Q 63: Poster Ultrakalte Moleküle

Zeit: Donnerstag 16:30–18:30 Raum: Poster C

Q 63.1 Do 16:30 Poster C

Forming Ultracold Polar Molecules in the Rovibrational Ground State — •Christian Glück, Jörg Lange, Johannes Deiglmayr, Stephan Kraft, Leif Vogel, Benjamin Müller, Christian Giese, Peter Staanum, Roland Wester, and Matthias Weidemüller — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

Recently, the spontaneous formation of ultracold LiCs molecules in a double MOT was observed for the first time in our group [1]. LiCs possesses the strongest permanent electric dipole moment of all alkali dimers and is therefore a promising candidate to study an ultracold gas with strong externally tunable interactions.
Here we present the formation of ultracold LiCs ground state molecules by active photoassociation, leading to a strongly increased production rate. In order to transfer the molecules in the rovibrational ground state we have developed a Raman-type relaxation scheme using potential curves from new high resolution sprectroscopy of LiCs [2]. Furthermore, we present experimental details which focus on the locking scheme of the photoassociation laser and an enhanced setup for storing the molecules in a crossed dipole trap.

[1] S. D. Kraft *et al.*, J. Phys. B **39**, S 993 (2006)
[2] P. Staanum *et al.*, arXiv/physics/0612031

Q 63.2 Do 16:30 Poster C

Formation of Ground State Strontium Molecules with Optical Feshbach Resonances — •Ruzin Aganoglu[1], Philippe Pellegrini[2], Robin Côté[2], and Christiane Koch[1] — [1]Freie Universität Berlin, Institut für Theoretische Physik, Arnimallee 14, 14195 Berlin — [2]University of Connecticut, Dept. of Physics, 2152 Hillside Road, Storrs, CT 06269-3046, USA

Ultracold earth alkali atoms are attracting interest in both experiment and theory because of the many exciting perspectives they offer from optical frequency clocks and high resolution spectroscopy to the manipulation of ultracold molecules. In the alkali species, magnetic Feshbach resonances proved to be the most efficient way to form molecules in their electronic ground state. Since even isotopes of the earth alkalis possess no hyperfine structure in their ground state, this route to ground state molecules is not available. Photoassociation of e.g. strontium atoms was successfully employed to create short lived excited state molecules.The formation of ultracold ground state earth alkali molecules has not yet been reported.

Optical Feshbach resonances may provide an alternative way to form molecules in their ground state, provided the atoms are kept in a tight trap such as an optical lattice. We study here the formation of Sr2 ground state molecules by employing an optical Feshbach resonance. We investigate the feasibility of this scheme as a function of the experimental control parameters laser intensity, detuning and trap frequency.

Q 63.3 Do 16:30 Poster C

Formation, Control and Spectroscopy of Cesium Feshbach Molecules — •Michael Mark[1], Francesca Ferlaino[1], Steven Knoop[1], Johann Georg Danzl[1], Harald Schöbel[1], Tobias Kraemer[1], Hanns-Christoph Nägerl[1], and Rudi Grimm[1,2] — [1]Institut für Experimentalphysik, Universität Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Innsbruck, Austria

We present our work on magnetic control of ultracold Cesium Feshbach molecules in an optical dipole trap. Starting with an ultracold Cs gas at 250 nK we create samples of ultracold trapped d- and g-wave molecules on various Feshbach resonances. After the initial formation we transfer the samples into other dimer states by adiabatically following or nonadiabatically jumping avoided crossings between intersecting molecular states. By this method we have complete control over the quantum state of the sample and we can populate all dimer states with s-, d-, g- and l-wave character up to binding energies of 10 MHz and magnetic fields up to 55 G [1]. In particular we show that molecular states with high relative angular momentum l=8 can be addressed for which direct Feshbach association is not feasible as a result of negligible coupling with the s-wave atomic threshold. To map out the molecular state structure we perform magnetic moment spectroscopy. From the avoided crossing we can determine the coupling strength between the different molecular states. In addition we use precise microwave spectroscopy to investigate the universal character of a weakly bound s-wave state. [1] M. Mark et al, submitted to PRA (2007)

Q 63.4 Do 16:30 Poster C

Coherent optical transfer of Feshbach molecules to a lower vibrational state — Klaus Winkler[1], •Florian Lang[1], Gregor Thalhammer[1], Peter van der Straten[2], Rudolf Grimm[1,3], and Johannes Hecker Denschlag[1] — [1]Institut für Experimentalphysik, Universität Innsbruck, Österreich — [2]Debye Institute, Universiteit Utrecht, Netherlands — [3]Institut für Quantenoptik und Quanteninformation, Innsbruck, Österreich

We have recently[1] demonstrated the realization of an efficient and highly selective transfer scheme, where an ensemble of $^{87}Rb_2$ Feshbach molecules in an optical lattice is coherently converted to a deeper bound molecular state via stimulated Raman adiabatic passage (STIRAP). In this experiment we reach a single transfer efficiency of 87% and a coherence time of 2ms. The experimental data is well described by our theoretical model without free parameters. The presented scheme can be extended in a straight forward manner for the transfer of ultracold molecules into the absolute vibrational ground state.

[1] cond-mat/0611222, accepted for publication in PRL (2007)

Q 63.5 Do 16:30 Poster C

UV photodissociation studies of polyatomic molecular ions at milli-Kelvin temperatures — •David Offenberg, Chaobo Zhang, Bernhard Roth, and Stephan Schiller — Institut für Experimentalphysik, Heinrich-Heine-Universität Düsseldorf

Photodissociation spectroscopy is a commonly used tool to investigate molecular properties. The spectral resolution can be enhanced by reducing the molecules' thermal energy [1], as recently demonstrated on $diatomic$ molecular ions [2]. Here, we present our initial advances towards photodissociation spectroscopy of $polyatomic$ molecules.

As a first model system we use translationally cooled, singly protonated molecules of Glycyrrhetinic Acid (GA) $-$ a biomolecule of mass 471 amu consisting of 80 atoms. In our apparatus, the molecular ions are generated by an electrospray ionization source, transferred to and stored in a radio-frequency trap together with laser-cooled barium ions. Due to their Coulomb interaction with the atomic coolant, they cool down from ambient temperature to the hundred milli-Kelvin range and can be kept and investigated under these low-temperature and nearly collisionless conditions for more than one hour [3]. We have measured the photodissociation rate of GA ions using a single-frequency cw-laser at 266 nm. In further studies we plan to investigate the feasibility of resonance enhanced two-photon dissociation with additional tunable IR lasers.

[1] O. Boyarkin et al., J. Am. Chem. Soc. 128, 2816 $-$ 2817 (2006)
[2] B. Roth et al., Phys. Rev. A 74, 040501(R) (2006)
[3] A. Ostendorf et al., Phys. Rev. Lett. 97, 243005 (2006)

Q 63.6 Do 16:30 Poster C

Creation of an ultracold heteronuclear mixture of fermionic lithium and potassium — •Andreas Trenkwalder[1,2], Gabriel Kerner[1], Devang Naik[1], Eric Wille[1,2], Frederik Spiegelhalder[1], Clarice Aiello[1,2], Raquel Chulia-Jordan[1], Gerhard Hendl[1], Florian Schreck[1], and Rudolf Grimm[1,2] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Experimentalphysik, Innsbruck, Austria

Studies of ultracold heteronuclear mixtures of fermionic atoms in the BEC-BCS crossover regime will give new insights into many-body physics. Therefore, we have constructed a new experiment to investigate mixtures of the three fermionic species ^{6}Li, ^{40}K and ^{87}Sr. We have already trapped various combinations of fermionic and bosonic isotopes in our multi-species MOT. We have loaded a ^{6}Li-^{40}K mixture into a crossed-beam optical dipole trap realized with a 100 W near-infrared fiber laser. Close to the 834 G Feshbach resonance of ^{6}Li, we have performed evaporative cooling and recently achieved our first $^6Li_2$ molecular BEC. Under the same conditions we observe efficient sympathetic cooling of ^{40}K by ^{6}Li. Currently we are investigating het-

eronuclear interactions. In this poster we present a brief overview of our experiment and our latest results.

Q 63.7 Do 16:30 Poster C

Femtosecond Pump-Probe Experiments on Ultracold Molecules — •Terence Mullins[1], Wenzel Salzmann[1], Judith Eng[1], Magnus Albert[1], Roland Wester[1], Matthias Weidemüller[1], Andrea Merli[2], Steffan Weber[2], Franziska Sauer[2], Mateusz Plewicki[2], Fabian Weise[2], Ludger Wöste[2], and Albrecht Lindinger[2] — [1]Universität Freiburg, Hermann Herder Str.3, D-79104 Freiburg i. Br., Germany — [2]Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

We present details of femtosecond pump-probe experiments on ultracold Rb atoms. The atoms are trapped in a high density dark magneto-optical trap (MOT) [1] (10^{11}cm^{-3}). MOT light photoassociated ground state molecules and colliding atom pairs are excited to bound molecular states with a femtosecond pump pulse, centered 75cm^{-1} red of the D1 atomic transition. After a defined delay, which may be adjusted with respect to the pump pulse, the molecules are ionized with a femtosecond probe pulse. A quadrupole mass spectrometer selects Rb_2^+ molecular ions. An increased ion signal, along with wavepacket oscillations, is observed when the pump pulse precedes the probe pulse. Propagation timescales suggest a two-photon transition to 5s5d states, consistent with the measured non-linear pump power dependence. The experimental requirements for pump-dump formation of ground state molecules [2,3] is discussed.

[1] C.G. Townsend *et al.*, Phys. Rev. A, **53**, 1702, 1996.
[2] C.P. Koch *et al.*, Phys. Rev. A, **73**, 043409, 2006.
[3] U. Poschinger *et al.*, J. Phys. B, **39**, 1001 2006.

Q 63.8 Do 16:30 Poster C

The Efimov Molecule: Is the Efimov effect really incomprehensible? — •Bettina Berg[1], Misha Ivanov[2], Lev Plimak[1], and Wolfgang P. Schleich[1] — [1]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany — [2]NRC Canada, 100 Sussex Drive, Ottawa, Ontario K1A 0R6, Canada

We investigate the so-called Efimov molecule, formed by two heavy and one light particle interacting via short-range potentials between the light particle and the heavy ones. Applying what we call "Quantum Chemistry 101"in the Born-Oppenheimer limit for the square-well model of the "light-heavy"potential, we obtain the molecular term with the characteristic $\sim 1/R^2$ behaviour of the Efimov potential. This derivation is physically straightforward, making the Efimov molecule arguably the simplest possible example of a three-body system exhibitig the Efimov effect. We also present an equation generalising this result to an arbitrary "light-heavy"potential.