PIKIMO Fall 2023

Report of Contributions

https://indico.cern.ch/e/1323700

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

Welcome

Saturday 11 November 2023 09:30 (30 minutes)

Primary author: Dr LUNGHI, Enrico (Indiana University)

Presenter: Dr LUNGHI, Enrico (Indiana University)

Session Classification: Reception

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

Invariant amplitudes, unpolarized cross sections, and polarization observables in charged-current elastic neutrino-nucleon scattering

Saturday 11 November 2023 10:45 (15 minutes)

The (anti)neutrino-nucleon charged-current elastic scattering cross sections are parametrized by vector and axial form factors at leading order in weak and electromagnetic couplings. On the other hand, radiative corrections in the Standard Model, and potential new physics contributions beyond the Standard Model, can generate additional operators with corresponding invariant amplitudes. We review the definition of these amplitudes in a general framework and study various constraints from existing experimental data. We explore the impact of modern and future cross section measurements, considering both unpolarized cross sections and polarization observables, on constraining these amplitudes. We also discuss the effects of radiative corrections on the observables of interest.

Primary author: BORAH, Kaushik

Co-authors: BETANCOURT, Minerba; TOMALAK, Oleksandr; HILL, Richard; JUNK, Tom (Fermi National Accelerator Lab. (US))

Presenter: BORAH, Kaushik

Session Classification: Morning session

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

ALP-assisted electroweak phase transition and baryogenesis

Saturday 11 November 2023 16:00 (15 minutes)

Axion-like particles (ALPs) can be naturally lighter than the electroweak scale. We consider an ALP that couples to the Standard Model Higgs to achieve the strong first-order electroweak phase transition. We discuss the two-field dynamics of the phase transition and the associated computation in detail and identify the viable parameter space. The ALP mass can be from the MeV to GeV scale. Baryon asymmetry can be explained by local baryogenesis without violating the electron electric dipole moment bound. The viable parameter space can be probed through Higgs exotic decay, rare kaon decay, the electron electric dipole moment, and the effective number of neutrinos in the cosmic microwave background. The gravitational-wave signal is too weak to be detected.

Primary authors: WANG, Isaac; Prof. HARIGAYA, Keisuke (University of Chicago)

Presenter: WANG, Isaac

Session Classification: Afternoon session

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

QCD-Collapsed Domain Walls

Saturday 11 November 2023 11:55 (15 minutes)

For a discrete symmetry that is anomalous under QCD, the domain walls produced in the early universe from its spontaneous breaking can naturally annihilate due to QCD instanton effects. The gravitational waves generated from wall annihilation have their amplitude and frequency determined by both the discrete symmetry breaking scale and the QCD scale. The evidence of stochastic gravitational waves at nanohertz observed by pulsar timing array experiments suggests that the discrete-symmetry-breaking scale is around 100 TeV, assuming the domain-wall explanation. The annihilation temperature is about 100 MeV, which could naturally be below the QCD phase transition temperature. We point out that the QCD phase transition within some domains with an effective large QCD θ angle could be a first-order one. To derive the phase diagram in θ and temperature, we adopt a phenomenological linear sigma model with three quark flavors. The domainwall explanation for the NANOGrav, EPTA, PPTA and CPTA results hints at a first-order QCD phase transition, which predicts additional gravitational waves at higher frequencies. If the initial formation of domain walls is also a first-order process, this class of domain-wall models predicts an interesting gravitational wave spectroscopy with frequencies spanning more than ten orders of magnitude, from nanohertz to 100 Hz.

Primary authors: KORWAR, MRUNAL PRASHANT; Mr CHEN, Ting-Kuo (University of Wisconsin-Madison); BAI, Yang

Presenter: KORWAR, MRUNAL PRASHANT

Session Classification: Noon session

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

Improved Constraints on Dark Matter Annihilations Around Primordial Black Holes

Saturday 11 November 2023 11:25 (15 minutes)

Cosmology may give rise to appreciable populations of both particle dark matter and primordial black holes (PBH) with the combined mass density providing the observationally inferred value $\Omega_{\rm DM} \approx 0.26$. Early studies highlighted that scenarios with both particle dark matter and PBH are strongly excluded by γ-ray limits for particle dark matter with a velocity independent thermal cross section $\langle \sigma v \rangle \sim 3 \times 10^{-26} {\rm cm}^3/{\rm s}$, as is the case for classic WIMP dark matter. Here we examine the limits from diffuse γ-rays on velocity-dependent, including annihilations which are p-wave with $\langle \sigma v \rangle \propto v^2$ or d-wave $\langle \sigma v \rangle \propto v^4$, which we find to be considerably less constraining. This work also utilyses a refined treatment of the PBH dark matter density profile. Importantly, we highlight that even if the freeze-out process is p-wave it is typical for (loop/phase-space) suppressed s-wave processes to actually provide the leading contributions to the experimentally constrained γ-ray flux from the PBH halo.

Primary authors: CHANDA, Prolay; UNWIN, James (UIC); Dr SCHOLTZ, Jakub

Presenter: CHANDA, Prolay

Session Classification: Noon session

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

2b or not 2b

Saturday 11 November 2023 10:15 (15 minutes)

Motivated by new physics models which lead to final states containing a high multiplicity of bottom and top quarks; we developed a tagging strategy to suppress reducible and non-reducible multi-jet backgrounds. The idea takes advantage of the properties of light parton showers and of the gluon fragmentation into heavy quarks to reject jets that do not originate from a bottom quark. Preliminary bounds on the upper limits of the branching ratios of heavy Higgses to vector-like quarks will be presented.

Primary author: PAZAR, Beni (Indiana University)

Presenter: PAZAR, Beni (Indiana University)

Session Classification: Morning session

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

Multi Higgs Boson Signals of a Modified Muon Yukawa Coupling at a Muon Collider

Saturday 11 November 2023 10:00 (15 minutes)

SMEFT is an efficient tool to parametrize the effect of BSM physics in a model-independent way. We study di-Higgs and tri-Higgs productions at the muon collider which is parametrized by the dimension 6 mass operator. We also study di-boson and tri-boson processes which also include the production of Goldstone bosons. We discuss possible model dependence of multi-boson processes resulting from other dimension 6 operators and identify that multi-Higgs processes could be a golden channel for studying deviation in muon Yukawa coupling. Finally, we extend the study to two Higgs doublet model type-II and show that cross-sections for multi-Higgs productions involving heavy Higgs bosons can be enhanced up to by a factor of $\tan^6 \beta$ which could be very sensitive probe of deviation in muon Yukawa coupling.

Primary author: LEE, Taegyu (Indiana University)

Co-authors: HERMANEK, Keith (Indiana University); Dr NAVIN, Mcginnis (Arizona university); DERMISEK, Radovan (Indiana University); YOON, Sangsik (Indiana University)

Presenter: LEE, Taegyu (Indiana University)

Session Classification: Morning session

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

Entanglement and Symmetry in Low-energy QCD

Saturday 11 November 2023 16:30 (15 minutes)

Quantum information science offers a fresh perspective to think about quantum field theory. In this talk, I look at the connection between entanglement and symmetries in low-energy scattering of spin-$\frac{1}{2}$ baryons. The baryons transform as an octet under the $SU(3)$ flavor symmetry and their interactions below the pion threshold are described by contact operators in an effective field theory (EFT) of QCD. I will show that successive entanglement minimization in $SU(3)$-symmetric scattering channels are correlated with increasingly large emergent symmetries in the EFT.

Primary author: LIU, Qiaofeng (Northwestern University)

Presenter: LIU, Qiaofeng (Northwestern University)

Session Classification: Afternoon session

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

Isosinglet vectorlike leptons at e^+e^- colliders

Saturday 11 November 2023 16:15 (15 minutes)

We study weak isosinglet vectorlike leptons that decay through a small mixing with the tau lepton, for which the discovery and exclusion reaches of the Large Hadron Collider and future proposed hadron colliders are limited. We show how an e^+e^- collider may act as a discovery machine for these τ' particles, demonstrate that the τ' mass peak can be reconstructed in a variety of distinct signal regions, and explain how the τ' branching ratios may be measured.

Primary authors: BHATTIPROLU, Prudhvi (University of Michigan); MARTIN, Stephen (Northern Illinois University); PIERCE, Aaron (University of Michigan)

Presenter: BHATTIPROLU, Prudhvi (University of Michigan)

Session Classification: Afternoon session

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

Optimal anti-ferromagnets for light dark matter detection

Saturday 11 November 2023 11:40 (15 minutes)

We propose anti-ferromagnets as optimal targets to hunt for sub-MeV dark matter with spin-dependent interactions. These materials allow for multi-magnon emission even for very small momentum transfers, and are therefore sensitive to dark matter particles as light as the keV. We use an effective theory to compute the event rates in a simple way. Among the materials studied here, we identify nickel oxide (a well-assessed anti-ferromagnet) as an ideal candidate target. Indeed, the propagation speed of its gapless magnons is very close to the typical dark matter velocity, allowing the absorption of all its kinetic energy, even through the emission of just a single magnon.

Primary authors: Dr PAVASKAR, Shashin; ESPOSITO, Angelo

Presenter: Dr PAVASKAR, Shashin

Session Classification: Noon session

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

The search for Neutrinoless Double Beta Decay in Germanium

Saturday 11 November 2023 16:45 (15 minutes)

Physicists around the world have been trying to detect an extremely rare, but not invalidated by Standard Model, decay process called neutrinoless double beta decay (0vBB) in Ge since the late 1960s. Two recent experiments, Majorana and GERDA, have pushed the frontier by setting the limit of half-life to be ˜10ˆ26 years using ˜40 kg of 76Ge. This result eventually also puts an upper limit on effective neutrino mass (113-269 meV). These results have been achieved partly due to great energy resolution of these highly pure Ge detectors (0.12% FWHM around ROI). Riding on the success of these two demonstrator experiments, people have now joined together to build a ton-scale experiment in Gran Sasso, Italy, named LEGEND, with the same detection technology and stronger background-mitigation plan. 140 kg of that has already been deployed and preliminary results have come out recently. In this talk, I'll explain the experimental set-up, detection technology, a summary of preliminary results and IU group's ongoing work on next phase R&D of these detectors.

Primary author: Mr FUAD, Nafis (Indiana University)

Presenter: Mr FUAD, Nafis (Indiana University)

Session Classification: Afternoon session

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

A Machine Learning Perspective on Hadronization Modeling with MLHAD

Saturday 11 November 2023 10:30 (15 minutes)

Hadronization, a crucial component of event generation, is traditionally simulated using finely-tuned empirical models. While current phenomenological models have achieved significant success in simulating this process, there remain areas where they fall short in accurately describing the underlying physics. In this talk, I will introduce MLHAD, an alternative approach that supplants the empirical model with a surrogate machine learning-based method, thereby facilitating data-trainability. I will delve into the current stage of its development and explore potential future direction.

Primary author: YOUSSEF, Ahmed (University of Cincinnati)

Presenter: YOUSSEF, Ahmed (University of Cincinnati)

Session Classification: Morning session

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

Dark Matter Search on Chips

Saturday 11 November 2023 11:10 (15 minutes)

Axions and axion-like particles are well motivated candidates for dark matter (DM) and have a signature two photon vertex. The most sensitive axion DM search is at the gigahertz (GHz) regime. It relies on microwave cavities with high quality factors resonantly converting axion DM to cavity photons in the background of a static magnetic field. However, axion DM mass could span a vast range above or below GHz. We describe a new proposal using integrated/on-chip photonic systems to search for axion DM at the optical frequency. This enables the use of waveguides to collect signal photons, which improves the detection efficiency, as well as the use of single photon, micron-sized detector, such as a skipper charge-coupled device, which has a dark count rate as low as 1e-9 per second per pixel. Furthermore, by coupling a series of resonators of different frequencies to a single receiver bus, the detection can be broadband in terms of the axion masses and has sensitivities to the axion-photon couplings expected for the QCD axion at the axion masses of around eV.

Primary author: GAO, Christina

Presenter: GAO, Christina

Session Classification: Noon session

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

Cosmological constraints on doubly-charged particles

Saturday 11 November 2023 13:30 (1 hour)

Presenter: POSPELOV, Maxim

Session Classification: Invited talk

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

Parity solution to the strong CP problem

Saturday 11 November 2023 14:45 (1 hour)

Presenter: HARIGAYA, Keisuke (University of Chicago)

Session Classification: Invited talk