MO 16: Cold Molecules II

Time: Wednesday 11:00–12:30 Location: F 107

MO 16.1 Wed 11:00 F 107

Towards a BEC of rovibronic ground state molecules — •Katharina Lauber, Emil Kirilov, Johann Danzl, Manfred Mark, Philipp Weinmann, Florian Meinert, and Hanns-Christoph Nägerl — Institut für Experimentalphysik und Zentrum für Quantenphysik, Universität Innsbruck, Innsbruck, Austria

An understanding of the scattering properties of ground-state molecules is of great importance for the modeling of molecular interactions and for the realization of molecular Bose-Einstein condensates. In our experiment we create ultracold and dense samples of molecules in their rovibrational ground state trapped in an optical lattice by a coherent optical 4-photon process with the Stimulated Raman Adiabatic Passage (STIRAP) technique while each molecule is trapped in the motional ground state of an individual optical lattice well. With several technical improvements we reach STIRAP efficiencies of approximately 80%. By removing the lattice along one or two directions we investigate the scattering properties in 2D and 1D, respectively. We have measured decay rates and their dependence of the magnetic field.

MO 16.2 Wed 11:15 F 107

Double Bose-Einstein condensate of rubidium and strontium — •Alex Bayerle[1,2], Slava Tzanova[2], Benjamin Pasquiou[2], Simon Stellmer[2], Jacek Szczepkowski[2,3], Mark Parigger[2], Florian Vogl[2], Rudolf Grimm[1,2], and Florian Schreck[2] — [1]Institut für Experimentalphysik und Zentrum für Quantenphysik Universität Innsbruck, 6020 Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation (IQOQI), Österreichische Akademie der Wissenschaften, 6020 Innsbruck, Austria — [3]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

In this talk I will present the production of a Rb-Sr double Bose-Einstein condensate. Our unusual scheme to cool rubidium to quantum degeneracy relies as first step on sympathetic cooling of rubidium by narrow-line laser-cooled strontium. In a second step, only very little evaporation is needed to bring both atomic species to quantum degeneracy.

We intend to use this alkali/alkaline-earth mixture to produce ground-state RbSr molecules, which are polar open-shell molecules. Their electric dipole moment gives rise to anisotropic long-range interactions. In contrast to bi-alkali ground-state molecules, they possess an unpaired electron, which provides them with additional degrees of freedom. Their interaction properties can be tuned by electric as well as magnetic fields, which will allow us to study novel quantum chemistry and provides us with a platform for spin-lattice quantum simulations.

MO 16.3 Wed 11:30 F 107

Multi-channel modelling of NaK — •Torben A. Schulze[1], Matthias Gempel[1], Torsten Hartmann[1], Silke Ospelkaus[1], Ivo Temelkov[2], Horst Knoeckel[1], and Eberhard Tiemann[1] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Germany — [2]Department of Physics, Sofia University, Bulgaria

Recently, ultracold polar molecules have attracted a lot of interest. Due to their strong dipole-dipole interaction, they are ideally suited for the study of quantum many-body phenomena with long-range and anisotropic interaction. NaK in its rovibronic ground state is a promising candidate for such studies, because of its large dipole moment of 2.72 Debye and because chemical reactions into homonuclear dimers are expected to be endothermic and therefore suppressed at ultracold temperature [PRA 81,060703(2010)]. Experimentally, the preparation of a quantum gas of molecules starts from the preparation of a quantum degenerate mixture of two atomic species, followed by the association of atoms into weakly bound molecules via a Feshbach resonance and a subsequent coherent two-photon transfer from dominantly $a^3\Sigma$ Feshbach molecules into the pure $X^1\Sigma$ rovibronic ground state molecules [Science 322,231(2008)]. Here, we discuss possible coherent two-photon transfer paths from Feshbach molecules to rovibronic ground state molecules. We present an analysis of the electronic ground and K($4p$) excited state manifold of $^{23}Na^{40}K$ and discuss the critical influence of the individual wavefunctions obtained out of our multi-channel calculations and effective transition dipole moments.

MO 16.4 Wed 11:45 F 107

High resolution spectroscopy of excited Rb_2 molecules — •Björn Drews, Markus Deiss, and Johannes Hecker Denschlag — Universität Ulm, Institut für Quantenmaterie, Albert-Einstein-Allee 45, D-89081 Ulm

A detailed understanding of the molecular level structure is essential to prepare and interpret cold collision experiments of ultracold molecules and atoms. We have performed laser spectroscopy on ultracold Rb_2 Feshbach molecules to obtain precision data with a typical resolution of a few MHz. Besides an improved understanding of the first excited triplet state $(1)^3\Sigma_g^+$ in terms of rotational, hyperfine and Zeeman structure we also have investigated levels of the $A^1\Sigma_u$ and the $(1)^3\Pi_u$ states.

MO 16.5 Wed 12:00 F 107

Lifetime measurement of the first vibrationally excited state in the MgH^+ ion — •Oscar O. Versolato[1], Maria Schwarz[1], Alexander Windberger[1], Joachim Ullrich[1,2], José R. Crespo López-Urrutia[1], Lukasz Klosowksi[3], Anders K. Hansen[3], Alexander D. Gingell[3], and Michael Drewsen[3] — [1]Max Planck Institute for Nuclear Physics, 69117 Heidelberg, Germany — [2]Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany — [3]Ion Trap Group, Department of Physics and Astronomy, University of Aarhus, DK-8000 Aarhus C, Denmark

Molecules at rest in space with fully controlled internal states are of great interest for physics as well as astrophysics and physical chemistry. Significant progress towards this end has been achieved recently in a room-temperature trap by means of a laser excitation scheme of a single rovibrational transition in vibrationally and translationally cold MgH^+ ions. Blackbody radiation induced rotational dynamics, which limit this cooling scheme, are slowed down significantly in our new 4K cryogenic trap (CryPTEx), as successfully demonstrated in experiments carried out at AU. These improved experimental conditions enabled the measurement of the lifetime of the first vibrationally excited state in MgH^+ by means of laser excitation to this state, followed by resonance enhanced two-photon dissociation of the ions that were trapped in a Coulomb crystal. The method presented here can readily be extended to other molecules of particular astrophysical relevance such as CH^+, OH^+, and NH^+, enabling the determination of decay rates at percent level accuracy.

MO 16.6 Wed 12:15 F 107

Identification and Non-destructive State Detection of Molecular Ions — •Matthias Keller, Amy Gardner, Jack Morphew, Kevin Sheridan, and Nic Seymour-Smith — University od Sussex

Cold molecules have a multitude of applications ranging from high resolution spectroscopy and tests of fundamental theories to cold chemistry and, potentially, quantum information processing. Prerequisite for these applications is the cooling of the molecules' motion and its non-invasive identification. Furthermore, the internal state of the molecules needs to be prepared and non-destructively detected. The cooling of the motion and trapping of molecular ions can be accomplished by trapping them in an rf-trap alongside laser cooled atomic ions. We have developed a novel technique to measure the average charge to mass ratio of trapped ions with high precision by broadband excitation of the ions' COM-mode motion and measuring their laser induced fluorescence. While blackbody assisted laser cooling was recently demonstrated, the non-destructive state detection is still beyond current experiments. Employing state selective laser induced dipole forces we aim to detect the internal state of molecular ions by mapping the state information onto the ions' motion. The scheme promises mitigation of the effect of laser polarisation and the distribution of population across Zeeman sublevels and it may be applicable for a larger number of simultaneously trapped molecules.