SYMC 1: Molecular collisions at ultracold temperatures I

Zeit: Montag 14:00–16:00 Raum: 5D

Hauptvortrag SYMC 1.1 Mo 14:00 5D

Towards the study of ultracold ion-molecule reactions — •Timothy Softley, Martin Bell, David Carty, Alexander Gingell, and James Oldham — Department of Chemistry, University of Oxford, Chemistry Research Laboratory, Mansfield Rd, Oxford, OX1 3TA, United Kingdom

In the sub-Kelvin temperature range, the de Broglie wavelength of colliding species becomes long compared to molecular dimensions and a range of quantum effects will play an important role in determining the dynamics of reactive collisions. However, only reactions with a low activation barrier will have rates that are amenable to study. Ion-molecule reactions are a general category of reactions with negligible activation barriers; free-radical insertion reactions are another suitable category, as are reactions of electronically excited species. In this presentation we describe the development of experiments which are geared towards studying ultracold ion-molecule chemistry. A Coulomb-crystal device has been set up in which calcium ions are laser cooled into the milliKelvin range. The characterization of the temperature of the ions formed in regular arrays, and the possibilities for sympathetic cooling of state-selected molecular ions will be discussed. This device is to be combined with a low-temperature source of neutral dipolar species, which are produced by either a quadrupole guide velocity selector, or by a 130-stage Stark decelerator. We are also developing a decelerator for Rydberg molecules, and a source of ultracold atoms based on photodissociation. Progress towards combining these sources for reactive studies will be discussed.

Hauptvortrag SYMC 1.2 Mo 14:30 5D

Molecular collisions in magnetic fields — •Jeremy Hutson — Department of Chemistry, Durham University, Durham, DH1 3LE, UK

The control of atom-atom interactions using magnetic fields has been crucial to recent advances in atomic physics. Similar control should be possible for atom-molecule and molecule-molecule collisions. We have generalized the BOUND and MOLSCAT packages to allow calculations in magnetic fields, initially for collisions of molecules in multiplet Sigma states with structureless atoms [1]. We have used the new capability to carry out bound-state and scattering calculations on 3He+NH and 4He+NH as a function of magnetic field. Following the bound-state energies to the point where they cross thresholds gives very precise predictions of the magnetic fields at which zero-energy Feshbach resonances occur.

We have located and characterized two very narrow zero-energy Feshbach resonances in 4He+NH. One resonance shows a pole in the scattering length as usually observed for atomic collisions, but for the second resonance the pole in the scattering length is dramatically suppressed and the cross sections show relatively small peaks.

The suppression of the pole in the scattering length is due to inelastic scattering. This is a general result, applicable to both atomic and molecular collisions [2]. In general, poles will be strongly suppressed whenever the resonant state is coupled with comparable strength to the elastic and inelastic channels.

[1] M. L. Gonzalez-Martinez and J. M. Hutson, arXiv:physics/0610214 (2006). [2] J. M. Hutson, arXiv:physics/0610210 (2006).

Hauptvortrag SYMC 1.3 Mo 15:00 5D

Photodynamics of Atoms in and on Helium Nanodroplets — •Marcel Drabbels — Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland

The photodynamics of excited silver atoms dissolved in, and sodium atoms attached to helium nanodroplets has been investigated. Embedded silver atoms are excited from the 5s $^2S_{1/2}$ state to either the 5p $^2P_{1/2}$ or $^2P_{3/2}$ state. The excited species are subsequently ionized by a second photon to provide time-of-flight mass spectra, photoelectron and ZEKE spectra. The experiments indicate that the helium environment induces non-adiabatic transitions between the different electronic states before the silver atoms are being ejected from the droplets. Ion imaging experiments demonstrate that the speed distributions of ejected Ag atoms depends on the excited state and consequently are not related to the critical Landau velocity, *i.e.* the velocity below which no energy and momentum can be transferred from a moving object to the helium environment.

Sodium atoms attached to the surface of the droplets are electronically excited and subsequently ionized. The excitation spectrum has been recorded up to the ionization threshold and indicates that the sodium atoms desorb from the droplets independent of the electronic state excited. Photoelectron spectroscopy and ion imaging experiments indicate that the helium environment induces a fast relaxation of the excited sodium atoms before they desorb from the droplets.

Hauptvortrag SYMC 1.4 Mo 15:30 5D

Ultracold molecules in an optical lattice — •Johannes Hecker Denschlag — Institut für Experimentalphysik, Universität Innsbruck, 6020 Innsbruck, Austria

An optical lattice is an excellent environment to produce, manipulate and study ultracold molecules. We describe recent experiments where we have created a pure ultracold ensemble of Rb_2 dimers in various well defined quantum states in the electronic ground state. Starting from an atomic ^{87}Rb condensate which is adiabatically loaded into a 3D optical lattice we first create Feshbach molecules by ramping over a Feshbach resonance. A purification scheme based on a combined laser and radiofrequency pulse removes all unbound atoms. Using optical STIRAP (stimulated Raman adiabatic passage) or a radio frequency sweep, we can efficiently transfer these Feshbach molecules to a more deeply bound vibrational level. In this way we create well defined mixtures and coherent superpositions of molecular states which can later be used to invesigate molecular interactions and collisions. Besides studying chemically bound molecules, optical lattices also allow forming a novel kind of stable bound state of two atoms which is based on repulsion rather than attraction between the particles. We will explain how these lattice-induced repulsively bound atom pairs come about and discuss their interesting properties.