PIKIMO Spring 2023

Report of Contributions

https://indico.cern.ch/e/1262310

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

Electroweak LHC: High-energy lepton colliders

Saturday, 29 April 2023 10:00 (30 minutes)

Presenter: Dr MA, Yang (INFN Bologna)

Session Classification: Talks

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

Isosinglet vectorlike leptons at e^+e^- colliders

Saturday, 29 April 2023 10:30 (15 minutes)

Vectorlike leptons are an intriguing possibility for physics beyond the Standard Model. This talk is concerned with the example of weak isosinglet vectorlike leptons that decay through a small mixing with the tau lepton, for which the discovery and exclusion reach of the Large Hadron Collider and future proposed hadron colliders is limited. For this minimal model, I will argue that an e^+e^- collider may act as a discovery machine, and discuss the prospects for observing a mass peak if they are indeed discovered.

Presenter: BHATTIPROLU, Prudhvi (University of Michigan)

Session Classification: Talks

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

Stabilizing the Higgs Potential with Vector-like Fermions

Saturday, 29 April 2023 10:45 (15 minutes)

This talk addresses the notorious metastability of the Standard Model and promotes it to a model building task. We explore the ingredients required to stabilize the SM up to the Planck scale without encountering sub-Planckian Landau poles. Using the SM extended by vectorlike fermions, we chart out the corresponding landscape of Higgs stability. We find that the "gauge portal mechanism", triggered by new SM charge carriers, opens up sizable room for stability in a minimally invasive manner. We also find models with Higgs criticality and Yukawa portals opening up at stronger coupling. Several models allow for vectorlike fermions in the TeV range, which can be searched for at the LHC. For nontrivial flavor structure, severe flavor-changing neutral current constraints arise that complement those from stability and push lower fermion masses up to order 10ˆ3 TeV.

Presenter: STEUDTNER, Tom

Session Classification: Talks

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

Recent Progress in Kaon Physics

Saturday, 29 April 2023 11:35 (30 minutes)

Kaon physics observables are among our most sensitive indirect probes of high-energy dynamics. I review recent progress in kaon physics, with a focus on CP violation and rare decays.

Presenter: BROD, Joachim (University of Cincinnati)

Session Classification: Talks

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

Exotic Heavy Mesons and Lattice QCD Potentials

Saturday, 29 April 2023 12:05 (15 minutes)

Quantum ChromoDynamics (QCD) is universally accepted as the theory of strong interactions. However, because of the nonperturbative nature of QCD at low energies, calculating the hadron spectrum from the fundamental theory is a daunting task. In this talk, I focus on mesons containing a pair of heavy quarks. This is particularly interesting because some of these mesons, like the famous X(3872), escape the conventional picture of a bound quark-antiquark state. I will show how such systems can be studied in the Born-Oppenheimer approximation, where the dynamics of the heavy quarks can be determined via a nonrelativistic Schrödinger equation, with potentials that are numerically accessible in lattice QCD.

Presenter: BRUSCHINI, Roberto

Session Classification: Talks

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

Femtoscopic correlations in Equation of State studies

Saturday, 29 April 2023 12:20 (15 minutes)

A coherent description of nuclear matter properties at low and high baryon densities is of utmost importance. The limited number of experimental references at the region of the phase diagram corresponding to Neutron Stars (NS) and NS mergers poses major challenges for constructing a universal Equation of State (EoS). In order to constrain the EoS from heavy-ion collisions, experimental observables responsive to its changes need to be found. We investigated the sensitivity of femtoscopic correlations (FC) of protons to different EoS within one transport code UrQMD. FC is a unique tool, which exploits correlations from final state interactions such as Coulomb or strong interactions, to
constrain the space-time evolution of the collision, which in turn constrains the EoS. The research was performed for collisions at the HADES experiment, Ag+Ag collisions at 1.58 AGeV where the created matter can be described with high baryon densities corresponding to NS mergers. This talk will briefly summarize the applied methods and present the first preliminary result of our studies.

Presenter: STEFANIAK, Maria

Session Classification: Talks

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

Seeing Gravity and the (Invisible) Universe with Pulsar Timing Arrays

Saturday, 29 April 2023 14:00 (30 minutes)

Pulsars are rotating neutron stars that emit beamed emission observed as periodic pulses on Earth. The practice of "pulsar timing" yields a wealth of uniquely powerful measurements across different astrophysical phenomena. Among these is the gradual detection of a stochastic background of gravitational waves (GWs) using a collection of pulsars rotating with millisecond spin periods. In my talk, I will overview the concept of "pulsar timing arrays" and discuss ongoing work being undertaken by members of the NANOGrav collaboration in constraining the presence of GWs at nanohertz frequencies.

Presenter: FONSECA, Emmanuel (West Virginia University)

Session Classification: Talks

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

Cosmologically Varying Kinetic Mixing

Saturday, 29 April 2023 14:30 (15 minutes)

The portal connecting the invisible and visible sectors is one of the most natural explanations of the dark world. However, the early-time dark matter production via the portal faces extremely stringent late-time constraints. To solve such tension, we construct the scalar-controlled kinetic mixing varying with the ultralight CP-even scalar's cosmological evolution. To realize this and eliminate the constant mixing, we couple the ultralight scalar within the mass range 10–33eV«m0«eV with the heavy doubly charged messengers and impose the Z2 symmetry under the dark charge conjugation. Via the varying mixing, the keV–MeV dark photon dark matter is produced through the early-time freeze-in when the scalar is misaligned from the origin and free from the late-time exclusions when the scalar does the damped oscillation and dynamically sets the kinetic mixing. We also find that the scalar-photon coupling emerges from the underlying physics, which changes the cosmological history and provides the experimental targets based on the fine-structure constant variation and the equivalence principle violation.

Presenter: GAN, Xucheng

Session Classification: Talks

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

Probing New Physics with Gravitational Waves

Saturday, 29 April 2023 14:45 (15 minutes)

The thermal plasma in the early universe produced a guaranteed stochastic gravitational wave (GW) background, which peaks today in the microwave regime and was dubbed the cosmic gravitational microwave background (CGMB). We show that the CGMB spectrum encodes fundamental information about particle physics and gravity at ultra high energies. In particular, one can determine from the CGMB spectrum the maximum temperature of the universe and the effective degrees of freedom at the maximum temperature. Quantum gravity effects arise in the CGMB spectrum as corrections to the leading order result. At the end of the talk I discuss how we could detect the CGMB in the future.

Presenter: SCHÜTTE-ENGEL, Jan

Session Classification: Talks

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

Low-scale Leptogensis

Saturday, 29 April 2023 15:00 (15 minutes)

We introduce a novel, testable low scale baryogenesis scenario involving the CP violating decays of sterile neutrinos. In contrast to the conventional leptogenesis mechanisms we transfer the produced lepton asymmetry into a baryon asymmetry via scatterings with dark matter particles which conserve total baryon and lepton number but violate visible baryon number. We show that the mechanism produces lepton and baryon abundances in agreement with current observational constraints. Finally, we discuss relevant phenomenology and potential signatures.

Presenter: MENZO, Tony

Session Classification: Talks

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

High-energy neutrino deeply inelastic scattering cross sections from 100 GeV to 1000 EeV

Saturday, 29 April 2023 15:15 (15 minutes)

We present a state-of-the-art prediction for cross sections of neutrino deeply inelastic scattering (DIS) from nucleon at high neutrino energies, E_ν, from 100 GeV to 1000 EeV (10^{12} GeV). Our calculations are based on the latest CT18 NNLO parton distribution functions (PDFs) and their associated uncertainties. In order to make predictions for the highest energies, we extrapolate the PDFs to small x according to several procedures and assumptions, thus affecting the uncertainties at ultra-high E_ν; we quantify the uncertainties corresponding to these choices. Similarly, we quantify the uncertainties introduced by the nuclear corrections which are required to evaluate neutrino-nuclear cross sections for neutrino telescopes. These results can be applied to currently-running astrophysical neutrino observatories, such as IceCube, as well as various future experiments which have been proposed.

Presenter: XIE, Keping (University of Pittsburgh)

Session Classification: Talks

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

The Physics of Neural Networks

Saturday, 29 April 2023 16:00 (15 minutes)

Neural networks (NNs) have gained significant attention in the physics community because of their ability to find non-trivial patterns in large datasets. However, developing a theory of NN learning has proven to be quite challenging because of the vast number of degrees of freedom in a typical NN. But fortunately, statistical field theory already provides tools for analyzing similar many-body problems. Infinite-width NNs correspond to free field theories, while finite widths give rise to interactions; signals propagating through a network can be thought of as a renormalization group flow where the marginal couplings are hyperparameters of the network tuned to criticality to prevent exponential growth or decay of signals. We study the effect of initializing a network with weights sampled from an orthogonal matrix distribution and find several key features which indicate that networks with orthogonal initialization might perform better than those with Gaussian initialization throughout training.

Presenter: DAY, Hannah

Session Classification: Talks

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

Going Underground or Listening to the Sky?

Saturday, 29 April 2023 16:15 (15 minutes)

Dark Matter (DM) remains mysterious. Despite decades of experimental efforts, its microscopic identity is still unknown. Terrestrial detectors are placing stringent exclusions on various parts of the DM parameter space, however, there exist a few blind-spots. In this talk, I will demonstrate how existing GW detectors can be used to unravel the particle nature of DM. More specifically, by observing low mass black hole mergers, existing GW detectors can provide unprecedented sensitivity to the weakly-interacting heavy dark matter, a blind spot to the terrestrial DM detectors. I will also walk you through how continued existence of a variety of stellar objects can probe strongly-interacting heavy DM, a yet another blind spot.

Presenter: RAY, Anupam

Session Classification: Talks

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

Directly Detecting Light Dark Matter

Saturday, 29 April 2023 16:30 (15 minutes)

While the experimental program to detect ever lighter dark matter is proceeding full steam ahead, the theory of such light, detectable dark matter is at a crossroads. I will detail two examples of sub-GeV hadrophilic dark matter models which these future direct detection endeavors may discover while highlighting the serious challenges model builders face. The first achieves probe-able direct detection cross sections by way of a late-time, dark-sector phase transition, while the second does so by assuming the entire thermal bath is reheated at very low temperatures. Both models lead to dark matter-nucleon scattering cross sections of interest for near-future experiments for dark matter masses in the range of 100 keV-100 MeV, often in parts of parameter space with few or no models.

Presenter: MCGEHEE, Robert

Session Classification: Talks

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

$g-2$ Model Building with Portal Matter

Saturday, 29 April 2023 16:45 (15 minutes)

In this talk, I discuss recent work on model building for the anomalous magnetic moment of the muon in the framework of so-called "portal matter", vector-like fermions charged under both the SM hypercharge and a hidden Abelian gauge group $U(1)_D$, which can induce kinetic mixing between the two groups at one loop. The portal matter fields are a well-motivated extension of simplified dark matter models in which the dark matter candidate interacts with the SM via the $U(1)_D$ gauge boson, in which case the loop-induced kinetic mixing from the portal matter is of the appropriate magnitude to recreate the observed dark matter relic abundance for dark matter and dark gauge bosons in the sub-GeV regime. If the portal matter fields are sufficiently light, they may have other significant phenomenological implications, either from direct production in collider experiments or precision effects. I will outline a minimal model of portal matter that can address the anomalous magnetic moment of the muon and discuss the other phenomenological probes of this construction, noting that the ability of the model to address the magnetic moment anomaly is remarkably agnostic about the precise parameters of the dark matter model at low energy.

Presenter: WOJCIK, GEORGE

Session Classification: Talks

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

Precision Electroweak Tensions and a Wide Dark Photon

Saturday, 29 April 2023 11:00 (15 minutes)

The dark photon is a well-motivated and well-studied extension to the Standard Model. The strongest bounds on a dark photon with a mass near the Z pole come from precision electroweak analysis while for higher masses, collider bounds dominate. Existing tensions involving the heavy flavor observables, the W boson mass, and the muon magnetic moment motivate a revisiting of the precision electroweak bounds, and the collider bounds can be relaxed if the dark photon has a nontrivial branching ratio to a dark sector. In this talk, I discuss the effects of different data combinations on the precision electroweak fit and the viable dark photon parameter space. I also discuss the complementarity between collider searches and precision electroweak bounds for a wide dark photon.

Presenter: PETROSKY, Evan

Session Classification: Talks

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

Reception

Saturday, 29 April 2023 09:30 (30 minutes)