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Recent highlights and new developments in (fluorescence based) collinear laser spectroscopy at ISOLDE

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Electromagnetic properties of short-lived radionuclides represent sensitive probes for the structural evolution of atomic nuclei far away from stability. Experimentally, these can be accessed, for instance, by laser spectroscopy in which measurements of the atomic hyperfine structure reveal electromagnetic moments and charge radii of nuclear ground states and long-lived isomers.

Due to the high experimental precision and accuracy, these observables represent critical benchmarks for modern nuclear-structure theory. Today, *ab initio* calculations can be extended well into the medium- to heavy-mass region where they connect with nuclear density functional theory.The predictive power of these theoretical methods has recently been benchmarked by collinear laser spectroscopy (CLS) performed on short-lived nickel (Ni) isotopes [2] at the COLLAPS beamline at ISOLDE/CERN. This work establishes a theoretical accuracy of ~1% for the description of nuclear charge radii in the Ni region.

Conventional CLS is based on fluorescence detection from laser-excited ions or atoms. This limits its application to radionuclides with yields of >100-10,000 ions/s, depending on the specific case and spectroscopic transition. Thus, the study of the 'most exotic'nuclides synthesised at today's radioactive ion beam facilities with very low production yields demands for more sensitive experimental methods.
To this end, we have developed the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) [3]. This novel approach exploits a Multi-Reflection Time-of-Fight (MR-ToF) device in which ions bounce back and forth between two electrostatic mirrors. Hence, the trapped ions are probed by the laser beam during each revolution inside the MRToF device compared to a single passage through a laser-ion integration region in conventional CLS. Thus, the MIRACLS approach enhances the sensitivity of CLS by a factor of 30-700.
In addition to the discussion of the Ni results at COLLAPS, this talk will present the MIRACLS
concept as well as recent experimental work on a proof-of-principle experiment which demonstrates the strength of the MIRACLS approach.

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Primary author: MALBRUNOT-ETTENAUER, Stephan (CERN, ISOLDE)

Presenter: MALBRUNOT-ETTENAUER, Stephan (CERN, ISOLDE)

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