

## MO 22: Cold Molecules 3

Time: Friday 10:30–12:00

Location: BEBEL SR144

MO 22.1 Fri 10:30 BEBEL SR144

**Low energy scattering of Stark-decelerated OH radicals with ortho- and para-H<sub>2</sub> molecules** — ●H.C. SCHEWE<sup>1</sup>, X. WANG<sup>1</sup>, S. Y. T. VAN DE MEERAKKER<sup>2</sup>, G. MEIJER<sup>1,2</sup>, Q. MA<sup>3</sup>, J. KLOS<sup>3</sup>, P. J. DAGDIGIAN<sup>3</sup>, M. H. ALEXANDER<sup>3</sup>, A. V. D. AVOIRD<sup>2</sup>, and N. VANHAECKE<sup>1,4</sup> — <sup>1</sup>Fritz-Haber-Institut der Max-Planck-Gesellschaft Faradayweg 4-6, 14195 Berlin, Germany. — <sup>2</sup>Radboud University Nijmegen, Institute for Molecules and Materials, Heijendaalseweg 135, 6525 AJ Nijmegen, the Netherlands. — <sup>3</sup>Department of Chemistry and Biochemistry and Institute for Physical Science and Technology, University of Maryland, College Park, MD 20742-2021, USA. — <sup>4</sup>Laboratoire Aimé Cotton, CNRS, Université Paris-Sud, 91405 Orsay, France.

The crossed beam scattering is an important experimental method to investigate molecular interactions, which can lead to energy transfer or chemical reactions. The Stark deceleration technique yields control over both the internal and external degrees of freedom of polar molecules in a molecular beam. The combination of these techniques opens up deeper investigations of molecular scattering processes as a function of the collision energy with a very high energy resolution.

Results on inelastic scattering of ortho- or para-H<sub>2</sub> with Stark-decelerated OH(X <sup>2</sup>Π<sub>3/2</sub>, J = 3/2, f) at collision energies between 60–150 cm<sup>-1</sup> are presented. The main difference in the scattering process of ortho- and para-H<sub>2</sub> is seen in the relative cross sections, originating from the different multipole interactions involved and are compared with theory.

MO 22.2 Fri 10:45 BEBEL SR144

**Ne\* + NH<sub>3</sub>: Polyatomic Chemical Reactions in the Low-Temperature Regime** — ●JUSTIN JANKUNAS, BENJAMIN BERTSCHE, and ANDREAS OSTERWALDER — Ecole Polytechnique Federale de Lausanne

A novel merged beam (MB) technique for neutral molecules has been employed to study bimolecular collisions between electronically excited neon atoms and supersonically cooled ammonia molecules. Cross sections of the two reaction channels, namely Ne\* + NH<sub>3</sub> → Ne + NH<sub>3</sub><sup>+</sup> + e<sup>-</sup> and Ne\* + NH<sub>3</sub> → Ne + NH<sub>2</sub><sup>+</sup> + H + e<sup>-</sup>, have been measured as a function of relative velocity between Ne\* and NH<sub>3</sub>. The lowest and highest collision energies achieved are 0.1 K (8 μeV) and 250 K (0.22 meV), respectively. We find that the cross section for the two reaction channels increases upon lowering the collision energy. The long range forces dominate the outcome of a reaction in the 0.1 K to ~ 10 K temperature range. The role played by short-ranged chemical forces becomes apparent when the collision energy is greater than ~ 10 K. We have also measured the ratio, Γ = NH<sub>2</sub><sup>+</sup> / (NH<sub>2</sub><sup>+</sup> + NH<sub>3</sub><sup>+</sup>), of the two reaction channels. Surprisingly, the ratio is constant (Γ ~ 0.3) in the collision energy range studied, defying our naïve expectation that as the collision energy vanishes, a channel with a lower minimum energy path dominates the reaction. We suggest that similar effects may be present in other electron transfer reactions.

MO 22.3 Fri 11:00 BEBEL SR144

**Ultracold collisions of a<sup>3</sup>Σ<sub>u</sub><sup>+</sup> molecules** — ●BJÖRN DREWS, MARKUS DEISS, BENJAMIN DESSLER, and JOHANNES HECKER DEN-SCHLAG — Institut für Quantenmaterie, Universität Ulm

We prepare a sample of ultracold <sup>87</sup>Rb<sub>2</sub> molecules in the a<sup>3</sup>Σ<sub>u</sub> rovibrational ground state in a three dimensional optical lattice. Starting from there we allow interaction in one (cigar-shaped trap) or two (pancake trap) directions. Fast inelastic two-body-collision losses are expected due to the energetically lower-lying x<sup>1</sup>Σ<sub>g</sub> potential. The observed lifetimes are on timescales ranging from a few up to hundreds of milliseconds and we see a dependency on the trap depth and on the external magnetic field.

With the ability to change the internal state of the molecule as well as the surrounding fields these experiments present a testing ground for ultracold chemistry. Data over a wide range of different experimental parameters will be shown as well as their placement in a theoretical background.

MO 22.4 Fri 11:15 BEBEL SR144

**Non-adiabatic alignment of molecules dissolved in small helium clusters** — G. GALINIS<sup>1</sup>, L.G. MENDOZA LUNA<sup>1</sup>, M. WATKINS<sup>1</sup>,

●K. VON HAEFTEN<sup>1</sup>, R. MINNS<sup>2</sup>, A.M. ELLIS<sup>3</sup>, R. CHAPMAN<sup>4</sup>, C. CACHO<sup>4</sup>, E. TURCU<sup>4</sup>, E. SPRINGATE<sup>4</sup>, M. MLADENOVICH<sup>5</sup>, M. LEWERENZ<sup>5</sup>, L. KAZAK<sup>6</sup>, R. IRSIG<sup>6</sup>, S. SKRUSZEWICZ<sup>6</sup>, S. GÖDE<sup>6</sup>, J. TIGGESBÄUMKER<sup>6</sup>, K.H. MEIWES-BROER<sup>6</sup>, A. ROUZEE<sup>7</sup>, and R. ZILLICH<sup>8</sup> — <sup>1</sup>Dep. of Physics and Astronomy, University of Leicester, UK — <sup>2</sup>Dep. of Chemistry, University of Southampton, UK — <sup>3</sup>Dep. of Chemistry, University of Leicester, UK — <sup>4</sup>Central Laser Facility, Rutherford Appleton Lab, UK — <sup>5</sup>Laboratoire Modelisation et Simulation, University of Paris-Est, Marne-la-Valee, France — <sup>6</sup>Institute for Physics, University of Rostock, Germany — <sup>7</sup>Max Born Institute, Berlin, Germany — <sup>8</sup>Institute for Theoretical Physics, University Linz, Austria

The rotational dynamics of C<sub>2</sub>H<sub>2</sub> molecules in small helium clusters was investigated using laser induced alignment in a pump-probe experiment. The Fourier-transform of the time-trace shows sharp, cluster-specific spectral features with coherence times limited only by our experimental resolution, contrary to the findings for molecules in helium droplets<sup>1</sup>. The generation of highly charged atomic and molecular ions, the formation and propagation of rotational and vibrational wavepackets, the role of cluster size and the relevance of this work in the study of incipient superfluid effects in small helium clusters will be discussed.

<sup>1</sup> D. Pentlehner et al., Phys. Rev. Lett. **110**, 093002 (2013)

MO 22.5 Fri 11:30 BEBEL SR144

**IR spectroscopy of biomolecular ions in liquid helium droplets** — ●DOO-SIK AHN, ANA ISABEL GONZALEZ FLORENZ, and GERT VON HELDEN — Fritz-Haber-Institut, Berlin, Germany

Liquid helium droplets are ideal nano-cryostats for the investigation of molecules because of intrinsic characters of superfluid helium droplets such as isothermality at 0.38 K, the weak interaction between the helium matrix and dopant, and a transparency over a wide spectral range from the far IR to the deep UV. For the application of this technique to the cooling and spectroscopic investigation of biomolecular ions in the gas phase, we have developed an experimental setup where mass/charge selected biomolecular ions picked up by helium droplets. The size-distributions of ion-doped He droplets are analyzed by the measurement of arrival time distributions at different acceleration field. IR Spectroscopy can be performed by irradiating the ion-doped He droplets with a pulsed laser and monitoring ejected ions as a function of wavelength. In this talk, we will report very recent result of IR spectroscopy of various peptide ions doped in He droplets using FHI(Fritz-Haber-Institut) free electron laser.

MO 22.6 Fri 11:45 BEBEL SR144

**Rydberg states of alkali atoms on helium nanodroplets: Screening effects of a nanosized helium dielectric** — FLORIAN LACKNER, GÜNTER KROIS, and ●WOLFGANG E. ERNST — Institute of Experimental Physics, Graz University of Technology, Graz, Austria

Rydberg series of Rb and Cs atoms on the surface of helium nanodroplets (HeN) [1] have been studied by resonance enhanced multiphoton ionization and laser induced fluorescence spectroscopy. The recorded excitation spectra [2,3] are analyzed by using a Rydberg-Ritz approach [4]. The dependence of the quantum defects on the principal quantum number within a Rydberg series gives insight into the interaction between the alkali valence electron and the superfluid helium droplet. For higher excited states, a screening of the valence electron from the alkali atom core by the helium droplet is observed, i.e. the helium reduces the probability to find the high-n electron nearby the core [4]. For lower states, the screening effect decreases and the quantum defects are found to lie closer to free atom values. In addition, the large spin-orbit constant of the Cs-HeN P states allows a detailed study of the influence of the helium droplet on the SO splitting as function of the principal quantum number. [1] C. Callegari and W.E. Ernst, in Handbook of High-Resolution Spectroscopy, edited by M. Quack and F. Merkt (John Wiley & Sons, Chichester, 2011), Vol. 3, pp. 1551-1594 [2] F. Lackner, G. Krois, M. Theisen, M. Koch, and W. E. Ernst, Phys. Chem. Chem. Phys. 2011, 13, 18781 [3] F. Lackner, G. Krois, M. Koch, and W. E. Ernst, J. Phys. Chem. Lett. 2012, 3, 1404 [4] F. Lackner, G. Krois, and W. E. Ernst, Mol. Phys. 2013, 111, 2118