MS 8: Speicherringe, ICP-MS, Neue Entwicklungen

Zeit: Mittwoch 14:00–16:00 Raum: VMP 8 R05

MS 8.1 Mi 14:00 VMP 8 R05

Time dependence of two-body weak decays of highly-charged single ions in the ESR Storage Ring of GSI Darmstadt — •N. Winckler[1,2], K. Beckert[1], F. Bosch[1], D. Boutin[1,2], C. Brandau[1], L. Chen[1,2], C. Dimopoulou[1], H.G. Essel[1], B. Fabian[2], Thomas Faestermann[3], H. Geissel[1,2], E. Haettner[2], S. Hess[1], P. Kienle[3,4], Ronja Knoebel[1,2], C. Kozhuharov[1], J. Kurcewicz[1], N. Kuzminchuk[2], S.A. Litvinov[1,2], Y.A. Litvinov[1,2], L. Maier[3], M. Mazzocco[1], F. Montes[1], P. Moritz[1], A. Musumarra[5], C. Nociforo[1], F. Nolden[1], T. Ohtsubo[6], W. Plass[2], A. Prochazka[1], R. Reda[4], R. Reuschl[1], C. Scheidenberger[1,2], U. Spillmann[1], M. Steck[1], T. Stoehlker[1], B. Sun[1,7], T. Suzuki[8], S. Torilov[9], M. Trassinelli[10], H. Weick[1], M. Winkler[1], D. Winters[1], and T. Yamaguchi[8] — [1]Gesellschaft für Schwerionenforschung GSI, Darmstadt, Germany — [2]Justus-Liebig-Universität Gießen, Gießen, Germany — [3]Technische Universität München, Garching, germany — [4]Stefan Meyer Institut für subatomare Physik, Vienna, Austria — [5]INFN-LNS Catania, Italy — [6]Department of Physics, Niigata university, Niigata, Japan — [7]Peking University, Beijing, China — [8]Department of Physics, Saitama university, Saitama, Japan — [9]St. Petersburg State University, St. Petersburg, — [10]Institut des NanoSciences de Paris, CNRS-UPMC, Paris, France

Nuclear decay properties have been well established from the studies of neutral atoms. However, the decay modes of highly-charged ions can be dramatically modified. Experimental studies can be performed in ion-storage rings or ion traps where the high-vacuum conditions are the prerequisite to preserve high charge states.

In this contribution we discuss experiments on orbital electron capture (EC) decay of hydrogen-like ions. These experiments have been performed at the FRS-ESR facility of GSI. Hydrogen-like ^{140}Pr, ^{142}Pm, and ^{122}I ions have been separated in-flight by the FRagment Separator FRS and injected, stored and cooled in the Experimental Storage Ring ESR. Using time-resolved Schottky Mass Spectrometry, a non-destructive and highly sensitive technique, the fate of each stored ion can be investigated.

Decay events accounting for nuclear electron capture processes have been unambiguously identified and the time between production and decay has been measured. The obtained results show a significant deviation from the expected exponential decay. The interpretation of this effect is widely disputed in literature and will be discussed.

MS 8.2 Mi 14:15 VMP 8 R05

Investigation of the Isochronous Mode of the ESR — •Sergey Litvinov, Aleksey Dolinskii, H. Geissel, F. Nolden, M. Steck, and H. Weick — GSI, 64291, Darmstadt, Germany

The isochronous mode of a storage ring is a special ion-optical setting in which the revolution time of circulating ions of one species does not depend of their velocity spread. In this mode the ring can be used as a Time-Of-Flight (TOF) mass spectrometer.

Isochronous Mass Spectrometry (IMS) is an experimental technique for direct measurements of short-lived exotic nuclei which has been developed at the FRS-ESR facility at GSI.

A bottleneck for the present IMS experiments is the low transmission from the FRS to the ESR due to ion-optical mismatch between both systems. Besides transmission, dispersion mismatch negatively influences the isochronicity. For the first time, the ion-optical matching of the FRS-ESR in the isochronous mode has been calculated and experimentally verified. The experimental results and perspectives of further improvements will be presented.

Additionally, the influence of the transverse motion on the isochronicity has been studied and the corresponding calculation results will be shown. Possible improvements of the isochronous mode of the ESR will be outlined.

MS 8.3 Mi 14:30 VMP 8 R05

Isochronous Mass Measurements of Neutron-Rich Fission Fragments at the FRS-ESR Facility — •Ronja Knöbel[1,2], K. Beckert[1], F. Bosch[1], D. Boutin[1,2], C. Brandau[1], L. Chen[1,2], I. J. Cullen[3], C. Dimopoulou[1], Aleksey Dolinskii[1], B. Fabian[1,2], H. Geissel[1,2], M. Hausmann[4], O. Klepper[1], C. Kozhuharov[1], J. Kurcewicz[1], S. A. Litvinov[1,2], Y. A. Litvinov[1,2], Z. Liu[3], M. Mazzocco[1], F. Montes[4], G. Münzenberg[1], A. Musumarra[5], S. Nakajima[6], C. Nociforo[1], F. Nolden[1], T. Ohtsubo[7], A. Ozawa[8], Z. Patyk[9], W. Plass[1,2], C. Scheidenberger[1,2], M. Steck[1], B. Sun[1,10], T. Suzuki[6], P. M. Walker[3], H. Weick[1], N. Winckler[1,2], M. Winkler[1], and T. Yamaguchi[6] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [3]University of Surrey, Guildford, GU2 7XH, U. K. — [4]Michigan State University, East Lansing, Mi 48824, U.S.A. — [5]Laboratori Nazionali del Sud, INFN Catania, Italy — [6]Saitama University, 338-8570 Saitama, Japan — [7]Niigata University, Niigata 950-2181, Japan — [8]University of Tsukuba, Tsukuba 305-8577, Japan — [9]Soltan Institute for Nuclear Studies, 00-681 Warszawa, Poland — [10]School of Physics, Peking University, Beijing 100871, China

Accurate mass measurements of exotic nuclei give insight into basic nuclear properties important for the understanding of nuclear structure and astrophysics. The unique combination of the fragment separator FRS and the cooler-storage ring ESR has been used for the investigations of short-lived neutron-rich masses of ^{238}U-fission fragments via Isochronous Mass Spectrometry (IMS). The method has been extended with an additional magnetic rigidity determination. Masses for 14 nuclides have been obtained for the first time. The experimental setup, the data analysis, and the results will be presented.

MS 8.4 Mi 14:45 VMP 8 R05

The electron target for the CSR — •andrey shornikov[1], alexandr s. jaroshevich[2], claude krantz[1], klaus blaum[1], andreas wolf[1], and dmitry a. orlov[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Institute of Semiconductor physics, Novosibirsk, Russia

An ultralow energy photoelectron cooler for the novel cryogenic electrostatic storage ring CSR is under development. The electron device will serve as a major tool for electron-ion collision studies and for phase space cooling of 20-300 keV (E/Q, charge number Q) ions in velocity matched electron and ion beams. Electrons in energy range from 165 eV (matched to 20 keV protons) down to a fraction of eV (matched to heavy molecules of mass up to 160 A/Q) will be confined by 30-150 Gauss guiding magnetic field in a newly developed configuration[1]. The key points related to ultralow energy cooling operation [2] (maximal gun current at the low energies, minimal longitudinal temperature) have been taken into account and were recently studied by experiments at the TSR e-target. Adiabatic beam transport has been simulated by the TOSCA code. In this talk we present experimental and simulation results as well as the mechanical and cryogenic concept of the CSR electron target.

[1] H. Fadil et al Proc. EPAC2006 pp 1630-1632

[2] D. Orlov et al. Proc COOL05 (2005) pp 478-487

MS 8.5 Mi 15:00 VMP 8 R05

Electron-capture decay probability for highly-charged single ions — •Nicolas Winckler for the GSI-oscillations collaboration — Gesellschaft für Schwerionenforschung GSI, 64291 Darmstadt, Germany — Justus-Liebig-Universität Gießen, 35392 Gießen, Germany

Nuclear decay properties have been well established from the studies of neutral atoms. However, the decay modes of highly-charged ions can be dramatically modified. Experimental studies can be performed in ion-storage rings or ion traps where the high-vacuum conditions are the prerequisite to preserve high charge states.

In this contribution we discuss experiments on orbital electron capture (EC) decay of hydrogen-like ions. These experiments have been performed at the FRS-ESR facility of GSI. Hydrogen-like ^{140}Pr, ^{142}Pm, and ^{122}I ions have been separated in-flight by the FRagment Separator FRS and injected, stored and cooled in the Experimental Storage Ring ESR. Using time-resolved Schottky Mass Spectrometry, a non-destructive and highly sensitive technique, the fate of each stored ion can be investigated.

Decay events accounting for nuclear electron capture processes have been unambiguously identified and the time between production and decay has been measured. The obtained results show a significant deviation from the expected exponential decay. The interpretation of this effect is widely disputed in literature and will be discussed.

MS 8.6 Mi 15:15 VMP 8 R05

CSR: a new tool for storage and cooling of keV ion beams — •Michael Froese[1], Klaus Blaum[1], Jose Crespo López-Urrutia[1], Florian Fellenberger[1], Manfred Grieser[1], Oded Heber[2], Dirk Kaiser[1], Michael Lange[1], Felix Laux[1], Sebastian Menk[1], Dmitry A. Orlov[1], Michael Rappaport[2], Roland Repnow[1], Claus D. Schröter[1], Dirk Schwalm[1], Thomas Sieber[1], Jonathan Toker[2], Joachim Ullrich[1], Jozef Varju[1], Robert von Hahn[1], Andreas Wolf[1], and Daniel Zajfman[2] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Weizman Institute of Science, Rehovot, 76100, Israel

An electrostatic Cryogenic Storage Ring (CSR) is currently being built in Heidelberg, Germany. The current status and final design of this ring, with a focus on the optimized 2 K chamber cooling, precision chamber suspension, and pumping down to extremely low pressures via cryogenic vacuum chambers will be presented. This ring will allow long storage times of highly charged ion and polyatomic molecular beams with energies in the range of keV per charge-state. Combining the long storage times with vacuum chamber temperatures approaching 2 K, infrared-active molecular ions will be radiatively cooled to their rotational ground states. Many aspects of this concept were experimentally tested with a cryogenic trap for fast ion beams (CTF), which has already demonstrated the storage of fast ion beams in a large cryogenic device. An upcoming test will investigate the effect of pre-baking the cryogenic vacuum chambers to 600K on the cryogenic vacuum and the ion beam storage.

MS 8.7 Mi 15:30 VMP 8 R05

Multicollector-ICP-Mass Spectrometry for Trace Analysis of Silicon Crystals — •Axel Pramann, Olaf Rienitz, and Detlef Schiel — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The measurement of the molar mass of highly pure silicon is a challenging task of an international project for the re-determination of the Avogadro constant[1] on a relative uncertainty level of 10^{-8}. At PTB a MC-ICP-Mass Spectrometer (*Neptune*™, ThermoFinnigan) is used to measure isotope ratios $^{28}Si/^{29}Si$ and $^{30}Si/^{29}Si$ of the silicon WASO17 crystal. This experiment is used to validate and optimize the current data received by gas mass spectrometry at IRMM.[1] Based on a new method for the analytical determination of calibration (K) factors which will be described elsewhere, both the principal proof of the ability of this method as well as a new chemical preparation route in combination with MC-ICP-MS has been demonstrated for the first time. The reported method shows the ability of the determination of molar masses traceable to the SI units. Details of the experiment and the way of sample preparation are described. First measurements show a repeatability of the K factors in the range of $s_{\rm rel} = 0.1 \ldots 0.4$ %. The abundance of Si isotopes ^{28}Si, ^{29}Si, and ^{28}Si in various Si crystal samples is determined by applying the K factors. Isotope ratios show standard uncertainties $u_{\rm rel}(^{30}{\rm Si}/^{29}{\rm Si}) = 0.13$ % and $u_{\rm rel}(^{28}{\rm Si}/^{29}{\rm Si}) = 0.6$ %. The study is completed with an uncertainty budget according to the guide to the expression of uncertainty in measurement (GUM).

[1]P. Becker, Metrologia **40**, 366 (2003).

MS 8.8 Mi 15:45 VMP 8 R05

Eine puffergasgefüllte Quadropolfalle zu selektiven Unterdrückung angeregter Zustände des Si$^-$ — •Tina Gottwald[1], Oliver Forstner[2], Dag Hanstorp[3], Anton Lindahl[3], Yuan Liu[4] und Klaus Wendt[1] — [1]Universität Mainz, Institut für Physik, Staudinger Weg 7, 55128 Mainz — [2]VERA Laboratory, Faculty of Physics, Universität Wien, Vienna, Austria — [3]Department of Physics, Göteborg University, SE-412 96 Göteborg, Sweden — [4]Physics Division, Oak Ridge National Laboratory, Oak Ridge TN, USA

Eine selektive Kühlung angeregter Zustände ist in Präzisionsexperimenten mit negativen Ionen oder Molekülen wünschenswert, z.B. zur genauen Bestimmung der Elektronenaffinität oder in Kollisionsexperimenten, in denen ein zustandsreiner Strahl im Grundzustand eingesetzt werden soll. Am Oak Ridge National Laboratory (ORNL) wurden Studien zur Kühlung angeregter Zustände des negativen Silizium Ions in einer puffergasgefüllten Quadrupolfalle durchgeführt. Ergänzend wurde die selektive Laserphotoneutralisation angeregter Energiezustände untersucht. Hierzu wurde der in einer Sputterionenquelle erzeugte Si$^-$ Ionenstrahl zunächst massenselektiert; hiernach enthält dieser ein Gemisch des Grundzustands sowie angeregter Zustände des negativen Ions. Zur Photoneutralisation der angeregten Zustände des Si$^-$ standen zwei Nd:YAG Laser, kontinuierlich bzw. mit 20 Hz gepulst, zur Verfügung. Angeregte Zustände des Si$^-$ wurden in der Kühlerfalle in Kombination mit selektiver Laserphotoneutralisation effizient unterdrückt.