The Mitchell Conference on Collider, Dark Matter, and Neutrino Physics 2024

Report of Contributions

https://indico.cern.ch/e/mitchell2024

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

Ab initio Nuclear Calculations for Dark Matter Detection and CEvNS

Friday, May 24, 2024 10:45 AM (25 minutes)

Over the past decades, ab initio nuclear calculation has made dramatic progress, especially reaching the heavy mass region as 208Pb recently. This means that it becomes possible to obtain first-principles computation (with quantified uncertainties) of quantities which even reside in the heavy-mass region. The quantities include these relevant for astrophysics and searches for physics beyond the Standard Model. In this talk, I will present a conceptual introduction to modern ab initio theory. Then, I will focus on recent advances in ab initio calculations of nuclear responses for dark matter (DM) direct detection and coherent elastic neutrino-nucleus scattering (CEvNS), including nuclei ^{19}F, ^{23}Na, ^{27}Al, $^{28-30}$Si, $^{70,72-74,76}$Ge, ^{127}I, ^{133}Cs, and $^{128-132,134,136}$Xe.

Author: HU, Baishan

Presenter: HU, Baishan

Session Classification: Neutrino

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

Detecting Rare Species of Dark Matter with Terrestrial Detectors

Saturday, May 25, 2024 12:00 PM (25 minutes)

A sub-component of dark matter with a short collision length compared to a planetary size leads to efficient accumulation of dark matter in astrophysical bodies. Such particles represent an interesting physics target since they can evade existing bounds from direct detection due to their rapid thermalization in high-density environments. In this talk, I will show that their annihilation to visible matter inside large-volume neutrino telescopes can provide a novel way to constrain or discover such particles. The signal is the most pronounced for relic masses in the GeV range, and can be efficiently constrained by existing Super-Kamiokande searches for dinucleon annihilation. I will also talk about possible neutrino signals from the annihilation of such dark matter particles, demonstrating that neutrino signals from the center of the Earth provide sensitivity to the unexplored parts of the parameter space. Finally, I will demonstrate how nuclear reactors can be utilised to probe such strongly interacting dark matter component.

Author: RAY, Anupam

Co-author: POSPELOV, Maxim

Presenter: RAY, Anupam

Session Classification: Dark Matter

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

Dark QCD: the Next Frontier in Dark Matter

Thursday, May 23, 2024 2:25 PM (25 minutes)

There has been a surge of interest in hidden valley models with new, strong forces, sometimes called “dark QCD”. These models propose asymmetric, composite dark matter in the form of “dark hadrons” that would evade direct and indirect bounds as well as typical collider DM searches for large missing transverse momentum accompanied by radiation. However, evidence of these models can still be found in collider datasets by targeting their unique phenomenological signatures, which include semivisible jets, emerging jets, and soft unclustered energy patterns. We will present the first experimental results for all of these signatures, which have made significant strides in exploring the vast space of dark QCD models. We will further discuss the prospects for dramatic improvements in sensitivity using machine learning.

Author: PEDRO, Kevin (Fermi National Accelerator Lab. (US))

Presenter: PEDRO, Kevin (Fermi National Accelerator Lab. (US))

Session Classification: Accelerator Exp.: BSM

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

Recent results from Belle and Belle II

Friday, May 24, 2024 9:00 AM (25 minutes)

The Belle II experiment has collected 424 fb^{-1} sample of e^+e^- collisions produced by the asymmetric SuperKEKB collider, at a centre-of-mass energy equal to or near the mass of the $\Upsilon(4S)$ resonance. Ninety-percent of the sample is at the $\Upsilon(4S)$ resonance, which decays to B-meson pairs. The predecessor experiment, Belle, collected nearly $1\ \mathrm{ab}^{-1}$ of data from 1999-2010, three-quarters of which was at the $\Upsilon(4S)$. From these $\Upsilon(4S)$ data, we have made measurements of rare B decays and CP violation, as well as searched for lepton-universality violation. Highlights include the first observation of $B \to K\nu\bar{\nu}$ and measurements of lepton-universality in semitauonic B decays. In addition, we study charm hadron decays, tau decays and quarkonium, which are also produced in abundance at these energies. Using low multiplicity events, we search for dark sector particles and make measurements related to the anomalous magnetic moment of the muon.

Author: DI CANTO, Angelo (Brookhaven National Laboratory (US))

Presenter: DI CANTO, Angelo (Brookhaven National Laboratory (US))

Session Classification: Collider: Belle, PDF

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

Beyond Kinematics for Optimal Hadronic Top Quark Polarimetry

Thursday, May 23, 2024 9:25 AM (25 minutes)

Top quark polarization measurements provide observables that are sensitive to spin correlation measurements and new physics. The down-type fermion from the W decay is the most powerful spin analyzer from top, which is not straight forward to measure in hadronic decays. Most applications measure top quark spin via an optimal hadronic spin analyzer built from kinematics. In this talk, we discuss how to improve the optimal hadronic polarimetry utilizing machine learning with information beyond simple kinematics.

Authors: NAVARRO, Alberto (Oklahoma State University); LARKOSKI, Andrew (UCLA); KONG, K.C.; DONG, Zhongtian (University of Kansas); GONÇALVES, dorival (Oklahoma State University)

Presenter: DONG, Zhongtian (University of Kansas)

Session Classification: Collider: Machine Learning, Quantum Information

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

Phenomenlogy of b-associated TeV scale scalar production with baryon-number violation in $t\phi$ final states at the LHC

Thursday, May 23, 2024 9:00 AM (25 minutes)

Minimal non-thermal dark matter models are an attractive type of model, since they can potentially explain both the existence of dark matter as well as the baryon asymmetry in the universe. In this presentation, I focus on a type of model with two color-triplet iso-singlet scalars at TeV scale masses and a singlet Majorana fermion dark matter candidate at the GeV scale. A phenomenological study of a BDT-driven search for such a model is presented in the semi-leptonic top decay final state at the LHC with Delphes. It is compared to the current best limits of boosted monotop analyses in reach. Further possible improvements with boosted algorithms like SIFT in complementary fully-hadronic decay channels will be discussed.

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

Co-authors: THOMPSON, Adrian; KALSI, Amandeep Kaur (Punjab Agricultural University, Ludhiana); WATSON, Ian James (University of Seoul); LEE, Jason (University of Seoul (KR)); KIM, Seulgi (University of Seoul, Department of Physics (KR)); KAMON, Teruki (Texas A & M University (US)); ROH, Youn Jung (University of Seoul, Department of Physics (KR))

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

Session Classification: Collider: Machine Learning, Quantum Information

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

Flavor-violating new physics at the intensity frontier

Thursday, May 23, 2024 3:15 PM (25 minutes)

In this talk, I will discuss examples of flavor-violating light new physics and how it can impact experiments like Mu3e, Mu2e, as well as neutrino experiments. Among the scenarios I will discuss include long-lived particles that can be abundantly produced at spallation sources and detected through their visible decays in neutrino experiments.

Author: HOSTERT, Matheus

Presenter: HOSTERT, Matheus

Session Classification: Accelerator Exp.: BSM

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

A Lower Bound on Dark Matter Mass

Thursday, May 23, 2024 10:45 AM (25 minutes)

I will argue that if the density of dark matter in the early universe is dominated by subhorizon, non-relativistic field modes, then there is a relatively model-independent lower bound on the mass of dark matter particles $m > 10^{-19}\,\mathrm{eV}$. The bound comes from considerations of (observed lack of) suppression of structure due to free streaming, and (observed lack of) an enhancement due to a isocurvature white noise contribution. Additional assumptions relevant for some well-explored models can strengthen the bound significantly. Time permitting, I will also discuss some novel phenomenology of ultralight bosonic dark matter with different intrinsic spin.

Author: AMIN, Mustafa

Presenter: AMIN, Mustafa

Session Classification: Dark Matter

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

Testing quantum entanglement and violation of the Bell inequality from the top-quark decay at the LHC

Thursday, May 23, 2024 9:50 AM (25 minutes)

Quantum entanglement is a fundamental property of quantum mechanics. Recently, studies have explored entanglement in the $t\bar{t}$ system at the Large Hadron Collider (LHC) when both the top quark and anti-top quark decay leptonically. Entanglement is detected via correlations between the polarizations of the top and anti-top and these polarizations are measured through the angles of the decay products of the top and anti-top. In this work, we propose searching for evidence of quantum entanglement in the semi-leptonic decay channel where the final state includes one lepton, one neutrino, two b-flavor tagged jets, and two light jets from the W decay. We find that this channel is both easier to reconstruct and has a larger effective quantity of data than the fully leptonic channel, and it is 60% more sensitive to quantum entanglement and a factor of 3 more sensitive to Bell inequality violation, compared to the leptonic channel.

Author: HAN, Tao

Presenter: HAN, Tao

Session Classification: Collider: Machine Learning, Quantum Information

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

Novel Neutrino Self-interaction Can Save Sterile Neutrino Dark Matter

Saturday, May 25, 2024 2:00 PM (25 minutes)

Sterile neutrino, a gauge-singlet fermion with a small active neutrino mixture, is a simple and one of the oldest dark matter candidates. In its first incarnation, proposed by Dodelson and Widrow, sterile neutrino dark matter can be produced via neutrino oscillation in the early universe, which is a very elegant mechanism. However, it has been completely ruled out by astrophysical observations including X-ray line searches. The leading alternative that resorts to a large lepton asymmetry, suggested by Shi and Fuller, has also been excluded by the recent DES experiment. These place a tantalizing challenge to the sterile neutrino dark matter hypothesis. In this talk, I will show that novel self-interaction among the active neutrinos can come to the rescue, allowing sterile neutrino to make up all the dark matter in the universe while passing all existing limits. The resulting framework offers rich tests and opportunities for the upcoming experiments at various frontiers.

Author: Prof. ZHANG, Yue

Presenter: Prof. ZHANG, Yue

Session Classification: Neutrino

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

Opening windows with Isospin-Violating Dark Matter

Sunday, May 26, 2024 10:15 AM (25 minutes)

We consider the effect of isospin-violating dark matter-nucleon interactions on direct detection constraints in the regime of small dark matter mass and large scattering cross section. Isospin-violation can lead to both reductions in sensitivity (due to a reduced cross section for scattering with nuclei in the detector) and enhancements in sensitivity (due to a reduced cross section for scattering in the overburden). Isospin-violating effects can thus open up some closed regions of parameter space, while closing off other regions.

Author: KUMAR, Jason

Co-authors: MARFATIA, Danny (University of Hawaii); Dr SONG, Ningqiang (Institute of Theoretical Physics, Chinese Academy of Sciences)

Presenter: KUMAR, Jason

Session Classification: Dark Matter, Axion

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

Constraints on Baryon Number Violation from Neutron Stars to the Lab

Saturday, May 25, 2024 9:00 AM (25 minutes)

In this work, we explore baryon number violating interactions (BNV) within a specific model framework involving a charged iso-singlet, color-triplet scalar and a Majorana fermion with interactions in the quark sector. This model has been useful for explaining baryogenesis, neutron-antineutron oscillations, and other puzzles such as the DM-baryon coincidence puzzle. We revisit this model, with chiral perturbation theory as a guide, at the level of baryons and mesons in the dense environments of neutron stars. BNV neutron decays become accessible in this environment where in vacuum they would be kinematically forbidden. By considering several equations of state in binary pulsar candidates, we establish strong constraints on the model parameter space from these decays, and the subsequent scattering of the Majorana fermions, in total amounting to a $\Delta B = 2$ loss in the star. These limits are highly complementary to laboratory bounds from rare dinucleon decay searches and collider probes.

Authors: THOMPSON, Adrian; ZAKERI, Mohammadreza (University of Kentucky); ALLAHVERDI, Rouzbeh (University of New Mexico)

Presenter: THOMPSON, Adrian

Session Classification: BSM, Dark Matter

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

(Generalized) Tri-Boson Signals from a Warped Extra Dimension

Saturday, May 25, 2024 5:00 PM (25 minutes)

Simple modifications of existing extensions of the Standard Model (SM) can dramatically alter its signals at the LHC. We illustrate this general point within the specific framework of SM fields propagating in a warped extra dimension, which can address both the Planck-weak and flavor hierarchy problems of the SM. We consider the possibility that,
among the SM particles, only the gauge bosons live in an extended region of the extra dimension. We show that such a scenario can suppress the usual decay channels of the gauge Kaluza-Klein (KK) excitations involving pairs of top quark and Higgs/W/Z gauge bosons. In turn, this leads to the emergence of novel final states consisting of three
SM gauge bosons in a variety of combinations and forms. We argue that new, dedicated searches are motivated for digging out such signals.

Authors: KIM, Doojin; COLLINS, Jack (SLAC National Lab); AGASHE, Kaustubh; DU, Peizhi; MISHRA, Rashmish (Harvard University); HONG, Sungwoo

Presenter: AGASHE, Kaustubh

Session Classification: Collider: BSM

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

Minimal Dark Matter Freeze-in with Low Reheating Temperatures and Implications for Direct Detection

Thursday, May 23, 2024 11:35 AM (25 minutes)

We investigate the influence of the reheating temperature of the visible sector on the freeze-in dark matter (DM) benchmark model for direct detection experiments, where DM production is mediated by an ultralight dark photon. Here we consider a new regime for this benchmark: we take the initial temperature of the thermal Standard Model (SM) bath to be below the DM mass. Then the production rate from the SM bath is drastically reduced due to Boltzmann suppression, necessitating a significant increase in the portal coupling to match the observed relic DM abundance. This enhancement in coupling strength increases the predicted DM-electron scattering cross section, making DM more accessible to current direct detection experiments.

Authors: SHAMS ES HAGHI, Barmak (University of Texas at Austin); MONTEFALCONE, Gabriele (University of Texas at Austin); FREESE, Katherine; Prof. BODDY, Kimberly (University of Texas at Austin)

Presenter: SHAMS ES HAGHI, Barmak (University of Texas at Austin)

Session Classification: Dark Matter

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

New Constraints on Axion-Like Particles from IXPE Polarization Data for Magnetars

Sunday, May 26, 2024 9:25 AM (25 minutes)

We derive new constraints on axion-like particles (ALPs) using precision X-ray polarization studies of magnetars. Specifically, we use the first detection of polarized X-rays from the magnetars 4U 0142+61 and 1RXS J170849.0-400910 by the Imaging X-ray Polarimetry Explorer (IXPE) to place bounds on the product of the ALP-photon and ALP-nucleon couplings, $g_{a\gamma}g_{aN}$, with g_{aN} being responsible for ALP production in the core of the magnetar and $g_{a\gamma}$ controlling the ALP-photon conversion probability in the magnetosphere. These bounds are most sensitive to the magnetar core temperature, and we use two benchmark values of 1×10^8 K and 5×10^8 K to derive our constraints. For the latter choice, our bounds are competitive with the existing bounds on the coupling product coming from a combination of CAST (for $g_{a\gamma}$) and SN1987A (for g_{aN}). We advocate for more precise and extensive observational campaigns in the higher end of the 2-8 keV spectral window, where ALP-induced polarization is the strongest. We further advocate for hard X-ray polarization studies of young, hot, near-Earth magnetars with strong magnetic fields.

Author: HAJKARIM, Fazlollah (University of Oklahoma)

Presenter: HAJKARIM, Fazlollah (University of Oklahoma)

Session Classification: Dark Matter, Axion

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

A guide to diagnosing colored resonances at hadron colliders

Saturday, May 25, 2024 5:25 PM (25 minutes)

We present a comprehensive study on how to distinguish the properties of heavy dijet resonances at hadron colliders. A variety of spins, chiral couplings, charges, and QCD color representations are considered. Distinguishing the different color representations is particularly difficult at hadron colliders. To determine the QCD color structure, we consider a third jet radiated in a resonant dijet event. We show that the relative rates of three-jet versus two-jet processes are sensitive to the color representation of the resonance. We also show analytically that the antennae radiation pattern of soft radiation depends on the color structure of dijet events and develops an observable that is sensitive to the antennae patterns. We demonstrate our results numerically at a 14 TeV LHC, and the methodology presented here should be applicable to other future hadron colliders.

Author: LEWIS, Ian (The University of Kansas)

Presenter: LEWIS, Ian (The University of Kansas)

Session Classification: Collider: BSM

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

Revealing the fundamental character of the strong force: From PDFs to the underlying QCD."

Friday, May 24, 2024 9:25 AM (25 minutes)

With the HL-LHC and EIC on the horizon, high-precision measurements are paramount to both SM and BSM studies. As PDF uncertainty is often a limiting factor, our goal is not only to 'fit' PDFs but also to better understand the underlying process at the precision level. We describe ongoing projects within both the nCTEQ and BNL-based SURGE project as we explore and characterize the full hadronic spectrum from pions and protons to heavy nuclei.

Author: Prof. OLNESS, Fred (Southern Methodist University (US))

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

Session Classification: Collider: Belle, PDF

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

Recent BSM Highlights from ATLAS and CMS: VLQ, LQ, W' and Z'

Saturday, May 25, 2024 4:35 PM (25 minutes)

Talk on behalf of the ATLAS and CMS Collaborations

Author: DE LA TORRE PEREZ, Hector (Northern Illinois University (US))

Presenter: DE LA TORRE PEREZ, Hector (Northern Illinois University (US))

Session Classification: Collider: BSM

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

Superheavy Decaying Dark Matter

Thursday, May 23, 2024 11:10 AM (25 minutes)

String theory setups can accommodate superheavy dark matter with the correct relic abundance. In addition, they may induce tiny R-parity violating couplings which make dark matter unstable with a lifetime well above the age of the universe. In this talk, I will discuss the high-energy gamma ray and neutrino signals from various three-body decays of superheavy neutralinos. I will then show how current observations and future experiments constrain the parameter space, with the bounds having only mild dependence on the exact nature of neutralino dark matter.

Author: ALLAHVERDI, Rouzbeh (University of New Mexico)

Presenter: ALLAHVERDI, Rouzbeh (University of New Mexico)

Session Classification: Dark Matter

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

Cosmological Stasis from Dynamical Scalars

Friday, May 24, 2024 2:50 PM (25 minutes)

It has recently been realized that many extensions of the Standard Model give rise to cosmological histories exhibiting extended epochs of cosmological stasis —epochs wherein the abundances of multiple energy components (such as matter, radiation, or vacuum energy) remain effectively constant despite cosmological expansion. In this talk, I shall discuss a novel realization of stasis involving a collection of scalar fields, each of which dynamically transitions from a period of slow roll to a period of rapid oscillation around its potential minimum as the universe expands. As I shall demonstrate, not only does cosmological stasis arise in such scenarios, but unlike in previous model realizations of this phenomenon, one finds that many properties of the stasis depend non-trivially on the initial conditions. For example, in the presence of an additional cosmological energy component, the system exhibits a tracking behavior wherein the effective equation of state for the universe as a whole evolves toward the equation of state of this energy component. The emergence of such tracking behavior has potential model-building implications in the context of dark-energy and cosmic-inflation scenarios.

Author: THOMAS, Brooks

Co-authors: Dr HUANG, Fei (Weizmann Institute); Prof. DIENES, Keith R. (University of Arizona); Dr HEURTIER, Lucien (King's College London); Prof. TAIT, Timothy M. P. (University of California Irvine)

Presenter: THOMAS, Brooks

Session Classification: Cosmology

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

”Stasis, Stasis, Stasis”

Friday, May 24, 2024 2:25 PM (25 minutes)

Many theories of physics beyond the Standard Model give rise to a unique early-universe cosmology during which the abundances of different energy components such as matter, radiation, and vacuum energy remain constant across extended cosmological eras, even though the universe is expanding. Even more surprisingly, such “stasis”epochs are actually universal attractors, with the universe necessarily entering (and later exiting) such epochs for a wide variety of initial conditions. In this talk, we give an overview of the stasis phenomenon and discuss some of its implications and applications. These stretch across the entire cosmological timeline, ranging from potential implications for gravitational waves and 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. Taken together, the stasis phenomenon therefore greatly expands the range of theoretical and phenomenological possibilities for the physics of the early universe.

Author: DIENES, Keith R. (University of Arizona)

Presenter: DIENES, Keith R. (University of Arizona)

Session Classification: Cosmology

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

Multi-Messenger Probes of First-Order Phase Transitions

Friday, May 24, 2024 5:00 PM (25 minutes)

Any particle physics model exhibiting symmetry breaking is necessarily accompanied by a phase transition taking the particle content of the universe from its initially symmetric phase to one where the underlying gauge symmetry is "broken". First-order phase transitions (FOPTs) are characterized by the rapid expansion of bubbles containing the new broken phase, which nucleate stochastically throughout space and eventually overtake the old symmetric phase. This violent transportation of matter and energy on cosmological scales invariably produces a stochastic background of gravitational waves (GW). If strong enough, signals from these GW may be detectable by upcoming experiments, offering a probe of an early universe as yet unobserved. Near the end of a FOPT, matter may be trapped within contracting pockets of the old phase, potentially leading to primordial black hole (PBH) formation. This provides additional probes as the PBHs may be evaporating and releasing detectable Hawking radiation. Furthermore, if the PBHs have not completely evaporated, they are expected to make up some fraction of the dark matter and are subject to abundance constraints.

This talk studies these multimessenger probes of the early universe in the context of conformal $B-L$ models. The underlying $B-L$ gauge symmetry is broken with a Higgs mechanism wherein a scalar field develops a nonzero vacuum expectation value, inducing a FOPT. Right-handed neutrinos are included in the model and become trapped in the old symmetric phase, possibly leading to PBHs. We find that not only can these models be simultaneously probed with GW signals and PBH constraints, but also different experiments can probe different energy scales within $B-L$ models as each energy scale exhibits a unique detection signature.

Authors: THOMPSON, Adrian; Prof. DUTTA, Bhaskar; HAUPTMANN, Cash; HUANG, Peisi

Presenter: HAUPTMANN, Cash

Session Classification: Gravitational Wave, Phase Transition

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

Opportunities for Dark Matter Searches in Cosmology

Friday, May 24, 2024 2:00 PM (25 minutes)

Cosmological and astrophysical observations provide a unique opportunity to probe the fundamental properties of dark matter. Dark matter interactions with the Standard Model of particle physics, for example, can alter predictions from the standard cosmological model, permitting robust tests of new dark matter physics. In this talk, I will describe the impact that dark matter interactions have on the CMB and structure formation and show how observational data can constrain broad classes of dark matter models.

Author: Prof. BODDY, Kimberly (University of Texas at Austin)

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

Session Classification: Cosmology

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

What's the wave packet size of neutrinos?

Friday, May 24, 2024 11:10 AM (25 minutes)

The standard calculations of neutrino oscillation are predicated on the assumption that neutrinos' wave packets maintain coherence throughout their propagation. Effects associated with neutrinos wave packets decoherence— specifically, damping of the oscillation probabilities—were considered unobservable in terrestrial experiments. However, recent claims suggest that if sterile neutrinos exist, we could observe decoherence effects in terrestrial experiments. To test these claims, one has to compute the neutrino wave packet size for a given source. In this talk, I will discuss our efforts to determine the wave packet size for neutrinos produced in accelerator-based experiments. We demonstrate that it is feasible to compute this value through a well-defined framework accompanied by precise input parameters, thereby eliminating the reliance on approximations.

Author: LI, Shirley (UC Irvine)

Presenter: LI, Shirley (UC Irvine)

Session Classification: Neutrino

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

Matter Effect on the Flavor Composition of Astrophysical Neutrinos

Saturday, May 25, 2024 2:50 PM (25 minutes)

The sources of the high-energy neutrino events detected by IceCube remain largely unknown. A more precise neutrino flavor ratio measurement in the future will be crucial in resolving this open question. We discuss how the flavor ratio gets modified in presence of matter effects for Active Galactic Nuclei (AGNs) which are currently the most promising astrophysical candidate sources. We show that the matter effect provides a unique probe of heavily Compton-thick AGNs which escape conventional detection in electromagnetic wavelengths. Finally, we will briefly talk about the matter effect induced by the relic neutrino background on the flavor composition.

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

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

Session Classification: Neutrino

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

Proton structure in precision calculations for colliders

Friday, May 24, 2024 9:50 AM (25 minutes)

On the example of recent work by the CTEQ-TEA group, I discuss the progress on precision parton distribution functions (PDFs) in the proton. I particularly emphasize new insights on quantification of uncertainties on PDFs that affect key electroweak and Higgs precision studies at the HL-LHC.

Author: Prof. NADOLSKY, Pavel (Southern Methodist University)

Presenter: Prof. NADOLSKY, Pavel (Southern Methodist University)

Session Classification: Collider: Belle, PDF

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

Unleashing the Power of EFT in Neutrino–Nucleus Scattering

Friday, May 24, 2024 11:35 AM (25 minutes)

Neutrino physics is advancing into a precision era with the construction of new experiments, particularly in the few GeV energy range. Within this energy range, neutrinos exhibit diverse interactions with nucleons and nuclei. In this talk I will delve in particular into neutrino–nucleus quasi-elastic cross sections, taking into account both standard and, for the first time, non-standard interactions, all within the framework of effective field theory (EFT). The main uncertainties in these cross sections stem from uncertainties in the nucleon-level form factors, and from the approximations necessary to solve the nuclear many-body problem. I will explain how these uncertainties influence the potential of neutrino experiments to probe new physics introduced by left-handed, right-handed, scalar, pseudoscalar, and tensor interactions. For some of these interactions the cross section is enhanced, making long-baseline experiments an excellent place to search for them.

Author: KHAJEH TABRIZI, Zahra

Presenter: KHAJEH TABRIZI, Zahra

Session Classification: Neutrino

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

The cosmology of ultralight scalar dark matter coupled to right-handed neutrinos

Saturday, May 25, 2024 11:35 AM (25 minutes)

Ultralight dark matter (ULDM) must be bosonic, and the arguably simplest model is furnished by a scalar field that is uncharged under the Standard Model gauge group oscillating in a harmonic potential. This field will generically couple to other BSM singlet states such as sterile neutrinos or other progenitors of neutrino mass. In this talk I will discuss how interactions between ULDM and neutrinos can alter the subsequent cosmology of an ULDM candidate.

Author: PLESTID, Ryan

Presenter: PLESTID, Ryan

Session Classification: Dark Matter

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

Dark Matter in the Time of Gravitational Waves

Friday, May 24, 2024 4:35 PM (25 minutes)

The observation of gravitational waves opens a new window for exploring astrophysics and cosmology. These messengers enable the concurrent measurement of their amplitudes and phases, facilitating a precise analysis of wave production and propagation. In this talk, I will demonstrate how gravitational waves can be utilized to study the properties of dark matter. Specifically, I will use wave dark matter as an example to show that gravitational waveforms, along with further multi-messenger observations involving photon signals, reveal distinctive features. These features can be probed with the ongoing LIGO and upcoming LISA missions.

Authors: BHALLA, Badal (University of Oklahoma); HAJKARIM, Fazlollah (University of Oklahoma); SINHA, Kuver (University of Oklahoma); RAI, Mudit (Texas AM University); XU, Tao (The University of Oklahoma)

Presenter: XU, Tao (The University of Oklahoma)

Session Classification: Gravitational Wave, Phase Transition

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

New Physics Opportunities at Tau Neutrino Experiments

Saturday, May 25, 2024 2:25 PM (25 minutes)

In this talk, I will discuss the potential of current/future tau neutrino experiments in probing new physics beyond the Standard Model. A focus will be given to a tau neutrino-philic new particle that can play an important role in the evolution of early Universe.

Authors: BAKHTI, Pouya (JBNU); Prof. SHIN, Seodong (Jeonbuk National University); RAJAEE, meshkat (JBNU)

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

Session Classification: Neutrino

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

Primordial black holes and mattergenesis

Friday, May 24, 2024 3:15 PM (25 minutes)

In this talk, we will look at the role of primordial black holes in sourcing the cosmic baryon as well as dark matter abundance.

Authors: Prof. DUTTA, Bhaskar; NOT SUPPLIED, Chee Sheng (Universidade Federal do ABC); DENT, James; XU, Tao (The University of Oklahoma)

Presenter: Dr FONG, Chee Sheng (Universidade de São Paulo)

Session Classification: Cosmology

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

Collider and gravitational wave signals for electroweak phase transition

Friday, May 24, 2024 5:25 PM (25 minutes)

The knowledge of the Higgs potential is crucial for understanding the origin of mass and the thermal history of our Universe. We show how collider measurements and observations of stochastic gravitational wave signals can complement each other to explore the multiform scalar potential in the two Higgs doublet model. In our investigation, we analyze critical elements of the Higgs potential to understand the phase transition pattern. Specifically, we examine the formation of the barrier and the uplifting of the true vacuum state, which play crucial roles in facilitating a strong first-order phase transition. Furthermore, we explore the potential gravitational wave signals associated with this phase transition pattern and investigate the parameter space points that can be probed with LISA. Finally, we compare the impact of different approaches to describing the bubble profile on the calculation of the baryon asymmetry.

Author: GONÇALVES, Dorival (Oklahoma State University)

Presenter: GONÇALVES, Dorival (Oklahoma State University)

Session Classification: Gravitational Wave, Phase Transition

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

Searches for BSM Higgs at the LHC

Thursday, May 23, 2024 4:35 PM (25 minutes)

Several theories beyond the Standard Model (BSM) suggest an expanded Higgs sector, prompting investigations for neutral and charged Higgs bosons in addition to the one observed at 125 GeV. The completion of Run 2 of the LHC in 2018 yielded a total of 139 fbˆ−1 of data, offering an opportunity to delve deeper into the BSM Higgs parameter space. This presentation covers the searches for BSM Higgs bosons conducted at the ATLAS and CMS experiments.

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

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

Session Classification: Higgs, Astrophysics/Cosmology

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

A comprehensive analysis of supernova neutrino-dark matter interactions

Thursday, May 23, 2024 5:50 PM (25 minutes)

We present a comprehensive analysis of nonstandard neutrino interactions with the dark sector in an effective field theory (EFT) framework, considering {\it exact} analytic formulae for the differential scattering cross sections of neutrinos with scalar, fermionic, and vector dark matter (DM) for dark sector models with mediators of different spins. We then implement the full catalog of constraints on the parameter space of the neutrino-dark matter/mediator couplings and masses, including cosmological/astrophysical bounds coming from Big Bang Nucleosynthesis, Cosmic Microwave Background, DM/neutrino self-interactions, DM collisional damping, thermal relic density, and SN1987A, as well as laboratory constraints from neutrinoless double decay, 3-body meson decays and invisible Z decays. To illustrate the practical consequences of our new results, we take the galactic supernova neutrinos in the MeV energy range as a concrete example and highlight the difficulties in finding any observable effect of neutrino-DM interactions. Finally, we identify new benchmark points potentially promising for future observational prospects of the attenuation of the neutrino flux of a galactic supernova and comment on their implications for the detection prospects in future large-volume neutrino experiments such as DUNE, Hyper-K and JUNO.

Author: SATHYAN, Deepak

Co-authors: DEV, Bhupal (Washington University in St. Louis); KIM, Doojin; SINHA, Kuver (University of Oklahoma); ZHANG, Yongchao

Presenter: SATHYAN, Deepak

Session Classification: Higgs, Astrophysics/Cosmology

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

Neutrino and Muon physics at Forward Detectors at LHC

Thursday, May 23, 2024 2:00 PM (25 minutes)

The recent observation of collider neutrinos and BSM searches for ALPs by the FASER collaboration highlights the potential the forward direction at the LHC has for neutrino physics and BSM studies. After briefly reviewing some of the FASER collaboration's recent results, I will present some of my own work on the phenomenological studies of the electromagnetic properties of neutrinos, namely magnetic moment, milli-charge, and charge radius. But in these studies the dominant background comes from muons, and significant effort goes into suppressing them. I will also describe efforts to use these "background"muons to study muon-philic particles. In a simple model with a scalar coupling to muons, we show how FASER and FASER2 detectors could potentially probe the parameter space that can solve the g-2 anomaly.

Author: MAMMEN ABRAHAM, Roshan (University of California Irvine (US))

Presenter: MAMMEN ABRAHAM, Roshan (University of California Irvine (US))

Session Classification: Accelerator Exp.: BSM

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

Dark-Matter Mass from Angular Dependence

Saturday, May 25, 2024 11:10 AM (25 minutes)

We propose a novel method to determine the mass scale of ambient dark matter that can be generally applied to the (at least effectively) two-dimensional direct detection experiments allowing for directional observables.

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

Co-author: KIM, Doojin

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

Session Classification: Dark Matter

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

Light axions with kinetic coupling

Thursday, May 23, 2024 12:00 PM (25 minutes)

I will discuss light dark matter candidates with kinetic coupling. More specifically, a condensate dark matter in a two-field model where the axion is coupled to a second moduli field at the level of its kinetic term. I will discuss cosmological consequences of such a dark matter candidate.

Author: Prof. KOUSHIAPPAS, Savvas (Brown University)

Presenter: Prof. KOUSHIAPPAS, Savvas (Brown University)

Session Classification: Dark Matter

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

New Cosmological Data Presents ν Opportunities

Thursday, May 23, 2024 5:25 PM (25 minutes)

The most precise determination of the sum of neutrino masses from cosmological data, derived from analysis of the cosmic microwave background and recent baryon acoustic acoustic oscillations data from DESI, favors a value below the minimum inferred from neutrino flavor oscillation experiments. The sum of neutrino mass is determined in cosmology from the suppression of matter clustering in the late universe. In this talk, I will explore how the preference for excess clustering compared to the Standard Model may have implications for cosmology and particle physics.

Author: MEYERS, Joel (Southern Methodist University)

Presenter: MEYERS, Joel (Southern Methodist University)

Session Classification: Higgs, Astrophysics/Cosmology

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

Addressing the Axion Quality Problem

Sunday, May 26, 2024 9:00 AM (25 minutes)

I will discuss the axion quality problem.

Author: BABU, Kaladi

Presenter: BABU, Kaladi

Session Classification: Dark Matter, Axion

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

Probing New Physics with Double Beta Decay

Saturday, May 25, 2024 3:15 PM (25 minutes)

Neutrinoless double beta decay is the primary means with which we can probe a potential Majorana nature of light neutrinos. Planned experiments searching for this hypothetical decay aim to be sensitive to half-lives of up to 10ˆ28 years, allowing to probe Majorana neutrino mass scales of O(10 meV). It is also well established that neutrinoless double beta decay receives contributions beyond light neutrino exchange in New Physics scenarios beyond the Standard Model (SM) that incorporate lepton number violation, such as sterile Majorana neutrinos and R-Parity violating supersymmetry. After briefly reviewing neutrinoless double beta decay and its interpretations, I will motivate the use of two-neutrino double beta decay to probe for exotic physics as well. This decay, allowed in the SM and observed in several isotopes, is typically considered background to neutrinoless double beta decay searches. Besides allowing insights into nuclear matrix elements it can also be used to search for New Physics, though, due to high event statistics in current and future double beta decay searches. In this context, I will discuss modifications of the double beta decay spectrum due to exotic particle emission (such as kinks from sterile neutrinos), exotic currents beyond V-A and neutrino self-interactions, motivating the search for such scenarios.

Author: Prof. DEPPISCH, Frank F

Presenter: Prof. DEPPISCH, Frank F

Session Classification: Neutrino

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

CMB Birefringence from Axion Strings

Sunday, May 26, 2024 9:50 AM (25 minutes)

A cosmological network of axion strings in our Universe today may leave its imprint on the polarization pattern of the cosmic microwave background radiation through the phenomenon of axion-string-induced birefringence. I will explain how this signal arises, discuss how it depends on the properties of the string network and the axion-photon coupling, describe how existing measurements of anisotropic birefringence place constraints on axion strings, and discuss how the non-Gaussian nature of this signal could be leveraged in searches with future data.

Author: LONG, Andrew (Rice University)

Presenter: LONG, Andrew (Rice University)

Session Classification: Dark Matter, Axion

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

Long-Lived Particles at the LHC

Saturday, May 25, 2024 4:10 PM (25 minutes)

Over the past decade the LHC collaborations have developed an extensive program of searches for new, long-lived particles produced in proton-proton collisions. These searches probe phase space where new physics could be hiding. I will review some of the newest results from the LHC collaborations.

Author: ADAMS, Todd (Florida State University (US))

Presenter: ADAMS, Todd (Florida State University (US))

Session Classification: Collider: BSM

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

Dark Matter and Dark Sectors at the LHC

Saturday, May 25, 2024 10:45 AM (25 minutes)

I will discuss the LHC search efforts for dark matter and dark-sector particles.

Author: LAVEZZO, Luca (MIT)

Presenter: LAVEZZO, Luca (MIT)

Session Classification: Dark Matter

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

BSM Physics with Future Gravitational Wave Detectors

Friday, May 24, 2024 4:10 PM (25 minutes)

Future gravitational wave detectors probing the mHz - nHz frequency range will provide a unique opportunity for BSM physicists to study new physics. Neutron star and white dwarf mergers can serve as axion probes, while extreme mass ratio inspirals can constrain dark forces. Gravitational wave detectors will also probe early first order phase transitions. I will discuss some ongoing work and future ideas in these directions.

Authors: BHALLA, Badal; HAJKARIM, Fazlollah; SINHA, Kuver (University of Oklahoma); XU, Tao

Presenter: SINHA, Kuver (University of Oklahoma)

Session Classification: Gravitational Wave, Phase Transition

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

Recent Results from COHERENT

I will present an overview of recent results from the COHERENT experiment.

Author: SCHOLBERG, Kate

Presenter: SCHOLBERG, Kate

Session Classification: Neutrino

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

Searching for scalar boson pairs at the Large Hadron Collider

Thursday, May 23, 2024 5:00 PM (25 minutes)

The Standard Model predicts non-resonant production of Higgs boson pairs, which provides a handle to directly measure the shape of the Higgs potential. Numerous BSM models predict new scalar fields with couplings that lead to the simultaneous production of scalar bosons. The ATLAS and CMS Collaborations have active search programs targeting multi-scalar-boson production. This talk provides and overview of these searches and their interpretations including SM HH production, resonant HH production, and the pair production of additional scalar bosons.

Author: VEATCH, Jason (California State University (US))

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

Session Classification: Higgs, Astrophysics/Cosmology

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

Introduction to DAMSA, A Novel Dark Sector Particle Search Experiment

Thursday, May 23, 2024 2:50 PM (25 minutes)

Dark matter is thought to make up 25% of the universe. Dark sector particles (DSP) do not interact through the known forces but could be weakly coupled to Standard Model particles through a portal or a mediator. Many searches for dark matter/dark sector particles at an accelerator thus far seem to face a ceiling that the sensitivity reach is greatly limited, beyond statistical effects. DAMSA is an extremely short baseline experiment at proposes to break through this limit, taking advantage of high beam powers available at various accelerator facilities around the world, including the PIP-II Linac under construction, an essential element in providing the necessary high flux proton beams to DUNE at Fermilab. In this talk, I will describe the DAMSA (Dump produced Aboriginal Matter Search at an Accelerator) experiment. I will also discuss current status and plan for DAMSA and its expected sensitivity reach in the search of the Axion-Like Particle as an example physics case.

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

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

Session Classification: Accelerator Exp.: BSM

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

TBA

TBA

Author: Prof. TANEDO, Flip (UC Riverside)

Presenter: Prof. TANEDO, Flip (UC Riverside)

Session Classification: BSM, Dark Matter

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

A quantum description of wave dark matter

Saturday, May 25, 2024 9:25 AM (25 minutes)

TBA

Author: RODD, Nicholas

Presenter: RODD, Nicholas

Session Classification: BSM, Dark Matter

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

Revisiting Reactor Anti-Neutrino 5 MeV Bump with 13C Neutral-Current Interaction

Friday, May 24, 2024 12:00 PM (20 minutes)

TBA

Author: PARK, Min-Gwa (Jeonbuk National University)

Presenter: PARK, Min-Gwa (Jeonbuk National University)

Session Classification: Neutrino

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

Measurements of Higgs boson properties with the ATLAS and CMS experiments

Thursday, May 23, 2024 4:10 PM (25 minutes)

I will discuss measurements of Higgs boson properties with the ATLAS and CMS experiments.

Author: CAVALIERE, Viviana (Brookhaven National Lab)

Presenter: CAVALIERE, Viviana (Brookhaven National Lab)

Session Classification: Higgs, Astrophysics/Cosmology

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

Direct Collapse Black Holes from Dark Matter Annihilation

Saturday, May 25, 2024 9:50 AM (25 minutes)

Pre-stellar galactic halos are highly sensitive to soft radiation: the presence of sources of O(10 eV) Lyman-Werner radiation changes the gas chemistry and prevent the standard fragmentation of the gas. Rather than producing Population III stars, this may instead lead to direct collapse black holes. Observations of supermassive black holes at high redshift have long been suspected to be evidence for direct collapse black holes. Recent studies have explored the possibility that direct collapse may be influenced by new particle physics.

We present a simple dark matter model where resonant annihilation can dissociate molecular hydrogen and discuss the assumptions that are necessary to induce direct collapse black holes. In these models, O(10 MeV) dark matter annihilates into electron-positron pairs which produce Lyman-Werner radiation by inverse Compton scattering CMB light. We present a self-consistent modeling of H2 self-shielding that highlights the challenges when building models for direct collapse.

Authors: Prof. D'ALOISIO, Anson (UC Riverside); Prof. TANEDO, Flip (UC Riverside); AGGARWAL, Yash

Presenter: Prof. TANEDO, Flip (UC Riverside)

Session Classification: BSM, Dark Matter