MS 2: Multi-Reflection Time-of-Flight Spectrometers

Time: Wednesday 11:00–12:15 Location: F128

MS 2.1 Wed 11:00 F128

Disentangling poly-cationic fullerenes with multi-reflection time-of-flight MS — •Paul Fischer and Lutz Schweikhard — Institut für Physik, Universität Greifswald, 17487 Greifswald, Germany

Large carbon-cluster cations of size-to-charge ratios $n/z \approx 40$ to ≈ 600 are observed after laser ablation of a glassy carbon target without additional aggregation gas. Their size distribution is well described by a log-normal function, implying an underlying coalescent growth mechanic. Resolving isotopologues via multi-reflection time-of-flight mass spectrometry (MR-ToF MS) confirms the clusters to be fullerenes as well as the presence of doubly- and triply-charged species. Comparing size- and charge-state-resolved abundances with results from a statistical simulation suggests charge aggregation through ion-ion collisions during the coalescent fusion processes. This is contrary to the assumption that poly-cations are formed primarily by subsequent photoionization under these conditions.

MS 2.2 Wed 11:15 F128

A setup for the study of clusters from a magnetron sputter source by MR-ToF mass spectrometry — •Paul Florian Giesel, Paul Fischer, and Lutz Schweikhard — Institut für Physik, Universität Greifswald, 17487 Greifswald, Germany

The Greifswald multi-reflection time-of-flight (MR-ToF) mass-spectrometer experiment investigates the properties of atomic clusters. So far, a pulsed laser-ablation source has been used to produce cluster ions with sizes up to about ten atoms from a solid target without the use of aggregation gas. The setup has now been expanded by a magnetron sputter source capable of producing considerably larger clusters. In order to incorporate this new source, a linear Paul trap has been installed to accumulate and bunch the continuous ion beam for injection into the MR-ToF analyzer. First measurements to characterize the new components as well as the system's capability to handle large clusters with masses up to 40,000 u have been performed.

MS 2.3 Wed 11:30 F128

Ion beam purification with the PUMA multi-reflection time-of-flight mass spectrometer — •Moritz Schlaich[1], Alexandre Obertelli[1], Frank Wienholtz[1], and Clara Klink[1,2] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Deutschland — [2]CERN, Genf, Schweiz

Using low-energy antiprotons provided by the Extra Low Energy Antiproton ring (ELENA) at CERN, the antiProton Unstable Matter Annihilation (PUMA) experiment aims to probe the isospin composition in the density tail of radioactive nuclei. For this purpose, PUMA intends to trap one billion antiprotons at ELENA in a portable Penning trap and transport them to the Isotope mass Separator On-Line DEvice (ISOLDE) at CERN. By analyzing the annihilation reactions of antiprotons with radioactive nuclei, the experiment plans to study neutron skin formation of neutron-rich nuclei and halo nuclei.

Reference measurements and the investigation of the neutron skin evolution along isotopic chains of stable nuclei (e.g. Ca, Sn or Xe) preceding the application to radioactive nuclei require a versatile offline ion source setup. In addition to a linear Paul trap used for ion cooling and accumulation, it includes a multi-reflection time-of-flight mass spectrometer (MR-ToF MS) for ion beam purification. By using electrostatic fields only, the MR-ToF MS can prolong the ion flight path by up to three orders of magnitude. This allows ion ejection with a mass resolving power up to 10^5, thus separating only the mass-over-charge value of interest. The talk will provide an overview of the experimental setup as well as first results of ion beam purification experiments.

MS 2.4 Wed 11:45 F128

A laser ablation carbon cluster ion source for the MR-TOF-MS of the FRS Ion Catcher — •Jiajun Yu[1,3], Christine Hornung[1,2], Timo Dickel[1,2], Zhuang Ge[1], Hans Geissel[1,2], Gabriella Kripko-Koncz[2], Meetika Narang[2], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], and FRS Ion Catcher Collaboration[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Justus-Liebig-Universität Gießen, Gießen — [3]Jinan University, Guangzhou, China

A laser ablation carbon cluster ion source (LACCI) has been built and commissioned. It is capable of providing closely-spaced calibrant ions in the mass range up to ∼300 u for highly accurate mass measurements of exotic nuclei (δm/m $\sim 10^{-8}$) and systematic studies of the mass uncertainties with the MR-TOF-MS of the FRS Ion Catcher at GSI Darmstadt, Germany. The LACCI contains newly developed advanced techniques, including a special ion optics design and a 2D movable target table to ensure stable long-term (weeks) operation, a laser-spot/target monitoring system, and a dedicated re-capture unit, which will be reported. A study of the laser energy, repetition rates and long-term measurements, has been carried out with carbon targets (Sigradur, Fullerene) and metallic targets (Ag, W, Au, Cu, Pt). The commissioning results of LACCI coupled via a radio frequency switchyard to merge ions from different sides and transport them through a quadrupole mass filter into an MR-TOF-MS will be reported in this contribution.

MS 2.5 Wed 12:00 F128

Mass measurements of neutron-rich nuclides at the N=126 shell with the FRS Ion Catcher — •Kriti Mahajan[1], Daler Amanbayev[1], Alison Bruce[3], Timo Dickel[1,2], Tuomas Grahn[4], Gabriella Kripko-Koncz[1], Ali Akbar Mehmandoost-Khajeh-Dad[5], Stephane Pietri[2], Wolfgang Plass[1,2], and Christoph Scheidenberger[1,2] — [1]JLU Gießen — [2]GSI Darmstadt — [3]University of Brighton, UK — [4]University of Jyvaskyla, Finland — [5]University of Sistan and Baluchestan, Zahedan, Iran

At GSI, experiments with exotic nuclides can be performed, including direct mass measurements. For such mass measurements, the nuclei can be produced at relativistic velocities by projectile fragmentation, separated, range-focused and slowed down in the fragment separator FRS and precise mass measurements are done with the FRS Ion Catcher. The beam from the FRS is injected into the cryogenic stopping cell (CSC), thermalized and transmitted to the multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). The MR-TOF-MS features a high resolving power of up to 1,000,000, short cycle times of a few ten milliseconds, and mass accuracies down to a few 1E-8.

Mass measurements were performed in the region "south" of the doubly magic nucleus ^{208}Pb close to the N=126 line, which is of key importance for the study of nuclear structure and nuclear astrophysics and can help us to better understand the r-process, in particular the third abundance peak. The preliminary results of these mass measurements will be presented along with comparisons with different mass models, including the first mass measurements of ^{204}Au and ^{205}Au.