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Probing Fundamental Interactions with Kaonic Atom X-ray Spectroscopy: From strong-field QED to low-energy QCD

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X-ray spectroscopy of kaonic atoms provides a unique tool for fundamental physics, enabling precision tests of quantum electrodynamics (QED) in strong electromagnetic fields and the exploration of the strong interaction at low energies with strangeness. In these exotic systems, the electromagnetic cascade of the kaon reveals both QED and strong-interaction effects in the innermost atomic levels.
Thanks to the low-energy kaon beam from the DAΦNE collider at the National Laboratories of Frascati - INFN (Italy) and state-of-the-art Silicon Drift Detectors, the SIDDHARTA-2 collaboration has achieved high-precision X-ray spectroscopy of kaonic atoms, including helium-4 and neon, and the first measurement of kaonic deuterium.
In this contribution, I will present the scientific motivation, experimental approach, and recent results of the SIDDHARTA-2 experiment, highlighting how X-ray spectroscopy of kaonic atoms is advancing our understanding of fundamental forces, from the strong-field QED to the strong interaction in the non perturbative regime.

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