MO 54 Cold Molecules II

Zeit: Donnerstag 14:00–15:45 Raum: H10

MO 54.1 Do 14:00 H10

Ultracold atom-molecule collisions — •Stephan Kraft[1], Peter Staanum[1,2], Jörg Lange[1], Roland Wester[1], and Matthias Weidemüller[1] — [1]Physikalisches Institut, Universität Freiburg, Freiburg, Germany — [2]Institut für Quantenoptik, Universität Hannover, Hannover, Germany

In the last years the field of ultracold molecules has developed rapidly and production and trapping of cold molecules has been demonstrated with different methods in several laboratories. The next step towards controlled ultracold chemistry is the investigantion of interactions between ultracold atoms and molecules.

In this talk we report on the first observations of state-resolved ultracold collisions between atoms and molecules [1]. Cs and Cs_2 dimers in the triplet electronic ground state are trapped in a quasi electrostatic dipole trap. In the collisions internal excitation energy is converted into kinetic energy which leads to a loss of atoms and molecules from the dipole trap. From the measured loss rates we determine collision rate coefficients $\beta \sim 10^{-10}$ cm^3/s which are independent of the vibrational and rotational states indicating unitary limited cross sections. The collision rate coefficients are six times larger than the s-wave collision limit showing that s-, p- and d-waves contribute as expected at the collision temperature of 60μK.

[1] P. Staanum *et al.*, arXiv:physics/0509123 (Phys. Rev. Lett. in print)

MO 54.2 Do 14:15 H10

Atom-molecule collisions in an optically trapped gas — •Marcel Mudrich[1,2], Nassim Zahzam[2], Thibault Vogt[2], Daniel Comparat[2], and Pierre Pillet[2] — [1]Physikalisches Institut, Universität Freiburg — [2]Laboratoire Aimé Cotton, Orsay, France

Cold inelastic collisions between Cs atoms and Cs_2 molecules are investigated inside a CO_2 laser dipole trap [1,2]. Inelastic atom-molecule collisions are observed with a rate constant of $\sim 9 \times 10^{-11}\,\mathrm{cm^3 s^{-1}}$, mainly independent of the populated molecular electronic ($a^3\Sigma_u^+$ / $X^1\Sigma_g$) and rovibrational states. Storage times of pure atomic and molecular samples are essentially limited by rest gas collisions. The pure molecular rest-gas limited lifetime of up to 1 s is four times smaller than the atomic one, as observed in a pure magnetic trap. We estimate the inelastic molecule-molecule collision rate to be of the order of $\sim 1 \times 10^{-11}\,\mathrm{cm^3 s^{-1}}$.

[1] N. Zahzam, T. Vogt, M. Mudrich, D. Comparat, P. Pillet, physics/0509197

[2] P. Staanum, S. D. Kraft, J. Lange, R. Wester, M. Weidemüller, physics/0509123

MO 54.3 Do 14:30 H10

Collision Observed in a Supersonic Atomic-molecular Beam of K — •I. Sherstov, S. Liu, H. Knöckel, and E. Tiemann — Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

We apply matter wave interferometry method implemented for Potassium molecules to investigate cold collision between Potassium atoms and molecules. Our goal is to interpret these observations with the interaction potential between K and K_2.

We use supersonic expansion to create an atomic beam with a few percent of K_2 molecules diluted in it. K_2 molecules propagate within an atomic medium and hence gain some additional phase shift due to cold collisions with the atoms. By changing the properties of the medium (like exciting K atoms to a higher electronic state or varying the density of the atoms in the beam) a change of the phase and amplitude of the interference patterns is expected. By deflecting atoms out of molecular beam we were able to change the atomic density by one order of magnitude and observed a phase shift of the interference structure relating to a pressure shift in the order of 10 kHz for molecular transition of Potassium.

MO 54.4 Do 14:45 H10

Experimental evidence for Efimov quantum states — •M. Mark[1], T. Kraemer[1], P. Waldburger[1], J.G. Danzl[1], C. Chin[1,2], B. Engeser[1], A.D. Lange[1], K. Pilch[1], A. Jaakkola[1], H.-C. Naegerl[1], and R. Grimm[1,3] — [1]Institut für Experimentalphysik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck — [2]James Franck Institute, Physics Department of the Univ. of Chicago, 5640 S. Ellis Ave. Chicago, Illinois 60637 USA — [3]Institut für Quantenoptik und Quanteninformation der Österreichischen Akademie der Wissenschaften, Otto-Hittmair-Platz 1, A-6020 Innsbruck

A landmark theoretical advance in few-body quantum physics is Efimov's prediction of weakly bound three-body states occurring close to a two-body scattering resonance. Among the amazing properties predicted for Efimov states is the existence of weakly bound trimer states even when the interaction does not support a weakly bound dimer state. Since the Efimov problem originally occurred 35 years ago in the context of nuclear matter, it has attracted great interest in many different areas of physics.

In my talk I will report on the observation of an "Efimov resonance" as a clear manifestation of an Efimov state. The resonance arises in the zero collision energy limit from the coupling of three free atoms to an Efimov trimer and shows up as a giant three-body loss feature when the two-body interaction is magnetically tuned near a Feshbach resonance. Our results confirm central theoretical predictions of Efimov physics and represent a starting point to explore the universal properties of resonantly interacting few-body systems [T. Kraemer et al., publ. subm. (2005)].

MO 54.5 Do 15:00 H10

Stark deceleration and trapping of OH radicals — •Steven Hoekstra, Joop J. Gilijamse, Sebastiaan Y.T. van de Meerakker, and Gerard Meijer — Fritz-Haber-Institut der Max-Planck-Gesellschaft,Faradayweg 4-6, 14195, Berlin

Over the last years our group has been developing methods to get improved control over the absolute velocity and the velocity spread of molecules in a molecular beam. With the Stark decelerator, a part of a molecular beam can be selected and transferred to any arbitrary velocity, producing bunches of state-selected molecules with longitudinal temperatures as low as a few mK.

We will report on the electrostatic trapping of ground state OH radicals. Typically 10^5 groundstate OH radicals are trapped for times up to 1.5 seconds at a temperature in the 50-500 mK range [PRL 94 23004 (2005)]. The long interaction time offered by the trap can be exploited to measure the radiative lifetime of long-lived excited states of a molecule [PRL 95 013003(2005)]. Furthermore, we have optimized the trap loading by using evolutionary strategies, resulting in an increase of the number of trapped molecules by 40%.

Recently we have performed the first inelastic scattering experiments using a Stark decelerated beam of polar molecules. Groundstate OH radicals are decelerated, and after collisions with a Xenon beam we measure the fraction of OH molecules in higher rotational states. The control we have over the beam of OH radicals enables us to tune the collision energy over the energetic threshold for inelastic scattering to these states.

MO 54.6 Do 15:15 H10

Zeeman spectroscopy and magnetic trapping of CrH radicals — •Joost M. Bakker[1,2], Michael Stoll[1,2], Jenhei Cheng[3], Timothy C. Steimle[3], Gerard Meijer[2], and Achim Peters[1] — [1]Humboldt Universität zu Berlin — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin — [3]Arizona State University, USA

The buffer gas loading and subsequent magnetic trapping of neutral molecules is a powerful tool for it provides samples of cold molecules with the highest densities known, while being applicable to a great variety of paramagnetic species. Metal-hydride molecules form an interesting class of molecules to study in such cold environments. Due to their complicated electronic structure, but still rather limited size, they form an appealing subject of study for quantum chemistry calculations. The possibillity to buffer gas load these molecules and confine them inside a trap at high densities would directly allow for the study of their intermolecular collisional properties.

To investigate the applicability of magnetically trapping CrH molecules, we have studied the Zeeman effect of CrH radicals produced in a molecular beam. The measured Zeeman structure is complex, but can

theoretically well be described using an effective Hamiltonian treatment. Finally, the feasibility of buffer-gas loading of these interesting radicals is discussed.

MO 54.7 Do 15:30 H10

LiCs molecules: High-resolution spectroscopy and applications to experiments with ultracold molecules — •P. Staanum[1,2], A. Pashov[3], H. Knöckel[2], E. Tiemann[2], S. D. Kraft[1], J. Lange[1], L. Vogel[1], C. Giese[1], B. Müller[1], R. Wester[1], and M. Weidemüller[1] — [1]Physikalisches Institut, Universität Freiburg, Hermann-Herder-Strasse 3, 79104 Freiburg — [2]Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover — [3]Department of Physics, Sofia University, 5 James Bourchier Blvd., 1164 Sofia, Bulgaria

With the recent developments in formation and trapping of ultracold molecules new possibilities for experimental studies within the field of ultracold chemistry have emerged. Ultracold atom-molecule and molecule-molecule collisions can be studied in an optical dipole trap as it was recently done for Cs + Cs_2 collisions (P. Staanum *et al.*, arXiv:physics/0509123 and N. Zahzam *et al.* arXiv:physics/0509197. To appear in Phys. Rev. Lett.). For heteronuclear molecules, studies of ultracold reactive collisions like LiCs+Cs ↔ Li+Cs_2 have become feasible.

We aim at formation of LiCs molecules by photoassociation from mixed Li-Cs cold atom samples. A detailed understanding of LiCs photoassociation as well as state-dependent collision processes requires accurate LiCs potential curves. We have obtained such curves for the $X^1\Sigma^+$ and $a^3\Sigma^+$ electronic ground states as well as the $B^1\Pi$ and $D^1\Pi$ excited states through high-resolution laser-induced fluorescence Fourier-transform spectroscopy. We present here our spectroscopic results on LiCs and their application, as well as the status of our work on formation of LiCs by photoassociation and experiments with these molecules.