T 47: Axions/ALPs II

Time: Wednesday 16:15–18:15 Location: VG 0.110

T 47.1 Wed 16:15 VG 0.110

Long-lived axion-like particles at the FCC-ee — Freya Blekman[1,2], Juliette Alimena[2], Lovisa Rygaard[1,2], and •Elnura Bakhishova[1] — [1]University of Hamburg, Germany — [2]Deutsche Elektronen-Synchrotron DESY, Hamburg, Germany

We study the sensitivity to long-lived particles (LLPs) of a proposed circular electron-positron collider, the FCC-ee. The very low background environments in electron-positron collisions provide exciting opportunities to search for several types of LLPs. This talk will focus on one example of a physics case resulting in a long-lived signature, namely, axion-like particles (ALPs), and it will show the sensitivity of the FCC-ee to a long-lived ALP signature.

T 47.2 Wed 16:30 VG 0.110

Searching for ALPs through Photon Fusion at the Belle II experiment — •Frederik Schmitt, Giacomo De Pietro, Torben Ferber, and Alexander Heidelbach — Institute of Experimental Particle, Karlsruhe Institute of Technology, Karlsruhe, Germany

Axion-Like Particles (ALPs) represent an extension of the standard model and may serve as a portal to a dark sector. At the high-intensity e^+e^- collider SuperKEKB, ALPs could be produced in direct e^+e^- interactions. For low masses, ALPs are predominantly produced via vector-boson fusion. Focusing on primarily electroweak couplings, specifically to photons, an interesting decay arises with $e^+e^- \to e^+e^-a$, $a \to \gamma\gamma$. This analysis investigates the sensitivity of Belle II for the given decay and its challenges which lie in the kinematic distribution of the final state particles - closely resembling radiative Bhabha-scattering. Considering the expectance of low lepton angles, the analysis considers 4 tag cases where either no, one positive/negative or both leptons are fully reconstructed. This talk will present the current status of the search and the complexities and advantages of each tag.

T 47.3 Wed 16:45 VG 0.110

Search for ALPs in $e^+e^- \to \gamma a, a \to \gamma\gamma$ at Belle II — •Alexander Heidelbach, Giacomo De Pietro, and Torben Ferber — Institute of Experimental Particle, Karlsruhe Institute of Technology, Karlsruhe, Germany

Axion-Like Particles (ALPs), predicted by theoretical extensions of the Standard Model, represent potential Dark Matter mediators. We are searching for the $e^+e^- \to \gamma a$ channel, with subsequent ALP decay into a photon pair, at the Belle II experiment. This study utilizes the Belle II detector's precision, the SuperKEKB collider's high luminosity, and a unique understanding of the initial state to explore a diverse range of ALP masses and couplings in this fully neutral three-photon final state.

Compared to the predecessor analysis based on the 2018 dataset, this analysis targets an around 1000 times larger dataset, an improved understanding of the photon reconstruction resolution, kinematic fits to the initial state, and an MVA-based candidate selection. This talk will discuss the current state of the new analysis.

T 47.4 Wed 17:00 VG 0.110

Search for the $K^+ \to \pi^+\pi^0 A$ decay — •Marco Ceoletta — Johannes Gutenberg Universitat, Mainz, Germany

This analysis aims to search for the hypothetical decay $K^+ \to \pi^+\pi^0 A$, where A is Feebly-Interacting Particle (FIP) like an Axion-like particle (ALP) or a Dark Photon, at the NA62 experiment (CERN). Obtaining a stringent upper limit on BR($K^+ \to \pi^+\pi^0 A$) is important for the verification of BSM theories. In particular the decay is sensitive to an axial-vector coupling of hypothetical pseudo-scalar particles to quarks. A search on $K^+ \to \pi^+\pi^0 A$ therefore complements the extensive work already performed on the associated two-body decay $K^+ \to \pi^+ A$, that is sensitive only to the polar-vector coupling current. A preliminary upper limit of the branching ratio to ALPs, as part of a feasibility study done in 2022, already outperformed the best previous limit using less than 20% of the available data. The presentation describes the analysis and gives an outlook on the selection and expected upper limits.

T 47.5 Wed 17:15 VG 0.110

Optimization of Background Determination Using Machine Learning with ATLAS Forward Proton Detector Data — •Andrei Aiurov, Viktoriia Lysenko, and Andre Sopczak — Czech Technical University in Prague

The neutral Standard Model Higgs boson was discovered in 2012 at CERN with a two-photon signature, and the search for further particles of extended models continues, in particular, the search for an Axion-Like-Particle (ALP). An ALP can be produced with a signature of two photons. The separation of ALP production from unwanted background reactions is crucial. In this analysis, the recorded data is used to determine the background expectation with machine learning algorithms to optimize the search for ALPs.

T 47.6 Wed 17:30 VG 0.110

Determination of the absolute X-ray detection efficiency of the TAXO SDD for IAXO — •Patrick Bongratz[1], Susanne Mertens[1,2], Lucinda Schönfeld[1], Daniel Siegmann[2], Juan Pablo Ulloa Beteta[2], and Christoph Wiesinger[2] for the IAXO-Collaboration — [1]Max Planck Institut für Kernphysik, Heidelberg, DE — [2]Physik-Department, Technische Universität München, Garching, DE

The International Axion Observatory (IAXO) aims to improve the search for solar axions by at least one order of magnitude with respect to previous helioscope experiments. In a helioscope experiment solar axions are back-converted to X-rays in a strong magnet pointed at the sun. Silicon drift detectors (SDDs) are particularly suited to detect this signal. Good noise performance allows for sub-keV thresholds, while a thin entrance window ensures high detection efficiency. In this talk, I will report on the TRISTAN SDD for IAXO (TAXO) project and the measurement of the absolute X-ray detection efficiency at the SOLEIL synchrotron facility. This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation programme (grant agreement No. 852845).

T 47.7 Wed 17:45 VG 0.110

Development for an all semiconductor active-shield Detectors for IAXO — •Juan Pablo Ulloa Beteta[1], Susanne Mertens[2], Lucinda Schönfeld[2], Christoph Wiesinger[1], Michael Willers[1], and Patrick Bongratz[2] for the IAXO-Collaboration — [1]Physik- Department, Technische Universität München, Garching, DE — [2]Max Planck Institut für Kernphysik, Heidelberg, DE

The search for axions - a solution to the strong CP problem and a promising candidate for cold dark matter - is at the heart of the International Axion Observatory (IAXO). This next-generation helioscope experiment seeks to detect solar axions by converting them into X-ray photons. A critical challenge in achieving the required sensitivity for IAXO is the suppression of background caused by radioactivity and cosmic radiation. To address this, we are developing a novel all-semiconductor active-shield detector system. The system consists of a single-pixel Silicon Drift Detector (SDD) embedded within a High-Purity Germanium (HPGe) well-type detector, which serves as an active shielding to suppress background events. I will discuss the design progress and characterization studies of both the SDD and the HPGe detector, focusing on their energy resolution and noise performance. This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation programme (grant agreement No. 852845). It has also been supported by the DFG through the Excellence Cluster ORIGINS.

T 47.8 Wed 18:00 VG 0.110

Searching for New Physics with Nuclear Lineshape Data — •Fiona Kirk — PTB Braunschweig Germany — Leibniz University Hannover

Because of its potential as a nuclear clock state, the exceptionally low-lying isomer thorium-229m has been the subject of intense research for several decades. Recently, this state was laser-excited for the first time, bringing us an important step closer to the realisation of nuclear clocks, but also opening up new possibilities to search for new physics that couples to the quantum chromodynamics (QCD) sector.

In this talk I will describe how new physics might affect the shape of the nuclear resonance, and explain how nuclear lineshape data can already today set competitive bounds on ultra-light dark matter coupling to the QCD sector, or more generally, on the time variation of the QCD scale.