Symposium Interactions with Negatively Charged Molecules (SYIN)

jointly organised by
the Mass Spectrometry Division (MS) and
the Molecular Physics Division (MO)

Robin Golser
Universität Wien
Währinger Straße 17
1090 Wien, Austria
robin.golser@univie.ac.at

Karin Hain
Universität Wien
Währinger Straße 17
1090 Wien, Austria
karin.hain@univie.ac.at

Alkwin Slenczka
Universität Regensburg
Universitätsstraße 31
93053 Regensburg, Germany
Alkwin.Slenczka@chemie.uni-regensburg.de

This symposium focuses on interactions of charged molecular species with photons and on collisions with other gas-phase species. Both processes are of particular interest for emerging isobar separation techniques in Accelerator Mass Spectrometry at low energies. Contributions from astrochemistry, elementary reaction studies, neutralization collisions, fundamental studies of atomic and molecular ions show the innovative potential of this research.

Overview of Invited Talks and Sessions

(Lecture hall RW 1)

Invited Talks

SYIN 1.1	Thu	11:00–11:30	RW 1	**Negative ion studies at ISOLDE: from radioactive atoms to molecules** — •Jessica Warbinek
SYIN 1.2	Thu	11:30–12:00	RW 1	**Leak-out spectroscopy in cryogenic ion traps** — •Stephan Schlemmer, Oskar Asvany, Sven Thorwirth, Philipp Schmid, Weslley Silva, Thomas Salomon
SYIN 1.3	Thu	12:00–12:30	RW 1	**Studies of negative ions in a cryogenic storage ring using laser driven state manipulation** — •Dag Hanstorp
SYIN 1.4	Thu	12:30–13:00	RW 1	**Photodetachment spectroscopy and reactions of negative molecular ions** — •Roland Wester

Sessions

SYIN 1.1–1.4	Thu	11:00–13:00	RW 1	**Symposium Interactions with Negatively Charged Molecules (SYIN)**

SYIN 1: Symposium Interactions with Negatively Charged Molecules (SYIN)

Time: Thursday 11:00–13:00 Location: RW 1

Invited Talk SYIN 1.1 Thu 11:00 RW 1

Negative ion studies at ISOLDE: from radioactive atoms to molecules — •Jessica Warbinek for the CRIS-Collaboration — CERN, Switzerland — KU Leuven, Belgium

Negative ions form when an atom or molecule binds an additional electron, creating fragile and highly correlated quantum systems. Strong electron-electron interactions dominate their structure, making negative ions ideal laboratories for studying electron correlation effects. A key property is the electron affinity, which provides insight into molecular bonding mechanisms and fundamental molecular properties. Negative ions also play an important role in interstellar chemistry, accelerator mass spectrometry, and antimatter research, motivating detailed studies of their electronic structure.

Over past decades, electronic structures of negative ions have been studied across the periodic table, reaching as far as U^-. However, several elements, particularly those without stable isotopes, remain experimentally unexplored. A major step toward this region was achieved with the on-line study of a radioactive negative ion, At^-, performed at ISOLDE, CERN. Recent developments at the CRIS experiment have further expanded access to radioactive elements and molecules. In particular, production via double-charge exchange enabled the first determination of the electron affinities of Po^- and of RaF^-.

This talk presents recent methodological advances and outlines new opportunities for studies of radioactive negative ions, including groundwork for novel proposed cooling and trapping schemes for heavy radioactive molecules for tests of fundamental symmetries.

Invited Talk SYIN 1.2 Thu 11:30 RW 1

Leak-out spectroscopy in cryogenic ion traps — •Stephan Schlemmer, Oskar Asvany, Sven Thorwirth, Philipp Schmid, Weslley Silva, and Thomas Salomon — I. Physikalisches Institut, Universität zu Köln

Action spectroscopy in ion traps is a rather mature field of molecular spectroscopy with infrared multiple photon dissociation (IRMPD) being the most widely spread technique. A relatively new method is leak-out spectroscopy (LOS, [1]), where mass selected ions are stored in a cryogenic trap. Upon internal excitation these ions undergo collisions with a buffer gas which convert this energy partially into kinetic energy such that the ions can leave the trap and be counted in a detector. We will demonstrate the method and present example rotational, vibrational and electronic spectra of selected molecular ions. Some of these spectra are used to find those molecules in space based on astronomical observations. Recent advances of LOS will be discussed.
References: [1] P. C. Schmid, O. Asvany, T. Salomon, S. Thorwirth, and S. Schlemmer, J. Phys. Chem. A, 126, 8111-8117 (2022)

Invited Talk SYIN 1.3 Thu 12:00 RW 1

Studies of negative ions in a cryogenic storage ring using laser driven state manipulation — •Dag Hanstorp — Department of Physics, University of Gothenburg, SE 412 96 Gothenburg, Sweden

I will in this talk discuss experimental investigations of negative ions at the Double ElectroStatic Ion Ring ExpEriment (DESIREE) in Stockholm. This facility consists of two cryogenic storage rings with a common section where collisions between positive and negative ions can be induced.

I will present measurements of lifetimes of long-lived excited states and high precision measurements of electron affinities. I will further present a study where we in an optically forbidden transition in Sn^- managed to resolve both hyperfine structures and isotope shifts. Finally, I will present a study of the mutual neutralization process $Si^- + Na^+/K^+ \rightarrow Si + Na/K$ using a beam of pure ground-state Si^- ions. These experiments were all made possible by preparing the stored negative ion beam using laser driven state manipulation.

Invited Talk SYIN 1.4 Thu 12:30 RW 1

Photodetachment spectroscopy and reactions of negative molecular ions — •Roland Wester — Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Austria

Negative molecular ions are interesting objects of study as fundamental building blocks of matter. Photodetachment experiments are powerful tools to study the electronic structure of anion and neutral, the long-range electron-molecule interaction, and the bound rovibrational levels of the negative ions. Using cryogenic radiofrequency multipole ion traps we have investigated a range systems, have determined electron affinities, studied dipole-bound states, and investigated optical pumping and inelastic collisions. The trapped negative ions are also well suited to study inelastic scattering and reaction processes, which are important processes in interstellar molecular clouds. Several examples will be presented.