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Search for Axion Like Particles using η meson decays in the HADES experiment

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The High-Acceptance Di-Electron Spectrometer (HADES) operates at the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt with pion, proton and heavy-ion beams provided by the synchrotron SIS-18 [1]. In February 2022, the HADES collaboration conducted measurements with proton beam at 4.5 GeV kinetic energy using the upgraded setup within the FAIR-Phase0 program collecting statistics of 6 pb^-1 [2]. One of the objectives of the HADES physics program is to test the predictions of the Standard Model and search for potential hints of new phenomena beyond current theoretical frameworks (BSM–Beyond Standard Model Physics).
To this end, the collected large data sample opens a possibility to search for Axion-Like Particles (ALPs) via the pseudoscalar portal, through which they couple to Standard Model particles [3]. Such particles, with masses in the MeV–GeV range, can be experimentally accessible through their couplings to Standard Model particles. A set of calculations was done which predicts a possible existence of ALPs with a mass m_a = O(1–100) MeV and decay constant f_a = O(1–10) GeV [4] with additional PQ-breaking contribution to their masses. In particular, by studying η meson decays into dilepton (e+e–) channels, we investigate the possible existence of an ALP [5-7]. In this scenario, an intermediate state of the η meson decay into π+π-e+e- could involve the creation of a new particle through the sequence η⟶π+π–a(⟶e+e–). These studies are further motivated by observed anomalies in the invariant mass distribution of e+e– pairs in nuclear transitions of 8Be and 4He nuclei [8-9]. In this presentation, we will discuss the general motivations for ALP studies, show analysis steps of experimental data and simulation to extract η⟶π+π-e+e- decay, and share preliminary results.

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Collaboration

HADES

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