

Research Project

Hybrid trapping of cold molecules and cold ions

Third-party funded project

Project title Hybrid trapping of cold molecules and cold ions

Principal Investigator(s) Willitsch, Stefan ;

Organisation / Research unit

Departement Chemie / Chemische Physik (Willitsch)

Department

Project start 01.10.2014

Probable end 30.09.2017

Status Completed

The recent development of "hybrid" traps for the simultaneous trapping of cold atoms and cold ions has initiated a new field of research concerned with the study of ion-atom interactions at extremely low temperatures. This new technology has opened up exciting new research directions such as the possibility to engineer new types of quantum systems and to explore ion-neutral collisions and chemical reactions at ultralow collision energies.

We propose to develop a new experimental setup which will enable for the first time the simultaneous trapping of neutral molecules and molecular ions at translational temperatures down to millikelvins (the "cold regime"), thereby pushing hybrid trapping technology to a new level. Translationally cold molecules will be generated by Stark deceleration of molecular beams. The cold molecules will be loaded into a magnetic trap integrated into a linear radiofrequency ion trap. Cold atomic and molecular ions will be generated by laser and sympathetic cooling, respectively, forming Coulomb crystals to be superimposed onto the cloud of cold molecules stored in the magnetic trap. Both species will be prepared in well-defined electronic, vibrational and rotational quantum states thus enabling the characterization of state-specific effects in cold ion-molecule interactions. The hybrid trap will be placed in a cryogenic environment held at a temperature $T \approx 10$ K to suppress the blackbody-radiation assisted redistribution of internal-state populations of the molecules. This measure will serve to preserve the internal molecular states and increase the trap lifetimes of the neutrals by several orders of magnitude.

The development proposed here will enable for the first time the study of collisions between neutral molecules and molecular ions in the cold regime and will pave the way for the exploration of distinctly molecular effects in ion-neutral interactions at very low translational temperatures. With the new setup, we will study the dynamics of cold collisions and explore elastic, inelastic and reactive processes between molecular ions and neutral molecules. Collision and reaction cross sections will be obtained as a function of the internal quantum states of the collision partners and their collision energy. The experimental results will be analyzed with the help of classical and quantum scattering calculations. Our first studies will concentrate on prototypical collision systems such as $\text{OH} + \text{Ca}^+$, N_2^+ and H_2O^+ .

Financed by

Swiss National Science Foundation (SNSF)

Add publication

Add documents

Specify cooperation partners