MS 2: Storage Rings

Time: Monday 14:00–15:15 Location: f128

Invited Talk MS 2.1 Mon 14:00 f128

Reaction studies with internally cold molecular ions in a storage ring — •Oldrich Novotny — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

In last decades room-temperature ion storage rings have proven to be unique tools for investigating properties and reaction dynamics of molecular ions, in particular the low-energy electron-ion collisions in merged beams. This is mainly due to 1) the long storage of the ions allowing relaxation of the internal ion states and 2) the ion beam target preparation for experiments at high collision-energy resolution by e.g., electron cooling. The recently built Cryogenic Storage Ring (CSR) [1] in Heidelberg, Germany, with its < 6 K vacuum wall temperature brings these advantages to a new level: the low radiation field allows the molecules to relax down to their ro-vibrational ground-state. Studying collisions of cold molecular ions with electrons, photons, and atoms give access to unprecedented details on the respective reaction dynamics. Also, the CSR environment mimics well the conditions in the cold interstellar medium, which makes CSR an outstanding experimental set-up for laboratory astrochemistry.

In the talk the measurements from the first four years of CSR operation will be reviewed, with an emphasis on the recent rotational-state resolved dissociative recombination studies [2].

[1] R. von Hahn et al. Rev. Sci. Instr. 87 063115 (2016)
[2] O. Novotny et al., Science 365, 676 (2019)

MS 2.2 Mon 14:30 f128

Electron-impact rotational de-excitation of CH^+ molecules — •Á Kálosi[1], K. Blaum[1], S. George[1,2], J. Göck[1], M. Grieser[1], F. Grussie[1], R. von Hahn[1], N. Jain[1], C. Krantz[1], H. Kreckel[1], C. Meyer[1], D. Müll[1], O. Novotný[1], F. Nuesslein[1], D. Paul[1], S. Saurabh[1], D. W. Savin[3], V. C. Schmidt[1], P. Wilhelm[1], and A. Wolf[1] — [1]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [2]University of Greifswald, Germany — [3]Columbia University, New York, NY, USA

Hydrides are the first molecules to form in the interstellar medium due to the abundance of hydrogen. The CH^+ ion was the first molecular cation identified in the interstellar medium. Interpretation of the observed spectrum relies, in part on radiative transfer models built on a knowledge of all the relevant excitation and de-excitation processes, such as inelastic collisions with electrons. Here we present merged beams experiments of CH^+ ions with the recently implemented electron cooler at the Cryogenic Storage Ring (CSR) in Heidelberg. This experimental setup facilitates low (meV) collision energy measurements to study inelastic electron-ion collisions. We combined the collision measurements with near-threshold photodissociation to directly probe the populations of the lowest rotational states of the stored CH^+ beam. Using a velocity-matched or slightly detuned electron beam, we can for the first time experimentally determine electron-impact rotational excitation and de-excitation rates for CH^+. Here we will present preliminary results.

MS 2.3 Mon 14:45 f128

Metastable states of the silicon anion observed in a cryogenic storage ring — •D. Müll[1], K. Blaum[1], S. George[1,2], M. Grieser[1], F. Grussie[1], E.A. Guerin[1], J. Göck[1], R. von Hahn[1], N. Jain[1], Á. Kálosi[1], C. Krantz[1], H. Kreckel[1], O. Novotný[1], F. Nuesslein[1], D. Paul[1], S. Saurabh[1], C. Schumacher[1], V. Schmidt[1], S. Sunil Kumar[1], X. Urbain[3], P. Wilhelm[1], A. Wolf[1], and A. Znotins[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, Germany — [3]Institute of Condensed Matter and Nanosciences, Université Catholique de Louvain, Louvain-la-Neuve B-1348, Belgium

We have used the Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics to study the metastable states of the silicon anion. We stored fast Si^- ions (58 keV kinetic energy) in the ultra-high cryogenic vacuum of the CSR, using only electrostatic deflection elements. We used several continuous wave laser systems at 633 nm, 980 nm, 1064 nm, 1390 nm and 2700 nm as well as a tunable pulsed optical parametric oscillator to obtain information about the decay of the metastable anionic states by selective photodetachment. Our data shows evidence for the existence of an extremely long-lived metastable state with a lifetime of several hours and of another very weakly-bound metastable state with a lifetime of around 20 s. We compare our results to state-of-the-art calculations of Si^- metastable lifetimes, which show considerable differences in the predicted time constants.

MS 2.4 Mon 15:00 f128

MOCCA: operating a full 4k-pixel molecule camera for the position and energy resolved detection of neutral molecular fragments — •Lisa Gamer[1], Steffen Allgeier[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Julia Hauer[1], Sebastian Kempf[1], Oldřich Novotný[2], Dennis Schulz[1], Sebastian Spaniol[2], and Andreas Wolf[2] — [1]Kirchhoff-Institute for Physics, Heidelberg University — [2]Max-Planck-Institute for Nuclear Physics, Heidelberg

The MOCCA detector is a high-resolution, large-area molecule camera based on metallic magnetic calorimeters and read out with SQUIDs that has the ability to detect neutral molecule fragments with keV kinetic energies. MOCCA is an array of 64 × 64 quadratic pixels with a side length of 700 μm and covers a total detection area of 4.5 cm × 4.5 cm with a filling factor of 99.5 %. It will be deployed at the Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg, a storage ring built to prepare and store molecular ions in their rotational and vibrational ground states, enabling studies on electron-ion interactions. To reconstruct the reaction kinematics, MOCCA is able to measure the energy and position of multiple incident particles hitting the detector simultaneously.

We present the fabrication of Through-Wafer Vias together with new measurements of a full-scale MOCCA detector, demonstrating the readout principle, multi-hit capability, and energy resolution of less than 200 eV, combined with a very low cross-talk between pixels.