Laser spectroscopy studies of short-lived isotopes using ion traps

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Laser spectroscopy methods have a rich history of use at radioactive ion beam laboratories. By probing atomic hyperfine structure and isotope shifts, nuclear-model independent access is provided to nuclear magnetic dipole and quadrupole moments, nuclear spins, and changes in mean-squared charge radii. Typically, these observables are extracted with very high statistical accuracy, and relatively well-controlled systematic uncertainties. In principle, it is possible to extract higher-order electromagnetic moments (magnetic octupole, electric hexadecapole, . . .), and higher-order moments of the radial charge distribution $\delta\langle r^{2k}\rangle$ ($k > 1$). However, current laser spectroscopy techniques used to study radioactive isotopes do not have the required resolution and accuracy to enable extraction of these terms.

In this talk, I will show that these new nuclear observables have already been determined for a handful of stable isotopes using ion trapping techniques. By discussing this (recent!) literature, a clear path towards implementation at radioactive ion beam laboratories will be presented as well. At KU Leuven, we have already constructed a development laboratory with this all in mind; first results will be presented here. This includes the construction of a new ultra-high vacuum Paul trap; demonstration of laser-cooling of 10 keV Sr^+ ion beams; realization of Coulumb crystals of these ions; lifetime measurements of atomic metastable states using single trapped Sr^+ ions; . . . . Plans for implementation at the IGISOL laboratory in the accelerator facility of the University of Jyväskylä will also be discussed.