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Light kaonic atoms

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Collaboration

Abstract content

A kaonic atom is a Coulomb-bound system formed by a kaon, electrons, and a nucleus. Effects of the strong interaction between the kaon and atomic nucleus are experimentally extracted from characteristic x-ray-emission spectra of the most tightly bound energy levels that are the most perturbed by the strong force. Especially on the light kaonic atom studies, there are significant progress in resent years and the further experiments are scheduled in J-PARC (Japan) and DAFNE (Italy). In this talk, an overview of those experimental studies and the future plans will be given.

As for the simplest kaonic atom, so-called Kaonic hydrogen, the SIDDHARTA collaboration have recently measured the K-series x-rays with significant improvements over the previous experiments [1]. This measurement offers a unique possibility to determine the KN s-wave scattering lengths, which is one of the most important observable to investigate chiral SU(3) dynamics in low-energy QCD. It is also strongly related to recent hot topics of the structure of the $\Lambda(1405)$ resonance and possible deeply bound kaonic systems. For further understanding of the KN interaction, especially to disentangle the isoscalar and isovector scattering lengths, a challenging measurement of the kaonic-deuterium K-series x-rays is planed at DAFNE (SIDDHARTA2) [2] and at J-PARC hadron facility (J-PARC E57) [3].

On the other hand, the depth of K-nucleus potential remains still unknown because of insufficient precision of kaonic-atom data for more than $Z \geq 2$, despite of significant progress of kaonic hydrogen ($Z = 1$). This is tied closely to the puzzling situation on experimental and theoretical studies of kaonic nuclei, and is one of the greatest concerns in the recent strangeness nuclear physics [4]. Aiming to provide a breakthrough, we will perform high-resolution x-ray spectroscopy of kaonic atoms at a J-PARC hadron beamline using a novel cryogenic detector, namely superconducting transition-edge-sensor (TES) microcalorimeter, which has unprecedented high energy resolution [5-7]. Very recently, a pathfinding experiment by measuring pionic-atom x-rays was performed with a 240-pixel TES array at PSI, and the feasibility of TES-based exotic-atom x-ray spectroscopy in a hadron-beam environment was successfully demonstrated [8]. Based on the results, an ultra-high resolution x-ray spectroscopy of kaonic helium is prepared (J-PARC E62) [9]. Additionally, hadronic-atom x-ray spectroscopy has been used as a tool for measuring the charged hadron mass; we intend to improve the precision of the charged kaon mass measurement with TES spectrometers as well. This talk will also cover the new kaonic-atom project with the novel technology.

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