Q 21 Ultrakalte Moleküle

Zeit: Dienstag 10:40–11:55 Raum: HII

Q 21.1 Di 10:40 HII

Coherent control of the manipulation of ultracold rubidium molecules — •J. Eng[1], W. Salzmann[1], U. Poschinger[1], R. Wester[1], M. Weidemüller[1], A. Merli[2], S. Weber[2], F. Sauer[2], M. Plewicki[2], F. Weise[2], A. Mirabal Esparza[2], L. Wöste[2], and A. Lindinger[2] — [1]Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str.3, 79104 Freiburg — [2]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin

We investigate a new scheme for the production of ultracold molecules by manipulating wavepacket dynamics [1]. A pair of ultracold rubidium atoms is excited by a shaped femtosecond (fs) laser pulse creating a molecular wavepacket. The wavepacket is transferred to the electronic groundstate by a second laser pulse. The process is expected to be greatly enhanced by coherent control techniques [2].

Precursor experiments are presented which explore the interaction of fs-pulses with weakly bound Rb molecules in the electronic groundstate. We observe molecular fragmentation through one-photon processes. To demonstrate the applicability of coherent control techniques to ultracold molecules we performed an iterative closed loop experiment aiming to increase this molecule fragmentation by fs-pulses [3]. We achieved an increase in molecular fragmentation by shaped laser pulses compared to transform-limited pulses by 30%.

[1] C. Koch et.al., /physics/0511235
[2] S. Vajda et.al., Chem.Phys. 267,231-239,(2001)
[3] W. Salzmann et. al., /physics/0509056

Q 21.2 Di 10:55 HII

Prospects for Quantum Control of Ultracold Photoassociation — •Ulrich Poschinger[1], Wenzel Salzmann[1], Roland Wester[1], Matthias Weidemüller[1], Christiane Koch[2], and Ronnie Kosloff[2] — [1]Physikalisches Institut, Universität Freiburg — [2]Fritz Haber Center for Molecular Dynamics Research, Hebrew University Jerusalem

We present a theoretical investigation concerning the pulsed photoassociation of ultracold molecules [1]. In this process, a colliding ultracold atom pair is excited by a tailored short laser pulse. The resulting coherent superposition of bound vibrational levels is de-excited after a time delay into bound ground-state levels. An analytical model for the photoassociation rate for weak excitation pulses is developed and compared to the simulations. By means of this model, numerically optimized pulses are obtained. These pulses can be used in future closed-loop quantum control experiments as an initial guess. In contrast to previous investigations concentrating on chirped pulses, we direcly model a closed-loop quantum control experiment[2] employing shaped laser pulses. This work explores the role of quantum interference and thereby the extent to which quantum control techniques can be applied on the process. Experiments on the photoassociation of ultracold molecules are currently carried out in our group. [1] C. Koch et al. physics/0508090 [2] W. Salzmann et. al.,physics/0509056

Q 21.3 Di 11:10 HII

Predictions of scattering length and Feshbach resonances from molecular spectroscopy of mixed alkalis — •A. Gerdes[1], O. Docenko[2], M. Tamanis[2], R. Ferber[2], A. Pashov[3], H. Knöckel[1], and E. Tiemann[1] — [1]Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Department of Physics and Institute of Atomic Physics and Spectroscopy, University of Latvia, Rainis Boulevard 19, LV 1586 Riga, Latvia — [3]Department of Physics, Sofia University, 5 James Bourchier blvd, 1164 Sofia, Bulgaria

For BEC experiments of mixed alkali systems scattering lengths for cold atomic collisions should be known. With molecuar spectroscopy we can provide this information by investigating the high vibrational levels of the $X^1\Sigma^+$ state and the $a^3\Sigma^+$ state simultaneously [1]. In a simple spectroscopic experiment with Fourier-Transform spectroscopy on laser-induced fluorescence in a heatpipe data were aquired for precise descriptions of the singlet and triplet ground state potentials of mixed alkali dimers like KRb, NaRb [2] and NaCs. Even more precise information on the long range behaviour of the atoms can be inferred from molecular beam experiments and multistep excitation of molecules. Such an experiment was done for Na_2 and is presently under way for K_2. The talk will give an introduction into the methods, the applied theoretical models, and their prospects combining molecular spectroscopy an Feshbachresonance spectroscopy on ultracold ensembles.

[1] J. Venturi *et al.* J. Phys. B **34**, 4339, 2001.
[2] A. Pashov *et al.* Phys. Rev. A, Potentials for modeling cold collisions between Na and Rb atoms, *in press*

Q 21.4 Di 11:25 HII

Long-lived Feshbach molecules in an optical lattice — •Klaus Winkler[1], Gregor Thalhammer[1], Florian Lang[1], Stefan Schmid[1], Rudolf Grimm[1,2], and Johannes Hecker Denschlag[1] — [1]Institut für Experimentalphysik, Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Innsbruck, Austria

We have investigated production and lifetime of Rb2 Feshbach molecules in an optical lattice. Compared to previous experiments without lattice we find dramatic improvements. We observe long molecular lifetimes of up to 700ms and near unit conversion efficiency of atom pairs into molecules (and vice versa) when ramping slowly across the Feshbach resonance. We also have developed a purification scheme based on a combination of both a radio-frequency and an optical transition which removes residual atoms from the lattice. Purification results in a pure molecular sample where individual lattice sites are either empty or occupied by a single molecule.

Q 21.5 Di 11:40 HII

Atom-Molecule Dark States in a Bose-Einstein Condensate — •Gregor Thalhammer[1], Klaus Winkler[1], Matthias Theis[1], Helmut Ritsch[2], Rudolf Grimm[1,3], and Johannes Hecker Denschlag[1] — [1]Institut für Experimentalphysik, Universität Innsbruck, Austria — [2]Institut für Theoretische Physik, Universität Innsbruck, Austria — [3]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria

We have created a dark quantum superposition state of a Rb Bose-Einstein condensate and a degenerate gas of Rb_2 ground-state molecules in a specific rovibrational state using two-color photoassociation. As a signature for the decoupling of this coherent atom-molecule gas from the light field, we observe a striking suppression of photoassociation loss. In our experiment the maximal molecule population in the dark state is limited to about 100 Rb_2 molecules due to laser induced decay. The experimental findings can be well described by a simple three mode model.