MS 8: Poster

Time: Wednesday 16:00–18:30 Location: Empore Lichthof

MS 8.1 Wed 16:00 Empore Lichthof

Nuclear structure studies of neutron-rich heavy nuclei by mass measurements of francium and radium isotopes — •M. Rosenbusch[1], D. Atanasov[2], D. Beck[3], K. Blaum[2], Ch. Böhm[2], Ch. Borgmann[2], M. Breitenfeldt[4], R. B. Cakirli[2,5], T. E. Cocolios[6], S. Eliseev[2], S. George[1], F. Herfurth[3], A. Herlert[7], M. Kowalska[8], S. Kreim[2,8], Y. Litvinov[3], D. Lunney[9], V. Manea[9], E. Minaya Ramirez[3,10], S. Naimi[11], D. Neidherr[2,3], S. Schwarz[12], L. Schweikhard[1], J. Stanja[13], F. Wienholtz[1], R. Wolf[1], and K. Zuber[13] — [1]Ernst-Moritz-Arndt-Universität, Institut für Physik, 17487 Greifswald — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [4]Katholieke Universiteit, 3000 Leuven, Belgium — [5]University of Istanbul, 334452 Istanbul, Turkey — [6]University of Manchester, M13 9PL Manchester, United Kingdom — [7]FAIR GmbH, 64291 Darmstadt — [8]CERN, CH-1211 Geneva, Switzerland — [9]CSNSM-IN2P3-CNRS, Université Paris-Sud, 91406 Orsay, France — [10]Helmholtz-Institut Mainz, 55099 Mainz — [11]RIKEN, Saitama 351-0198, Japan — [12]NSCL, Michigan State University, 48824-1321 East Lansing, USA — [13]Technische Universität Dresden, 01069 Dresden

The mass is a unique property of an atomic nucleus reflecting its binding energy and thus the sum of all interactions at work. Precise measurements of nuclear masses especially of short-lived exotic nuclides provide important input for nuclear structure, nuclear astrophysics, tests of the Standard Model, and weak interaction studies. The Penning-trap mass spectrometer ISOLTRAP at the on-line isotope separator ISOLDE/CERN has been set up for precision mass measurements and continuously improved for accessing more exotic nuclides. The mass uncertainty is typically $\delta m/m = 10^{-8}$ and the accessible half-life has been reduced to about 50 ms. In this contribution, the results of a measurement campaign of neutron-rich francium and radium isotopes will be presented, i.e. the masses of the isotopic chain of $^{224-233}$Fr and ^{233,234}Ra, one of the most neutron-rich ensemble obtainable at ISOL facilities. The mass ^{234}Ra denotes the heaviest mass ever measured with ISOLTRAP. Experimental data in the neutron-rich, heavy mass region is of great interest for studies of structural evolution far from stability, especially because the knowledge from nuclear mass models is scarce. The impact of the new data on the physics in this mass region as well as recent technical developments of ISOLTRAP will be discussed.

MS 8.2 Wed 16:00 Empore Lichthof

The Preparation Penning Trap for the project TRAPSENSOR — •Juan Manuel Cornejo, Juan Pablo Fernández, Antonio Lorenzo, and Daniel Rodríguez — Universidad de Granada 18071, Granada, Spain

Penning traps allow performing mass measurements with very high accuracy and very high sensitivity [1]. However the techniques in use, i.e. the time-of-flight and the induced-image-current technique cannot provide still mass measurements on some specific nuclei like for instance superheavy elements: produced in fusion evaporation reactions at accelerators nor even the level of accuracy required on medium and heavy mass isotopes to contribute to neutrino mass spectrometry. In order to overcome this problem, a new device called Quantum Sensor is under development at the University of Granada (Spain) [2]. Masses will be determined using a laser-cooled ion as sensor instead of electronic detection. In this contribution, the device will be presented showing the status of the project addressing specially the preparation Penning trap built up to delivered cooled samples for the proposed mass measurements

[1] K. Blaum, Phys. Rep. 425, 1-78 (2006)
[2] D. Rodríguez, Appl. Phys. B: Lasers O. 107, 1031-1042 (2012)

MS 8.3 Wed 16:00 Empore Lichthof

Störungstheoretische Betrachtung zylindersymmetrischer magnetischer und elektrischer Feldfehler einer Penningfalle — •Jochen Ketter, Tommi Eronen, Martin Höcker, Sebastian Streubel und Klaus Blaum — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Eine ideale Penningfalle besteht aus einem homogenen Magnetfeld und einem elektrostatischen Quadrupolpotential. Zylindersymmetrische Abweichungen davon werden durch die Koeffizienten B_n beziehungsweise C_n beschrieben. Während in der idealen Penningfalle die drei charakteristischen Eigenfrequenzen des gespeicherten Teilchens bis auf die relativistische Massenzunahme unabhängig von den Bewegungsamplituden sind, wird diese für Präzisionsmessungen extrem nützliche Eigenschaft von der Inhomogenität des Magnetfeldes und der Anharmonizität des elektrostatischen Potentials außer Kraft gesetzt. Die bislang umfassendste theoretische Behandlung der anharmonischen Frequenzverschiebungen durch B_2, B_4 sowie C_4, C_6, C_8 erfolgte von Thompson und Rainville [1] am MIT-ICR-Massenspektrometer. Ausgehend von einem ähnlichen Ansatz, der auf der Betrachtung säkularer Störungsterme beruht, leiten wir in erster Ordnung des Störungsparameters B_n oder C_n eine geschlossene Formel für dessen Einfluss auf die Bewegungsfrequenzen in Abhängigkeit der Bewegungsamplituden her. Dieses Verständnis spielt eine wichtige Rolle bei der Abschätzung von Systematiken am Penningfallenexperiment THe-Trap [2].

[1] S. Rainville, Thesis (Ph. D.)–MIT, Dept. of Physics, 2003.
[2] C. Diehl *et al.*, Hyperfine Interactions (2011) 199:291–300

MS 8.4 Wed 16:00 Empore Lichthof

Status of the low-energy electron cooler for the Cryogenic Storage Ring in Heidelberg — •Stephen Vogel[1], Claude Krantz[1], Andrey Shornikov[2], Klaus Blaum[1], and Andreas Wolf[1] — [1]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [2]CERN, Genève, Switzerland

The Cryogenic Storage Ring (CSR) is under construction at the Max Planck Institute for Nuclear Physics in Heidelberg. It will feature a low-energy electron cooler, which will allow cooling of beams with a charge-to-mass ratio q/m of 1 to 1/160 e/amu. This corresponds to a cooling energy range of 1 to 163 eV. The two different operation modes of CSR, cryogenic at 10 K and room temperature, impose high requirements on the design of the cooler. The electron source is a GaAs photocathode which has been used at the Test Storage Ring (TSR). The electron cooler will improve the storage time and emittance of beams significantly. In addition electron-ion collisions with electron energies up to 1 keV (lab frame) will be possible to perform electron-ion collison experiments with a wide range of atomic and molecular species. The design and status of the CSR electron cooler will be presented.

MS 8.5 Wed 16:00 Empore Lichthof

Direct mass measurements of neutron-deficient ^{152}Sm projectile fragments at FRS-ESR facility — •X.L. Yan[1,2,3,4], Yu.A. Litvinov[3,1], K. Blaum[4], F. Bosch[3], C. Brandau[3], L. Chen[5], H. Geissel[3,5], R. Knöbel[3,5], C. Kozhuharov[3], J. Kurcewicz[3], S.A. Litvinov[3,5], G. Münzenberg[3], C. Nociforo[3], F. Nolden[3], W.R. Plass[3,5], M.S. Sanjari[3,6], C. Scheidenberger[3,5], M. Steck[3], B. Sun[7], X.L. Tu[1], H. Weick[3], N. Winckler[3,4], M. Winkler[3], H.S. Xu[1], Y.H. Zhang[1], and X.H. Zhou[1] — [1]Institute of Modern Physics, Chinese Academy of Sciences, China — [2]University of Chinese Academy of Sciences, China — [3]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [4]Max Planck Institute for Nuclear Physics, Germany — [5]Justus-Liebig Universität Gießen, Germany — [6]Goethe-Universität Frankfurt, Germany — [7]Beihang University, China

Direct mass measurement was performed on neutron-deficient ^{152}Sm projectile fragments at the FRS-ESR facility at GSI, employing the time-resolved Schottky Mass Spectrometry method. Exotic nuclei were produced via fragmentation of relativistic ^{152}Sm projectiles in a thick beryllium target. The reaction products were separated in-flight with the fragment separator FRS, and injected into the storage-cooler ring ESR. 311 different nuclides were identified by means of their revolution frequency spectra. Masses for 14 nuclides (^{116,118}Ba, ^{122,123}La, ^{124,125}Ce, ^{123,127}Pr, ^{129}Nd, ^{130,132}Pm, ^{134}Sm, ^{137}Eu, ^{138}Gd) have been determined for the first time. The new masses allow us to uncover a part of the previously unknown mass surface and will be used to constrain nuclear mass models. The data analysis is in progress.

MS 8.6 Wed 16:00 Empore Lichthof

Detector Systems for Beam Diagnostics and Neutral Molecular Fragment Imaging at the Cryogenic Storage Ring — •Arno Becker[1], Klaus Blaum[1], Manfred Grieser[1], Robert von Hahn[1], Claude Krantz[1], Oldřich Novotný[2], Kaija Spruck[3], Xavier Urbain[4], Stephen Vogel[1], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Columbia Astrophysics

Laboratory, New York, USA — [3]Institut für Atom- und Molekülphysik, Giessen — [4]Université catholique de Louvain, Louvain-la-Neuve, Belgium

The electrostatic Cryogenic Storage Ring (CSR), currently under construction at the Max Planck Institute for Nuclear Physics in Heidelberg, will enable long time storage of slow molecular ions with energies up to 300 keV and low blackbody radiation corresponding to the ∼10 K temperature of the storage ring enclosure. Under these conditions polyatomic ions up to high masses can be prepared in or near the rovibrational ground state. Their fragmentation can be studied by fast-beam coincidence fragment momentum imaging.

For direct beam diagnostics as well as for imaging of neutral fragments from dissociative recombination reactions MCP-based detector systems with phosphor screens are being developed. The requirements of the CSR regarding the huge temperature range from operation at ∼10 K to bakeout at ∼520 K as well as an extremly high vacuum of better then 10^{-13} mbar place strong demands on the design. The technical details for the installation of these cryogenic detection systems in the CSR will be presented.

MS 8.7 Wed 16:00 Empore Lichthof

Untersuchung einer Magnetronsputterquelle zur Erzeugung von atomaren Metallclustern — •Stefan Knauer, Gerrit Marx, Robert Wolf und Lutz Schweikhard — Institut für Physik, Universität Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald

Eine wesentliche Grundlage für die Untersuchungen an atomaren Clustern ist deren größen- und ladungsselektive Erzeugung mit Hilfe von Ionenfallen. In Greifswald wurde dazu eine Paufallen-Flugzeitmassenspektrometer-Apparatur zur Charakterisierung einer Magnetronsputterquelle [1] aufgebaut und in Betrieb genommen. In der linearen Paulfalle werden atomare Cluster gespeichert und nach ihrem Masse-zu-Ladungsverhältnis selektiert. Für einen einfachen Betrieb bei variablen Frequenzen im Bereich 10-300 kHz wird die Paulfalle mit einem Rechtecksignal-Führungsfeld betrieben. Mit dem beschriebenen Aufbau wurde die Größenverteilung von Clustern aus einer Magnetronsputterquelle untersucht. In ersten Experimenten wurden Silbercluster (Ag_2 (m=216 u) bis Ag_{1000} (m=108000u)) akkumuliert, mittels Puffergas gekühlt und massenselektiert. Das Clusterpaket wurde anschließend mittels Flugzeitmassenspektroskopie untersucht. In einem nächsten Schritt soll die Magnetronsputterquelle Metallcluster für Laserwechselwirkungsexperimente bereitstellen. Die Charakterisierung der Magnetronquelle wird vorgestellt.

[1] H. Haberland *et al.* Z. Phys. D, 20 (1991) 413.

MS 8.8 Wed 16:00 Empore Lichthof

Untersuchung von massenselektierten Clusteranionen mittels Laseranregung und Photoelektronenspektroskopie — •Madlen Müller[1], Gerrit Marx[1], Patrice Oelssner[2], Josef Tiggesbäumker[2], Robert Wolf[1], Karl-Heinz Meiwes-Broer[2] und Lutz Schweikhard[1] — [1]Ernst-Moritz-Arndt-Universität Greifswald, Deutschland — [2]Universität Rostock, Deutschland

Die Clusterphysik ist als Bindeglied zwischen der Molekül- und Festkörperphysik ein bedeutendes Forschungsgebiet. Einblicke in die elektronische Struktur der Cluster eröffnen Photonenwechselwirkungsexperimente. Im SFB652 (TP A3) sollen mehrfach negativ geladene Metallcluster [1] als Modellsysteme für elektronische Korrelationsphänomene mittels Photoelektronenspektroskopie untersucht werden. Die Flugzeit der Photoelektronen bietet Aufschluss über die Elektronenaffinität der Cluster [2]. Weiterhin kann die Coulomb-Barriere von mehrfach negativ geladenen Clustern durch Variation der Photonenenergie abgetastet werden. Die Selektion und Akkumulation einer bestimmten Clustergröße wird mit Hilfe einer Paulfalle realisiert. Vorgestellt werden Testmessungen an Fullerenmonoanionen mit Nanosekunden-Laserpulsen im UV-Bereich. Bei den geplanten Messungen an mehrfach negativ geladenen Systemen werden Metallcluster in einer Hochfrequenzfalle auf die höheren Ladungszustände gebracht werden [3].

[1] A. Herlert et al., New J. Phys. **14**, 055015 (2012)
[2] L.-S.Wang et al., J. Phys. Chem. A **104**, 1978 (2000)
[3] siehe Vortrag S. Bandelow (MS)

MS 8.9 Wed 16:00 Empore Lichthof

Commissioning of Traptor, PIPE — •Karolin Mertens[1], Ricarda Laarsch[1], Alexander Guda[2], Stephan Klumpp[1], and Michael Martins[1] — [1]Institzut für Experimentalphysik, Universität Hamburg — [2]Southern Federal University, Rostov-on-Don, Russia

The radio frequency ion trap Traptor for PIPE (Photo-Ion-Spectrometer at PETRA III) is designed to store metal clusters (and molecules) from one atom up to a number of atoms in the cluster (or molecule) with a total weight of the system of 30.000amu in maximum. Usually the production of system with such many constituents is quite difficult and the yield is very low. Thus, one of the major goals of Traptor is to improve the density of these dilute targets with higher masses to be able to perform absorption spectroscopy measurements. As PIPE is build up at the soft x-ray beamline P04 at PETRA III, DESY, photons between 250eV and 3000eV can be used for inner shell excitations e.g. of many of the transition metals. Further, using a gas mixture, not only He as buffer gas, one is able to prepare chemical reactants with the trapped clusters to examine them using either mass spectroscopy with an installed Wiley-McLaren time-of-flight ion spectrometer (iTOF) and/or absorption spectroscopy using the synchrotron radiation for fragment excitation or structural determination. Design and commissioning results of the iTOF and the operation of the trap will be shown.

MS 8.10 Wed 16:00 Empore Lichthof

Kontrolle der Linienbreite in hochrepetierenden Ti:Sa-Laserresonatoren mittels Zwei-Etalon-Design — •Tobias Kron[1], Ralf Erik Rossel[1], Volker Sonnenschein[2], Sebastian Rothe[3], Klaus Wendt[1] und Sebastian Raeder[4] — [1]Institut für Physik, Universität Mainz, Deutschland — [2]Institute of Physics, University of Jyväskylä, Finnland — [3]CERN, Genf, Schweiz — [4]TRIUMF, Vancouver, Kanada

Mit der Resonanzionisationsspektroskopie lassen sich optische Dipolübergänge im gesamten Energiebereich der atomaren Elektronenhülle sehr präzise vermessen. Dabei werden grundlegende Parameter des jeweiligen Atoms zugänglich, wie etwa das Ionisationspotenzial, die Lage und Sequenz von angeregten Zuständen, sowie bei ausreichender Auflösung auch die jeweilige Hyperfeinstruktur oder Verschiebungen aufgrund externer Felder oder der Isotopie.

Limitierende Faktoren werden durch Verbreiterungen aufgrund der experimentellen Bedingungen und der Linienbreite der zur Anregung verwendeten abstimmbaren Laser vorgegeben. Die Laserlinienbreite von hochrepetierenden Titan:Saphir-Lasersystemen, welche weltweit neben Farbstofflasersystemen zum Standard an on-line-Laserionenquellen zur selektiven Erzeugung von Radionukliden zählen, kann deutlich verkleinert werden. Eine Reduktion in den Bereich von einigen hundert MHz ist hier mit Hilfe einer Kombination von resonatorinternen Etalons möglich. Diskutiert werden dazu der theoretische Hintergrund, die Realisierung, sowie die Modifikationen des bisher eingesetzten Resonatordesigns.

MS 8.11 Wed 16:00 Empore Lichthof

Commissioning and Characterization of an Atmospheric Pressure Interface and Ion Trap System for a Mobile High-Resolution MR-TOF Mass Spectrometer — •Wayne Lippert[1], Timo Dickel[1,2], Hans Geissel[1,2], Johannes Lang[1], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], and Mikhail Yavor[3] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]RAS, St. Petersburg

A mobile multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) combines the advantages of high mass resolving power and high mass accuracy with the possibility of in-situ mass measurement applications in the field. For example, it is an excellent tool for real-time tissue recognition in electrosurgery and identification of mycotoxins. Such a mobile MR-TOF-MS has been developed and a mass resolving power in excess of 100.000 has been demonstrated.

To enable the coupling of various types of ion sources to the mass spectrometer, an atmospheric pressure interface (API) has been designed and commissioned. The API is connected to an RFQ ion trap system consisting of a mass filter, ion cooler and ion trap. The ion trap system ensures the highly efficient transport of the ions from the ion source to the mass analyzer and provides cooled ions for the bunched extraction into the mass analyzer. A characterization and first measurement results of the MR-TOF-MS utilizing the new ion trap system in combination with the API will be presented.

MS 8.12 Wed 16:00 Empore Lichthof

Experimental setup of a time-of-flight mass spectrometer for reaction product detection in heterogeneous catalysis — •Andreas Winbauer, Martin Tschurl, Josef Kiermaier, Ulrich Boesl, and Ulrich Heiz — Chemistry Department, Technical University of Munich, Germany

Mass spectrometry is a very powerful analytical tool for the study of

heterogeneous catalysis. It is often used to study reaction processes by analyzing the reaction products, both in a qualitative and in a quantitative way. Typically, mass spectrometers work by using electron impact ionization, where discrimination between isomers is difficult to achieve. Fragmentation patterns of the isomers must differ to a large extent to be distinguishable. A powerful and soft method for selective ionization is REMPI (Resonant Enhanced Multiphoton Ionization). In this technique a laser of specific wavelength is employed to ionize a single isomer through resonant intermediate states. Other isomers are not ionized as they are non resonant at the energy used. A new experimental setup was built for the study of catalytic reactions on metal clusters supported on single crystal surfaces under UHV conditions. Custom ion optics were designed to incorporate the crystal support and enable future desorption-ionization studies and enantioselective laser mass spectrometry. In this work we present our experimental setup, in which we combine time of flight mass spectrometry and resonance enhanced multiphoton ionization for investigation of products formed via surface reactions. It will thus be possible to examine the selectivity of catalytic reactions on size selected clusters.

MS 8.13 Wed 16:00 Empore Lichthof

Simulation, Design and Measurements of an RF Carpet for the Cryogenic Stopping Cell for the the Super-FRS — •Samuel Ayet San Andrés[1], Timo Dickel[1,2], Peter Dendooven[3], Hans Geissel[1,2], Wolfgang R. Plass[1,2], Sivaji Purushothaman[1], Pascal Reiter[2], Christoph Scheidenberger[1,2], Frans Schreuder[3], and Daniel Schäfer[2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [2]Justus-Liebig-Universität Giessen — [3]Kernfysisch Versneller Instituut (KVI)

In order to provide radioactive ions almost at rest from a high energy beam to different precision experiments, the ions need to be stopped and thermalized. This can be achieved using a cryogenic gas-filled stopping cell where the ions are slowed down to almost at rest and extracted. A RFQ beam line can be used to transmit the extracted ions to a multiple-reflection time-of-flight mass spectrometer.

To extract the stopped ions from the stopping cell we generate with the RF Carpet RF fields to repel the ions and don't let them impinge on the RF Carpet and DC fields in order to focus the ions towards the extraction hole. Also the gas flow through the exit hole will pull the ions along the extraction hole. Simulations were made to determine the operation frequency of the system needed to extract the ions of the desired mass. The electronics of the RF Carpet were designed for the desired operation frequency, trying to dissipate as less heat as possible. In this poster, simulations of ion motion in the stopping cell, the electronic design of the RF Carpet and firsts measurements will be presented.

MS 8.14 Wed 16:00 Empore Lichthof

First operation of the Bern AMS MICADAS — •Sönke Szidat[1], Gary Salazar[1], Edith Vogel[1], Michael Battaglia[1], Lukas Wacker[2], and Hans-Arno Synal[2] — [1]Universität Bern, Departement für Chemie und Biochemie & Oeschger-Zentrum für Klima- und Klimafolgenforschung, Bern, Schweiz — [2]ETH Zürich, Labor für Ionenstrahlphysik, Zürich, Schweiz

The University of Bern has a long history of experience in precise 14C measurements based on the conventional counting laboratory founded more than 50 years ago. Due to the demanding preparation and measurement procedures, the throughput and required carbon mass of this technique both are the limiting factors. Therefore, the University of Bern decided to update the facility aiming at a new 14C laboratory equipped with an accelerator mass spectrometer (AMS) MICADAS. The focus of this laboratory is twofold. On the one hand, the access to routine 14C analysis for climate research and other disciplines will be improved on site. On the other hand, new hyphenated analytical systems shall be developed for online separation and 14C detection of specific fractions or individual compounds. The MICADAS became operational in November 2012. In this work, instruments, laboratory equipment, measures of quality assurance and first results will be presented.