MS 2: Ionenfallen- und FT-IZR-MS, Moleküle, Cluster, Zerfälle und Reaktionen

Zeit: Montag 16:30–18:45 Raum: 3E

Hauptvortrag MS 2.1 Mo 16:30 3E

Penning Trap Mass Spectrometry in North America — •Jens Dilling — TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3, Canada

Penning Traps (PT) are among the most versatile tools used in atomic physics, and the Noble prize in physics was given for its development and application in 1989. PTs have been adapted to physics applications in many different ways and the most precise atomic mass measurements are nowadays done using PT. The talk will give an overview of the status and recent developments in Penning trap mass spectrometry in North America, both for stable and unstable atoms. A particular emphasis is given to the TITAN (Triumf's Ion Trap for Atomic and Nuclear science) facility at the ISAC accelerator complex at TRIUMF, Vancouver, Canada. Recent mass measurements from TITAN on exotic helium and lithium isotopes will be presented.

MS 2.2 Mo 17:00 3E

TRIGA-TRAP: A Penning trap setup for mass measurements on exotic and heavy nuclides — •Jens Ketelaer[1], Klaus Blaum[1,2], Klaus Eberhardt[3], Georg Eitel[1], Sebastian George[1], Rafael Ferrer[1], Frank Herfurth[2], Szilard Nagy[1], W. Nörtershäuser[2,3], Julia Repp[1], Christian Smorra[1], and Christine Weber[4] — [1]Department of Physics, D-55099, University of Mainz — [2]GSI, D-64291 Darmstadt — [3]Department of Nuclear Chemistry, D-55099, University of Mainz — [4]Department of Physics, FI-40014, University of Jyväskylä

The research reactor Triga Mainz offers unique possibilities for on-line mass measurements on neutron-rich isotopes as produced by fisson of U-235, Pu-239 or Cf-249 targets. In addition, off-line measurements of actinide elements up to Cf-252 are planned. To this end a new Penning trap mass spectrometer will be installed at Triga Mainz, featuring not only the commonly used time-of-flight resonance technique, but also the non-destructive narrow-band image current technique, enabling the detection of a single singly-charged ion stored in the trap. Triga-Trap is the first on-line mass spectrometer for singly-charged heavy ions using this image current detection technique in combination with cryogenic Penning traps. In case of many heavy and superheavy nuclides, the production rates are often less than a few ions per second, but some isotopes exhibit comparably long half-lives in the order of seconds, which allows for repeated measurement cycles on the same trap content. Measurements with the newly developed narrow-band FT-ICR system at Triga-Trap will also serve as tests for future experiments at Shiptrap at Gsi or Mats at Fair.

MS 2.3 Mo 17:15 3E

Aufbau eines breitbandigen Spiegelstromnachweises für Präzisionsmassenmessungen — •Julia Repp[1], Klaus Blaum[1,2], Klaus Eberhardt[3], Georg Eitel[1], Rafael Ferrer[1], Sebastian George[1,2], Jens Ketelaer[1], Szilard Nagy[1], Christian Smorra[1] und S. Ulmer[1] — [1]Institut für Physik, Universität Mainz, 55099 Mainz, Germany — [2]GSI, 64291 Darmstadt, Germany — [3]Institut für Kernchemie, Universität Mainz, 55099 Mainz, Germany

Der breitbandige FT-IZR Nachweis des von gespeicherten Ionen in einer Penningfalle induzierten Spiegelstromes wird schon seit längerer Zeit erfolgreich zur Massenbestimmung in der Chemie angewendet. Er soll nun in einem Doppel-Penningfallen-Massenspektrometer für Präzisionsmassenmessungen an schweren und superschweren Nukliden dazu dienen, die von der Ionenquelle gelieferten Spezies in einer Präparationsfalle zu identifizieren. Das Ionensignal, induziert durch alle Ionen verschiedener Spezies, die die Falle erreichen, wird an den Fallenelektroden abgegriffen und entsprechend verstärkt. Eine Verstärkung des im oberen nV-Bereich liegenden Signals stellt besondere Anforderungen an die nachfolgenden Verstärkerstufen. So soll die Eingangsimpedanz des an die Falle angeschlossenen Verstärkers an die Falle angepasst sein. Zudem ist ein geringes Eingangsrauschen des Verstärkers notwendig, um eine präzise Identifizierung des Signals bei der weiteren Datenauswertung zu gewährleisten. In diesem Vortrag werden Verstärkungs- und Rauschdaten vorgestellt, die an verschiedenen kommerziell erhältlichen Verstärkern gemessen wurden. Ihre Anwendbarkeit für die breitbandige FT-IZR Detektion wird diskutiert.

MS 2.4 Mo 17:30 3E

MLLTRAP: Penning trap facility for high precision mass measurements — •Veli Kolhinen[1], Michael Bussmann[1], Dietrich Habs[1], Jürgen Neumayr[1], Ulrich Schramm[2], Christian Schürmann[1], Michael Sewtz[1], Jerzy Szerypo[1], and Peter Thirolf[1] — [1]Department für Physik, Ludwig-Maximilians-Universität München, Am Coulombwall 1,85748 Garching, Germany — [2]Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany

The MLLTRAP at the Maier-Leibnitz-Laboratory (Garching) will be a new Penning trap facility designed to combine several novel technologies to decelerate, charge breed, cool, bunch and purify the reaction products and perform high-accuracy nuclear and atomic mass measurements.

The double Penning trap is now in its commissioning phase at the Maier-Leibnitz-Laboratory in Garching. In the first phase we have set up the system off-line and test it with stable Cs ions. The beam has been shot through the trap system and pulsing of the walls has successfully been tested.

This contribution will present the status of the project including results from the commissioning phase and technical details as well as future plans.

MS 2.5 Mo 17:45 3E

Development of a FT-ICR detection system for KATRIN — •Marta U. Diaz[1], Klaus Blaum[1,2], Jochen Bonn[1], and Aleksandra Gotsova[3] — [1]Institute of Physics, D-55099, University of Mainz — [2]GSI, D-64291 Darmstadt — [3]Forschungszentrum Karlsruhe, D-76344, Eggenstein-Leopoldshafen

The KATRIN experiment, at Forschungszentrum Karlsruhe, is a next generation tritium β-decay experiment, designed to measure the mass of the electron neutrino directly with a sensitivity of 0.2 eV. It uses a Windowless Gaseous Tritium Source (WGTS) to determine the neutrino mass from the $T_2 \longrightarrow \left({}^3HeT\right)^+ + e^- + \bar{\nu}_e$ decay. The e^- are guided by a strong magnetic field into the spectrometer where they get analysed. Tritium is removed from the system by differential pumping and cryogenic trapping. $({}^3HeT)^+$ will dissociate and form clusters $(T_{2n+1})^+$. The β-decay endpoint of these clusters differs from the endpoint of the T_2 decay. The knowledge of the concentration of each cluster species is therefore essential to evaluate the β-spectrum. To measure these concentrations a Fourier-Transformation-Ion-Cyclotron-Resonance (FT-ICR) system is installed in the differential pumping system. The FT-ICR system, a cylindrical Penning trap setup with $\approx$ 75 mm diameter, is being developed at Johannes Gutenberg-Universität Mainz. The system to control the ion density consists of a first FT-ICR trap, an electric dipole, an electric potential barrier to block the ions, and a second FT-ICR trap. The layout of the setup and first results will be presented.

MS 2.6 Mo 18:00 3E

SIMION simulations of ion trajectories in a novel Quadrupole Mass Filter / ICR cell with an unusual geometry — •Basem Kanawati[1,2] and Karl-Peter Wanczek[1] — [1]Institute of Physical and Inorganic Chemistry, University of Bremen, FB 2, Leobener Str., NW 2, D- 28334 Bremen, Germany — [2]GSF, Institut of Ecological Chemistry , Ingolstädter Landstraße 1 , D-85764 Neuherberg , Germany

An open cylindrical design has been investigated for trapping ions under the influence of a combined DC/RF electric field with presence and absence of a strong magnetic field. The simulated ion trajectories indicate the possibility of this design to confine ions in the 3D region inside the trap for further processing events, such as radial ion excitation and axial ion ejection. Therefore, the device can be useful for both ICR and quadrupole ion trap techniques. The new design has a specific geometry with concentric ring electrodes of different diameters. The cell is axially segmented into five different ring electrodes. This establishes three effective stability regions inside the detection region for trapping and detecting both ion polarities simultaneously under ICR conditions. 3D analysis of electric potential distribution inside this new design gives explanation for some interesting and unusual ion behaviour discerned in this trap.

Reference: Characterisation of a New Open Cylindrical ICR Cell for Ion-Ion Collision Studies. B. Kanawati, K. P. Wanczek, Int. J. Mass Spectrom. (2007),DOI:10.1016/j.ijms.2007.09.007

MS 2.7 Mo 18:15 3E

Photoionization and Fragmentation of Closo-Carboranes — •Norman Frank Riehs[1], Hans-Werner Jochims[1], Ertugrul Serdaroglu[1], Peter A. Dowben[2], and Eckart Rühl[1] — [1]Physikalische und Theoretische Chemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin — [2]Department of Physics and Astronomy, University of Nebraska-Lincoln, NE 68588-0111, U.S.A.

Photoionization and photon-induced fragmentation of isomeric icosahedral closo-carboranes by monochromatic synchrotron radiation is reported. Vacuum ultraviolet radiation from the 3 m NIM-I beam line at the storage ring BESSY (Berlin) was used for the experiments. This allows us to measure ionization thresholds and fragmentation patterns at various photon energies. In spite of complexities that result because of the natural isotope abundance of boron and photon-induced loss of hydrogen, the distinct mass spectrometry fragmentation patterns have been partially identified. At low photoionization energies, we find that the loss of atomic hydrogen corresponds to even numbers of hydrogen atoms. Distinct differences between the isomers of closo-dicarbadodecaborane (orthocarborane (1,2-$C_2B_{10}H_{12}$), metacarborane (1,7-$C_2B_{10}H_{12}$), paracarborane (1,12-$C_2B_{10}H_{12}$) are observed indicating that the loss of pairs of hydrogen depends on the carbon placement within the carborane cage. Furthermore, fragmentation of the cage into singly charged fragments of variable mass is observed along with stable doubly charged intact carborane cages. These results are discussed along with plausible fragmentation mechanisms.

MS 2.8 Mo 18:30 3E

A novel Penning trap mass spectrometer for fundamental studies — •Sebastian George[1,2], Frank Herfurth[2], Jens Ketelaer[1], Szilard Nagy[1], Wolfgang Quint[2], and Klaus Blaum[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]GSI, 64291 Darmstadt, Germany

A novel five-Penning trap system designed for high-precision mass measurements on highly-charged stable and radioactive nuclides is currently planned and under construction at the University of Mainz in collaboration with GSI Darmstadt. High-precision mass values are required in many fields of physics and the required uncertainty ranges from 10^{-7} in nuclear physics down to below 10^{-11} in metrology and for the determination of fundamental constants. To this end we develop a new five-trap mass spectrometer with single-ion-sensitivity. It is a combination of one precision trap for the actual mass measurement, two preparation traps for ion storage and cooling, and two monitoring traps for a continuous B-field observation. It will be dedicated to highly-charged isotopes delivered first by the EBIT at the Max-Planck-Institut of Heidelberg and later after full commissioning by the HITRAP facility at GSI. The setup of the trap itself is finished and will be presented together with the present status of the project.