

## Q 12: Kalte Moleküle II [gemeinsam mit MO]

Zeit: Dienstag 11:00–13:00

Raum: 3G

Q 12.1 Di 11:00 3G

**Deceleration, trapping and accumulation of NH molecules** — ●STEVEN HOEKSTRA, MARKUS METSÄLÄ, PETER C. ZIEGER, LUDWIG SCHARFENBERG, JOOP J. GILJAMSE, SEBASTIAAN Y.T. VAN DE MEERAKKER, and GERARD MEIJER — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany

We report on the Stark-deceleration and electrostatic trapping of metastable NH molecules. Furthermore, the progress towards higher densities of cold neutral molecules by accumulation of multiple Stark-decelerated packets of NH molecules in a magnetic trap will be presented.

NH molecules in the long-lived metastable  $a^1\Delta(v=0, J=2)$  state are ideally suited for Stark deceleration experiments because of their relatively large Stark shift and low mass. The metastable molecules ( $\tau > 2.7\text{s}$ ) are produced in a supersonic expansion with a velocity of  $\sim 450\text{ m/s}$ , and are decelerated to a standstill by a 108-stage decelerator. Subsequently the metastable molecules are trapped electrostatically, with a temperature of about 50–100 mK, a density of  $\sim 10^6\text{ cm}^{-3}$  and a  $1/e$  trapping lifetime of 1.4 s.

Following the deceleration and trapping, the metastable NH molecules are detected by the excitation of a spin-forbidden transition, resulting in spontaneous decay to the electronic ground state ( $X^3\Sigma^-$ ). The electronic ground state has a negligible Stark shift, but can be trapped magnetically. The first experiments on the accumulation of ground state NH molecules in a magnetic trap will be presented.

Q 12.2 Di 11:15 3G

**Alternating gradient focusing and deceleration of large molecules** — KIRSTIN WOHLFART, ●FABIAN GRÄTZ, FRANK FILSINGER, GERARD MEIJER, and JOCHEN KÜPPER — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

During the last decade, fascinating progress has been made in the spectroscopy of the “molecular building blocks of life”. Meanwhile, our group has been developing methods to decelerate neutral, polar molecules using time varying inhomogeneous electric fields. Extending these techniques to bio-molecules would allow, for instance, to increase observation times for precision spectroscopy or to separate different conformers. However, for such large molecules all states are practically high-field seeking. Therefore, alternating gradient focusing has to be applied. Here, we demonstrate the focusing and deceleration of benzonitrile ( $\text{C}_7\text{H}_5\text{N}$ ) from a molecular beam. Benzonitrile is prototypical for large asymmetric top molecules that exhibit rich rotational structure and a high density of states. It is decelerated in its absolute ground state from 320 m/s to 289 m/s, and similar velocity changes are obtained for excited rotational states. We are setting up a longer alternating gradient decelerator, which will enable us to decelerate benzonitrile or larger molecules to much lower velocities and to thereby completely separate the decelerated packet from the rest of the beam pulse.

Q 12.3 Di 11:30 3G

**On the Stark effect of NaK** — ●ANDREAS GERDES, HORST KNÖCKEL, and EBERHARD TIEMANN — Institut für Quantenoptik, Gottfried Wilhelm Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

After preliminary measurements in a heatpipe setup [1] and characterization of our new molecular beam apparatus we show the next step of investigation concerning the heteronuclear molecule NaK. A homogeneous electric field in the detection zone will modify the rotational structure of the spectral lines under consideration. For a model description of the line shapes, not only the molecular Stark effect of the absolute ground state  $X^1\Sigma^+$  of the molecule, but also the splitting of the excited state  $B^1\Pi$  has to be taken into account. Results of our investigation into this direction will be shown. A comparison with theoretical predictions is possible [2]. Prospects heading to the target molecule KRb will be discussed.

[1] A. Gerdes *et al.*, To be published[2] M. Aymar and O. Dulieu, *J. Chem. Phys.* **122** 204302 (2005)

Q 12.4 Di 11:45 3G

**Simulations of LiCs spectra** — ●ANNA GROCHOLA, JOHANNES DEIGLMAYR, JÖRG LANGE, KARIN MÖRTLBAUER, CHRISTIAN GLÜCK, ROLAND WESTER, and MATTHIAS WEIDEMÜLLER — Albert-Ludwigs Universität, Physikalisches Institut, Hermann-Herder-Str. 3, 79104 Freiburg i.Brs., Germany

Recently the formation of ultracold LiCs molecules was achieved in our group [1] and spectra of resonant enhanced one-color two photon ionization were recorded.

Here we present predictions for photoassociation and REMPI spectra of the LiCs molecule based on theoretical potential energy curves [2-4] and experimental data [5,6]. Hund’s cases (a) and (c) are taken into account. The Franck-Condon factors are calculated for the  $B^1\Pi-X^1\Sigma^+$  system for the free-bound and bound-bound transitions. The results of spectra simulations are compared with the experimental results.

[1] S. D. Kraft *et al.*, *J. Phys. B* **39**, S993 (2006)[2] M. Aymar and O. Dulieu, *J. Chem. Phys.* **122**, 204302 (2005)[3] M. Korek *et al.*, *Can. J. Phys.* **78**, 977 (2000)

[4] Dunia Houalla, Master Thesis, Beirut Arab University (2005)

[5] P. Staantum *et al.*, *Phys. Rev. A* **75**, 042513 (2007)

[6] A. Pashov, private communication

Q 12.5 Di 12:00 3G

**Triplet spectroscopy on ultracold  $87\text{Rb}_2$  molecules** — ●FLORIAN LANG<sup>1</sup>, GREGOR THALHAMMER<sup>1,2</sup>, KLAUS WINKLER<sup>1</sup>, CHRISTOPH STRAUSS<sup>1</sup>, RUDOLF GRIMM<sup>1,3</sup>, and JOHANNES HECKER DENSCHLAG<sup>1</sup> — <sup>1</sup>Institut für Experimentalphysik und Forschungszentrum für Quantenphysik, Universität Innsbruck — <sup>2</sup>LENS European Laboratory for Nonlinear Spectroscopy and Dipartimento di Fisica, Università di Firenze — <sup>3</sup>Institut für Quantenoptik und Quanteninformatik, Österreichische Akademie der Wissenschaften

Starting from a pure sample of ultracold  $87\text{Rb}_2$  Feshbach molecules held in a 3D optical lattice we have performed spectroscopic measurements on electronically excited triplet molecules. We investigate the vibrational ladder down to the vibrational ground state with high resolution in the order of 1 MHz and find good coupling strength to the electronic ground state. In combination of our previous results[1],[2] this offers a promising route towards the production of molecules in the triplet ground state. In my talk I will report on the latest progress in our work.

[1] Coherent optical transfer of Feshbach molecules to a lower vibrational state, K. Winkler, F. Lang, G. Thalhammer, P. v.d. Straten, R. Grimm, J. Hecker Denschlag *Phys. Rev. Lett.* **98**, 043201 (2007)

[2] Cruising through molecular bound state manifolds with radio frequency, F. Lang, P.v.d. Straten, B. Brandstätter, G. Thalhammer, K. Winkler, P.S. Julienne, R. Grimm, J. Hecker Denschlag, submitted for publication, arXiv:0708.3958

Q 12.6 Di 12:15 3G

**Photoexcitation and photodissociation of  $\text{H}_3^+$**  — ●DENNIS BING<sup>1</sup>, MAX H. BERG<sup>1</sup>, HOLGER KRECKEL<sup>2</sup>, ANNEMIEKE PETRIGNANI<sup>1</sup>, SASCHA REINHARDT<sup>1,3</sup>, XAVIER URBAIN<sup>4</sup>, and ANDREAS WOLF<sup>1</sup> — <sup>1</sup>Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — <sup>2</sup>Columbia University, 550 West 120th Street, New York, NY 10027, USA — <sup>3</sup>Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany — <sup>4</sup>Département de Physique, Université Catholique de Louvain, B-1348, Louvain-la-Neuve, Belgium

We present ro-vibrational laser spectroscopy of cold  $\text{H}_3^+$  towards the dissociation limit and photodissociation of vibrationally excited  $\text{H}_3^+$  ions, using two distinct experimental setups. The photoexcitation of  $\text{H}_3^+$  was performed in a 22-pole radiofrequency ion trap, where the ions were cooled down to their lowest rotational states and then ro-vibrationally excited by  $\sim 1\text{ eV}$  ( $\sim 5$  vibrational quanta), i.e., above the molecule’s barrier to linearity. Transitions of about 11230 - 13330  $\text{cm}^{-1}$  were scanned with a Titanium-Sapphire laser, finding lines with predicted Einstein  $A$ -coefficients down to  $<10^{-1}\text{ s}^{-1}$ . The photodissociation of  $\text{H}_3^+$  was performed in a crossed photon and ion-beam setup using a pulsed frequency-doubled dye laser at 294 nm and  $\text{H}_3^+$  ions from a hot ion source. Both dissociation channels,  $\text{H}_2^+ + \text{H}$  and  $\text{H}^+ + \text{H}_2$ , were found and investigated.

Q 12.7 Di 12:30 3G

**Photodetachment of cold negative ions** — ●PETR HLAVENKA, RICO OTTO, SEBASTIAN TRIPPEL, JOCHEN MIKOSCH, MATHIAS WEIDEMÜLLER, and ROLAND WESTER — Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

With the recent detection of negative carbon clusters in the interstellar molecular clouds, laboratory studies of negative ions are becoming exceedingly important. We study absolute  $\text{OH}^-$  photodetachment cross sections as a model for the low temperature behavior of this fundamental light-matter interaction, which is a main loss channel of the anions in interstellar medium (ISM). To reach ISM-relevant conditions we study the photodetachment interaction of laser light with anions captured in a 22-pole RF trap [1]. The sympathetic cooling of ions in the flat effective potential yields well defined rotational-state distributions. We record the relative loss of stored anions due to the photodetachment while scanning the volume of the trap with a focussed, 2D movable laser beam. A column-density map and the absolute photodetachment cross section are obtained. We present results for  $\text{OH}^-$  photodetachment at different temperatures and laser wavelengths. This gives insight to the rotational dependence of the photodetachment process, which gives us better understanding of the processes leading to the anion abundances in the ISM.

[1] S. Trippel et al., Phys. Rev. Lett. **97**, 193003 (2006)

Q 12.8 Di 12:45 3G

**Trapping and cooling of single molecular ions for time resolved diffraction experiments** — ●GÜNTHER LESCHHORN, STEFFEN KAHRA, and TOBIAS SCHAEZT — Max-Planck-Institut für Quantenoptik, Garching

The interest in observing structural changes in molecules with a time resolution of a few femtoseconds and below give rise to discussions about modifying the established target schemes. The Tlamo-project (trapped ions and molecules) aims for an electron or X-ray diffraction experiment using single molecular ions. We report on the progress towards a setup for the preparation of single, cold and well (spatial resolution:  $1\ \mu\text{m}$ ) localized molecular ions, that can be continuously replaced to achieve suitable statistics in a single target experiment. By combining numerous experimental techniques like Paul-traps, sympathetic cooling, light pressure and separation of molecular ions from a Coulomb-crystal using electric fields, it should be possible to achieve a replacement in the kHz-regime. In the future, this scheme together with electron or X-ray diffraction on a single molecular ion can be used to directly observe fast molecular reaction dynamics. Supported by: MAP, IMPRS-APS, MPG