MS 9: Ion Storage Rings

Time: Thursday 14:00–15:15 Location: MS-H9

Invited Talk MS 9.1 Thu 14:00 MS-H9

Isochronous mass spectrometry and beam purification in an electrostatic storage ring — •Viviane C. Schmidt — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

Electrostatic storage rings have been primarily used for collision studies of charged atoms or molecules with photons, atoms, and electrons until now. Due to the electrostatic nature and therefore mass-independent storage of the devices, multiple ion species can be stored simultaneously. The identification and removal of these predominantly isobaric contaminations from the beam is not obvious. So far, electrostatic storage rings mostly rely on identification and purification methods prior to injection for contaminant-free measurements. Here, we report the first successful isochronous operation of an electrostatic storage ring achieved at the Cryogenic Storage Ring (CSR) facility at the Max-Planck-Institut für Kernphysik in Heidelberg (*von Hahn et al., Rev. Sci. Instrum. 87, 2016*). The isochronous operation enables a sensitive, mass based identification of the stored beam components, information vital for all experiments conducted at CSR. Uncooled beams with typical momentum spreads of 10^{-3} and emittance of a few mm·mrad were investigated at non-relativistic beam energies of a few hundred keV. Mass resolutions of $\frac{\Delta m}{m} < 10^{-5}$ could be reached and isobaric contaminations below relative beam fractions of 10^{-4} could be identified. The proof-of-principle measurements presented here open up a new field of application in the form of ion mass measurements for these devices. Furthermore, beam purification methods to remove the identified contaminations inside the ring have been developed.

MS 9.2 Thu 14:30 MS-H9

4k-pixel microcalorimeter detector for the Cryogenic Storage Ring CSR - standalone experimental setup and new readout possibilities — •Christopher Jakob[1], Lisa Gamer[1], Klaus Blaum[1], Christian Enss[2], Andreas Fleischmann[2], Ansgar Lowack[2], Michael Rappaport[3], Dennis Schulz[2], Yoni Toker[4], Andreas Wolf[1], and Oldřich Novotný[1] — [1]MPIK Heidelberg — [2]KIP Heidelberg University — [3]Weizmann Institute of Science, Rehovot, Israel — [4]Bar-Ilan University, Ramat Gan, Israel

The Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics, Heidelberg, can store heavy molecular ions in their rotational and vibrational ground states, enabling the investigation of electron-ion interactions such as the dissociative recombination in laboratory environment under conditions close to those in cold interstellar plasmas. To reconstruct the full kinematics of these processes, position- and energy-sensitive coincident detection of multiple reaction products is necessary. For this purpose, MOCCA, a 4k-pixel molecule camera based on magnetic calorimeters with a detection area of 45 mm×45 mm, was developed at the Kirchhoff-Institute for Physics in Heidelberg. We introduce a new readout scheme and present the plans for the integration of MOCCA and its ^{3}He/^{4}He dilution refrigerator into CSR, as well as a CSR-independent experimental setup where MOCCA will be used to study collision- and photon-induced ion fragmentation processes.

MS 9.3 Thu 14:45 MS-H9

Measurement of the bound-state beta decay of bare 205-Thallium and its nuclear astrophysical implications — •Ragandeep Singh Sidhu, Rui-Jiu Chen, Yu. A. Litvinov, and the E121 collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

We report on the first direct measurement of the bound-state beta decay [1] of ^{205}Tl^{81+} ions, an exotic decay mode, in which an electron is directly created in one of the empty atomic orbitals instead of being emitted into the continuum. One of the most awaited and pioneering experiments was realized in the spring beamtime at GSI, Darmstadt in 2020, wherein the entire accelerator chain was employed. ^{205}Tl^{81+} ions (with no electron) were produced with the projectile fragmentation of ^{206}Pb primary beam on ^{9}Be target, separated in the fragment separator (FRS), accumulated, cooled, and stored for different storage times (up to 10 hours) in the experimental storage ring (ESR). The experimentally measured half-life value [2] draws a 2.7σ [3] and 4.2σ [4] tension with the theoretically predicted values, which could influence our understanding of the abundance of chemical elements in the early universe. In this contribution, the authors aim to present the s-process motivation and a preliminary value of the ^{205}Tl^{81+} half-life.

[1] R. Daudel *et al.*, J. Phys. Radium, **8**, 238, 1947.
[2] Ragandeep Singh Sidhu, Ph.D. Thesis, Ruprecht-Karls-Universität, 2021.
[3] K. Takahashi *et al.*, Phys. Rev. C, **36**, 1522, 1987.
[4] S. Liu *et al.*, Phys. Rev. C, **104**, 024304, 2021.

MS 9.4 Thu 15:00 MS-H9

Search of the exotic nuclear two-photon emission decay in isochronous heavy ion storage rings — •David Freire[1,2,3,4], F. Çağla Akinci[5], Klaus Blaum[1,2], Wolfram Korten[3], Yuri A. Litvinov[2,4], Shahab Sanjari[4,6], and the E143 Collaboration[4] — [1]Max Planck Institute for Nuclear Physics, D-69117 Heidelberg, Germany — [2]Heidelberg University, D-69117 Heidelberg, Germany — [3]IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France — [4]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [5]Istanbul University, T-34452 Istanbul, Turkey — [6]Aachen University of Applied Sciences, D-52005 Aachen, Germany

The nuclear two-photon (2γ) decay is a rare decay mode in atomic nuclei whereby a nucleus in an excited state emits two gamma rays simultaneously. First order processes usually dominate the decay, however two-photon emission may become significant when first order processes are forbidden or strongly retarded, which can be achieved at the experimental storage ring ESR (GSI/FAIR). Within this work we will present the implemented methodology and the obtained results of two beam times performed in 2021, when for the first time the isochronous mode of ESR alongside non-destructive Schottky detectors were operated for the study of short-lived isomer production yields and lifetimes. We investigated specifically the isotope ^{72}Ge, as it is the most easily accessible nucleus having a first excited 0^+ state below the pair creation threshold paramount for the study of 2γ decay without competition of first order decays. In addition, the nuclei ^{70}Se and ^{72}Br were studied, as their isomeric states play a major role in nuclear astrophysics.