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Absolute nuclear charge radii for elements without stable isotopes via precision x-ray spectroscopy of lithium-like ions

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There is currently no method to experimentally determine the absolute charge radius of nuclei for elements that have no stable or extremely long-lived isotope: The standard methods, electron scattering and muonic atom spectroscopy, require macroscopic amounts of the isotope under investigation. Thus, for nuclei with charge Z > 83, (uranium is the exception), there is no experimental data for the absolute nuclear charge radius. We are currently developing a technique to measure the absolute charge radius of any heavy isotope of sufficient half-life (order of seconds) using precise x-ray spectroscopy of the electronic 2s-2p transition in lithium-like ions. The finite nuclear size shifts the transition energy by more than 10 eV in these systems, whereas experimentally, the transition energy can be measured absolutely with an accuracy below 100 meV [1]. In addition, recent progress in QED theory allows us to account for radiative corrections at a comparable level as well [2]. As a result, the contribution by the finite nuclear charge distribution can be extracted at the 100 meV level. In this presentation, we will give details of our computational approach, and address prospects for future experiments.

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[1] P. Beiersdorfer et al., Phys. Rev. Lett. 80, 3022 (1998).

[2] V.A. Yerokhin et al., Phys. Rev. Lett. 97, 253004 (2006).

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