SYMC 2: Molecular collisions at ultracold temperatures II

Zeit: Montag 16:30–18:30 Raum: 5D

Hauptvortrag SYMC 2.1 Mo 16:30 5D

Cold Molecular Ions: Single Molecule Studies — •Michael Drewsen — Department of Physics and Astronomy, University of Aarhus, Ny Munkegade, Build. 1520, DK-8000, Aarhus C, Denmark

In ion traps, the translational motion of molecular ions can effectively be sympathetically cooled to temperature in the mK range through the Coulomb interaction with laser cooled atomic ions. At such low temperatures the molecular ions typically become part of spatial ordered structures (Coulomb crystals) in which the individual molecules can be localized within a few μm^3. The extreme situation of having only a single laser-cooled atomic ion interacting with a single molecular ion is an ideal starting point for single molecule studies. A few years back, we have demonstrated a rather simple non-destructive technique for the identification of the single molecular ion in such a situations relying on an in-situ mass measurement of the molecule. In the talk, I will focus on two recent single molecule studies using this technique, namely, photofragmentation of singly changed Aniline ions ($C_6H_7N^+$) and isotope effects in the reaction of $^{26}Mg^+$ atomic ions with a H_2, HD, and D_2 molecules.

Hauptvortrag SYMC 2.2 Mo 17:00 5D

Cool anion molecule collisions — •Jochen Mikosch, Sebastian Trippel, Rico Otto, Christoph Eichhorn, Matthias Weidemüller, and Roland Wester — Physikalisches Institut, Universität Freiburg

Collisions of neutral molecules with anions at low relative energy are strongly affected by long range ion-dipole interactions. On the potential energy surface reactions are steered through deeply bound entrance and exit channel complexes separated by a central barrier. We investigate the quantum dynamics of reactive collisions, in particular rovibrational state dependencies, tunneling, and stereodynamical effects.

For the S_N2 reaction $Cl^- + CH_3Cl$ we were able to stabilize the short lived collision complex in a high order multipole trap by a third impacting particle. The three body association is strongly enhanced for decreasing temperature. On the other hand the proton transfer of H_2 to NH_2^- exhibits a maximal rate coefficient at around 20 K and is strongly suppressed for decreasing temperature. We also investigate slow collisions of anions with cold neutrals at fixed energy rather than temperature. Crossed beam ion imaging gives access to the doubly differential cross section. A detailed study of the S_N2 reaction $Cl^- + CH_3I \longrightarrow ClCH_3 + I^-$ shows the cone of acceptance opening up for increasing collision energy accompanied by excitation of many vibrational quanta in the molecular product.

We will extend our studies to the stereodynamics of ion-molecule reactions using microsolvated anions, which are subject to stereodynamics hindrance, and alignment in strong laser fields.

Hauptvortrag SYMC 2.3 Mo 17:30 5D

Controlled Xe-OH collisions and the OH(v=1) radiative lifetime — •Gerrit Groenenboom — Theoretical Chemistry, Institute for Molecules and Materials, Radboud University Nijmegen, Toernooiveld 1, 6525ED Nijmegen, The Netherlands

Beams of polar molecules can be produced with very well controlled velocities with the Stark deceleration technique developed by Gerard Meijer and coworkers. In a recent proof-of-principle experiment this was used to study collisions of Xe with Stark controlled OH in the 50-400 wavenumber region [1]. Inelastic cross sections were determined for several rotational and spin orbit inelastic transitions. I will present calculated Xe-OH potential energy surfaces, theoretical cross sections, and the comparison with experiment.

In earlier work Stark decelerated OH was loaded into an electrostatic quadrupole trap. The long observation time in the trap made it possible to measure the radiative lifetime, which was found to be 59 +/- 2 ms., in excellent agreement with our calculations [2]. I will present new results for the OH Meinel system [3].

[1] J. J. Gilijamse, S. Hoekstra, S. Y. T. van de Meerakker, G. C. Groenenboom, and G. Meijer, Science, 313, 1617 (2006)

[2] S. Y. T. van de Meerakker, N. Vanhaecke, M. P. J. van der Loo, G. C. Groenenboom, and G. Meijer, Phys. Rev. Lett., 95, 013003 (2005).

[3] Mark P. J. van der Loo and Gerrit C. Groenenboom, J. Chem. Phys., accepted (2007).

Hauptvortrag SYMC 2.4 Mo 18:00 5D

Molecular collision studies with Stark-decelerated beams — •Gerard Meijer — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin, Germany

Molecular scattering behavior has generally proven difficult to study at low collision energies. We formed a molecular beam of OH radicals with a narrow velocity distribution and a tunable absolute velocity by passing the beam through a Stark decelerator. The transition probabilities for inelastic scattering of the OH radicals with Xe atoms were measured as a function of the collision energy in the range of 50 to 400 wavenumbers, with a high intrinsic energy resolution. The behavior of the cross-sections for inelastic scattering near the energetic thresholds was accurately measured, and excellent agreement was obtained with cross-sections derived from coupled-channels calculations on ab initio computed potential energy surfaces [Science 313, (2006) 1617-1620]. The possibilities to perform collision studies using either two Stark-decelerated beams in a crossed beam configuration or counter-propagating packets of molecules in a molecular synchrotron will be discussed. Time permitting, our experimental approach to the sympathetic cooling of polar molecules with ultra-cold Rb atoms will be presented as well.