

Titles and abstracts of speakers

- Speaker: Juliette Alimena (Ohio State University)
Title: Searches for Long-Lived Particles at the LHC
Abstract: Particles beyond the standard model (SM) can generically have lifetimes that are long compared to SM particles at the weak scale. When produced at the Large Hadron Collider (LHC) at CERN, these long-lived particles (LLPs) can decay far from the primary proton-proton interaction, or even completely pass through the detector before decaying. Such LLP signatures are distinct from those of promptly decaying particles that are targeted by the majority of searches for new physics at the LHC. These LLP analyses often require customized techniques to collect, reconstruct, and analyze the data. In this talk, I will give an overview of Run 2 searches for LLPs at ATLAS, CMS, and LHCb. I will also give some idea of what we can expect from LLP searches at the High-Luminosity LHC.
- Speaker: Charles C. Young (SLAC)
Title: Overview of new LHC projects in the search for Long-Lived Particles.
Abstract: Long-lived particles (LLP) are well-motivated signatures of beyond Standard Model physics. The LHC is a natural place for this research given its high energy and luminosity; however, the searches to date have to contend with trigger limitations and QCD background. New projects have been proposed that circumvent them and operate in a near-zero background environment, thus significantly extending the LLP reach of the LHC program. We will discuss the relative strengths of these projects and how they compare with other programs.
- Speaker: Marco Drewes (UC Louvain)
Title: Heavy Neutral Leptons below the EW scale: theory and perspectives at accelerators
- Speaker: Satoshi Shirai (KAVLI IPMU)
Title: Long Lived Particles in Viable SUSY Dark Matter Models

Abstract: The supersymmetric standard model is the most promising physics beyond the standard model. After the discovery of the Higgs boson, mini-split SUSY is getting more attention. In this talk, I will discuss that it is very likely that there are meta-stable particles in the parameter region consistent with the current dark matter observation. Such a long-lived particle plays a critical role in the SUSY discovery at the LHC.

- Speaker: Jonathan Feng (U.C. Irvine)

Title: On the Ubiquity of Long-Lived Particles

Abstract: New long-lived particles are present in a large variety of particle physics models. I outline some of the underlying reasons from particle physics and cosmology and attempt a rough classification of the various types of long-lived particles. I also give some examples, both old and new, of long-lived particles and the exciting new approaches being investigated to discover them experimentally.

- Speaker: Jonathan Feng (U.C. Irvine)

Title: FASER

Abstract: FASER, the Forward Search Experiment at the LHC, is an approved and funded experiment, currently being constructed to take data in LHC Run 3 from 2021-23. I will describe FASER's physics goals, the detector, and the experiment's current status.

- Speaker: Artur Shaikhiev (CERN)

Title: Exotic searches at the NA62 experiment at CERN

Abstract: The features of the NA62 experiment at the CERN SPS high-intensity setup, trigger-system flexibility, high-frequency tracking of beam particles, redundant particle identification, and ultra-high-efficiency photon vetoes make NA62 particularly suitable to search for long-lived, weakly-coupled particles within Beyond the Standard Model physics. Searches for Heavy Neutral Lepton (HNL) production in charged kaon decays using the data collected by the NA62 experiment are reported. Upper limits are established on the elements of the extended neutrino mixing matrix for HNL masses in the range 130-450 MeV, improving on the results from previous HNL production searches.

Latest results on production searches of Dark Photons in neutral pion decays at NA62 are also presented, together with sensitivity results for production and decay searches of Axion-Like Particles, and prospects for future data taking at the NA62 experiment.

- Speaker: Laura Molina Bueno (ETH Zrich)

Title: Latest results from NA64 experiment

Abstract: A possibility that in addition to gravity, dark matter could interact with ordinary matter through a new very weak force is quite exciting. The mediator of this new interaction could be a new massive vector boson, called dark photon (A'), with a predominant decay into dark matter particles (χ). If the A' exists, it could be produced in NA64 in the reaction $e^- Z \rightarrow e^- Z A'$ of 100 GeV electrons dumped against an active target, followed by the prompt invisible decay $A' \rightarrow \chi\chi$. The experimental signature of this process would be a clean event with an isolated electron and large missing energy in the detector. This allows us to probe the $\gamma - A'$ mixing strength and put stringent constraints in the parameter space predicted by the relic dark matter density. NA64 has been taking data since 2016 and will resume running after the CERN long-shutdown in 2021. In this talk, we present the latest results from the combined analysis of data sample collected during 2016-2018. Dark photons could also decay to standard model leptons, $A' \rightarrow e^+e^-$. Preliminary results of NA64 for this search, as well as the ones for the decay of a 17 MeV X boson, which could explain a recently observed anomaly in the 8Be transitions, will be also discussed in this talk.

- Speaker: Arthur Moraes (CBPF)

Title: Exotica in the forward region at the LHC

Abstract: Forward detectors at the LHC allow the search of "beyond-the-Standard Model physics" in corners of the phase-space not yet explored. In this talk we will present a brief review of the forward physics program at the LHC and its impact on searches for exotica. Focusing on the CMS-PPS and AFP detectors, we will show results on studies of anomalous quartic gauge couplings (AQGC), searches for axion-like particles, Dark Matter and SUSY signatures.

- Speaker: Iaroslava Bezshyiko (University of Zurich (UZH))

Title: The SHiP experiment at CERN

Abstract:

The SHiP Collaboration has proposed a general-purpose experimental facility operating in beam dump mode at the CERN SPS accelerator with the aim of searching for light, long-lived exotic particles of Hidden Sector models. The SHiP experiment incorporates a muon shield based on magnetic sweeping and two complementary apparatuses. The detector immediately downstream of the muon shield is optimised both for recoil signatures of light dark matter scattering and for tau neutrino physics, and consists of a spectrometer magnet housing a layered detector system with heavy target plates, emulsion film technology and electronic high precision tracking. The second detector system aims at measuring the visible decays of hidden sector particles to both fully reconstructible final states and to partially reconstructible final states with neutrinos, in a nearly background free environment. The detector consists of a 50 m long decay volume under vacuum followed by a spectrometer and particle identification with a rectangular acceptance of 5 m in width and 10 m in height. Using the high-intensity beam of 400 GeV protons, the experiment is capable of integrating 2×10^{20} protons in five years, which allows probing dark photons, dark scalars and pseudo-scalars, and heavy neutrinos with GeV-scale masses at sensitivities that exceed those of existing and projected experiments. The sensitivity to heavy neutrinos will allow for the first time to probe, in the mass range between the kaon and the charm meson mass, a coupling range for which baryogenesis and active neutrino masses can be explained. The sensitivity to light dark matter reaches well below the elastic scalar Dark Matter relic density limits in the range from a few MeV/c^2 up to $200 \text{ MeV}/c^2$. The tau neutrino deep-inelastic scattering cross-sections will be measured with a statistics a thousand times larger than currently available, with the extraction of the F_4 and F_5 structure functions, never measured so far, and allow for new tests of lepton non-universality with sensitivity to BSM physics. Following the review of the Technical Proposal, the CERN SPS Committee recommended in 2016 that the experiment and the beam dump facility studies proceed to a Comprehensive Design Study phase. These studies have resulted

in a mature proposal submitted to the European Strategy for Particle Physics Update.

- Speaker: Jusak Tandean (National Taiwan University)

Title: Probing new physics with rare hyperon and kaon decays involving invisible particles.

Abstract:

The flavor-changing neutral current decays of light hyperons into another baryon plus missing energy can serve as potentially sensitive probes of new physics (NP) beyond the standard model (SM), as their branching fractions are tiny in the SM. The latest data on $K \rightarrow \pi \nu \nu$ do not permit sizable NP effects on the hyperon modes if the underlying operators have mainly parity-even quark parts. In contrast, the available empirical bounds on $K \rightarrow \pi \text{invisible}$ and $K \rightarrow \pi \pi \nu \nu$ are far less restrictive on NP operators with primarily parity-odd quark parts. Consequently, the latter type of NP interactions is presently allowed to produce substantially amplifying effects on the hyperon modes. Their NP-enhanced branching fractions could reach levels potentially discoverable in the ongoing BESIII or future experiments. Under certain circumstances, the hyperon modes are the only direct probes of strangeness-changing NP couplings to invisible particles. Thus, it is important to measure these rare hyperon decays, as they can provide information on the underlying new interactions which is complementary to that gained from the corresponding kaon decays.

- Speaker: Gang Li (National Taiwan University)

Title: CP-violating Dark Photon Interaction

Abstract: We introduce a scenario for CP-violating (CPV) dark photon interactions in the context of non-abelian kinetic mixing. Assuming an effective field theory that extends the Standard Model (SM) field content with an additional U(1) gauge boson (X) and a SU(2)_L triplet scalar, we show that there exist both CP-conserving and CPV dimension five operators involving these new degrees of freedom and the SM SU(2)_L gauge bosons. The former yields kinetic mixing between the X and the neutral SU(2)_L gauge boson (yielding the dark photon), while the latter induces CPV interactions of the dark photon with the SM

particles. We discuss the experimental probes of CPV dark photon interaction.

- Speaker: SungWoo Youn (KAIST)

Title: Axion dark matter search at IBS/CAPP

Abstract:

The axion has been considered as an elegant solution to the strong-CP problem and a compelling candidate for cold dark matter. The Center for Axion and Precision Physics Research of the Institute for Basic Science has been establishing state of the art axion experiments in Korea since 2013. The detection scheme relies on the haloscope technique in which axions are resonantly converted into microwave photons in a strong magnetic field. Our strategy is to run several experiments in parallel to cover a wide range of axion mass with a sensitivity sufficiently high enough to probe the QCD axion models. The current approaches to achieve this goal are three folds commissioning high field magnets, designing high-frequency high-Q cavities, and developing nearly quantum-limited noise amplifiers. We present the current status of the experiments and discuss the future prospects.

- Speaker: Raymundo Ramos (Academia Sinica)

Title: Complex scalar dark matter from the gauged two Higgs doublet model

Abstract: In the gauged two Higgs doublet model (G2HDM) an accidental Z_2 symmetry remains after spontaneous symmetry breaking. The lightest neutral Z_2 -odd particle is a dark matter (DM) candidate. In this talk we will discuss a recent study on the properties of the complex scalar DM candidate. The presentation will be divided between three classes of DM. We will see how their different properties affect the predictions for relic density, direct and indirect detection. In particular, we will consider experimental results from XENON1T, PLANCK and Fermi-LAT Pass 8.

- Speaker: Alice Morris

Title: Long-lived particles at ATLAS

- Speaker: Albert de Roeck (CERN)

Title: Physics Beyond Colliders at CERN: Long Lived Particles

Abstract: The Physics Beyond Colliders initiative is an exploratory study aimed at exploiting the full scientific potential of the CERNs accelerator complex and scientific infrastructures through projects complementary to the LHC and other possible future colliders. These projects will target fundamental physics questions in modern particle physics. This presentation gives the status of the proposals presented in the framework of the Beyond Standard Model physics working group, and explore their physics reach, in particular for long lived particles and the impact that CERN could have in the next 10-20 years on the international landscape.

- Speaker: Albert de Roeck (CERN)

Title: MilliQan: a Milli-charged Particle Detector at LHC

Abstract: We discuss the status of a dedicated experiment that will search for milli-charged particles produced in pp collisions at LHC Point 5. The experiment aims be installed during ongoing long shutdown of the LHC. With 300 fb⁻¹ of integrated luminosity, sensitivity to a particle with charge $O(0.001)e$ can be achieved for masses of $O(1)$ GeV, and charge $O(0.01)e$ for masses of $O(10)$ GeV, greatly extending the parameter space explored for particles with small charge and masses above 100 MeV.

- Speaker: Leandro de Paula (UFRJ - Federal University of Rio de Janeiro)

Title: Exotica Searches at LHCb

Abstract: The LHCb detector has been conceived for the study of flavor physics at LHC. Due to its excellent performance and complementarity to the general purpose detectors it is also able to give important contribution in other sectors. It will be presented a report on the searches for new Physics done with Run 1 and Run 2 LHCb data, with emphasis on the ones related to long lived particle observation. Prospects for Run 3 will also be discussed.

- Speaker: Jyothsna Rani Komaragiri (Indian Institute of Science, Bangalore, India)

Title: Review and prospects of Dark Matter searches at CMS

Abstract: Searches for dark matter in various final states with invisible particles recoiling against standard model particles are presented. Various topologies and kinematic variables are explored. The focus of the talk is on the recent Compact Muon Solenoid (CMS) experiment results obtained using data collected at Run-II of the Large Hadron Collider (LHC) with an outlook towards the future.

- Speaker: James Pinfold (University of Alberta)

Title: Expanding the LHC's Discovery Frontier - Recent Results and Future Plans of the MoEDAL Experiment

Abstract: MoEDAL is a pioneering LHC experiment designed to search for anomalously ionizing messengers of new physics such as magnetic monopoles or

massive (pseudo-)stable charged particles, which are predicted to exist in a plethora of models beyond the Standard Model. It started data

taking at the LHC at a centre-of-mass energy of 13 TeV in 2015. Its ground breaking physics program defines a number of scenarios that yield

potentially revolutionary insights into such foundational questions as: are there extra dimensions or new symmetries; what is the mechanism for

the generation of mass; does magnetic charge exist; and what is the nature of dark matter. MoEDAL's purpose is to meet such far-reaching challenges at the frontier of the field. We will present the results from the MoEDAL detector on magnetic monopole and highly ionizing electrically

charged particle production that are the worlds best. In addition, MoEDAL's plan for LHC's RUN-3 will be presented in

particular the installation of the MAPP (MoEDAL Apparatus for the detection of Penetrating Particles) sub-detector designed to expand

MoDAL's physic reach to include fractionally charged particles and new very long-lived neutral particles.

- Speaker: Glennys Farrar (NYU)

Title: Stable sexaquark: Dark Matter predictions, constraints and lab detection

Abstract: A stable sexaquark is an appealing Dark Matter candidate. After a short overview, the talk will focus on the following aspects: Relic Abundance Prediction Simple statistical physics arguments, plus known QCD parameters (quark masses and QCD transition temperature), predicts the DM to baryon ratio after the QGP-hadron transition to be 4.5 ± 1 , in remarkable agreement with the observed value of 5.3 ± 0.1 . Constraints on m_S and S - B - B breakup amplitude Strongest limits come from deuterium lifetime for $d \rightarrow S e^+ \nu$ from SNO. The limits leave open an unexpectedly large mass range and the overlap expectations comfortably accommodate the DM relic density. (Contrary to the intuition of Kob and Turner, sexaquarks would not be dissociated in the low temperature hadronic phase, given reasonable estimates of their wave-function overlap with two baryons; McDermott et al claim of exclusion via SN1987a also rely on unjustified assumptions, as will be mentioned.) Sexaquark Detection in Lab Expts A stable sexaquark is surprisingly elusive. Experimental strategies for discovering the S will be enumerated. The recent BABAR search in exclusive final states would need a factor 10^4 higher statistics to be sensitive.

- Speaker: Henry Lubatti (University of Washington)

Title: MATHUSLA - a new detector to probe the life-time frontier

Abstract: Long-lived particles are fundamentally motivated and appear in all beyond the Standard Model theoretical constructs that address the key issues not included in the Standard Model such as Dark Matter, Baryon Asymmetry, Neutrino Masses and the Heirarchy problem. Big Bang Nucleosynthesis (BBN) imposes an upper limit of 0.1 s on the allowable long-lived particle lifetime. Very large backgrounds limit the lifetime reach of current LHC detectors. This talk describes recent developments of the large area MATHUSLA detector proposed for the HL-LHC, which has the sensitivity to probe lifetimes up to the BBN

limit. Current detector design concepts, tracking detector technology and layout of MATHUSLA above the CMS interaction point will be discussed.

- Speaker: David Curtin (University of Toronto)
Title: Neutral Naturalness: From Colliders to Cosmology and Astrophysics
Abstract: After briefly reviewing long-lived particle signatures of Neutral Naturalness and other hidden sector models, I will discuss how the same models can instead give rise to rich cosmological and astrophysical signatures, including modifications to the CMB, Large Scale Structure, DM Direct Detection and even exotic astrophysical signals. This demonstrates the importance of both collider and cosmological/astronomical searches to solve the mystery of the hierarchy problem.
- Speaker: Tran Van Que (Nanjing University)
Title: Time-delayed leptons from dark photon in extension Stueckelberg model.
- Speaker: Igal Jaegle (University of Florida)
Title: Search for axion-like and dark particles at Belle (II)
Abstract: The 86 years old enigma of the Universe missing mass problem could be explained by the presence of a non-luminous matter, the so-called dark matter. If it exists, Belle (II) are ideal tools to search for the hypothetical dark matter candidates such as axion-like and light dark matter particles for a mass below $10\text{GeV}/c^2$.
- Speaker: Alice Morris (University College London)
Title: Snapshot and projections of long-lived particle searches with the ATLAS experiment
Abstract: BSM physics with long-lived particles (LLPs) can produce many complex topologies. The ATLAS experiment has a broad range of LLP searches in which the experimentally challenging signatures may require custom triggers and non-standard reconstruction algorithms. This talk will cover a selection of recent results, and show

some prospects for LLP searches with the ATLAS experiment at the HL-LHC.