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# Muonic x-ray spectroscopy on La and Lu: measurement techniques and target preparations

Lanthanum ($Z = 57$) and lutetium ($Z = 71$) serve as ideal candidates to study proton-emission effects. Lutetium proton-emitting isotopes, showing oblate deformations, are positioned near the $N = 82$ shell closure while lanthanum proton-emitting isotopes, which exhibit significant prolate deformation, are located far from any shell closures. Comparing these two cases helps disentangle proton-emission effects from nuclear shape effects. The precision of mean square charge radii extraction for these proton-emitting isotopes from laser spectroscopy can be improved by incorporating experimental benchmarks for mass and field shift parameters. Such benchmarks can be established through absolute charge radii measurements of stable and long-lived lanthanum and lutetium isotopes using muonic x-ray spectroscopy, combined with the King-Plot analysis method. In muonic x-ray spectroscopy, muons are shot on the target material, where they are captured at a high principal quantum number shell forming the muonic atoms. When this captured muon cascades down to the lower shells, it emits x-rays whose energies are studied and interpreted in terms of nuclear properties. One of the several limiting factors of this technique is the requirement of sufficiently large and isotopically pure targets (at least hundreds of milligrams) to effectively stop and capture muons. For certain radioactive elements, for example $^{138}$La, it is impractical to have such large quantities with high purity due to either their availability or radiation safety regulations. To overcome this, the muX collaboration developed an indirect muon capture method, enabling measurements with microgram-scale targets. The purity of the microscopic lanthanum target is enhanced using mass separation techniques. In this poster presentation, the key aspects of muonic x-ray spectroscopy measurements for lanthanum and lutetium will be discussed, including the measurement techniques, the production of microscopic lanthanum and macroscopic lutetium targets, and the preliminary data analysis from the lutetium measurement.

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