MS 4: Ion Storage Rings

Time: Tuesday 14:00–15:15 Location: DO24 1.205

Invited Talk MS 4.1 Tue 14:00 DO24 1.205

The Cryogenic Storage Ring Project — •Robert von Hahn[1], Klaus Blaum[1], Arno Becker[1], Florian Fellenberger[1], Sebastian George[1], Manfred Grieser[1], Florian Grussie[1], Philipp Herwig[1], Claude Krantz[1], Holger Kreckel[1], Michael Lange[1], Sebastian Menk[1], Roland Repnow[1], Kaija Spruck[2], Stephen Vogel[1], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Justus-Liebig-Universität, Giessen, Germany

At MPIK the electrostatic cryogenic storage ring CSR is nearing completion. At beam energies of 20 to 300 keV per charge unit and 35 m circumference the CSR will allow experiments in a cryogenic environment providing conditions of extremely low vacuum and heat radiation. By using liquid helium at 2 K for cryopumping, the projected vacuum (confirmed at a prototype) lies at 1E-13 mbar or below, ensuring long storage times for slow singly charged and highly charged ions, molecules and clusters. Moreover, phase space cooling by electrons will be implemented. The internal quantum states of molecular and cluster ions can be cooled to low temperature, yielding well defined vibrational and for smaller systems also rotational structures. In the CSR construction, the cryogenic ion beam vacuum system has been set up. Extensive tests confirming the criteria on heat flow, alignment and high-voltage stability were successfully completed on the first quadrant. In addition beam diagnostic units for electric pickup signals and spatial profiles, detectors for neutral and charged fragments, the injection beam line, and an electron cooling device are under construction.

MS 4.2 Tue 14:30 DO24 1.205

A New Data Evaluation Approach for Mass Measurements of Exotic Nuclei performed with Isochronous Mass Spectrometry — •M. Diwisch[1], R. Knöbel[1,2], H. Geissel[1,2], Z. Patyk[3], W.R. Plass[1,2], C. Scheidenberger[1,2], H. Weick[2], K. Beckert[2], F. Bosch[2], D. Boutin[1,2], C. Brandau[1,2], L. Chen[1,2], I.J. Cullen[4], C. Dimopoulou[2], A. Dolinskii[2], B. Fabian[1], M. Hausmann[5], O. Klepper[2], C. Kozhuharov[2], J. Kurcewicz[2], N. Kuzminchuk[1], S.A. Litvinov[2], Yu.A. Litvinov[2], Z. Liu[4], M. Mazzocco[2], F. Montes[5], G. Münzenberg[2], A. Musumarra[7], S. Nakajima[8], C. Nociforo[2], F. Nolden[2], T. Ohtsubo[9], A. Ozawa[10], M. Steck[2], B. Sun[2,11], T. Suzuki[8], P.M. Walker[4], N. Winckler[6], M. Winkler[2], and T. Yamaguchi[8] — [1]Justus Liebig University Gießen — [2]GSI, Darmstadt — [3]Soltan Institute for Nuclear Studies, Warszawa, Poland — [4]University of Surrey, Guildford, United Kingdom — [5]Michigan State University, East Lansing, U.S.A. — [6]Max Planck Institut für Kernphysik, Heidelberg — [7]Laboratori Nazionali del Sud, INFN Catania, Italy — [8]Saitama University, Saitama, Japan — [9]Niigata University, Niigata, Japan — [10]University of Tsukuba, Tsukuba, Japan — [11]School of Physics, Peking University, Beijing, China

The Isochronous Mass Spectrometry (IMS) and Schottky Mass Spectrometry (SMS) are powerful tools to measure masses of rare exotic nuclei in a storage ring. While the SMS method provides very high accuracies it does not give access to rare isotopes with lifetimes in the sub second range because beam cooling has to be performed for a few seconds before the measurements start. As a complementary method IMS can be used without beam cooling to reach isotopes with lifetimes of only a few 10μs. As a drawback of the IMS method one cannot achieve the high mass accuracy of the SMS method until now.

For the data evaluation of the SMS data a correlation matrix method has been successfully applied in the past. In order to improve the accuracy of the IMS measurements the same method will now be used, which will allow to combine and to correlate data from different IMS measurements with each other. Applying this method to the analysis of previous experiments with uranium fission fragments at the FRS-ESR facility at GSI and to future experiments, will increase the accuracy of the IMS method and may lead to new mass values with reasonable accuracies for very rare and important nuclei for nuclear astrophysics such as ^{130}Cd, which were not accessible before.

MS 4.3 Tue 14:45 DO24 1.205

The low-energy electron cooler for the Cryogenic Storage Ring — •Stephen Vogel, Klaus Blaum, Claude Krantz, and Andreas Wolf — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

The Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, is being commissioned. CSR will be an ideal tool for preparing and studying cold atomic and molecular ions using ion beams of $20-300$ keV kinetic energy (per ion charge unit). As a first important upgrade CSR will be equipped with an electron cooler. Latter is designed for cooling beams with a charge-to-mass ratio q/m of 1 to 1/160 e/amu. This corresponds to an electron beam energy range of 1 to 163 eV. The beam will be produced by a cryogenic photocathode and electron temperatures in the co-moving frame reach down to 10 K. The cooler can also be used as an electron target by detuning the electrons' kinetic energy. This allows precision experiments on low-energy collisions between cold electrons and stored atomic and molecular ions using counting and imaging detectors. The design and the status of the setup will be presented.

MS 4.4 Tue 15:00 DO24 1.205

Cryogenic microcalorimeter energy resolution measurements for multi-keV atoms and molecules. — •Oldřich Novotný[1], Steffen Allgeier[3], Lisa Gamer[3], Daniel Hengstler[3], Sebastian Kempf[3], Claude Krantz[2], Andreas Pabinger[3], Christian Pies[3], Daniel W. Savin[1], Dirk Schwalm[2,4], Christian Enss[3], Andreas Fleischmann[3], and Andreas Wolf[2] — [1]Columbia Astrophysics Laboratory, New York, USA — [2]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [3]Kirchhoff Institute for Physics, Heidelberg, Germany — [4]Weizmann Institute of Science, Rehovot, Israel

We have experimentally investigated the kinetic energy resolution of an $\sim$ 10 mK magnetic microcalorimeter (MMC) detector for 12-150 keV atomic and molecular ion beams. The ion masses were varied from 1 amu (H^+) to 58 amu ($C_3H_6O^+$). The resulting FWHM energy resolutions were $\lesssim$ 0.5 keV for atomic ions and $\lesssim$ 1 keV for molecular ions. The measured energy resolutions were similar for the neutral particles of the corresponding ions. The high resolving power in energy, the charge independence, and the optional position sensitivity all demonstrate the expected versatility of the MMC detectors for use in various mass spectrometry techniques. As a next step we will implement the MMC detector for mass and position resolved fragment counting in the Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics in Heidelberg. The storage energies of $\sim$ 300 keV will allow 1 amu mass resolution for stored ions of up to $\sim$ 150 amu (assuming a separation of 2 FWHMs between peaks).