MS 6: New Developments I

Time: Tuesday 14:00–15:30 Location: H2

Invited Talk MS 6.1 Tue 14:00 H2

The Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy and its potential for fast and highly selective mass separation — •Stephan Malbrunot — CERN, ISOLDE, Experimental Physics Department, CH-1211 Geneva 23, Switzerland

Collinear laser spectroscopy (CLS) is a powerful tool to access nuclear ground state properties of short-lived radionuclides such as spin, charge radius, and electromagnetic moments. Conventional CLS is based on the detection of fluorescence from laser-excited ions or atoms. It is limited to radioactive ion beams with yields of more than 100 to 10,000 ions/s, depending on the specific case and spectroscopic transition.

To reach radionuclides with lower production yields, we have developed the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) [1,2]. It is based on a Multi Reflection Time of Flight (MR-ToF) device in which ions bounce back and forth between electrostatic mirrors. The trapped ions are probed by the laser during each revolution inside the MR-ToF device which largely enhances the sensitivity of CLS.

As part of MIRACLS, we are developing new cooling schemes as well as an unprecedented 30-keV MR-ToF device. These techniques also open new possibilities for fast and highly selective mass separation beneficial for a wide range of applications. This talk will present the MIRACLS concept and its first experimental highlights.

[1] S. Sels et al., Nucl. Instr. Meth. Phys. Res. B, 463, 310 (2020)
[2] V. Lagagki et al., Nucl. Instr. Meth. Phys. Res. B, in press (2021)

MS 6.2 Tue 14:30 H2

Advancing radiation detected resonance ionization towards heavier elements and more exotic nuclides — •Jessica Warbinek[1,2], Brankica Andelić[1,3], Michael Block[1,2,4], Premaditya Chhetri[1,4], Arno Claessens[5], Rafael Ferrer[5], Francesca Giacoppo[1,4], Oliver T. Kaleja[1,6], EunKang Kim[2], Mustapha Laatiaoui[2], Jeremy Lantis[2], Andrew Mistry[1,7], Danny Münzberg[1,2,4], Steven Nothhelfer[1,2,4], Sebastian Raeder[1,4], Emmanuel Rey-Herme[8], Elisabeth Rickert[1,2,4], Jekabs Romans[5], Elisa Romero-Romero[2], Marine Vandebrouck[8], and Piet Van Duppen[5] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [2]Johannes Gutenberg-Universität, Mainz, Germany — [3]KVI-CART, Groningen, The Netherlands — [4]Helmholtz Institut Mainz, Germany — [5]KU Leuven, IKS, Belgium — [6]Universität Greifswald, Germany — [7]TU Darmstadt, Germany — [8]CEA Saclay, France

RAdiadtion Detected Resonance Ionization Spectroscopy (RADRIS) is a versatile method for highly sensitive laser spectroscopy of the heaviest actinides. Here, most of the nuclides need to be produced at accelerator facilities in fusion-evaporation reactions and are studied immediately after production and separation due to their short lifetimes and low production rates of only a few atoms per second or less. Only recently, the first laser spectroscopic investigation of nobelium (Z=102) was performed by applying the RADRIS technique in a buffer-gas filled stopping cell at the GSI in Darmstadt. To expand this technique for the search of the first atomic levels in the heaviest actinide, lawrencium (Z=103), the sensitivity of this setup needs to be improved. Therefore, a new movable detector design was added increasing the RADRIS efficiency by about 75 %. Further development work was performed to enable the study of longer-lived (>1 h) and shorter-lived nuclides (<1 s) with the RADRIS method.

MS 6.3 Tue 14:45 H2

Development of an apparatus for in gas-jet laser spectroscopy of the heaviest elements — •Danny Münzberg[1,2,3], Michael Block[1,2,3], Arno Claessens[4], Piet Van Duppen[4], Rafael Ferrer[4], Jekabs Roman[4], Sandro Kraemer[4], Jeremy Lantis[3], Mustapha Laatiaoui[3], Steven Nothhelfer[1,2,3], Sebastian Raeder[1,2], Simon Sels[4], and Thomas Walther[5] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [2]Helmholtz-Institut Mainz, DE — [3]Department Chemie, Johannes Gutenberg-Universität, Mainz, DE — [4]Instituut voor Kern- en Stralingsfysica, KU Leuven, Leuven, Belgium — [5]Technische Universität Darmstadt

Laser spectroscopy is a commonly used technique for determining basic nuclear and atomic properties. At GSI-Darmstadt, we focus on studying elements in the heavy actinide region. Due to low production rates in these experiments, high efficiency and sensitivity are necessary. The Radiation Detected Resonance Ionization (RADRIS) technique has been used to study isotopes of Nobelium. However, with this technique the spectral resolution is limited to a few GHz, preventing the determination of nuclear properties from hyperfine spectra. To overcome this problem, an in-gas-jet-spectroscopy apparatus is being developed. It combines features of the RADRIS and the in-gas-jet technique to minimize typical broadening mechanisms and improving the spectral resolution by about an order of magnitude. Laser induced fluorescence measurements on Yb and Dy samples have been performed to compare different hypersonic nozzles with respect to the obtained gas-jet conditions for high resolution laser spectroscopy. Recent results will be discussed and an update on the status of the gas jet apparatus will be given.

MS 6.4 Tue 15:00 H2

Conceptual design of an actinide ion mobility spectrometer — •Elisabeth Rickert[1,2,3], Hartmut Backe[3], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Mustapha Laatiaoui[1,3], Werner Lauth[3], Sebastian Raeder[2], and Philipp Sikora[3] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]Johannes Gutenberg-Universität Mainz, Mainz, Germany

Chemical and physical properties of the heaviest elements are strongly influenced by relativistic effects which can result in deviations from the periodicity predicted by the periodic table of elements. Systematic mobility measurements on monoatomic lanthanide ions previously proved a dependence of ion-atom interactions on the underlying electronic configuration, providing a way to measure these deviations [Laatiaoui2012]. Mobility studies are presently being extended to the actinides which are expected to have more pronounced deviations from periodicity. In our experiment, element-selective ion production is provided by two-step photo ionization from a filament sample in an argon filled drift cage. In my talk, experimental approach, first results and future plans are presented.

[Laatiaoui2012]: Laatiaoui, M. et al., EPJD (2012) 66:232

MS 6.5 Tue 15:15 H2

Design of an isotope separator for target production — •Dominik Studer[1], Rugard Dressler[2], Ulli Köster[3], Dorothea Schumann[2], and Klaus Wendt[1] — [1]JGU Mainz — [2]PSI Villigen — [3]ILL Grenoble

With the rising demand for isotopically pure targets for the study of specific nuclear reactions, the construction of a high-throughput isotope separator is foreseen within the SANDA project. Specifically the handling and purification of radioisotopes is mandatory and will be enabled by installation of the whole setup within a radioactivity monitoring area in close contact to a hot lab. In the current project phase the design of the apparatus and establishment of a suitable facility, located at PSI, is planned. The design will be derived from experiences with the RISIKO isotope separator at Mainz University, which has been successfully used for radioisotope purification and implantation, e.g. within the ECHo project. It features a hot-cavity laser ion source. The laser system is based upon tunable pulsed Ti:sapphire lasers with high repetition-rate. Ion extraction from the source region with about 30 kV, electrostatic beam focussing and separation with a conventional double focussing sector field magnet seem most suitable for the task. After passing the separation slit, the ion beam can be re-focused to well below mm size for implantation into detectors, collectors or targets with sub mm control and resolution. In this contribution we present the principles, capabilities and limitations of the RISIKO separator using experimental and simulation data. Improvements which can be implemented in the new SANDA isotope separator are discussed.