MS 6: Präzisionsmassenspektrometrie und Ionenfallen

Zeit: Mittwoch 14:00–16:00 Raum: 5F

Hauptvortrag MS 6.1 Mi 14:00 5F

Proton-Neutron Interactions in Terms of Double Differences of Binding Energies : Relation to New Mass Measurements — •Burcu Cakirli — Nukleer Fizik Anabilim Dali, Istanbul Universitesi

Proton - neutron interactions determine structural evolution with N and Z including the onset of collectivity, deformation, and phase transitions. We have extracted the interaction of the last proton (p) and the last neutron (n), called δV_{pn}, from a specific double difference of binding energies using the new mass tabulation [1]. The results are especially revealing for self-conjugate nuclei and in regions of strong shell closures in heavy nuclei. For example in the Pb region, δV_{pn} values are interpreted using overlaps of shell model orbits, which are large when both protons and neutrons are in similar orbits, and small when they are not. Moreover, a relation between p-n interactions and growth rates of collectivity in terms of particle-particle (or hole-hole) and particle-hole regions was found. Finally, nuclear masses were calculated using nuclear density functional theory for even-even nuclei over the enrire nuclear chart. δV_{pn} values were predicted and showed excellent agreement with the empirical results. Using these calculations in conjunction with empirical δV_{pn} values, it was shown that unknown binding energies could be predicted and some anomalies were onserved. They might reflect structural effects or suggest the need for new mass measurements. These topics and related work will be discussed.

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[1] A.H. Wapstra *et al.*, Nucl. Phys. A 729, 129 (2003)

MS 6.2 Mi 14:30 5F

Raumladungseffekte in Penningfallen — •Sven Sturm[1], Martin Breitenfeldt[2], Alexander Herlert[1], Romain Savreux[3], Chabouh Yazidjian[3] und Lutz Schweikhard[2] — [1]CERN, Genf — [2]Inst. f. Physik, Universität Greifswald — [3]GSI Darmstadt

In der Kühlerfalle des ISOLTRAP Experiments wurden bei isotopisch verunreinigten Ionenwolken mit 10.000 Teilchen Raumladungseffekte in Kühlresonanzen gemessen [1]. In dem untersuchten Parameterbereich ergibt sich eine Aufspaltung der Kühlresonanz in zwei oder mehr Einzelresonanzen. Dieser Effekt kann unter Verwendung eines einfachen Modells in der numerischen Simulation reproduziert und verstanden werden. Der Beitrag stellt die Messergebnisse sowie das verwendete Simulationsmodell und seine Auswirkungen auf die Ionenbewegung dar.

[1] L. Schweikhard et al. Eur. J. Mass Spectrom. 11, 457 (2005)

MS 6.3 Mi 14:45 5F

Newly developed image current detection system for high-accuracy mass measurements in a Penning trap — •Jens Ketelaer[1], Klaus Blaum[1,2], Sebastian George[1], Rafael Ferrer[1], Szilard Nagy[1], Dennis Neidherr[1], Stefan Stahl[1], Christine Weber[1], and collaboration SHIPTRAP[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]GSI Darmstadt, 64291 Darmstadt, Germany

Penning trap mass spectrometry is based on the determination of the mass related cyclotron frequency of charged particles confined in a quadrupolar electric field and a homogeneous magnetic field [1]. Ideally suited for nuclides with very low production rates but rather long half-lives is the narrow-band Fourier Transform-Ion Cyclotron Resonance (FT-ICR) detection technique. A tuned LC circuit with a high quality factor Q serves as a detector for ion-induced image currents. A new double-Penning trap mass spectrometer using this method has been recently developed and constructed for SHIPTRAP [2]. The setup is currently tested at the University of Mainz to demonstrate the required single-ion sensitivity. It consists of a cryogenic helical coil at 4.2 K with an unloaded Q-value of about 15000 and a chain of amplifiers to ensure a suitable signal-to-noise ratio. The characteristics determined so far allow for the detection of the reduced cyclotron frequency of a single ion. Some test results and the current status of the project will be presented.

[1] K. Blaum, Phys. Rep. 425, 1 (2006).
[2] C. Weber et al., Eur. Phys. J. A 25, S01, 65 (2005).

MS 6.4 Mi 15:00 5F

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], Stefan Stahl[1], and Klaus Blaum[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]GSI, 64291 Darmstadt, Germany

A novel four-Penning trap system designed for mass measurements of highly charged stable and radioactive nuclides is currently planned and under construction in a GSI - University of Mainz Collaboration. High-precision mass values are required in many fields of physics. Since the required upper limit of the uncertainty differs from 10^{-7} in nuclear physics down to below 10^{-11} in metrology and for new determinations of fundamental constants, a further development of Penning trap mass spectrometers opens new applications for atomic masses in these very active fields of physics [1]. However, new cooling and detection techniques for exotic nuclei far from stability are needed to use highly charged and rarely produced specie at radioactive ion beam facilities efficiently. To this end we develop a new four-trap mass spectrometer with single-ion-sensitivity dedicated to highly charged rare isotopes delivered by the HITRAP facility at GSI. The design studies as well as the present status of the project will be presented.

[1] K. Blaum, Phys. Rep. 425, 1 (2006)

MS 6.5 Mi 15:15 5F

Trapping and Cooling of Highly Charged Ions at the HITRAP facility — •Stephen Koszudowski[1], Klaus Blaum[2], Sergej Eliseev[1], Oliver Kester[1], Heinz-Jürgen Kluge[1], Christophor Kozhuharov[1], Giancarlo Maero[1], Dennis Neidherr[2], Wolfgang Quint[1], Stefan Schwarz[3], Stefan Stahl[2], and Gleb Vorobjev[1] — [1]GSI, Planckstr. 1, 64291 Darmstadt, Germany — [2]Institut für Physik, Johannes Gutenberg Universität, Staudingerweg 7, 55128 Mainz, Germany — [3]NSCL/MSU, South Shaw Lane, East Lansing, MI 48824, USA

With the HITRAP facility the means are given to trap and cool heavy highly charged ions up to U92+ in order to perform experiments on atomic properties. These include collision studies, precision measurements and hyperfine spectroscopy. Within the Cooler Trap 10e5 particles will be cooled by electron and resistive cooling down to 4K. For the electron cooling electrons produced by an electron source have to be loaded and confined in the trap. Then the ions coming from the decelerator with an energy of 6keV/u are loaded into the trap. Therefore the entrance electrode needs to be switched with about 2keV in 400ns, which will be conducted by Behlke switches. In order to manipulate the electrons and ions inside of the trap, on each trap electrode a voltage of +-200V maximum can be applied by special power supplies build at GSI. For the precision measurements and the in trap diagnostic different ion motions can be accessed via quadrupol or dipol exitation. We give an overview on the trapping process and the needed electronics.

MS 6.6 Mi 15:30 5F

Development and simulation of a pumping barrier for the Penning trap mass spectrometer SHIPTRAP — •Dennis Neidherr[1], Klaus Blaum[1], Rafael Ferrer[1], Frank Herfurth[2], Jens Ketelaer[1], and Szilard Nagy[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]GSI Darmstadt, 64291 Darmstadt, Germany

Penning traps are ideal tools to perform high-precision mass measurements. For this purpose the cyclotron frequency of the stored charged particles is measured. In case of short-lived radionuclides the ions get in general first prepared and cooled by buffer-gas collisions in a preparation trap to reduce their motional amplitude and are then transported to a precision trap for the cyclotron frequency determination. In the double Penning trap mass spectrometer SHIPTRAP at GSI the traps are placed in the homogeneous region of one superconducting magnet with a distance of only 20 cm to avoid transport losses. Because the gas pressure inside the measurement trap has to be very low in order to minimize the damping of the ion motion with the rest gas molecules while the frequency determination, a pumping barrier is installed between both traps. This barrier consists of a 47 mm long channel with an inner diameter of either 1.5, 2 or 3mm. To predict the pressure difference between the two traps in the region of molecular gas flow the movement of each particle can be simulated without consideration of the other particles. Thus it is possible to calculate the transit probability through a tube of a given geometry. The results are compared with the experimentally obtained pressure differences.

MS 6.7 Mi 15:45 5F

Implementation of a sensitive, narrow-band Fourier-Transform Ion-Cyclotron-Resonance detection for short-lived radionuclides at SHIPTRAP — •Rafael Ferrer[1], Klaus Blaum[1,2], Frank Herfurth[2], Jens Ketelaer[1], Szilard Nagy[1], Dennis Neidherr[1], Christine Weber[1,2], and collaboration SHIPTRAP[2] — [1]Johannes Gutenberg-Universität, Institut für Physik, D-55099 Mainz — [2]GSI Darmstadt, D-64291 Darstadt.

High-precision Penning trap mass spectrometry on radionuclides is so far only performed with the destructive Time-of-Flight Ion-Cyclotron-Resonance (ICR) detection method. One of the main limitations to the experimental investigation in the transuranium region as observed at SHIPTRAP [1], are the low production rates that make the destructive detection method not longer applicable. A non-destructive method with single ion sensitivity, like the narrow-band Fourier Transform-ICR technique, is then ideally suited for the identification and characterization of these superheavy species. Accordingly, a cryogenic FT-ICR Penning trap setup has been built [2] and is currently tested at the University of Mainz [3]. It consists of a cylindrical trap for isobaric cleaning with helium as buffer gas and a hyperbolically shaped trap including a narrow-band LC-circuit that will record the induced image current of a single, singly-charged ion for its mas determination. An overview of the current status of the setup as well as some test results will be presented. [1] M. Block et al., Eur.Phys. J. A. 25, S01, 49 (2005) [2] C. Weber et al., Eur. Phys. J. A. 25, S01, 65 (2005) [3] R. Ferrer et al., Eur. Phys. J A., accepted (2006)