MS 1: Resonance Ionization Spectroscopy / Mass Spectrometry

Time: Monday 11:30–13:00 Location: N 6

Invited Talk MS 1.1 Mon 11:30 N 6

Ion sources and mass separators for on-line radioactive ion beam facilities — •Jens Lassen — TRIUMF - Canada's particle accelerator laboratory, Vancouver BC, Canada — Simon Fraser Univerisity, Burnaby BC, Canada

Isotope separator on-line facilities using the ISOL method produce intense radioactive ion beams by spallation, fragmentation and fission of nuclei in target materials irradiated by high energy ion beams or gamma radiation. This produces a spectrum of isotopes to be ionized and separated to provide ion beams with intensity, purity and energy that satisfy user experiments. The isobaric contamination of nuclei produced is similar to that encountered in elemental ultra-trace analysis appplications. The low production rate and decay loss encountered for isotopes with sub second half live adds another dimension to this analytical problem. User facilities such as TRIUMF's advanced rare isotope laboratory employ the best suited combination of isotope production target, ion-source, mass-separator, and as required charge breeder and post accelerators. The combined capabilities and features of our radioactive ion beam user facillity will be presented, with reference laser ion source, high throughput mass- and isobar- separator, charge breeder and post-accelerators, and cooler-buncher.

Offering: intense radiactive ion beams Seeking: high impact physics experiments / users / scientists & students

MS 1.2 Mon 12:00 N 6

Thermal Neutron-Induced Cross-Sections of ^{254}Es and ^{255}Es — •Melanie P. Feucht[1], Thomas E. Albrecht[2], Sebastian Berndt[1], Christoph E. Düllmann[1,3,4], Julie G. Ezold[5], Raphael Hasse[1], Ulli Köster[6], Andrea T. Loria Basto[1,4], Christoph Mokry[1,4], Kristian Myhre[5], Thorben Niemeyer[1], Sebastian Raeder[3,4], Dennis Renisch[1,4], Jörg Runke[1,3], Samantha K. Schrell[5], and Klaus Wendt[1] — [1]JGU Mainz, Germany — [2]CSM Golden, CO, USA — [3]GSI Darmstadt, Germany — [4]HIM Mainz, Germany — [5]ORNL Oak Ridge, TN, USA — [6]ILL Grenoble, France

Knowledge of neutron-induced cross-sections is essential for predicting the production of heavy isotopes via neutron capture. Previous studies show that the experimentally observed yield of ^{255}Es produced from ^{254}Es in nuclear reactors deviates significantly from theoretical expectations. We have studied the burnup (which is the sum of the neutron capture (n,γ) and the neutron induced fission (n,f)-processes) of ^{254}Es and ^{255}Es. For this we investigated the transmutation of ^{254}Es to ^{255}Es by irradiations at different neutron fluence in order to deduce the relevant cross-sections. The study made use of ^{254}Es samples irradiated at the high-flux reactor at ILL. The isotopic composition of all samples was characterized before and after irradiation, and the ^{254}Es/^{255}Es ratios were determined using alpha spectrometry and resonance ionization mass spectrometry. The results provide an enhanced and more precise basis for predicting the yields of the heaviest reactor-producible elements, einsteinium and fermium.

MS 1.3 Mon 12:15 N 6

High-resolution resonance ionisation spectroscopy on a sequence of americium isotopes 241-243Am — •Pia Breinbauer[1], Sebastian Berndt[1], Christoph E. Düllmann[1,2,3], Raphael Hasse[1], Ulli Köster[4], Andrea T. Loria Basto[1,2], Christoph Mokry[1,2], Sebastian Raeder[3], Jörg Runke[1,3], Matou Stemmler[1], and Klaus Wendt[1] — [1]JGU Mainz — [2]HIM Mainz — [3]GSI Darmstadt — [4]ILL Grenoble

High-resolution laser spectroscopy measurements were performed on the americium isotopes ^{241}Am and ^{243}Am, as well as the long-lived isomer ^{242m}Am, at the RISIKO mass separator of Johannes Gutenberg University Mainz. ^{242m}Am had been produced by a high fluence neutron irradiation of a ^{241}Am target at the ILL high flux reactor. The measurements were performed using two-step resonance ionisation spectroscopy (RIS) in two well established excitation schemes. Previous ^{241}Am and ^{243}Am data serve as a reference for the analysis of ^{242m}Am.

The spectra were analysed using the SATLAS package to yield hyperfine parameters A and B, as well as centers of gravity for both transitions. These results provide quantitative estimates of the magnetic dipole and electric quadrupole moments of the isomer ^{242m}Am, complementing the parameters of the isotopes ^{241}Am and ^{243}Am.

MS 1.4 Mon 12:30 N 6

In-gas-jet Resonance Ionization Laser Spectroscopy with JetRIS — •Julian Hindermann for the JetRIS Collaboration-Collaboration — GSI, Darmstadt, Germany — HIM, Mainz, Germany — JGU Mainz, Germany

Nuclear shell effects stabilize nuclei beyond $Z > 103$ against spontaneous fission. With increasing Z, also the electron shells are modified due to relativistic effects, QED effects and electron correlations. Probing atomic spectra with laser spectroscopy can reveal atomic information from energy, position and lifetime of an electronic state. Furthermore, it enables the determination of isotope shifts and hyperfine splittings to infer nuclear properties.

The heaviest nuclides are produced in limited quantities, requiring efficient tools for their studies. Within our collaboration, **R**esonance **I**onization Laser **S**pectroscopy (RIS) is employed providing high selectivity and high sensitivity. Here, a tunable laser probes electronic transitions in the investigated atom. A second laser then ionizes the excited atom. The resulting laser ions are detected - leading to a resonance profile when the laser is tuned around the transition frequency. In the JetRIS setup, RIS is performed in a low-density and low-temperature supersonic gas jet. This enables higher spectral resolution measurements, as Doppler and pressure broadening are significantly reduced compared to in-gas cell methods.

This talk will discuss the status of the apparatus and address the long-discussed configuration of the 8^- K-isomer of ^{254m}No that was recently determined using the JetRIS setup.

MS 1.5 Mon 12:45 N 6

Ionization efficiency measurements of actinides using Ti:Sa Lasers at RISIKO — •Raphael Hasse[1,2,3], Felix Berg[1], Sebastian Berndt[1], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Sebastian Raeder[2,3], Tobias Reich[1], and Klaus Wendt[1] — [1]Johannes Gutenberg-Universität, Mainz — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Helmholtz-Institut, Mainz

Resonance ionization mass spectrometry (RIMS) is the combination of element selective resonant laser excitation and ionization with subsequent mass separation which is a powerful technique for laser spectroscopy and ultra-trace analysis particularly for the actinides. For quantitative measurements towards reliable determination of elemental ratios the precise characterization of the ionization schemes used is essential. In this context, the laser ionization efficiencies of the environmentally relevant actinides Pu, Np and Cm are discussed, which were determined at the RISIKO mass separator at the Johannes Gutenberg University Mainz. With efficiencies well above 10 %, the range of elements with high ionization efficiencies is extended to include the actinides. In combination with the saturation behavior of each individual excitation step we gain important information on the ionization schemes. And additionally different ionization schemes in Pu are compared with respect to the overall efficiencies of different three-step schemes with the favored selective two-step scheme.