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Photoelectron spectroscopy of nuclear transitions

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Electron dynamics play a fundamental role in the behavior of matter and underpin many essential natural phenomena. Notably, these processes are also crucial to fundamental mechanisms in nuclear physics. Nuclear states can exchange energy with surrounding electrons, and nucleus–electron couplings drive a wide range of nuclear decay processes that are of significant scientific and technological interest.

In this context, we present a Helmholtz-funded project aimed at investigating electron dynamics involved in low-energy nuclear transitions triggered by photoexcitation using various advanced light sources. Specifically, we report recent results on the photoelectron spectroscopy of nuclear excitation in the Mössbauer resonance of ^{57}Fe , induced by resonant synchrotron radiation at PETRA III (DESY).

We also explore the potential to extend this approach to photoelectron spectroscopy of internal conversion in ^{229}Th , using non-resonant visible-to-ultraviolet table-top laser sources. The ability to study and control electron processes in nuclear transitions through light not only deepens our understanding of fundamental physics but also opens up innovative applications across multiple disciplines. As the field advances, its convergence with broader studies of electron dynamics promises to establish a novel platform at the intersection of nuclear science, atomic physics, and photonics—poised to drive groundbreaking scientific and technological developments.

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