MO 65: Ultracold Molecules II (gemeinsam mit Q)

Zeit: Freitag 14:00–15:45 Raum: 6J

Gruppenbericht MO 65.1 Fr 14:00 6J

A Mott-like State of Molecules — •Stephan Dürr, Thomas Volz, Niels Syassen, Dominik Bauer, Eberhard Hansis, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, 85748 Garching, Germany

Mott insulators of ultracold gases in optical lattices bear a great potential for applications in quantum simulations and quantum information processing, in particular when using particles with a long-range dipole-dipole interaction, such as polar molecules. Here we show the realization of a Mott-like state of molecules. The molecules are produced from an atomic Mott insulator with a density profile chosen such that the central region of the gas contains two atoms per lattice site. A Feshbach resonance is used to associate the atom pairs to molecules. Remaining atoms can be removed with blast light. In order to show that the resulting state has exactly one molecule per lattice site, the molecules are dissociated and the lattice depth is reduced. This restores phase coherence which is seen in time-of-flight images. Additional information is obtained from measurements of the excitation spectrum [1].

[1] T. Volz et al. *Nature Physics* **2**, 692–695 (2006).

MO 65.2 Fr 14:30 6J

Resonant enhancement in ultracold atom-dimer scattering — •Steven Knoop[1], Michael Mark[1], Francesca Ferlaino[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

Ultracold quantum gases with tunable interaction yield the unique possibility to study universal properties of resonantly interacting few-body systems. A clear example has been the experimental evidence for Efimov quantum states in an ultracold Cs gas [1]. Their signature was found in a giant three-body loss feature due to resonant coupling between three free atoms and an Efimov trimer. Following the Efimov scenario an Efimov trimer can also couple to an atom and a dimer [2].

Here we will report on the experimental observation of resonant enhancement in the inelastic atom-dimer collision rate. By means of Feshbach association ultracold dimers in a weakly bound s-wave state are produced and trapped in an optical dipole trap [3]. Together with the remaining atoms they form an atom-dimer mixture which is at a temperature of 250 nK. By selectively measuring the loss of dimers the inelastic atom-dimer collision rate is obtained. A resonance in the collision rate at a scattering length of 400 Bohr radii is found which might represent an atom-dimer Efimov resonance.

[1] T. Kraemer et al, Nature 440, 315 (2006); [2] E. Braaten and H.-W. Hammer, Phys. Rep. 428, 259 (2006); [3] M. Mark et al, submitted to PRA (2007)

MO 65.3 Fr 14:45 6J

Formation and Detection of ultracold LiCs molecules — •Jörg Lange, Stephan Kraft, Johannes Deiglmayr, Christian Giese, Leif Vogel, Christian Glück, Peter Staanum, Roland Wester, and Matthias Weidemüller — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

We report on the first observation of ultracold LiCs molecules, formed by the trapping light in a double species magneto optical trap. After one-colour two-photon ionization, the molecules are detected with high resolution time-of-flight mass spectrometry. The molecule formation rate coefficient is found to be in the range of $10^{-18}\,\mathrm{cm^3\,s^{-1}}$ to $10^{-16}\,\mathrm{cm^3\,s^{-1}}$ [1]. This is an order of magnitude smaller than for other heteronuclear alkali dimers formed under comparable condtions, but in agreement with predictions.

In current experiments, we study controlled photoassociation via the $[\mathrm{Li}(2S_{3/2})+\mathrm{Cs}(6P_{3/2})]$-asymptote to increase the production rate of electronic ground state molecules. Together with a more detailed investigation of the resonantly enhanced two-photon ionization process, precise information on the rovibrational structure of the involved LiCs-potentials can be obtained.

[1] S. D. Kraft *et al.*, J. Phys. B **39**, S 993 (2006)

MO 65.4 Fr 15:00 6J

Experiments with an ultracold ^{6}Li-^{40}K Fermi-Fermi mixture — •Eric Wille[1,2], Frederik Spiegelhalder[1], Gabriel Kerner[1], Devang Naik[1], Andreas Trenkwalder[1,2], 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

Degenerate mixtures of the two fermionic species ^{6}Li and ^{40}K provide a new, intriguing many-body quantum system, which allows to study strongly interacting Fermi gases consisting of atoms with unequal masses. We have recently created our first molecular $^6\mathrm{Li}_2$ BEC in a newly build machine. The ^{6}Li atoms were loaded into a crossed-beam optical dipole trap realized with a 100 W near-infrared fiber laser. The sample was cooled evaporatively by lowering the laser power by three orders of magnitude within 5 s, leading to quantum degeneracy of $^6\mathrm{Li}_2$. To study heteronuclear mixtures, we have simultaneously trapped ^{40}K and ^{6}Li. We have sympathetically cooled ^{40}K with ^{6}Li during the evaporation process in the dipole trap. We will present our first investigations on heteronuclear interactions.

MO 65.5 Fr 15:15 6J

Molecular wavepacket oscillations of ultracold Rb_2 — •A. Merli[1], S. Weber[1], F. Sauer[1], M. Plewicki[1], F. Weise[1], S. Birkner[1], L. Wöste[1], A. Lindinger[1], W. Salzmann[2], J. Eng[2], T.G. Mullins[2], M. Albert[2], R. Wester[2], and M. Weidemüller[2] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D 14195 Berlin — [2]Physikalisches Institut, Universität Freiburg, Hermann Herder Str. 3, D 79104 Freiburg i. Br.

Our long-term aim is the efficient formation and vibrational cooling of ultracold Rb_2 molecules to their vibrational ground state by pump-dump like processes via an intermediate excited state, theoretical predicted by [1]. First pump-probe experiments with femtosecond light pulses in a dark SPOT magneto-optical trap were successfully performed in order to gain information about the molecular dynamic in the excited state of the Rb-Dimer. The observed wavepacket oscillation periods are depending from the cut-off of the spectral frequencies (made in the Fourier plane of a zero-dispersion compressor) in the pump pulse below the Rb atomic D1 and D2 resonances, respectively. Linear chirps of the excitation pulse influence the pump-probe spectra. Measurements at different bright state fractions [2] of the trapped molecules provide advice about the origin of the molecules which are oscillating.

[1] C. P. Koch, R. Kosloff, and F. Masnou-Seeuws, Phys. Rev . A, 73, 043409, 2006

[2] C.G. Townsend, N.H. Edwards, K.P. Zetie, C.J.Cooper, J. Rink, and C.J Foot, Phys. Rev.A 53, 1702, 1996

MO 65.6 Fr 15:30 6J

Temperature shift of a triatomic Efimov resonance in an ultracold gas of cesium atoms — •Almar Lange[1], Bastian Engeser[1], Karl Pilch[1], Andrea Prantner[1], Hans-Christoph Nägerl[1], and Rudolf Grimm[1,2] — [1]Institut für Experimentalphysik, Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften

We report on measurements of three-body recombination at negative scattering lengths in an ultracold cesium gas. Magnetic tuning of the scattering length by means of a Feshbach resonance is used to investigate a strong loss peak resulting from an Efimov resonance. The position of maximum loss shifts significantly when the temperature of the gas is varied, providing quantitative insight into the evolution of an Efimov state into a triatomic continuum resonance. We compare our measurements with several calculations that extend the theory of three-body recombination to non-zero collision energies.

In our apparatus we prepare an ultracold gas of cesium atoms in an optical surface trap. The main part is a glass cell with an integrated prism, providing good optical access and accurate and fast control of the magnetic field. The atoms are located a few micrometers above the dielectric prism surface. Raman sideband and Sisyphus cooling are applied to reach temperatures of a few μK. We further reduce the temperature below 100nK via evaporative cooling. We then apply different magnetic fields and measure the rate of three-body recombination.