MS 7: Präzisionsmassenspektrometrie und Anwendungen II

Time: Thursday 10:30–12:30 Location: F 428

Group Report MS 7.1 Th 10:30 F 428

Fortschritte bei WITCH — •Marcus Beck[1], Peter Friedag[1], Jonas Mader[1], Christian Weinheimer[1], Martin Breitenfeld[2], Sam Coeck[2], Nathal Severijns[2], Emil Traykov[2], Michael Tandecki[2], Simon van Gorp[2], Frederick Wauters[2], Alexander Herlert[3], Fredrik Wenander[3], Dalibor Zákoucký[4] und Valentin Yu. Kozlov[5] — [1]Westfälische Wilhelms-Universität Münster — [2]K.U.Leuven, Belgien — [3]CERN, Schweiz — [4]NPI Rez/Prag, Tschechien — [5]KIT, Karlsruhe

Das WITCH Experiment misst das Rückstoßspektrum der Tochterionen nach Kern-Betazerfall unter Verwendung von Penningfallen als Quelle und eines Retardierungsspektrometers zur Energieanalyse. Aus dem Rückstoßspektrum soll die Beta-Neutrino Winkelkorrelation mit hoher Genauigkeit (< 0.5%) bestimmt werden. Ziel ist dabei die Suche nach exotischen Wechselwirkungen jenseits des Standardmodelles.

In 2008 und 2009 wurden zahlreiche Verbesserungen am experimentellen Aufbau vorgenommen, die Ende 2009 mit einer Strahlzeit mit ^{35}Ar erfolgreich getestet wurden. Sowohl das Problem der starken Entladungen im Spektrometer wie auch der des Ladungsaustauschs in den Penningfallen wurden gelöst und die Kühlung in und Transfer zwischen den Penningfallen verbessert. Es wurden Rückstoßionen aus dem Zerfall des ^{35}Ar mit niedriger Statistik gemessen und verschiedenen systematische Effekte untersucht. Der Status des Experimentes und erste Ergebnisse der Messung werden dargestellt.

Dieses Projekt wird vom BMBF unter der Nummer 06MS270 unterstützt.

MS 7.2 Th 11:00 F 428

Massenmessungen zur Untersuchung der Kernstruktur von Kr und Ag an Isoltrap — •Ch. Borgmann[1], G. Audi[2], D. Beck[3], K. Blaum[1], Ch. Böhm[1], M. Breitenfeldt[4], D. Fink[1], S. George[1], F. Herfurth[3], A. Herlert[5], M. Kowalska[5], S. Kreim[1], D. Lunney[2], S. Naimi[2], D. Neidherr[6], M. Rosenbusch[4], S. Schwarz[7] und L. Schweikhard[4] — [1]Mpi für Kernphysik, Heidelberg — [2]Csnsm, Orsay, Frankreich — [3]Gsi, Darmstadt — [4]Universität Greifswald — [5]Cern, Genf, Schweiz — [6]Universität Mainz — [7]Nscl Msu, East Lansing, Usa

Mit dem Penningfallen-Massenspektrometer Isoltrap am Isotopen-Separator Isolde (Cern) können die Massen von kurzlebigen Radionukliden mit relativen Genauigkeiten von 10^{-8} gemessen werden.

2009 wurden unter anderem die Massen und damit die Kernbindungsenergien von ^{96,97}Kr und $^{122-124}$Ag bestimmt. Ziel dieser Messungen war die Untersuchungen der Kernstruktur, außerdem ermöglichen sie Tests der Genauigkeit von Massenmodellen. Durch die neuen Massenwerte für neutronenreiche Silbernuklide wurden zuvor beobachtete Auffälligkeiten in den Zweineutronenseparationsenergien der Silber–Isotopenkette korrigiert. Ihr Verhalten entspricht nun wie erwartet dem für sphärische Kerne. Die erstmals gemessenen Krypton–Massen liefern einen wichtigen Beitrag in der Diskussion um den plötzlichen Wechsel von sphärischen zu deformierten Kernen in der Region um $A = 100$.

Im Rahmen dieses Beitrags werden die oben erwähnten Messungen vorgestellt.

MS 7.3 Th 11:15 F 428

A new route for neutrino mass determination using the electron capture of ^{194}Hg — Dietrich Beck[1], Klaus Blaum[2,3], •Christine Böhm[2,3], Martin Breitenfeldt[4], Sergey Eliseev[2], Valentin Fedoseev[5], Sebastian George[2], Frank Herfurth[1], Alexander Herlert[5], Magdalena Kowalska[5], David Lunney[6], Sarah Naimi[6], Dennis Neidherr[7], Yuri Novikov[8], Stefan Schwarz[9], Lutz Schweikhard[4], Maxim Seliverstov[5], and Kai Zuber[10] — [1]GSI, Darmstadt — [2]MPI für Kernphysik, Heidelberg — [3]Ruprecht-Karls-Universität, Heidelberg — [4]Ernst-Moritz-Arndt-Universität, Greifswald — [5]CERN, Genève — [6]Université de Paris Sud, Orsay — [7]Johannes Gutenberg-Universität, Mainz — [8]PNPI, Gatchina, St. Petersburg — [9]NSCL, MSU, East Lansing, Michigan — [10]Technische Universität, Dresden

The electron neutrino mass is of highest importance for many fields of physics. To measure the neutrino mass, beta-decay spectra are typically used. Here an alternative way to determine the neutrino mass, using an electron capture in ^{194}Hg will be presented. Direct mass measurements of ^{194}Hg and its daughter nucleus ^{194}Au were performed at the high-precision Penning trap mass spectrometer ISOLTRAP at the ISOLDE facility (CERN). The Q_{EC}-value obtained by the mass difference of these nuclei leads to the conclusion that the K-capture is forbidden, thus an L-capture is assumed. For further investigations a measurement using a cryogenic micro-calorimeter is suggested. From this, a de-excitation spectrum is obtained which can be compared to the Q_{EC}-value in order to determine the neutrino mass.

MS 7.4 Th 11:30 F 428

First direct Penning trap mass measurements on nobelium and lawrencium — •Michael Dworschak[1], Michael Block[1], Dieter Ackermann[1], Klaus Blaum[2], Christian Droese[3], Sergey Eliseev[2], Timo Fleckenstein[4], Emma Haettner[4], Frank Herfurth[1], Fritz-Peter Hessberger[1], Sigurd Hofmann[1], Jens Ketelaer[5], Jochen Ketter[5], Heinz-Jürgen Kluge[1], Gerrit Marx[3], Marco Mazzocco[6], Dmitriy Nesterenko[7], Yuri Novikov[1,7], Wolfgang Plass[1,4], Andrey Popeko[8], Saidur Rahaman[9], Daniel Rodríguez[10], Christoph Scheidenberger[1,4], Lutz Schweikhard[3], Peter Thirolf[11], Gleb Vorobyev[1], and Christine Weber[9] — [1]GSI Helmholtzzentrum, Darmstadt — [2]MPI für Kernphysik, Heidelberg — [3]Universität Greifswald — [4]Universität Gießen — [5]Universität Mainz — [6]INFN Sezione, Padova — [7]PNPI RAS, Gatchina — [8]JINR, Dubna — [9]University of Jyväskylä — [10]Universidad de Granada — [11]LMU, München

The mass measurements of the three nobelium isotopes $^{252-254}$No and the lawrencium isotope ^{255}Lr measured with the Penning trap mass spectrometer SHIPTRAP/GSI have been evaluated. These were the first direct mass measurements of transfermium elements ever performed. The results mark the first step in the exploration of masses of even heavier nuclides which is planned at SHIPTRAP. The main objective is to measure the endpoints of α-decay chains starting from superheavy nuclei in the region of the predicted island of stability. The SHIPTRAP results were compared with previous measurements based on α-decay chains and new literature values were obtained.

MS 7.5 Th 11:45 F 428

A Gas-Jet ECR Ion Source at TRIGA-SPEC — •Christian Smorra[1,2], Thomas Beyer[2,3], Klaus Blaum[2,3], Michael Block[4], Martin Eibach[1,2], Klaus Eberhardt[1], Frank Herfurth[4], Jens Ketelaer[5], Konstantin Knuth[5], Szilard Nagy[3,4], and Wilfried Nörtershäuser[1,4] — [1]Institut für Kernchemie, Johannes Gutenberg-Universität, Fritz-Strassmann-Weg 2, 55128 Mainz — [2]Physikalisches Institut, Ruprecht Karls-Universität, Philosophenweg 12, 69120 Heidelberg — [3]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstrasse 1, 64291 Darmstadt — [5]Institut für Physik, Johannes Gutenberg-Universität, Staudingerweg 7, 55128 Mainz

The TRIGA-SPEC experiment has been installed recently at the research reactor TRIGA Mainz. Ground state properties like masses, charge radii, spins, and moments of short-lived nuclides can be determined with very-high precision using the Penning trap mass spectrometer TRIGA-TRAP, and the collinear laser spectroscopy setup TRIGA-LASER. Short-lived neutron-rich radionuclides in the mass range $80 < A < 140$ are produced by thermal neutron induced fission of e.g. U-235, Pu-239 or Cf-249, respectively. For the extraction and ionization of the fission products a gas-jet system is coupled to a 2.45-GHz ECR ion source for the production of singly charged ions. The gas-jet has been tested on-line and fission products have been extracted. First off-line tests of the ion source have been performed successfully with argon gas. The results of the commissioning test of the ion source and the on-line coupling of the experiments will be presented.

MS 7.6 Th 12:00 F 428

MR-TOF-MS: A Time-of-Flight-Based System with sub-ppm Mass Measurement Accuracy and Large Isobar Separation Ion Capacity (> 10^6 ions/s) — •Timo Dickel[1], Wolfgang R. Plass[1,2], Arno Becker[1], Ulrich Czok[1], Hans Geissel[1,2], Emma Haettner[1,2], Christian Jesch[1], Wadim Kinsel[1,2], Martin Petrick[1], Christoph Scheidenberger[1,2], and Mikhail I. Yavor[3] — [1]Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]Inst. for Analytical Instrum., Russian Academy of Sci., St. Petersburg, Russia

At low-energy radioactive ion beam facilities, mass measurements and spectroscopy for a broad range of nuclei can be performed. For these experiments, the nuclei have to be stopped, cooled, separated and measured as fast and efficiently as possible. A multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) has been developed that will be essential for these experiments. It is a multi-purpose, non-scanning mass spectrometer with single-ion sensitivity. The MR-TOF-MS has been tested at the tandem accelerator of the Maier-Leibnitz-Laboratory Garching (Germany). Systematic studies on the mass resolving power (>300.000), transmission efficiency (∼70%), separation power and dynamic range of the MR-TOF-MS will be presented. Mass measurements of an isobaric triplet indicate that the systematic errors of the device are as low as 10^{-7}.

MS 7.7 Th 12:15 F 428

The ion circus — •Enrique Minaya Ramirez[1] and David Lunney[2] — [1]GSI Helmholtzzentrum, Darmstadt, Germany — [2]CSNSM- IN2P3/CNRS, Université de Paris-Sud, Orsay, France

The ability to prepare radioactive beams for experiments in nuclear structure has seen important developments in recent years. The use of ion traps and buffer-gas cooling now enables the accumulation and purification of even short-lived nuclides. This is a key point for future installations since higher intensity also brings increased isobaric contamination which can be disastrous for background. Until now, the development of beam cooler/bunchers has relied on linear (radiofrequency quadrupole) Paul traps. In this contribution we describe the progress in developing a novel circular Paul trap. The ion circus, so named for its ability to trap ions at different positions along the ring circumference and to eject them in either perpendicular or tangential direction, has also been designed to cool and mass separate the ions over a longer flight path. The resolving power is increased as the ions orbit in the ring and are cooled with buffer gas at a much lower pressure. The first prototype is now under test in Orsay. We report results of the first tests and the future program.