MS 5: Präzisionsmassenspektrometrie und Anwendungen I

Time: Wednesday 14:00–16:00 Location: F 428

Invited Talk MS 5.1 We 14:00 F 428

Progress in Mass Spectrometry of Exotic Nuclei at the FRS-ESR Facility at GSI — •Wolfgang Plass — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — Justus-Liebig-Universität Gießen

Storage ring mass spectrometry at the FRS-ESR facility at GSI offers unique capabilities for the research with exotic nuclei. Schottky Mass Spectrometry (SMS) allows for broadband mass measurements with mass accuracies on the level of 0.2 ppm, whereas Isochronous Mass Spectrometry (IMS) gives access to nuclei with lifetimes as short as a few tens of microseconds. Both methods are sensitive to single ions and can be used to investigate the decay and the lifetime of exotic nuclei.

Using SMS, mass measurements of uranium projectile fragments in the element range Pt to U have been performed. Five isotopes and six isomers have been observed for the first time, the masses of 35 nuclides have been measured for the first time, and the proton-neutron interaction strength at the doubly magic shell closure of lead has been determined. Methodical improvements have enabled a first broadband IMS experiment on uranium fission fragments, addressing nuclei in the vicinity of the r process path. The 4.6 MeV isomeric state in ^{133}Sb has been measured directly for the first time, whose neutral-atom lifetime is 17 μs only.

For storage ring mass spectrometry at the international accelerator facility FAIR a detection system for IMS is being developed, which offers significantly improved accuracy, detection efficiency and rate capability compared to the system available at GSI currently.

Invited Talk MS 5.2 We 14:30 F 428

Mass measurements on neutron-rich fission products and actinoids at Triga-Trap — •J. Ketelaer[1], T. Beyer[2,3], M. Block[4], K. Eberhardt[1], M. Eibach[1,3], F. Herfurth[4], Sz. Nagy[2,4], C. Smorra[1,3], W. Nörtershäuser[1,4], and K. Blaum[2,3] — [1]Johannes Gutenberg-Universität, 55128 Mainz — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Ruprecht-Karls-Universität, 69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt

The double Penning trap mass spectrometer Triga-Trap has been installed at the research reactor Triga Mainz to perform high-precision mass measurements on neutron-rich fission products and actinoids. Masses of these nuclides are important for nuclear structure studies of heavy elements, tests of mass models, and nucleosynthesis calculations of the astrophysical r-process. Ions of many stable isotopes as well as carbon clusters for calibration purposes can be produced by a non-resonant laser ablation ion source, allowing off-line mass measurements independently from the research reactor. Besides the physics program, Triga-Trap serves as a test bench for the development of new ion detection techniques, which will enable mass measurements on single stored singly-charged ions with a half-life in the order of one second. To this end, a unique combination of the commonly used destructive time-of-flight technique and the non-destructive image current detection method is employed here in an on-line mass spectrometer for short-lived nuclides. First time-of-flight mass measurements on rare earth elements and actinoids will be reported.

MS 5.3 We 15:00 F 428

Setup of a separator magnet and an RFQ-buncher for the TRIGA-SPEC experiment — •T Beyer[1,2], M Block[5], K Eberhardt[3], M Eibach[1,3], F Herfurth[5], J Ketelaer[4], K Knuth[4], D Lunney[6], Sz Nagy[2,5], W Nörtershäuser[3,5], C Smorra[1,3], and K Blaum[1,2] — [1]Physikalisches Institut, Universität Heidelberg, 69120 Heidelberg — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Institut für Kernchemie, Universität Mainz, 55128 Mainz — [4]Institut für Physik, Universität Mainz, 55128 Mainz — [5]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [6]CSNSM, Université de Paris Sud, 91495 Orsay, France

Precise experimental data of the ground-state properties of heavy nuclides are required to test the predictive power of nuclear mass models and to support nucleosythesis calculations of the astrophysical r-process. The TRIGA-TRAP mass spectrometer and the TRIGA-LASER laser spectroscopy setup, forming the TRIGA-SPEC experiment, were recently installed at the research reactor TRIGA Mainz in order to perform high-precision measurements of the ground state properties of short-lived neutron-rich radionuclides. The radionuclides are produced by thermal neutron-induced fission in an actinoide target inside the reactor, extracted by a gas-jet system, and ionized by an ECR ion source. The ions of interest will then be mass-separated in a 90° dipole magnet. An RFQ buncher is being installed to accumulate, cool and bunch the ion beam. The status of the implementation of the dipole magnet and the RFQ buncher will be presented.

MS 5.4 We 15:15 F 428

Status of the ^{3}H/^{3}He mass ratio measurement — •Christoph Diehl[1], Jochen Ketter[1], Martin Höcker[1], David B. Pinegar[1], Sebastian Streubel[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

A precise determination of the ^{3}H/^{3}He mass ratio, and hence of the tritium Q-value, is of relevance for the determination of the electron antineutrino mass by the Karlsruhe Tritium Neutrino Experiment (KATRIN). In our double Penning trap mass spectrometer we aim to measure the mass ratio of ^{3}H to its β-decay product ^{3}He with an precision of 10^{-11} and below. The spectrometer, originally built at the University of Washington, is setup now in a new laboratory in Heidelberg, and first test measurements have been performed. Tests have focused on $^{12}C^{4+}$ because it has the same mass-to-charge ratio as ^{3}H and ^{3}He. The new axial frequency lock loop performed well and first cyclotron resonances have been recorded with the new traps. Work continues towards the elimination of contaminations and the isolation of single ions.

MS 5.5 We 15:30 F 428

Ion Transport in the ^{3}H/^{3}He Penning trap mass spectrometry experiment — •Martin Höcker[1], Christoph Diehl[1], Jochen Ketter[1], David B. Pinegar[1], Sebastian Streubel[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

The ^{3}H/^{3}He mass spectrometry experiment features two hyperbolical Penning traps and an external ion source in order to measure the Q-value of the ^{3}H to ^{3}He beta decay. The setup is designed to allow fast switching between ^{3}H and ^{3}He ions. This will enable us to decrease the dead time between cyclotron frequency measurements on the different ion species, which will in turn decrease the influence of magnetic field drift and other time dependent perturbations on the measured Q-value. This talk will focus on the challenges of single ion transport in a precision trap with high impedance electrodes.

MS 5.6 We 15:45 F 428

PENTATRAP: A high-precision Penning trap mass spectrometer for highly-charged ions — •Christian Roux[1,2], Christine Böhm[1,2], Jose Crespo Lopez-Urrutia[1], Sergey Eliseev[1], Yuri Novikov[5], David Pinegar[1], Wolfgang Quint[2,4], Julia Repp[1,2], Andreas Rosa[1,2], Sven Sturm[3], Stefan Ulmer[1,2,3], and Klaus Blaum[1,2] — [1]Max-Planck Institut für Kernphysik, D-69117 Heidelberg — [2]Ruprecht-Karls-Universität Heidelberg, D-69120 Heidelberg — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz — [4]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — [5]St. Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia

A novel cryogenic Penning trap setup called PENTATRAP is presently under construction at the Max-Planck-Institut für Kernphysik, Heidelberg. The project aims for high-precision mass measurements on single highly-charged and stable ions related to e.g. tests of non-perturbative QED in strong electric fields as well as neutrino oriented mass determinations. In order to achieve the needed accuracy of $\delta m/m = 10^{-11}$, non-destructive cryogenic detection methods will be used at a stack of five Penning traps. Thereby, two traps will be used for real time monitoring of the magnetic field whereas the relative mass measurements will be performed in the central three traps. The apparatus is planned to be coupled to the EBIT at MPI-K and later to the HITRAP facility at GSI Darmstadt. The design studies of the project as well as the present status of the experimental setup will be presented.