



国立研究開発法人理化学研究所 仁科加速器研究センター
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High-resolution Exotic Atom x-ray spectroscopy with TES microcalorimeters

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The HEATES collaboration aims to pioneer the next-generation high-resolution x-ray spectroscopy of exotic atoms especially for kaonic atoms. We use a novel cryogenic x-ray spectrometer: an array of superconducting transition-edge-sensor (TES) microcalorimeters, offering unprecedented full-width-at-half-maximum energy resolution of 2 - 3 eV at 6 keV. The 240 pixel spectrometer array will have a large collecting area of about 20 mm² thanks to recent technological advances in multiplexed readout of TES multi-pixel arrays [1]. This will open a new door to investigate kaon-nucleus strong interactions.

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 (e.g., [2-4] are recent measurements). Therefore, many experiments have collected data on a variety of targets [5]; however, the energy resolution of the conventional semiconductor spectrometers employed in these experiments is insufficient to see the small spectral effects due to the strong interaction. As a result, the depth of the K⁻ - nucleus potential at zero energy remains unknown. This is closely related to the investigation of bound states of the kaon to the nucleus and is one of the greatest problems today in strangeness nuclear physics [6]. Aiming to provide a breakthrough, we will perform kaonic-atom x-ray spectroscopy at J-PARC using arrays of the TES microcalorimeters, J-PARC E62 [7].

We have conducted a pathfinding experiment by measuring pionic-atom x rays with a 240-pixel TES array at the Paul Scherrer Institut (PSI), and successfully demonstrated the feasibility of TES-based exotic-atom x-ray spectroscopy in a hadron-beam environment [8,9]. Recently we performed an experiment at the actual kaon beamline of J-PARC (K1.8BR) as a commissioning run. Kaon stop tuning and TES detector commissioning have been performed.

In this talk we will give an overview of this project and present preliminary results of experiments at PSI and J-PARC.

[1] J.N. Ullom et al., Synchrotron Radiation News 27 (2014) 24.[2] S. Okada et al., Phys. Lett. B 653 (2007) 387-391[3] SIDDHARTA collaboration, Phys. Lett. B 697 (2011) 199-202.[4] SIDDHARTA collaboration, Phys. Lett. B 704 (2011) 113-117.[5] C.J. Batty, E. Friedman, A. Gal, Phys. Rep. 287 (1997) 385-445.[6] A. Gal, Nucl. Phys. A 914 (2013) 270-279.[7] https://j-parc.jp/researcher/Hadron/en/pac_1507/pdf/P62_2015-6.pdf[8] S. Okada et al., Prog. Theor. Exp. Phys. (2016) 091D01.[9] H. Tatsuno et al., J Low Temp Phys, 184 (2016) 930-937.

* The talk will be given in English language.

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