons and neutrinos that may be detectable on earth. The search for the nature of DM is, therefore, closely tied to precision measurements, of both point and diffuse sources of ultra-high-energy (> 10 TeV) Galactic and extra-galactic emission. I will describe the efforts to survey the universe in extreme energies with two on-going experiments —High Altitude Water Cherenkov (HAWC) Gamma-ray Observatory, and the IceCube South Pole Neutrino Observatory. In particular, I will discuss how we use the high-statistics, continuous measurements in neutrinos and gamma rays to search for signatures of DM in a variety of astrophysical targets, and will present some of the resulting constraints on model parameters.

Primary author: NISA, Mehr Un (Michigan State University)

Presenter: NISA, Mehr Un (Michigan State University)

Session Classification: Dark Matter

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

New Strategies and Targets for Probing of Velocity-Dependent Dark Matter Annihilation

Friday, 27 May 2022 11:13 (23 minutes)

We consider the well-motivated scenario of dark matter annihilation with a velocity-dependent cross section. At higher speeds, dark matter annihilation may be either enhanced or suppressed, which affects the relative importance of targets like galactic subhalos, the Galactic Center, or extragalactic halos. We consider a variety of new strategies for determining the associated J-factors, and for extracting information about the velocity-dependence of the cross section from gamma-ray data, including the study of non-Poisson fluctuations in the photon count, and the use of likelihood-free inference.

Primary author: KUMAR, Jason

Presenter: KUMAR, Jason

Session Classification: Neutrino, Dark Matter, String

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

The H_0 and S_8 tensions necessitate early and late time changes to ΛCDM

Wednesday, 25 May 2022 15:02 (23 minutes)

The Hubble tension is a result of variations between the late-Universe measurements of H_0 and those inferred from early-Universe physics measurements. Many solutions have been proposed to address this tension; among the most successful are alterations to the early-Universe physics such as Early Dark Energy (EDE). However, each of these proposed solutions mitigate the tension at the expense of other quantities, such as the mild S_8 tension. Conversely, other solutions have been proposed to address the S_8 tension, such as Decaying Dark Matter (DDM), but these similarly fail to address all constraints as they do not alter H_0. The difficulty in finding a resolution could be an indicator that a single solution is not sufficient to resolve the tensions. Here we investigate how merging compatible models can address both H_0 and S_8 simultaneously, in particular, EDE + DDM where EDE raises H_0 and DDM controls the growth of structure.

Primary author: CLARK, Steven (Brown University)

Presenter: CLARK, Steven (Brown University)

Session Classification: Collider: W mass/QCD, Electroweak

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

$e4\nu$ & $\mu4\nu$: Brightening the Future of Neutrino Oscillation Measurements

Wednesday, 25 May 2022 10:02 (23 minutes)

Sensitivities of future large underground neutrino oscillation experiments are critically dependent upon precisely understanding the initial energy of an incoming neutrino via cross section models and event generator predictions which summarize prospective final states. Extracting the true initial energy of the neutrino is thus model dependent, requiring a deep understanding of the biases present within the community's generators and various reconstruction paradigms. The Electrons-for-Neutrinos ($e4\nu$) and Muons-for-Neutrinos ($\mu4\nu$) Initiatives aim to constrain both of these issues by studying the light charged leptonic cousins of the neutrino, exploiting universal vector-like interactions to better understand underlying systematic modeling uncertainties, improve neutrino cross sections models, and calibrate reconstruction techniques \textit{in situ}. $e4\nu$ has recently taken new electron scattering data on ^{12}C, ^{40}Ar, and many other nuclei using the CLAS12 detector in Hall B at Thomas Jefferson National Accelerator Laboratory, and plans to release many relevant measurements for the neutrino community in the coming years. $\mu4\nu$ is a burgeoning concept, and currently works within the MicroBooNE Collaboration at Fermilab to study cosmic muon scattering topologies relevant for testing energy reconstruction techniques in calorimetric experiments such as future flagship experiments like DUNE. Each of these programs will be discussed, and recent work will be shown.

Primary author: BARROW, Joshua

Co-authors: ASHKENAZI, Adi (Tel Aviv University (IL)); PAPADOPOULOU, Afroditi; HEN, Or; WEINSTEIN, Lawrence (ODU); KALRA, Daisy (Columbia University)

Presenter: BARROW, Joshua

Session Classification: Machine Learning, Neutrino

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

Dark Axion Portal

Tuesday, 24 May 2022 13:30 (23 minutes)

The dark matter sector is mysterious. One possible scenario is the dark matter sector is basically separated from the visible sector and is made up of its own particle spectrum similar to the standard model. Here, the concept of the portal between the dark sector and the visible sector is important to investigate the dark sector. We will talk about the dark axion portal, which connects some hypothetical dark sector particles (axion and dark photon) to the standard model sector, and how we can use it to probe the dark sector.

Primary author: LEE, Hye-Sung (KAIST)

Presenter: LEE, Hye-Sung (KAIST)

Session Classification: Dark Matter

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

Highlights of Search for New Particles at the LHC

Wednesday, 25 May 2022 10:50 (23 minutes)

This presentation discusses searches for heavy particles by the ATLAS and CMS collaborations at the Large Hadron Collider (LHC). The talk discusses a motivation for such searches and the experimental challenges to discover heavy particles in the mass range from 400 GeV to 8 TeV using jets, leptons and missing transverse energy. The presented experimental limits use the LHC Run 2 dataset collected between 2015 and 2018.

Primary author: CHEKANOV, Sergei (Argonne National Laboratory (US))

Presenter: CHEKANOV, Sergei (Argonne National Laboratory (US))

Session Classification: Collider

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

Short-Baseline neutrino oscillation searches with the ICARUS detector

Friday, 27 May 2022 08:30 (23 minutes)

The ICARUS collaboration employed the 760-ton T600 detector in a successful three-year physics run at the underground LNGS laboratories studying neutrino oscillations with the CNGS neutrino beam from CERN, and searching for atmospheric neutrino interactions. ICARUS performed a sensitive search for LSND-like anomalous νe appearance in the CNGS beam, which contributed to the constraints on the allowed parameters to a narrow region around 1 eV2, where all the experimental results can be coherently accommodated at 90% C.L. After a significant overhaul at CERN, the T600 detector has been installed at Fermilab. In 2020 cryogenic commissioning began with detector cool down, liquid Argon filling and recirculation. ICARUS has started operations and is presently in its commissioning phase, collecting the first neutrino events from the Booster Neutrino Beam and the NuMI off-axis. The main goal of the first year of ICARUS data taking will then be the definitive verification of the recent claim by NEUTRINO-4 short baseline reactor experiment both in the ⊠μ channel with the BNB and in the ⊠e with NuMI. After the first year of operations, ICARUS will commence its search for evidence of a sterile neutrino jointly with the SBND near detector, within the Short Baseline Neutrino (SBN) program. The ICARUS exposure to the NuMI beam will also give the possibility for other physics studies such as light dark matter searches and neutrino-Argon cross section measurements. The proposed contribution will address ICARUS achievements, its status and plans for the new run at Fermilab and the ongoing developments of the analysis tools needed to fulfill its physics program.

Presenter: HOWARD, Bruce (Indiana University)

Session Classification: Neutrino

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

Quantum Interference in Jets at Subleading Color

In this talk, I introduce observables for identification of quantum interference effects in jets from the interference of gluon states with distinct color quantum numbers. These effects are exclusively beyond the leading-color approximation, and so can have important consequences for fixed-order predictions or parton shower modeling that includes full-color physics.

Primary author: LARKOSKI, Andrew (SLAC National Accelerator Laboratory)

Presenter: LARKOSKI, Andrew (SLAC National Accelerator Laboratory)

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

Correlating Gravitational Wave and Gamma-ray Signals from Primordial Black Holes

Thursday, 26 May 2022 10:02 (23 minutes)

Asteroid-mass primordial black holes (PBH) can explain the observed dark matter abundance while being consistent with the current indirect detection constraints. These PBH can produce gamma-ray signals from Hawking radiation that are within the sensitivity of future measurements by the AMEGO and e-ASTROGAM experiments. PBH which give rise to such observable gamma-ray signals have a cosmic origin from large primordial curvature fluctuations. There must then be a companion, stochastic gravitational wave (GW) background produced by the same curvature fluctuations. I will show that the resulting GW signals will be well within the sensitivity of future detectors such as LISA, DECIGO, BBO, and the Einstein Telescope. The multi-messenger signal from the observed gamma-rays and GW will allow a precise measurement of the primordial curvature perturbation that produces the PBH, and the correlation between the two types of observations can provide a smoking-gun signal of PBH.

Primary authors: DUTTA, Bhaskar (Texas A&M University); CHANG, Jae Hyeok (JHU/UMD); AGASHE, Kaustubh; TSAI, Yuhsin (University of Notre Dame); CLARK, Steven (Brown University); XU, Tao

Presenter: TSAI, Yuhsin (University of Notre Dame)

Session Classification: Dark matter

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

CP Violation at Long-Baseline Neutrino Experiments

Friday, 27 May 2022 08:53 (23 minutes)

The nature of CP violation in the lepton sector is one of the biggest open questions in particle physics. Long-baseline accelerator neutrino experiments have the opportunity to determine if CP is violated in the mass matrix. I will look at the most recent NOvA and T2K data which show a slight and very interesting tension. While this tension possibly indicates a flipping in the mass ordering, it is better fit by new physics such as non-standard neutrino interactions (NSI) with an additional source of CP violation. The strength of this NSI can be easily estimated analytically and I will present a numerical analysis of the preferred regions which are generally consistent with other constraints.

Primary author: Dr DENTON, Peter (Brookhaven National Laboratory)

Co-authors: GEHRLEIN, Julia; PESTES, Rebekah (Virginia Tech)

Presenter: Dr DENTON, Peter (Brookhaven National Laboratory)

Session Classification: Neutrino

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

Machine learning the Higgs-top CP Measurement

We explore the direct Higgs-top CP structure via the $pp \to t\bar{t}h$ channel with machine learning techniques, considering the clean $h \to \gamma\gamma$ final state at the high luminosity LHC˜(HL-LHC). We show that a combination of a comprehensive set of observables, that includes the $t\bar{t}$ spin-correlations, with mass minimization strategies to reconstruct the $t\bar{t}$ rest frame provides large CP-sensitivity.

Primary authors: GONÇALVES, Dorival (Oklahoma State University); BARMAN, Rahool Kumar (Oklahoma State University)

Presenter: BARMAN, Rahool Kumar (Oklahoma State University)

Session Classification: Machine Learning, Neutrino

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

Status and Prospect of Search for LLP

Wednesday, 25 May 2022 11:13 (23 minutes)

Many extensions of the standard model (SM) predict the existence of weakly-coupled particles that have a long lifetime. These long-lived particles (LLPs) often provide striking displaced signatures in detectors, thus escaping the conventional searches for prompt particles and remaining largely unexplored at the LHC. I will discuss the broad search program for LLPs enabled by the unique detector designs of CMS and ATLAS and how they enable new LLP physics programs in the future.

Primary author: WANG, Christina Wenlu (California Institute of Technology (US))

Presenter: WANG, Christina Wenlu (California Institute of Technology (US))

Session Classification: Collider

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

Probing CP-violation and thermal history of our Universe with Higgs physics

Thursday, 26 May 2022 11:59 (23 minutes)

Searching for new sources of CPV and uncovering the mechanism behind EWSB are cornerstones of the LHC program and forthcoming experiments, such as FCC and LISA. First, we show how collider measurements and observations of stochastic gravitational-wave signals can complement each other to explore the multiform scalar potential in the 2HDM. The well-motivated 2HDM leads to a rich phase transition, favoring SFOEWPT below the TeV scale, with the smoking gun signature of scalar resonant searches to top pairs. Second, we show the prospects of directly probing CPV in the Higgs-top coupling. In particular, we use machine learning techniques to uplift the analysis from a raw rate to a polarization study.

Primary author: GONÇALVES, Dorival (Oklahoma State University)

Presenter: GONÇALVES, Dorival (Oklahoma State University)

Session Classification: Collider

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

EFT at Neutrino Experiments

Friday, 27 May 2022 09:16 (23 minutes)

We will discuss how to systematically study physics beyond the standard model (BSM) in the neutrino experiments within the Standard Model Effective Field Theory (SMEFT) framework. In this way, the analysis of the data can capture large classes of models, where the new degrees of freedom have masses well above the relevant energy of the experiment. Moreover, it allows us to compare several experiments in a unified framework and in a systematic way. Our proposed approach could be applied to several short- and long baseline neutrino experiments. We will show the results of this approach at the FASERv experiment, which will be soon installed 480 m downstream of the ATLAS interaction point, as well as the medium baseline reactor experiments Daya Bay and RENO. For some coupling structures, we find that these neutrino detectors will be able to constrain interactions that are almost three orders of magnitude weaker than the Standard Model weak interactions, implying that they will be indirectly probing new physics at the 10 TeV scale.

Primary author: TABRIZI, Zahra (Northwestern University)

Presenter: TABRIZI, Zahra (Northwestern University)

Session Classification: Neutrino

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

Exploring Dark Matter Shadows with AI

Wednesday, 25 May 2022 08:30 (23 minutes)

Transit spectroscopy is the primary tool for inferring the physical parameters and the atmospheric chemical composition of extrasolar planets. I will discuss some recently proposed AI-inspired techniques for exoplanet parameter retrievals, including dimensional analysis, vector component analysis, exploratory data analysis, feature engineering, dimensionality reduction and manifold learning, clustering, anomaly detection and visualization. I will also draw analogies to the corresponding simulation and data analysis chain in high energy physics.

Primary author: MATCHEV, Konstantin (University of Florida (US))

Co-authors: MATCHEVA, Katia (University of Florida); ROMAN, Alex (University of Florida)

Presenter: MATCHEV, Konstantin (University of Florida (US))

Session Classification: Machine Learning, Neutrino

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

Naturally light Dirac neutrinos from left-right symmetry

Friday, 27 May 2022 09:39 (23 minutes)

I shall describe the natural origin of Dirac neutrinos with small masses in a class of left-right symmetric theories. These models also solve the strong CP problem via parity symmetry, without the need for an axion. Consistency with neutrino oscillation data will be shown. Such Dirac neutrino models can be tested in CMB measurements of Neff, which is predicted to be larger by about 0.14.

Primary author: BABU, Kaladi

Presenter: BABU, Kaladi

Session Classification: Neutrino

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

Prospects for Dark Sector Search at the Deep Underground Neutrino Experiment

Tuesday, 24 May 2022 15:50 (23 minutes)

Dark matter is known to make up more than 75% of matters of the universe. However, its nature remains to be unveiled. Over the several decades, extensive studies have been done on the weak scale mass regime, but there have been no positive results thus far. This naturally led to an interest in the dark matter models in areas other than the weak scale.

The Deep Underground Neutrino Experiment (DUNE) is an international collaboration that aims at a variety of physics topics, while its primary scientific goal is a precision measurement of neutrino oscillation parameters. The high-intensity proton beams and precision detector system are essential to the design goals for this project. These provide ample opportunities for the potential discoveries of new particles, new interactions, and symmetries beyond the Standard Model (BSM). The beam power is expected to be 1.2 MW corresponding to protons-on-target of 1.1×1021/year, upgradable to multi-megawatt power. The Near Detector (ND) complex will be located 574 m away from the neutrino production target. The ND complex consists of a liquid argon time projection chamber (TPC), a magnetized gaseous argon TPC, and a large, magnetized beam monitor. This environment provides excellent conditions to probe many BSM physics topics.

This presentation will discuss the dark sector search program at DUNE, specifically light dark matter and axion-like particles. I will introduce their physics motivation, production mechanisms, the current status of the study, and its prospects.

Primary author: JANG, Wooyoung (University of Texas at Arlington)

Presenter: JANG, Wooyoung (University of Texas at Arlington)

Session Classification: Electroweak

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

The XENONnT Dark Matter Experiment

Thursday, 26 May 2022 09:39 (23 minutes)

The XENONnT experiment has made great commissioning strides in the last year. Operating at the INFN Gran Sasso National Laboratory in Italy, XENONnT has substantially improved upon its predecessor, XENON1T, which to date is the most sensitive direct-detection dark-matter experiment for spin-independent WIMPs above 6 GeV/cˆ{2}. As part of its multi-pronged physics program, XENONnT aims to reach a sensitivity of 1.4x10ˆ{–48}cmˆ{2} for the WIMP-nucleon cross section. In this talk, I will describe the improved subsystems (ranging from liquid purification, radon distillation, neutron veto and data processing) and their impacts on various physics searches, as well as their current status

Primary author: HIGUERA PICHARDO, Aaron

Presenter: HIGUERA PICHARDO, Aaron

Session Classification: Dark matter

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

CEvNS with the LBNF beamline and the nuBDX-DRIFT directional detector

Tuesday, 24 May 2022 09:39 (23 minutes)

nuBDX-DRIFT is a directional low-pressure TPC detector suitable for measurements of coherent elastic neutrino-nucleus scattering (CEvNS) using a variety of gaseous target materials which include carbon disulfide, carbon tetrafluoride and tetraethyllead. In this talk, I will briefly discuss various aspects of the physics opportunities that measurements using the LBNF beamline offer. Special attention will be given to SM parameters measurements and searches for new physics.

Primary author: ARISTIZABAL, Diego (Universidad Tecnica Federico Santa Maria (USM))

Presenter: ARISTIZABAL, Diego (Universidad Tecnica Federico Santa Maria (USM))

Session Classification: Neutrino

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

Backgrounds in the νBDX-DRIFT Experiment at Fermilab

Tuesday, 24 May 2022 10:50 (23 minutes)

The νBDX-DRIFT experiment seeks to study CEνNS interactions and search for BSM physics using low-energy nuclear recoils at Fermilab, detailed in another talk at this conference. Background suppression is the key to the success of this endeavor. Using GENIE and Geant we have benchmarked our simulations to results from a preliminary COUPP run in the NuMI beam in 2009. Utilizing this result we can then confidently predict backgrounds during an envisioned run at NuMI. With use a scintillating veto we show sufficient background reduction to carry out the aims of the νBDX-DRIFT experiment.

Primary author: SNOWDEN-IFFT, Daniel

Presenter: SNOWDEN-IFFT, Daniel

Session Classification: Cosmology, Dark Matter

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

Stasis in an Expanding Universe: A Recipe for Stable Mixed-Component Cosmological Eras

Tuesday, 24 May 2022 11:36 (23 minutes)

One signature of an expanding universe is the time-variation of the cosmological abundances of its different components. For example, a radiation-dominated universe inevitably gives way to a matter-dominated universe, and critical moments such as matter-radiation equality are fleeting. In this talk, we point out that this lore is not always correct, and that it is possible to obtain a form of "stasis"in which the relative cosmological abundances Ω_i of the different components remain unchanged over extended cosmological epochs, even as the universe expands. Moreover, we demonstrate that such situations are not fine-tuned, but are actually global attractors within certain cosmological frameworks, with the universe naturally evolving towards such long-lasting periods of stasis for a wide variety of initial conditions. The existence of this kind of stasis therefore gives rise to a host of new theoretical possibilities across the entire cosmological timeline, ranging from potential implications for primordial density perturbations, dark-matter production, and structure formation all the way to early reheating, early matter-dominated eras, and even the age of the universe.

Primary author: HUANG, Fei (ITP CAS and UC Irvine)

Co-authors: THOMAS, Brooks; DIENES, Keith (University of Arizona); TAIT, Tim M.P. (University of California, Irvine); KIM, Doojin (Texas A & M University (US)); HEURTIER, Lucien (IPPP, Durham, England)

Presenter: HUANG, Fei (ITP CAS and UC Irvine)

Session Classification: Cosmology, Dark Matter

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

Searching for New Interactions at Sub-micron Scale Using the Mossbauer Effect

Wednesday, 25 May 2022 14:39 (23 minutes)

A new technique to search for new scalar and tensor interactions at the sub-micrometer scale is presented. The technique relies on small shifts of nuclear gamma lines produced by the coupling between matter and the nuclei in the source or absorber of a Mossbauer spectrometer. Remarkably, such energy shifts are rather insensitive to electromagnetic interactions that represent the largest background in searches for new forces using atomic matter. This is because nuclei are intrinsically shielded by the electron clouds. Additionally, electromagnetic interactions cause energy shifts by coupling to nuclear moments that are suppressed by the size of the nuclei, while new scalar interactions can directly affect these shifts. Finally, averaging over unpolarized nuclei, further reduces electromagnetic interactions. We discuss several possible configurations, using the traditional Mossbauer effect as well as nuclear resonant absorption driven by synchrotron radiation. For this purpose, we examine the viability of well known Mossbauer nuclides along with more exotic ones that result in substantially narrower resonances. We find that the technique introduced here could substantially improve the sensitivity to a variety of new interactions and could also be used, in conjunction with mechanical force measurements, to corroborate a discovery or explore the new physics that may be behind a discovery.

Primary author: RAJENDRAN, Surjeet

Presenter: RAJENDRAN, Surjeet

Session Classification: Collider: W mass/QCD, Electroweak

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

Twin Quark Dark Matter

Wednesday, 25 May 2022 15:50 (23 minutes)

I will present an extension of the Twin Higgs scenario where the dark matter particle is a twin quark which becomes a (twin) color singlet after a spontaneous breaking of twin color. This model cogenerates matter/antimatter asymmetries in both the visible and twin sectors, thus addressing the naturalness, dark matter, and matter/antimatter puzzles. I will discuss constraints on the parameter space of the model as well as discovery prospects.

Primary authors: KILIC, Can; VERHAAREN, Christopher (Brigham Young University); YOUN, Taewook (University of Texas at Austin)

Presenter: KILIC, Can

Session Classification: Electroweak, Neutrino

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

Liquid-Argon Time-Projection Chambers DIY

Thursday, 26 May 2022 16:36 (23 minutes)

Based on their millimeter resolution and potential on calorimetric capabilities, liquid-argon time-projection chambers (LArTPCs) offer unique opportunities for detection of weakly interacting particles, and have been selected as the technology of the far detector of the Deep Underground Neutrino Experiment (DUNE). While LArTPCs have demonstrated good performance at keV-scale in small-scale detectors, and at GeV-scale detecting neutrinos produced by accelerators, further development is required to cope with different situations, such as near detectors of intense neutrino beams for DUNE, or MeV-scale particles for detection of neutrinos produced from core-collapse supernova explosions or astrophysical gamma rays. A crucial step in LArTPC R&D is an integrated test of the active detector elements, such as the field cage, charge and light collection systems. In the talk, I will introduce the essential components of such a facility, and the ongoing and planned R&D projects at SLAC.

Primary author: TSAI, yun tse (SLAC)

Presenter: TSAI, yun tse (SLAC)

Session Classification: Neutrino

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

Tumblers: A Novel Collider Signature for Long-Lived Particles

Wednesday, 25 May 2022 11:36 (23 minutes)

In this talk, we point out a novel signature of physics beyond the Standard Model which could potentially be observed both at the LHC and at future colliders. This signature, which emerges naturally within many proposed extensions of the Standard Model, results from the multiple displaced vertices associated with the successive decays of unstable, long-lived particles along the same decay chain. We call such a sequence of displaced vertices a "tumbler." We examine the prospects for observing tumblers at the LHC and assess the extent to which tumbler signatures can be distinguished from other signatures of new physics which involve multiple displaced vertices within the same collider event. As part of this analysis, we also develop a procedure for reconstructing the masses and lifetimes of the particles involved in the corresponding decay chains. We find that the prospects for discovering and distinguishing tumblers can be greatly enhanced by exploiting precision timing information —information such as would be provided by the CMS timing layer at the HL-LHC. Our analysis therefore provides strong motivation for continued efforts to improve the timing capabilities of collider detectors at the LHC and beyond.

Primary author: THOMAS, Brooks (Lafayette College)

Co-authors: KIM, Doojin (Texas A&M University); DIENES, Keith (University of Arizona); LEININGER, Tara (Lafayette College)

Presenter: THOMAS, Brooks (Lafayette College)

Session Classification: Collider

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

COHERENT: an Update

Tuesday, 24 May 2022 08:30 (23 minutes)

The COHERENT experiment consists of a suite of neutrino detectors located in a basement hallway at the Spallation Neutron Source in Oak Ridge National Laboratory. In 2017 (and again in 2021) COHERENT reported the first (and second) observation of CEvNS. I will present the status of these measurements. COHERENT is in the process of deploying four new neutrino detectors to "neutrino alley", including Ge, NaI, Th and D2O targets. I will also present the status and near-term plans for these measurements.

Primary author: Prof. BARBEAU, Phil

Presenter: Prof. BARBEAU, Phil

Session Classification: Neutrino

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

Evolution of Self-Interacting Dark Matter Halos

Thursday, 26 May 2022 09:16 (23 minutes)

Large self interactions between dark matter particles allow for efficient heat transfer within a dark matter halo, altering halo properties from LCDM predictions and thereby potentially alleviating small-scale structure formation puzzles. These properties can be explored using a semianalytic approach in which the halo is modeled as a gravothermal fluid. In this talk, I will describe the phases of halo evolution and discuss how the choice of the particle physics model for self interactions, as well as the environment of the halo, can impact evolution.

Primary author: BODDY, Kimberly (University of Texas at Austin)

Presenter: BODDY, Kimberly (University of Texas at Austin)

Session Classification: Dark matter

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

Dark Matter Production meets Cosmologically Evolving Couplings

I will discuss the possibility that the coupling constants are dynamical quantities which take different values during early cosmological epochs. In particular, I will show that such scenarios (focused on the gauge couplings of either the SU(2) or SU(3) SM interactions) can have a profound effect on the production of dark matter through various mechanisms, resulting in different expectations for parameters which can realize the observed DM abundance with respect to standard cosmological histories.

Primary author: TAIT, Tim M.P. (University of California, Irvine)

Presenter: TAIT, Tim M.P. (University of California, Irvine)

Session Classification: Cosmology, Dark Matter

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

Stückelberg Effective Field Theory

Tuesday, 24 May 2022 16:59 (23 minutes)

We explore the effective field theory of a vector field X_mu that has a Stückelberg mass. The absence of a gauge symmetry for X implies Lorentz-invariant operators are constructed directly from X_mu. Beyond the kinetic and mass terms, allowed interactions at the renormalizable level include Xˆ4, Hˆ2 Xˆ2 and Xˆmu j_mu, where j_mu is a global current of the SM or of a hidden sector. We show that all of these interactions lead to scattering amplitudes that grow with powers of the energy E, except for the case of X_mu coupling to an exactly conserved current. Our analysis suggests there is no free lunch by appealing to Stückelberg for the mass of a vector field: the price paid for avoiding a dark Higgs sector is replaced by the non-generic set of interactions that the Stückelberg vector field must have to avoid amplitudes that grow with energy.

Primary author: MARTIN, Adam Orion (University of Notre Dame (US))

Presenter: MARTIN, Adam Orion (University of Notre Dame (US))

Session Classification: Electroweak

Contribution ID: **54** Type: **not specified**

UV/IR Mixing, EFTs, and Origami: Calculating the Higgs Mass in String Theory

Friday, 27 May 2022 11:36 (23 minutes)

In this talk, we shall present a non-technical method of understanding UV/IR mixing from a field-theoretic perspective. We will then discuss how these ideas are ultimately realized in string theory, providing a self-contained introduction to relevant string ideas as we proceed. Finally, we shall present a fully string-theoretic framework for calculating one-loop Higgs masses directly from first principles in perturbative closed string theories. Notably, using our framework, we find that a gravitational modular anomaly generically relates the Higgs mass to the one-loop cosmological constant, thereby yielding a string-theoretic connection between the two fundamental quantities which are known to suffer from hierarchy problems in the absence of spacetime supersymmetry. We also discuss a number of crucial issues involving the use and interpretation of regulators in UV/IR-mixed theories such as string theory, and the manner in which one can extract an EFT description from such theories. Finally, we analyze the running of the Higgs mass within such an EFT description, and uncover the existence of a "dual IR" region which emerges at high energies as the consequence of an intriguing scale-inversion duality symmetry. We also identify a generic stringy effective potential for the Higgs fields in such theories. Our results can therefore serve as the launching point for a rigorous investigation of gauge hierarchy problems in string theory.

Primary author: DIENES, Keith R.

Presenter: DIENES, Keith R.

Session Classification: Neutrino, Dark Matter, String

Contribution ID: **55** Type: **not specified**

Direct Detection of Low Mass Fast Moving Dark Matter

Tuesday, 24 May 2022 14:16 (23 minutes)

Low mass fast moving/energetic dark matter (DM) is very well motivated and has been a subject of attention in the literature. These fast-moving particles can gain enough kinetic energy to pass the thresholds of some Large volume terrestrial detectors. For instance, fast-moving or "boosted" DM can account for the recent excess in electron recoil events observed by the XENON1T detector, due to its velocity being large enough to give rise to ˜keV recoil electrons. An explanation from ambient DM seems challenging otherwise. In this talk, I will focus on "boosted" DM which is a byproduct of the annihilation of heavier, ambient, dark sector partners. I will present on-going work in which the atomic effects are considered and show that, in the case of fast-moving DM, the limits can change depending on the electron ionization form factor used.

Primary author: MOHLABENG, Gopolang (University of California, Irvine)

Co-authors: KONG, K.C.; KIM, Doojin (Texas A & M University (US)); SHIN, Seodong (Seoul National University); PARK, Jong-Chul; ALHAZMI, Haider

Presenter: MOHLABENG, Gopolang (University of California, Irvine)

Session Classification: Dark Matter

Contribution ID: **56** Type: **not specified**

Dark Sector Insights with Upcoming CMB Observations

Thursday, 26 May 2022 14:39 (23 minutes)

Observations of the cosmic microwave background (CMB) have played an essential role in shaping our understanding of the history, evolution, and contents of the universe. CMB surveys planned over the next decade will map the microwave sky with unprecedented precision. I will discuss how these forthcoming observations will provide characteristically new insights into particle physics and cosmology, focusing especially on probes of dark sector physics enabled by CMB observations.

Primary author: MEYERS, Joel (Southern Methodist University)

Presenter: MEYERS, Joel (Southern Methodist University)

Session Classification: Astrophysics

Contribution ID: **57** Type: **not specified**

Dark Matter Annihilations in Massive Stars: A New Lease on Life?

Thursday, 26 May 2022 14:16 (23 minutes)

Stars whose initial mass is between approximately 150 and 240 $M_\odot$ face a fate of complete explosion in a pair instability supernova (PISN). However, by injecting energy into the star, it may be possible in some cases to avoid this fate. We outline conditions on this energy injection which can lead to the survival or incomplete explosion of the star, and we discuss how dark matter annihilations throughout a star may offer one mechanism to provide this energy. Finally, we begin to explore the range of energy conditions which may allow stars to avoid PISN.

Primary author: ZIEGLER, Joshua

Co-author: FREESE, Katherine (University of Michigan)

Presenter: ZIEGLER, Joshua

Session Classification: Astrophysics

Contribution ID: **58** Type: **not specified**

CMB birefringence from ultra-light axion string networks

Thursday, 26 May 2022 15:02 (23 minutes)

If ultra-light axion-like particles exist in nature, they might manifest themselves as a cosmological axion string network that fills the universe today. Such a string network is expected to leave a distinctive imprint on the polarization pattern of the Cosmic Microwave Background radiation. A coupling between axions and electromagnetism causes a photon's plane of polarization to rotate as it passes through the axion string network —a phenomenon known as axion-induced cosmological birefringence. Searches are underway for signs of birefringence in CMB data. Studying this birefringence can reveal valuable information about the axion-photon coupling, the axion mass scale, and the structure and evolution of the string network. In this talk I will discuss recent and ongoing work with collaborators at Rice University where we have focused on improved modeling of the expected signal.

Primary author: LONG, Andrew (Rice University)

Presenter: LONG, Andrew (Rice University)

Session Classification: Astrophysics

Contribution ID: **59** Type: **not specified**

Dark Sector Particle Searches at Rare Nuclear Isotope Accelerator Facilities

Tuesday, 24 May 2022 16:36 (23 minutes)

Recent discoveries of a new scalar boson, the gravitational wave and the black hole greatly advance our understanding of the nature of the universe. The 95% of the universe, however, is yet to be uncovered. Of these is the dark matter thought to make up about a quarter of the universe. Dark matter has been searched both directly and indirectly. Direct searches have hard bounds in the low mass regime due primarily to the radioactive impurities in the detector active materials. Recent theoretical advances and precision neutrino experimental facilities under development present an opportunity to expand dark sector particle searches in accelerators. The unprecedented proton beam power and precision detection capabilities make it possible. Many nuclear rare isotope facilities either ready for operation or close to be completed also possess similar advantages in search of dark sector particles in a different kinematic regime, providing synergistic opportunities. The primary challenges in this endeavor, however, are the backgrounds from neutral particles, in particular the beam related neutrons. In this talk, I will present a case study at a rare nuclear isotope facility, in particular the Axion-Like Particle (ALP) and present a methodology and a strategy to overcome the challenges. I will discuss the search sensitivity of the ALP and demonstrate the feasibility for dark sector particle searches at the rare nuclear isotope facilities.

Primary authors: KIM, Doojin (University of Florida); Prof. YU, Jae (University of Texas at Arlington (US)); PARK, Jong-Chul; PARK, Jong-Chul (Korea Institute for Advanced Study); SHIN, Seodong (University of Chicago / Yonsei University); SHIN, Seodong (Seoul National University); JANG, Wooyoung (University of Texas at Arlington); JANG, Wooyoung (Kyungpook National University (KR))

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

Session Classification: Electroweak

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

MINER: Review

Friday, 27 May 2022 11:59 (23 minutes)

Presenter: MIRABOLFATHI, Nader (UC-Berkeley)

Session Classification: Neutrino, Dark Matter, String

Contribution ID: **61** Type: **not specified**

Deep Learning Models of the Galactic Gamma-ray Emission and Implications for the Galactic Center Excess

Presenter: MURGIA, Simona (University of California, Irvine)

Session Classification: Dark Matter

Contribution ID: **62** Type: **not specified**

TBD

Presenter: THOMPSON, Adrian Raphael

Session Classification: Electroweak

Contribution ID: **63** Type: **not specified**

High-Precision Measurement of the W Boson Mass with the CDF II Detector

Wednesday, 25 May 2022 13:30 (23 minutes)

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

Session Classification: Collider: W mass/QCD, Electroweak

Contribution ID: **64** Type: **not specified**

M_W at Hadron Colliders: Theoretical Considerations

Wednesday, 25 May 2022 13:53 (23 minutes)

In light of the recent CDF result on the MW measurement at the Fermilab Tevatron, I discuss some implications from theoretical considerations. I first summarize the current global fit on the EW parameters from the PDG and observe the clear tension with the CDF MW measurement. I then discuss the transverse kinematical variables at hadron colliders, such as PT(e) and MT(en), from which the MW is extracted at hadron colliders. Unlike the invariant mass variable, those transverse variables have a convoluted relation with MW, and depend on the finite W width and the transverse motion of the W. Finally, taking the face value of the CDF MW result, I briefly comment on the possible new physics needed to accommodate the discrepancy.

Presenter: HAN, Tao

Session Classification: Collider: W mass/QCD, Electroweak

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

Ultrafeeble Neutrino Interactions with Ultralight DM

Wednesday, 25 May 2022 16:36 (23 minutes)

Presenter: KRNJAIC, Gordan (Fermilab)

Session Classification: Electroweak, Neutrino

Contribution ID: **66** Type: **not specified**

Low-energy neutrino-nucleus interaction

Presenter: PANDEY, Vishvas (University of Florida)

Session Classification: Electroweak, Neutrino

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

Searching for dark matter with COHERENT at the SNS

Wednesday, 25 May 2022 17:22 (23 minutes)

Presenter: PERSHEY, Daniel (Duke University)

Session Classification: Electroweak, Neutrino

Contribution ID: **68** Type: **not specified**

The Oscura Experiment

Thursday, 26 May 2022 08:53 (23 minutes)

Presenter: ESTRADA, juan (fermilab)

Session Classification: Dark matter

Contribution ID: **69** Type: **not specified**

TBD

Presenter: ARGÜELLES-DELGADO, Carlos A. (Harvard University)

Session Classification: Neutrino

Contribution ID: **70** Type: **not specified**

Reinstating Dark Sector Solutions to the MiniBooNE Anomaly

Tuesday, 24 May 2022 17:22 (23 minutes)

We point out that production of new bosons by charged meson decays can greatly enhance the sensitivity of beam-focused accelerator-based experiments to new physics signals. This enhancement arises since the charged mesons are focused and their three-body decays do not suffer from helicity suppression in the same way as their usual two-body decays. As a realistic application, we attempt to explain the MiniBooNE low energy excess utilizing this overlooked mechanism, reinstating the dark-sector interpretations as plausible solutions to the excess. As proof of the principle, we consider two well-motivated classes of dark-sector models, models of vector-portal dark matter and models of long-lived (pseudo)scalar. We argue that the model parameter values to accommodate the excess are consistent with existing limits and that they can be tested at current and future accelerator-based neutrino experiments.

Primary author: THOMPSON, Adrian Raphael

Presenter: THOMPSON, Adrian Raphael

Session Classification: Electroweak

Contribution ID: **71** Type: **not specified**

Low-energy neutrino-nucleus interactions

Wednesday, 25 May 2022 16:59 (23 minutes)

Tens of MeV neutrinos, e.g. from the stopped pion or core-collapse supernova sources, scatter off the target nucleus in the detector either via a coherent elastic or the inelastic process and allow the study of a variety of SM and BSM processes. The precision of the coherent elastic process, where the scattered nucleus remains in its ground state, is limited by the precision with which the underlying weak form factor of the nucleus is known. In the inelastic scattering, neutrino excites the target nucleus to low-lying nuclear states and is subject to more detailed underlying nuclear structure and dynamics, and is therefore quite poorly understood. This talk will cover neutrino-nucleus interaction in the tens of MeV region, constraining those are vital in disentangling beyond the Standard Model physics signals from the SM signals in neutrino experiments.

Primary author: PANDEY, Vishvas

Presenter: PANDEY, Vishvas

Session Classification: Electroweak, Neutrino

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

Exploring Dark Sector Physics at Neutrino Facilities

Tuesday, 24 May 2022 16:13 (23 minutes)

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

Session Classification: Electroweak

Contribution ID: **73** Type: **not specified**

Challenging the Standard Model with IceCube

Tuesday, 24 May 2022 09:16 (23 minutes)

The IceCube Neutrino Observatory located near the geographical South Pole has measured the spectra of high-energy atmospheric and astrophysical neutrinos. Using the data collected over more than ten years, IceCube has performed searches for new neutrino forces, partners, and space-time symmetries have been performed. This talk will review recent results on beyond Standard Model measurements with IceCube.

Primary author: ARGUELLES DELGADO, Carlos (Harvard University)

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Session Classification: Neutrino