MS 10: Poster 2

Time: Thursday 16:15–18:15 Location: Orangerie

MS 10.1 Thu 16:15 Orangerie

Resonant Laser Ionization Spectroscopy for Highly Selective Extraction of Specific Lanthanides — •Felix Weber, Vadim Gadelshin, Dominik Studer, Pascal Naubereit, and Klaus Wendt — Johannes Gutenberg-Universität, Mainz

Resonance ionization spectroscopy is a versatile technique for efficient and selective ionization as well as to study the energy levels of exotic species. Due to the unique energy level structure a multi-step ionization scheme is selective for a specific element. The combination of resonance ionization with techniques from mass spectrometry allows the selection of a single isotope of interest. The LARISSA group in Mainz uses a high-repetition rate pulsed Ti:sapphire laser system with tunability from about 680 to 1000 nm for spectroscopy, which can be extended using frequency doubling, tripling and quadrupling. All lanthanide elements can be ionized by a two stage excitation using SHG for both steps. An automatized tunable grating laser with intra-cavity frequency doubling provides high output power over a wide wavelength range. In order to combine high ionization efficiency and selectivity with the ability to rapidly switch between different lanthanides, dedicated ionization schemes are developed at Johannes Gutenberg University Mainz. These will be used within the CERN-MEDICIS project which aims to produce lanthanide isotopes for medical applications and in addition serve as preparation for few-element detection of minor actinides by laser based ultratrace determination techniques.

MS 10.2 Thu 16:15 Orangerie

Laserablations unterstützte RIMS refraktärer Elemente — •Felix Julian Wiescher, Reinhard Heinke, Dominik Studer und Klaus Wendt — Johannes Gutenberg Universität, Mainz, Deutschland

Optische Spektren refraktärer Elemente wurden bisher nur eingeschränkt untersucht, da diese aufgrund ihres hohen Schmelzpunktes und hoher Reaktivität für die meisten Experimente an neutralen Atomen nur schwer zugänglich sind. An der Mainzer Atomstrahlapparatur MABU wurde daher die ursprüngliche Quellenregion, eine resistiv geheizte Kavität, durch eine kompakte Quadrupolfallenkonstruktion, den sogenannten Mini-RFQ [1], ersetzt. Dieser beinhaltet ein rotierendes Laserablationstarget an dessen einem Ende. Unter Einsatz hochrepetierender Titan:Saphir-Laser Mainzer Bauart (Pulslänge ca. 50 ns, Pulsenenergie ca. 0.4 mJ) werden Atome aus dem rotierendem Target ablatiert und erzeugte Neutrale in mehreren Anregungsschritten selektiv resonant ionisiert. Das Durchstimmen der einzelnen Anregungsschritte erlaubt die Messung der Spektrallinien, wodurch fundamentale atomphysikalische Größen wie Energielagen hochangeregter Zustände und z.B. das Ionisationspotential präzise ermittelt werden können. [1] - F. Schneider et al., Eur.Phys. J. A (2015)

MS 10.3 Thu 16:15 Orangerie

An improved value of the proton's atomic mass — •Fabian Heisse[1,2], Florian Köhler-Langes[1], Sascha Rau[1], Jiamin Hou[1], Sven Junck[3], Anke Kracke[1], Andreas Mooser[4], Wolfgang Quint[2], Stefan Ulmer[4], Günter Werth[3], Klaus Blaum[1], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [4]RIKEN, Ulmer Fundamental Symmetries Laboratory, Wako, Saitama 351-0198, Japan

The proton is a central building block of the visible universe. The precise knowledge of its properties is of great interest for tests of fundamental physics and metrology.

To measure the proton's mass in natural units, a new cryogenic five-fold Penning-trap setup was constructed. The measurement principle is based on a phase-sensitive comparison of the proton's cyclotron frequency to that of a bare carbon nucleus ($^{12}C^{6+}$) in a highly harmonic and purpose-built Penning trap.

The setup as well as the proton's atomic mass will be presented. The result improves the current literature value by a factor of 3 and reveals a disagreement of about 3 standard deviations to it [1].

[1] F. Heiße et al., Phys. Rev. Lett. 119, 033001 (2017)

MS 10.4 Thu 16:15 Orangerie

High-precision mass measurements with Pentatrap — •Ch. Schweiger[1], R. X. Schüssler[1], A. Rischka[1], M. Door[1], P. Filianin[1], Y. Novikov[1], S. Sturm[1], S. Ulmer[2], S. Eliseev[1], and K. Blaum[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [2]RIKEN, Ulmer Initiative Research Unit, Saitama, Japan

The high-precision Penning-trap mass spectrometer Pentatrap [1] is currently being commissioned at the Max-Planck-Institut für Kernphysik in Heidelberg. It aims at mass-ratio measurements of stable and long-lived highly-charged ions with a relative uncertainty below 10^{-11} through measurements of their respective cyclotron frequencies in the strong magnetic field of a Penning trap.

Mass data at this level of precision have numerous applications, especially for tests of fundamental interactions and their symmetries, among others in neutrino physics research or a direct test of the theory of special relativity (SR). For a determination of the electron neutrino mass on the sub-eV level within the ECHo collaboration [2] Pentatrap contributes with an independent measurement of the Q-value of the electron capture transition of ^{163}Ho to ^{163}Dy. In collaboration with the Institut-Laue-Langevin (ILL) a direct test of SR by conversion of a mass to electromagnetic radiation as e.g. in the neutron capture process of ^{35}Cl is planned. The mass ratio of ^{35}Cl/^{36}Cl will be precisely measured at Pentatrap whereas the photon wavelength is measured by means of crystal Bragg spectroscopy at the ILL.

[1] Repp, J. et al., Appl. Phys. B 107, 983 (2012)
[2] Gastaldo, L. et al., Eur. Phys. J. ST 226, 1623 (2017)

MS 10.5 Thu 16:15 Orangerie

Commissioning and First Experiments with TITAN's Multiple-Reflection Time-of-Flight Isobar Separator and Mass Spectrometer — •S. Beck[1,4], C. Hornung[1], S. Ayet[1,4], M.P. Reiter[1,2], J. Bergmann[1], T. Dickel[1,4], J. Dilling[2,3], A. Finlay[2,3], H. Geissel[1,4], F. Greiner[1], C. Jesch[1], A.A. Kwiatkowski[2], E. Leistenschneider[2,3], W.R. Plass[1,4], C. Scheidenberger[1,4], D. Short[2], C. Will[1], M. Yavor[5], and the TITAN collaboration[2] — [1]Justus-Liebig-Universität, Gießen — [2]TRIUMF, Vancouver — [3]University of British Columbia, Vancouver — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [5]Russian Academy of Sciences, St. Petersburg

Exotic nuclei can be produced with very high rates at the ISOL facility ISAC at TRIUMF (Vancouver, Canada). TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) is a multiple ion-trap system for high-precision mass measurements and in-trap decay spectroscopy. Recently a Multi-Reflection Time-of-Flight Mass Separator and Spectrometer (MR-TOF-MS) has been installed and commissioned at TITAN. It is based on an established concept tested at the FRS Ion-Catcher at GSI. The ion of interest can be spatially separated from isobaric contaminations with mass-selective dynamic re-trapping. Furthermore, the device is well suited to perform high precision mass measurements, particularly for short-lived isotopes produced at low rate.

High-precision mass measurements of neutron-rich titanium isotopes were performed by the MR-TOF-MS to probe the existence of the N=32 sub-shell closure above calcium.

MS 10.6 Thu 16:15 Orangerie

MOCCA: A 4k-pixel molecule camera for the position and energy resolving detection of neutral molecule fragments at the Cryogenic Storage Ring CSR — •Dennis Schulz[1], Steffen Allgeier[1], Christian Enss[1], Andreas Fleischmann[1], Lisa Gamer[1], Loredana Gastaldo[1], Sebastian Kempf[1], Oldřich Novotný[2], and Andreas Wolf[2] — [1]Kirchhoff-Institute for Physics, Heidelberg — [2]Max Planck Institute for Nuclear Physics, Heidelberg

The Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg can be used to prepare and store molecular ions in their rotational and vibrational ground states, enabling state-resolved studies on electron-ion interactions. The use of Metallic Magnetic Calorimeters for particle detection allows for identifying all neutral reaction products, using the deposited energy of incident particles into MMC absorbers as a measure of the particle mass. To resolve the complete reaction kinematics, a position sensitive coincident detection of multiple reaction products is necessary.

For those measurements we designed MOCCA, a 4k-pixel molecule camera based on MMCs with a detection area of 45 mm×45 mm, which is segmented into 64×64 absorbers and read out using only 32 SQUIDs. We discuss the detector design, multi-hit capability, cross-talk and the integration of its ^{3}He/^{4}He dilution refrigerator into the setup of the CSR. We show first measurements and the expected energy resolution.

MS 10.7 Thu 16:15 Orangerie

Multi-reflection time-of-flight mass spectrometry with combined in-trap lift capture and mirror-switch ejection — •Paul Fischer[1], Stefan Knauer[1], Gerrit Marx[1], Birgit Schabinger[1], Lutz Schweikhard[1], and Robert N. Wolf[2] — [1]Institut für Physik, Universität Greifswald, 17489 Greifswald, Germany — [2]ARC Centre of Excellence for Engineered Quantum Systems, School ofPhysics, The University of Sydney, NSW 2006 Australia

Multi-reflection time-of-flight (MR-ToF) devices are mass separators and analyzers with high resolving powers and fast processing times. For ion injection and ejection, either the electrostatic ion-mirrors or an in-trap lift electrode [1] can be switched. Both methods result in advantages as well as drawbacks. We show the results of a combination of the two, i.e. in-trap lift switching is employed for ion capture with increased mirror-potential stability and exit-side mirror switching for increased ejection mass band width.

Measurements with small lead clusters illustrate the individual techniques as well as the gain from their combination [2].

[1] R. N. Wolf et al., Int. J. Mass Spectrom. 313:8-14(2012)
[2] S. Knauer et al., Int. J. Mass. Spectrom., online: https://doi.org/10.1016/j.ijms.2017.10.007(2017).

MS 10.8 Thu 16:15 Orangerie

A laser ablation ion source for the MR-TOF-MS at the FRS Ion Catcher — •Lizzy Gröf[1], Daler Amanbayev[1], Samuel Ayet[1,2], Julian Bergmann[1], Timo Dickel[1,2], Hans Geissel[1,2], Florian Greiner[1], Christine Hornung[1], Wolfgang Plass[1,2], Ann-Kathrin Rink[1], and Christoph Scheidenberger[1,2] — [1]Justus-Liebig Universität Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

High resolution mass spectrometry of exotic nuclei is an important tool to provide information about nuclear structure. Multiple reflection time-of-flight mass spectrometers (MR-TOF-MS) proved to be the perfect devices in particular for short-lived (≈ms) isotopes. For MR-TOF-MS it is necessary to have calibrant ions over a broad mass range and a high repetition rate(≈100 Hz). These requirements can be full-filled by the laser ablation carbon cluster ion source (LACCI), which is a part of the new diagnostics unit for the FRS Ion Catcher. The new diagnostics unit consists in addition of an RFQ based beam transport and distribution system, differential pumping sections and an RF Quadrupole mass filter. It will be integrated in 2018 in the beam line of the FRS Ion Catcher, which consists of a cryogenic stopping cell, a RFQ based beamline and a MR-TOF-MS. With LACCI a stable (10 hours) and high repetition rate (100Hz) ion production from different target materials is possible due to a 2D movable target table. The capabilities of the new diagnostics unit and first long term measurements with LACCI will be presented.

MS 10.9 Thu 16:15 Orangerie

Analysis of isobaric interferences in the analysis of Tc-99 with SF-ICPMS — •Markus Plaschke, Francesca Quinto, Frank Geyer, and Horst Geckeis — Institute for Nuclear Waste Disposal, Karlsruhe Institute of Technology, Karlsruhe, Germany

Tc-99 is, due to its long half-life and high mobility in the environment, a fission product of concern for the safe management of nuclear waste. SF-ICPMS constitutes a powerful tool for the analysis of Tc-99 in samples from nuclear decommissioning activities or experiments on the geochemical behavior of Tc. Isobaric background in the determination of Tc-99 with SF-ICPMS arise from the molecular species Mo-98H and from the stable nuclide Ru-99. Chemical separation of Tc from Mo and Ru is effective in removing a relevant part of the interfering nuclides. However, for some applications the direct measurement of Tc-99 in water samples without previous chemical separation is required. It is of great interest to verify which levels of Tc-99 can be reliably determined in presence of variable concentrations of Mo and Ru. We present a systematic investigation of the influence of Mo and Ru at various orders of magnitude on the background for the determination of Tc-99 in samples with different matrices.

MS 10.10 Thu 16:15 Orangerie

Lab Intercomparison for the Establishment of a New Multi-Isotope Plutonium Standard — Björn Dittmann[1,2], Raffaele Buompane[3], Elena Chamizo[4], Marcus Christl[5], Alfred Dewald[6], Tibor Dunai[2], Claus Feuerstein[6], Kieth Fifield[7], Fabio Marzaioli[3], Carsten Münker[2], Antonio Petraglia[3], Erik Strub[1], Carmina Sirignano[3], Hans-Arno Synal[5], Michael Fröhlich[7], •Stefan Heinze[6], Filippo Terrasi[3], Stephen Tims[7] und Anton Wallner[7] — [1]Division of Chemistry, University of Cologne — [2]Institute of Geology and Mineralogy, University of Cologne — [3]VanCentre for Isotopic Research on the Cultural and Environmental Heritage, University Luigi Vanvitelli — [4]Centro Nacional de Aceleradores, Universidad de Sevilla — [5]Laboratory of Ion Beam Physics, ETH Zurich — [6]Institute of Nuclear Physics, University of Cologne — [7]Department of Nuclear Physics, Research School of Physics & Engineering, Australian National University

A new multi-isotopic plutonium standard for isotopic ratio measurements with AMS was created by mixing different single-isotope IRMM standards (Pu-239, Pu-240, Pu-242, Pu-244). This standard material has been measured at the AMS facilities at Canberra (Australia), Cologne (Germany), Caserta (Italy), Sevilla (Spain) and Zurich (Switzerland). Aditionally, the material was characterized using a Neptune MC-ICPMS (multi-collector inductively coupled plasma mass spectrometry) at the joint Cologne-Bonn facility and with RIMS (resonant ionisation mass spectrometry) at the University of Mainz (Germany). Consensus values for the standard material will be proposed.