Seminar on Particle Physics Phenomenology and Experiments

Report of Contributions

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

Experimental detection of the CNO cycle

Monday, 26 September 2022 13:30 (1 hour)

Borexino recently reported the first experimental evidence for a CNO neutrino. Since this process accounts for only about 1% of the Sun's total energy production, the associated neutrino flux is remarkably low compared to that of the pp chain, the dominant hydrogen-burning process. This experimental evidence for the existence of CNO neutrinos was obtained using a highly radio-pure Borexino liquid scintillator. Improvements in the thermal stabilization of the detector over the last five years have allowed us to exploit a method of constraining the rate of 210-Bi background. Since the CNO cycle is dominant in massive stars, this result is the first experimental evidence of a major stellar hydrogen-to-helium conversion mechanism in the Universe.

Presenter: MISIASZEK, Marcin (Jagiellonian University)

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

LFV and dark sector searches at Belle (II) experiment

Monday, 12 September 2022 13:00 (1 hour)

Final states with tau leptons at the Belle (II) experiment are a very promising test ground to search for lepton flavor violation and dark sector candidates. Recent searches for lepton flavor violation and dark sector candidates with data collected by the Belle (II) are presented. Future projections of expected sensitivity are also discussed. Beam polarization upgrade at SuperKEKB/Belle (II) can further enhance the sensitivity for these searches. Such searches will either discover new physics or strongly constrain several new physics models.

Presenter: SWAGATO, Banerjee (University of Louisville, Kentucky, USA)

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

Testing Bell inequalities in H -> tau,tau at lepton colliders

Monday, 10 October 2022 13:00 (1 hour)

It has been know that Quantum Mechanics allows a strong and bizarre correlation among particles, called entanglement, that is not possible in any alternative theories that are local and real. In those local-real theories, correlations among particles must satisfy Bell inequalities, while Quantum Mechanics can violate them.

The entanglement and Bell inequalities are therefore thought of the key to understand Quantum Mechanics in a deeper level and play important roles in quantum information and computation theories. Violation of Bell inequalities has been observed in low energy experiments but it has not been tested at high-energy collider experiments with energy higher or around the weak scale.

In this talk I will review the collider test of Bell inequalities and
argue that H->tau,tau process at the ILC provides an ideal environment for it. We study the prospect of testing Bell inequalities at the ILC using Monte Carlo simulation including the detector effects.

Presenter: SAKURAI, Kazuki (Warsaw University)

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

Vector meson photoproduction in ALICE at the LHC

Monday, 24 October 2022 13:00 (1 hour)

Ultra-peripheral collisions (UPC) of heavy ions provide unique opportunity to study vector meson (VM) photoproduction in ALICE. Analyses of different species of VMs address the gluon saturation and nuclear shadowing. Light vector mesons offer the opportunity to study the approach to the black-disc limit of QCD. Measurement of the heavy vector meson photoproduction cross section as a function of |t| (t~p_T^2) gives information about the impact parameter dependence of spatial gluon distributions and so constrains the transverse gluonic structure in nuclei at very low Bjorken-x. ALICE has published the rho^0 coherent photoproduction cross sections in Pb-Pb and Xe-Xe UPC at sqrt(s_NN) = 5.02 and 5.44 TeV, respectively, for different nuclear-breakup classes. Moreover, ALICE has measured rapidity and |t| dependence of coherent J/psi and rapidity dependence of psi′ photoproduction cross section in Pb-Pb UPC at sqrt(s_NN) = 5.02 TeV. Recently, J/ψ photoproduction and exlusive dimuon cross section has been studied in p-Pb collisions at sqrt(s_NN) = 8.16 TeV. All the measurements are compared to QCD based models and allow for constraints on these models. An overview of the recent results from ALICE on the VM photoproduction as well as perspectives for future measurements in Run 3 and beyond will be presented.

Presenter: MATYJA, Adam (Institute of Nuclear Physics PAS)

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

JEDI and beyond – the quest for EDMs of charged particles

Monday, 7 November 2022 13:00 (1 hour)

The detection of an electric dipole moment (EDM) of elementary particles can shed light on two nagging questions of contemporary particle physics and cosmology. These are the excess of matter over antimatter, which is related to the strength of the CP symmetry violation, and the composition of dark matter (DM), which comprises a large fraction of the energy content of the Universe. In order to measure the EDM of charged particles, storage rings equipped with polarimeters have been proposed. A non-zero EDM interacting with the electric field of the ring in the particle rest frame would lead to a torque rotating the particle´s spin, which is parallel to the EDM vector. The resulting change in beam polarisation is the observable allowing one to deduce the EDM value. Though simple in its principle, the method is very challenging, since the smallness of the sought effect requires unprecedented precision in the ring construction, operation and monitoring, and thus demands many new developments.

On the roadmap towards such storage-ring based EDM measurements, a stepwise approach has been adopted. Pioneering efforts of the JEDI collaboration, exploiting the existing COSY synchrotron of Forschungszentrum Jülich, have led to the first-ever measurement for the deuteron. Along with that, an attempt to search for oscillating EDMs as an indication for axions or axion-like particles – presumed DM-candidates - has been undertaken. The results of those experiments will be reported. Next steps will also be envisaged. They comprise development of the key technologies to construct a precursor, 100-m circumference ring with electrostatic deflectors as well as magnetic elements, featuring clockwise and counter-clockwise beams. The concept, once proven, would then be extended into a full-glory all-electric 500-m ring for highest EDM sensitivity.

Presenter: WROŃSKA, Aleksandra (Jagiellonian University)

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

Exploring resemblance between liquid crystal topological defects and particle physics

Monday, 21 November 2022 13:00 (1 hour)

There are experimentally observed long-range e.g. Coulomb-like interactions for topological defects in liquid crystals, suggesting investigation how far can we take this resemblance with particle physics. I will discuss postulating skyrmion-like Lagrangian to get electromagnetism for their effective dynamics, interpreting filed curvature as electric field - making Gauss law count (quantized) topological charge, also regularizing charge to finite energy. For biaxial nematic - with 3 distinguished axes, hedgehogs of one of 3 axes are different mass realizations of the same topological charge - resembling 3 leptons. Further baryon-like topological structures require charge, which has to be compensated for neutron - suggesting why it is heavier than proton. For analog of quantum phase there is derived Klein-Gordon-like equation.

Presenter: DUDA, Jarosław (Jagiellonian University)

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

CERN from the beam instrumentation perspective, and a deeper view on some traditional instruments

Monday, 12 December 2022 13:00 (1 hour)

A brief introduction to the CERN accelerator complex, as seen from a beam instrumentation perspective, will be presented. In addition, a deeper look into the physics and challenges of some traditional intensity, position and Schottky instruments will also be discussed.

Presenter: ALVES, Diogo (CERN)

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

LHCb silicon detectors according to Gauguin

Monday, 23 January 2023 13:00 (1 hour)

D'où venons nous? Que sommes nous? Où allons nous? Where Do We Come From? What Are We? Where Are We Going? This is a good metaphorical summary of the initial design, upgrade I and upgrade II silicon detectors for LHCb – the precision experiment at LHC. The first LHCb era, after LHC Run 1 and Run 2, finished in 2018, and the second one began immediately with an ambitious upgrade I project that will be finished this year with the commissioning of the Upstream Tracker silicon microstrip detector. Due to a significant increase in instantaneous luminosity, the LHCb experiment almost completely rebuilt its DAQ, trigger and detector systems. The most challenging tasks pertaining to the sophisticated trackers that are required to provide excellent resolutions for momentum, impact parameter and lifetime of elusive beauty and charm hadrons and potential new particles. LHCb is one of the leaders in applying the recent developments in silicon technologies as well as stimulating new research directions. The main goal is always the same – push the boundaries of precision, robustness and radiation tolerance. But pure geometrical 3D tracking is no longer a viable option for what is ahead of us. Thus, the next-generation silicon trackers must also add the temporal coordinate into the picture to cope with the challenges of HL-LHC and beyond. This is a tale of the bold chase for new ingenious detection systems that push the envelope by providing new possibilities for super precise tests of the Standard Model and possibly discovering the nature of the mysterious New Physics.

Presenter: SZUMLAK, Tomasz (AGH University of Science and Technology)

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

Studies of pion-induced reactions with HADES

Monday, 6 February 2023 13:00 (1 hour)

A main goal of the HADES (High Acceptance Di-Electron Spectrometer) experiment at GSI is to study medium effects in e+e- production in heavy-ion reactions in the SIS-18 energy range (1-4 GeV/nucleon). Its excellent particle identification capabilities allowed for a systematic investigation of dielectron, strange particles and pion production in pion, proton, deuteron or heavy-ion induced reactions on proton or nucleus. The obtained dilepton spectra measured at various beam energies show important contributions from baryon resonance decays (R⟶Ne+e-) and a strong influence of the intermediate vector mesons (ρ/ω/φ) in the corresponding time-like electromagnetic form factors (eTFF).
In order to directly access such transitions, HADES has started a dedicated pion-nucleon program using the pion beam facility at GSI. For the first time, combined measurements of hadronic and dielectron final states have been performed in p-N reactions in the second resonance region, using polyethylene and carbon targets. Based on 2-pion production channels in p-p the baryon-meson couplings have been determined which are very crucial for the dilepton studies and finally the extraction of resonance Dalitz decay and eTFF.
The data collected with the carbon target have been used to study the pion and proton emission channels in various topologies (inclusive, pπ−, pπ+, pp, π+π−,..., ππpp). The interest is to provide information on the pion dynamics, which is crucial for dense hadronic matter studies using heavy-ion collisions at a few GeV/nucleon at GSI and later at FAIR. Results are compared to predictions of the INCL++ cascade and of transport models (SMASH, rQMD, GIBUU) providing a detailed test of the ingredients of these models.

Presenter: CIEPAŁ, Izabela (Institute of Nuclear Physics PAS)

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

SOLARIS synchrotron. Status and planned developments.

Monday, 20 February 2023 12:30 (1 hour)

The National Center for Synchrotron Radiation SOLARIS in Cracow is the only operator of a synchrotron radiation source in Poland and a premier center in the world. It provides beam time both for scientific and commercial users, in a broad range of topics from material sciences to biological and pharmaceutical applications. Currently we operate six experimental beam lines and three are under construction. All are available for different users from Poland and abroad. Therefore, it is crucial to supply the best possible quality and stability of light for the yearly running schedule. This requires a stable and continuous electron beam within the storage ring. The utilization of ML algorithms based on modern open-source libraries will enable us to perform on-line corrections of the beam profile enhancing its lifetime and the quality and stability of the light delivered by the SOLARIS ring. The suggested Bayesian algorithms such as Bayesian Neural networks or BSTS are finding the application in both science and industry such as forecasting seasonal events in time series (econometry), classifying convoluted overlapping sets of data and performing accurate predictions. For simpler and less complex problems we plan to use small and commonly used algorithms based on Boosted Decision Trees (XGBoost) to classify small subsets of data. We plan to study in detail the proposed method, to understand its effect on the correction. In the scope of this seminar the general setup of the SOLARIS accelerator complex, diagnostic tools and plans for the future will be discussed.

Presenters: BIERNAT, Jacek (Jagiellonian University); PANAŚ, Roman (Jagiellonian University)

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

From UPC to semi-central heavy-ion collisions

Monday, 6 March 2023 13:00 (1 hour)

My research aims at solving and broadening the view on current problems related to ultrarelativistic heavy-ion collisions. These results form integral to ongoing and planned experiments at CERN, the European Organization for Nuclear Research.

I will present the elementary and nuclear cross section for electromagnetic production of particles that result from $\gamma\gamma$-fusion or photoproduction. The research innovation lies in the possibility of making distributions of many measurable kinematic variables, which are often crucial to understanding better the reaction mechanism, rather than being limited to presenting only the value of the total cross section. This aspect of the research can be used to plan future experiments and interpret existing experimental results. My analyses are interdisciplinary. The correctness of the results is strongly influenced by the type of nuclear form factor used, which is known from electron scattering on nuclei. Application of the Fourier transform of the charge density in the nucleus allows a result more consistent with existing experimental data.

I will present results for the electromagnetic production of particles in ultraperipheral heavy ion collisions. I would also like to describe the transition from UPC case to more central collisions and show the verification of theoretical results with experimental ones.

Presenter: KŁUSEK-GAWENDA, Mariola (Institute of Nuclear Physics PAS)

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

Overview of ATLAS heavy-ion program

Monday, 20 March 2023 13:00 (1 hour)

ATLAS is one of the two general purpose experiments operating at LHC. Besides it's main goals, the Higgs boson studies, searches for new physics at energy frontier and precise test of the Standard Model, ATLAS is also perfectly suited for heavy-ion physics. This talk presents an overview of ATLAS measurements in heavy-ion collision systems. These include multiple measurements of jet production and structure, which probe the dynamics of the hot, dense quark-gluon plasma (QGP) formed in relativistic nucleus-nucleus collisions. Another powerful tool to understand the properties of the QGP is the presence of angular correlations that have long been used to study matter created in nucleus-nucleus collisions. Over the last several years such measurements have also been used in proton-proton and proton-nucleus collisions that shows interesting similarities to a QGP behaviour, with
ATLAS group being very active in that area.

Finally, the results from ultra-peripheral collisions (UPCs) where intensive electromagnetic flux surrounding charged ions lead to photon-induced processes when the colliding nuclei have a transverse separation larger than the nuclear diameter, will be discussed.

Presenter: DERENDARZ, Dominik (Institute of Nuclear Physics PAS)

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

Image reconstruction for novel imaging concepts in emission tomography

Monday, 8 May 2023 13:00 (1 hour)

In this seminar I will revise the principles of tomographic reconstruction in nuclear imaging, not only for nuclear medicine applications. Emphasis will be placed on unconventional imaging concepts for preclinical research, diagnosis and particle therapy monitoring. Some of the related challenges (low-count data, limited-angle acquisition, etc.) and possible solutions will be presented.

Presenter: RAFECAS, Magdalena (University of Lübeck)

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

Laboratorium Akceleratorowej Spektrometrii Masowej w Krakowie

Monday, 12 June 2023 13:15 (1 hour)

W ostatnich latach technologia akceleratorowej spektrometrii masowej (Accelerator Mass Spectrometry, AMS) poskutkowała możliwością zakupu kompleksowej aparatury badawczej, umożliwiającej prowadzenie badań na zupełnie nowych poziomach w różnych dziedzinach nauki. Podczas seminarium przedstawiony zostanie raport, którego celem było zebranie informacji na temat możliwości powstania laboratorium AMS w Krakowie, jako międzywydziałowej jednostki Uniwersytetu Jagiellońskiego.

Presenter: SWORST, Rafał (Jagiellonian University)