MO 29: Poster: Cold Molecules

Zeit: Dienstag 16:30–18:30 Raum: Poster A

MO 29.1 Di 16:30 Poster A

BEC in the Coffee Mug? — •Whally Dilbert — United Feature Syndicate, Inc.

During the recent years, unprecedented levels of unverifiable productivity were achieved with shaped sips. We will discuss slurping efficiency on a temperature scale from 350K down to a few mK. Predictions of the sippability of an eventually emerging BEC will be made.

MO 29.2 Di 16:30 Poster A

Controlling Molecular Orientation through Radiative Rotational Transitions in Strong Static Electric Fields — •Michael Mayle[1], Rosario Gonzalez-Ferez[2], and Peter Schmelcher[1,3] — [1]Theoretische Chemie, Physikalisch-Chemisches Institut, Im Neuenheimer Feld 229, D-69120 Heidelberg, Germany — [2]Instituto 'Carlos I' de Física Teórica y Computacional and Departamento de Física Atómica Molecular y Nuclear, Universidad de Granada, E-18071 Granada, Spain — [3]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, D-69120 Heidelberg, Germany

The effects of a static, homogeneous and strong electric field on the radiative and steric properties of the LiCs molecule in its $^1\Sigma^+$ electronic ground state are investigated. Combining discretization and basis-set methods, the rovibrational Schrödinger equation is solved and dipole transition rates are calculated. Spontaneous emission decay rates and radiative lifetimes of rovibrationally excited states have been studied extensively, incorporating in particular the interaction with the external field. Furthermore, the intriguing possibility to control the alignment and orientation of the molecules by applying a sufficiently strong field while switching between different rotational configurations via absorption and emission processes is demonstrated.

MO 29.3 Di 16:30 Poster A

Spectroscopy of the $X^1A_1 \rightarrow A^1A_2$ transition of formaldehyde in the 329-331.7 nm region: The $2_0^1 4_0^3$ rovibrational band — •Michael Motsch, Markus Schenk, Martin Zeppenfeld, Pepijn W.H. Pinkse, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany

Optical manipulation of cold polar molecules necessitates a molecule with strong electronic transitions, preferably in a spectral region accessible with standard cw-laser techniques, and a large Stark shift for efficient electric guiding and trapping. Slow beams of up to $10^{10}\,s^{-1}$ formaldehyde molecules with velocities around 50 m/s have been produced [1]. Moreover formaldehyde (H_2CO) exhibits a rich ultraviolet spectrum between 280 and 360 nm [2].

Room-temperature absorption spectroscopy is performed in a multipass setup at H_2CO pressures of 50 Pa. The use of a frequency-doubled cw dye laser allows higher resolution than previous studies relying on pulsed dye lasers [3]. Comparison between calculations based on available rotational constants and our measurement indicates the necessity to include sixth-order centrifugal distortion coefficients.

Progress towards state-dependent detection of electrically guided formaldehyde molecules is discussed.

[1] S.A. Rangwala et al., Phys. Rev. A **67**, 043406 (2003)
[2] G. Herzberg, Molecular Spectra and Molecular Structure 3, Van Nostrand Reinhold Company, New York 1966
[3] C.A. Smith et al., J. Phys. Chem. A **110**, 11645-11653 (2006)

MO 29.4 Di 16:30 Poster A

Interactions of negative ions in multipole traps — •Jochen Mikosch[1], Sebastian Trippel[1], Rico Otto[1], Markus Debatin[1], Michael Kröner[2], Christoph Eichhorn[1], Peter Woias[2], Matthias Weidemüller[1], and Roland Wester[1] — [1]Physikalisches Institut, Universität Freiburg — [2]Institut für Mikrosystemtechnik, Universität Freiburg

We study reactions of negative ions down to the previously unexplored temperature range below 25 Kelvin, where small molecular ions are prepared predominantly in the rovibrational ground state. Here we present recent results obtained in a temperature variable 22pole trap. Evaporation of atomic anions over the effective barrier gives insight into the stability of ion motion and allows us to determine absolute trap depths. The absolute cross section of OH^- photodetachment was measured using a tomography scan and found to depend on the rotational quantum state. Proton transfer from H_2 to NH_2^- shows an unexpected decrease in the absolute rate coefficient below 20 K indicating a very small reaction barrier. Finally, the three body association of Cl^- with CH_3Cl is strongly dependent on the internal structure of the stabilizing agent and shows a very strong enhancement for decreasing temperature.

In a new project we aim at interactions of trapped anions with ultracold Rubidium atoms. For this purpose we have developed a planar 32 pole ion trap on a chip; first storage results have been acchieved. The next ion trap generation will employ ITO electrodes with high optical transmission to allow laser cooling of atoms inside the ion trap.

MO 29.5 Di 16:30 Poster A

Trapping and cooling of single molecular ions for time resolved electron diffraction — •Günther Leschhorn, Steffen Kahra, Axel Friedenauer, Hector Schmitz, Ernst Fill, and Tobias Schätz — Max-Planck-Institut für Quantenoptik, Garching

We propose an experimental setup for the preparation of single, cold and localized molecular ions using a linear Paul-trap. The ions are cooled sympathetically by a Mg^+ or Ba^+-Coulomb crystal stored in the trap. We present a technique to achieve a reliable positioning of the molecular ions after separating them from the crystal at repetition rates on the order of 1 kHz or higher. The reloading scheme operates on axis of the linear Paul-trap and bases on dissipative interaction between the crystal and the molecular ions. This provides us with a source for cold and located charged molecules as targets for time resolved electron diffraction. Our electron gun should emit short electron bunches using recent developments of short and intense laser facilities. It is expected that the diffracted electrons will provide us with information about synchronized and photo triggered structural changes of molecules on a short timescale. Further developments such as the alignment of the molecular ion by fs-laser pulses, internal cooling and the generation of even shorter electron pulses or implementing X-ray pulses should considerably increase the efficiency and suitability of the apparatus and can be discussed.

Supported by: IMPRS, MAP, MPG

MO 29.6 Di 16:30 Poster A

Ein langer Stark-Abbremser für Schwefeldioxid — •Oleg Bucicov, Marcin Nowak, Sebastian Jung, Eberhard Tiemann und Christian Lisdat — Leibniz Universität Hannover

Wir werden einen Stark-Abremser für niedrig-Feld-suchende Zustände mit 326 Stufen vorstellen. Mit diesem Experiment wird es möglich sein, das relativ schwere SO_2 Molekül bis zum Stillstand abzubremsen. Der Aufbau ist die Weiterentwicklung eines erfolgreich getesteten Stark-Abremsers mit 140 Stufen [1]. 326 Stufen sind notwendig, um SO_2 abzubremsen, da das Verhältnis von Stark-Energie zu kinetischer Energie trotz des groß Dipolmomentes von SO_2 sehr ungünstig ist.

Mit dem abgebremsten, kalten Schwefeldioxid werden dann Experimente zu Photodissoziation durchgeführt. Durch die Möglichkeit der Photodissoziation direkt an der Schwelle können die Fragmente SO und O zustandsselektiv ebenfalls kalt erzeugt werden. Die Überschußenergie ist durch externe Felder einstellbar [2].

[1] S. Jung *et al.*, Phys. Rev. A **7**4, 040701(R), 2006.
[2] S. Jung *et al.*, J. Phys. B **3**9, S1085, 2006.

MO 29.7 Di 16:30 Poster A

Collisions between cold, trapped ND_3 and hot gases — •Christian Sommer, Sebastian Pohle, Thomas Rieger, Laurens D. van Buuren, Pepijn W.H. Pinkse, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans

Currently, there is a wide interest to trap cold molecules at temperatures around 1 Kelvin [1]. At high densities cold collisions and chemical reactions can be studied, whereas the low velocities and long storage times permit high-resolution spectroscopy. Besides, these traps could form the starting point for a second cooling mechanism, such as evaporation, to bring molecules into the ultra-cold regime.

In previous experiments our group demonstrated filtering and trapping of slow polar molecules from an effusive source using an electrostatic guide and storage trap [2]. For ND_3, trap densities up to 10^8 molecules/cm^3 were obtained with a 130 ms life time.

Here, we investigate the trap losses of ND_3 molecules due to collisions with several room-temperature gases. A constant background

pressure in the trap environment is obtained by adding a constant flow of gas with a needle valve. From the data taken at several background pressures, cross sections are inferred. These can be used to estimate collisional losses in future trap geometries or in gaseous environments.

[1] J. Doyle, B. Friedrich, R.V. Krems and F. Masnou-Seeuws, European Physical Journal D **31**, 149 (2004)
[2] T. Rieger, T. Junglen, S.A. Rangwala, P.W.H. Pinkse and G. Rempe, Physical Review Letters **95**, 173002 (2005)

MO 29.8 Di 16:30 Poster A

NaK beam experiments: Cold Collision Studies — Andreas Gerdes, Matthias Hobein, •Alexander Stein, Horst Knöckel, and Eberhard Tiemann — Institut für Quantenoptik, Gottfried Wilhelm Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

Investigation of the potential energy curves (PEC) of singlet and triplet electronic ground states of mixed alkalis allows for the description of cold collisions deriving characteristic properties of the system like scattering lengths or Feshbach resonance positions [1]. Heatpipe measurements were performed as a first approach to the energy structure of the starter molecule NaK. The detailed analysis of the spectra taken in the heatpipe setup will be presented as well as first steps with NaK at a new built beam setup (characterization of the beam conditions). Furthermore first results of experiments supplemental to the heatpipe data will be shown. Most interesting for prediction of scattering properties are the high lying rovibrational levels in the potential to study cold collision spectroscopy as already shown for Na_2 [2]. The next step to the very actual case of KRb (cold molecules produced in a trap) has come into reach.
[1] A. Crubellier *et al.*, Eur. Phys. J. D **6**, 211-220 (1999)
[2] O. Docenko *et al.*, J. Phys. B: At. Mol. Opt. Phys. **39** 929-943 (2006)

MO 29.9 Di 16:30 Poster A

Blackbody thermometry with cold molecular ions and possible application to ion-based frequency standards — •Jeroen Koelemeij, Bernhard Roth, and Stephan Schiller — Institut für Experimentalphysik, Universität Düsseldorf

We have used laser spectroscopy to measure the rotational level distribution of trapped molecular HD^+ ions at translational temperatures in the millikelvin range. Under our experimental conditions, the internal (rotational) degrees of freedom turn out to be independent of the translational degrees of freedom, and an effective rotational temperature close to room temperature is found. The near absence of background-gas collisions allows to relate the rotational temperature directly to the temperature of the ambient blackbody radiation (BBR). This feature suggests the use of molecular ions for BBR thermometry, which may help to improve the accuracy of frequency standards based on trapped atomic ions. We present a detailed proposal for the implementation of BBR thermometry, using CO^+ molecular ions, in a generic trapped-ion optical clock apparatus. Our proposal includes a method to load CO^+ by photoionization of neutral CO in the residual gas, while BBR thermometry would be based on a novel scheme for nondestructive detection of rotational states of CO^+.

MO 29.10 Di 16:30 Poster A

Experiments with decelerated and trapped OH radicals — •Joop Gilijamse[1], Steven Hoekstra[1], Nicolas Vanhaecke[2], Ludwig Scharfenberg[1], Sebastiaan van de Meerakker[1], and Gerard Meijer[1] — [1]Fritz-Haber-Institut der Max-Planck-Geselllschaft, Berlin, Germany — [2]Laberatoire Aime Cotton, CNRS II, Campus d'Orsay, France

With a Stark decelerator, bunches of state-selected molecules with a controlled velocity and with longitudinal temperatures as low as a few mK can be produced. We will report on the deceleration and electrostatic trapping of ground state OH and OD radicals. The trap loading has been optimized using evolutionary strategies, and using a new trap geometry. The radicals are trapped at a density of 107 * 108 cm-3 and at a temperature in the 50-500 mK range. The blackbody radiation limited trap lifetime is measured to be 1.9 s and 3.7 for the OH and OD radical, respectively. Recent experimental results illustrate two unique features of our experimental method: the long interaction time afforded by the trap and the high energy resolution of the velocity-tunable molecular beam.

MO 29.11 Di 16:30 Poster A

Manipulating molecules in high-field seeking quantum states with electric fields — •Frank Filsinger, Kirstin Wohlfart, Jochen Küpper, and Gerard Meijer — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

The manipulation of molecules in low-field seeking quantum states with electric fields is a well established technique today. A wide range of applications, from simple electrostatic focusing devices to sophisticated tools such as Stark decelerators, have been realized.

However, the ground state of every molecule and, for larger (bio-)molecules, practically all states that are populated in a molecular beam, are high-field seeking. Therefore, similar tools for molecules in high-field seeking quantum states are highly desirable. Recently it has been shown, that molecules in high-field seeking quantum states such as metastable CO, YbF, and benzonitrile can be focused and decelerated using switched electric fields in an Alternate Gradient decelerator [1]. These techniques can also be used to specifically manipulate individual structural isomers of large (bio-)molecules.

We discuss the behaviour of molecules in high-field seeking quantum states in the practically relevant electric fields. A profound understanding of the Stark effect of large molecules, their focusing properties, and possible loss mechanisms (e.g. Majorana transitions) is essential for these experiments.
[1] H.L. Bethlem, M.R. Tarbutt, J. Küpper, D. Carty, K. Wohlfart, E.A. Hinds, and G. Meijer, *J. Phys. B*, **39**, R263-R291, (2006)

MO 29.12 Di 16:30 Poster A

Majorana transitions and their compensation in electric Ioffe-Pritchard traps — •Moritz Kirste, Melanie Schnell, Hendrick L. Bethlem, and Gerard Meijer — Fritz-Haber-Institut der MPG, Abt. Molekülphysik, Faradayweg 4-6, D-14195 Berlin

Trapping of polar molecules with the use of the Stark effect is possible. Due to the Stark effect the molecules separate in low field seeking and high field seeking states. The low field seeking molecules can be trapped in the minimum of an electrostatic quadrupole trap. Trapped molecules are used in the study of dipole-dipole interaction and of the alignment of molecules in external fields as well as in the application of high-resolution spectroscopy. All these techniques are limited by the quality of the trap - the time the molecules remain in the trap and the trap depth - which is itself limited by the loss rate of the trap. Trap losses are caused by inelastic collisions of the electrostatically trapped molecules and by Majorana transitions. This poster gives a short overview of the theoretical background of Majorana transitions and their influence on electrostatically trapped ND3.

The Majorana losses in electrostatic quadrupole traps can be compensated by the use of a so called Ioffe-Pritchard trap. A Ioffe-Pritchard trap generates a quadrupole field which is non-zero at the center. They have already been realized for magnetic fields but not yet for electrostatic fields. This poster introduces different types of possible electric Ioffe-Pritchard trap configurations and discusses their advantages and disadvantages.