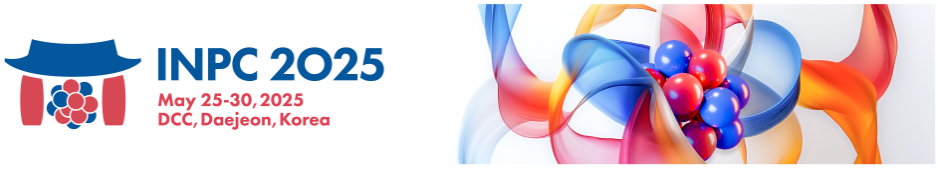

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Search for Axion-Like-Particles in η meson decays with the HADES Detector

Monday, 26 May 2025 14:00 (15 minutes)

The High-Acceptance Di-Electron Spectrometer (HADES) operates at the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt, using pion, proton, and heavy-ion beams provided by the SIS-18 synchrotron [1]. In February 2022, the HADES Collaboration measured proton-proton collisions at 4.5 GeV momentum using the upgraded setup as part of the FAIR-Phase0 program [2]. One of the key 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). It can be experimentally accessible via particles in the MeV–GeV mass range, which are coupled to the Standard Model.

Recently, a new set of calculations were done which predicts a possible existence of Axion-Like-Particles with a mass $m_a = \mathcal{O}(1-100)$ MeV and $f_a = \mathcal{O}(1-10)$ GeV [3] 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 Axion-Like Particle (ALP) [4-5] In this scenario, an intermediate state of the η meson decay could involve the creation of a new particle through the sequence $\eta \to \pi^+\pi^- a(\to e^+e^-)$. The particle is hypothesized to be an iso-scalar or axial-vector gauge boson, which may mediate a fifth force with couplings to Standard Model particles [6].

These studies are further motivated by observed anomalies in the invariant mass distribution of e^+e^- pairs in isoscalar magnetic nuclear transitions of ^{8}Be and ^{4}He nuclei [7-8]. These anomalies have been interpreted as evidence for the creation and decay of an intermediate particle with a mass of approximately 17 MeV/c^2, and suppressed mixing with the neutral pion.

In this talk, we will discuss the general motivations for ALP studies, present our analysis methodology, and share preliminary results from data collected using the high-resolution HADES spectrometer.

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