Precision Measurement of Kaonic Deuterium X-rays with the SIDDHARTA-2

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Content

The low-energy antikaon–nucleon interaction remains one of the key challenges in hadron physics. It is intimately linked to the spontaneous and explicit breaking of chiral symmetry in QCD and provides critical information on the nature of the strong interaction in the strangeness sector. In particular, kaonic atoms—exotic atoms in which a K^- replaces an electron—allow experimental access to the real and imaginary parts of the $\bar{K}$N scattering amplitude at threshold via precision spectroscopy of atomic X-ray transitions[1].

Among these systems, kaonic deuterium is of particular importance because, when combined with data from kaonic hydrogen, it provides the necessary input to disentangle the isospin I = 0 and I = 1 components of the $\bar{K}$N scattering lengths (a_0, a_1) within theoretical frameworks [2,3]. Despite its significance, the experimental observation of kaonic deuterium X-rays has remained elusive for decades due to the extremely low yield of the K-series transitions (particularly K_α) and overwhelming background signals in hadronic environments.

The SIDDHARTA-2 experiment, conducted at the DAΦNE e^+e^- collider at INFN-LNF, was designed specifically to meet this challenge. Utilizing a cryogenic gaseous deuterium target and a newly developed large-area Silicon Drift Detector (SDD) system with excellent energy resolution (~150 eV FWHM at 6 keV) and sub-microsecond timing capability, the experiment achieved a significantly enhanced signal-to-background ratio compared to previous attempts. Sophisticated trigger and veto systems were implemented to suppress beam-induced and accidental background, making high-precision X-ray spectroscopy feasible even in the presence of intense beam conditions.

In this poster, I present the latest results of the SIDDHARTA-2 experiment, focusing on the successful observation of the kaonic deuterium K_α X-ray line and new high-precision spectroscopy of kaonic neon[4]. I describe the experimental setup[5] and analysis approach used to extract the strong-interaction-induced energy shift and width in deuterium, essential for constraining low-energy QCD models and for understanding the $\bar{K}$N interaction near threshold. In addition, the kaonic neon measurement provides an independent and precise determination of the charged kaon mass, offering a novel test of fundamental constants relevant to QED. I also discuss the broader impact of these results on the study of kaonic atoms as precision tools for hadron physics, highlighting their potential to probe fundamental aspects of the strong interaction and to open new avenues for future investigations across a wide range of nuclear systems.

Reference

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