MS 1: Precision Mass Spectrometry and Fundamental Applications I

Time: Monday 11:00–12:30 Location: F 442

Invited Talk MS 1.1 Mon 11:00 F 442

Reducing nuclear physics uncertainties in r-process models using high-precision mass measurements of highly charged, neutron-rich Rb and Sr ions — •Vanessa V. Simon — TRIUMF, 4004 Wesbrook Mall, V6T2A3, Vancouver, Canada

High-precision atomic mass measurements are vital for the description of nuclear structure, investigations of nuclear astrophysical processes, and tests of fundamental symmetries. The neutron-rich $A \approx 100$ region presents challenges for modeling the astrophysical r-process because of sudden nuclear shape transitions. We report on high-precision masses of short-lived neutron-rich ^{94,97,98}Rb and $^{94,97-99}$Sr isotopes using the TITAN Penning-trap mass spectrometer at TRIUMF. The isotopes were charge-bred to $q = 15+$ and uncertainties of less than 4 keV were achieved. Results deviate by up to 11σ compared to earlier measurements and extend the region of nuclear deformation observed in the $A \approx 100$ region. A parameterized r-process model network calculation shows that mass uncertainties for the elemental abundances in this region are now negligible.

To increase the overall efficiency and precision of the mass measurement of highly charged ions, the novel trap CPET is introduced for the purpose of cooling highly charged ions sympathetically using either electrons or protons. The status of the setup and commissioning experiments are presented.

MS 1.2 Mon 11:30 F 442

Extraction of neutron-rich fission products from a nuclear reactor for ground state studies: commissioning of the online-coupling at TRIGA-SPEC — •T. Beyer[1,2], K. Blaum[1,2], M. Block[4], K. Eberhardt[3,6], M. Eibach[2,3], Ch.E. Düllmann[3,4,6], F. Herfurth[4], D. Lunney[5], Sz. Nagy[1,4], W. Nörtershäuser[3,4], D. Renisch[3], and Ch. Smorra[1,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Physikalisches Institut, Universität Heidelberg — [3]Institut für Kernchemie, Universität Mainz — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [5]CSNSM, Université de Paris Sud, Orsay, France — [6]Helmholtz Institut Mainz

The mass spectrometer TRIGA-TRAP and the laser spectroscopy TRIGA-LASER setup, forming the TRIGA-SPEC experiment, are 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. Such measurements allow testing the predictive power of nuclear mass models and support astrophysical nucleosynthesis calculations. The extraction of these nuclei for both experiment branches is achieved by using an aerosol-based gas-jet system to transport fission products from an actinide target located inside the reactor to an external high-temperature surface ion source. TRIGA-SPEC will shortly go online, already having recorded a cyclotron resonance of an ion produced in the source. The commissioning of the online-coupling involving a separator magnet, a radiofrequency quadrupole cooler/buncher, and a pulsed drift tube will be presented.

MS 1.3 Mon 11:45 F 442

Status of THe-Trap — •Sebastian Streubel[1], Tommi Eronen[1], Martin Höcker[1], Jochen Ketter[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-Trap (short for Tritium-^{3}He Trap) is a Penning-trap setup dedicated to measure the ^{3}H to ^{3}He mass-ratio with a relative uncertainty of better than 10^{-11}. The ratio is of relevance for the KArlsruhe TRItium Neutrino experiment (KATRIN), which aims to measure the electron anti-neutrino mass, by measuring the shape of the β-decay energy spectrum close to its endpoint. An independent measurement of the ^{3}H to ^{3}He mass-ratio pins down this endpoint, and thus will help to determine the systematics of KATRIN.

The trap setup consists of two Penning-traps: One trap for precision measurements, the other trap for ion storage. Ideally, the trap content will be periodically switched, which reduces the time between the measurements of the two ions' motional frequencies.

In 2012, a mass ratio measurement of $^{12}C^{4+}$ to $^{14}N^{5+}$ was performed to characterize systematic effects of the traps. This measurement yielded a accuracy of 10^{-9}. Further investigations revealed that a major reason for the modest accuracy is the large axial amplitude of $\approx 100\,\mu$m, compared to a ideal case of $3\,\mu$m at 4 K. In addition, relative magnetic fluctuations at a 3×10^{-10} level on a 10 h timescale need to be significantly improved. In this contribution, the aforementioned findings and further systematic studies will be presented.

MS 1.4 Mon 12:00 F 442

Investigation of the work function fluctuations for high precision experiments — •Christian Schmidt[1], Martin Babutzka[2], Matt Bahr[3], Marcus Beck[1], Werner Heil[1], Benjamin Monreal[3], Ernst-Wilhelm Otten[1], Klaus Schlösser[2], Kerstin Schönung[2], and Alexander Wunderle[1] — [1]Institut für Physik, Mainz — [2]Institut für Experimentelle Kernphysik, Karlsruhe — [3]Department of Physics, Santa Barbara, California

High precision experiments at low energies are an important branch for the investigation of atomic properties. Examples are experiments using Penning traps for mass measurements or g-factor measurements, experiments using a gravitational balance to search for short range interactions, and experiments utilizing MAC-E filters.

The knowledge of the electrical potentials and potential differences inside these experiments is a crucial factor to achieve the best results. However, the potentials are directly influenced by the work function of the electrodes, which can show fluctuations of several hundred meV .

For the low energy, precision experiments aSPECT and KATRIN we commissioned and studied a scanning Kelvin probe system to investigate the work function fluctuations of different gold surfaces on different substrates. Since the Kelvin probe is a relative method, also photoelectron spectroscopy was performed additionally to obtain information on the absolute work functions. The work functions of the surfaces were also tested on their stability in time, and on a standard vacuum cleaning procedure and a bake out. This talk will present the results of the measurements.

MS 1.5 Mon 12:15 F 442

The high-precision Penning trap mass spectrometer PENTATRAP — •Andreas Dörr[1,2], Hendrik Bekker[1,2], Klaus Blaum[1,2], Christine Böhm[1,2,3], José Crespo López-Urrutia[1], Sergey Eliseev[1], Mikhail Goncharov[1,2], Christian Hökel-Schmöger[1,2], Yuri Novikov[4], Julia Repp[1], Christian Roux[1], Sven Sturm[1], and Stefan Ulmer[1,5] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Fakultät für Physik und Astronomie, Ruprecht-Karls-Universität, Heidelberg, Germany — [3]Extreme Matter Institute EMMI, Helmholtz Gemeinschaft, Darmstadt, Germany — [4]Petersburg Nuclear Physics Institute, Gatchina, Russia — [5]RIKEN Advanced Science Institute, Hirosawa, Wako, Saitama, Japan

Currently, the high-precision Penning trap mass spectrometer PENTATRAP is being built up at the Max-Planck-Institut für Kernphysik, Heidelberg, Germany. It aims at mass-ratio measurements of medium- to high-Z elements with uncertainties of a few parts in 10^{12}. Mass-ratios will be determined by the measurement of cyclotron frequency-ratios in the strong magnetic field of the trap. The experiment will host five identical cylindrical Penning traps and will allow for simultaneous cyclotron frequency determinations in all measurement traps. It will feature access to highly charged ions provided by EBITs. Measurements at PENTATRAP will contribute to various fields of physics. For example, input parameters for neutrino mass determinations will be provided with measurements of Q-values of relevant β-transitions. The current status of the experiment will be outlined in the talk.