Contribution ID: **55** Type: **not specified**

The quest for kaonic atoms' measurements: technological challenges and future perspectives

Friday, April 4, 2025 11:00 AM (30 minutes)

The precise measurements of X-ray emissions from kaonic atoms represent one of the most valuable contributions to our knowledge of low-energy strangeness strong interactions.
The SIDDHARTA Collaboration at the INFN Laboratories of Frascati, thanks to the powerful combination of the unique low-momentum Kaon beam delivered by the DAΦNE e+e- collider and the implementation of cutting-edge X-ray detection systems, has played a crucial role in completing such precise measurements in the last decades.
After performing the most precise measurement of the strong interaction-induced shift and width of the 1s energy level in kaonic hydrogen in 2009, the collaboration is now providing a new fundamental brick for a better understanding of this low-energy strong interaction.
The SIDDHARTA-2 experiment at the INFN-LNF DAΦNE collider is now advancing our understanding by performing the first-ever determination of the strong-interaction induced shift and width of the 1s energy level in kaonic deuterium, a crucial step toward resolving antikaon-nucleon scattering lengths in both isospin channels.
In parallel, utilizing DAΦNE's superior low-energy kaon beam and cutting-edge radiation detection technologies, such as Silicon Drift Detectors (SDDs), High Purity Germanium (HPGe), and Cadmium-Zinc-Telluride (CdZnTe) detectors, the SIDDHARTA-2 collaboration performed other important measurements on various kaonic atoms, including helium and neon. These efforts, essential for probing the strong interaction at the strangeness frontier and for testing fundamental symmetries, are anticipated to have significant implications for the low-energy strangeness sector and represent a solid ground for future kaonic atoms measurements both at DAFNE and at J-PARC.
This contribution will outline the physics motivation, describe the experimental apparatus, highlight several promising results obtained so far with different kaonic atoms, provide an update on the current status of the kaonic deuterium measurement, and offer an overview of the forthcoming kaonic atom measurements planned by the collaboration.

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Session Classification: Plenary Session