A 3: Ultracold atoms, ions, and BEC I (joint session A/Q)

Time: Monday 11:00–13:00 Location: f303

Invited Talk A 3.1 Mon 11:00 f303
Creation of ultracold bosonic ^{23}Na^{39}K ground state molecules — •Kai Konrad Voges, Philipp Gersema, Torsten Hartmann, Mara Meyer zum Alten Borgloh, Torben Alexander Schulze, Alessandro Zenesini, and Silke Ospelkaus — Universität Hannover, Institut für Quantenoptik

Heteronuclear ground state molecules, with their large electric dipole moments, are an excellent platform for the investigation of fascinating dipolar quantum phenomena.
Bialkali ground state molecules are assembled from an ultracold atomic quantum gas mixture by utilizing Feshbach molecule association and subsequent stimulated Raman adiabatic passage (STIRAP) to the ground state.
In this talk we present the coherent creation of bosonic ^{23}Na^{39}K rovibrational ground state molecules following this pathway. We perform radio frequency pulses to populate a weakly bound molecular state close to a broad Feshbach resonance. We analyze the molecule creation efficiency with respect to the atom number ratio and radio frequency pulse duration. After that, we transfer the Feshbach molecules to a single spin-polarized hyperfine ground state using STIRAP through strongly coupled $c^3\Sigma(v=30)$ and $B^1\Pi(v=8)$ states, which we investigated spectroscopically beforehand. In this way we reach efficiencies of up to 70 %. We model the transfer process by incorporating multiple states from the excited state manifold and find a good agreement with our experimental results.

A 3.2 Mon 11:30 f303
Spin-rotation coupling in p-wave Feshbach resonances — •Manuel Gerken[1], Binh Tran[1], Eleonora Lippi[1], Bing Zhu[1,2], Stefan Häfner[1], Juris Ulmanis[1], Eberhard Tiemann[3], and Matthias Weidemüller[1,2] — [1]Physikalisches Institut, Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany — [2]Shanghai Branch, University of Science and Technology of China, Shanghai 201315, China — [3]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany

We report on the observation of spin-rotation coupling in p-wave Feshbach resonances in an ultracold mixture of fermionic ^{6}Li and bosonic ^{133}Cs. In addition to the doublet structure in the Feshbach spectrum due to spin-spin interaction, we observe a triplet structure of different m_ℓ states by magnetic field dependent atom-loss spectroscopy. Here, the m_ℓ states are projections of the pair-rotation angular momentum ℓ on the external magnetic field. Through comparison with coupled-channel calculations, we attribute the observed splitting of the $m_\ell = \pm 1$ components to electron spin-rotation coupling. Comparison with an oversimplified model, estimating the spin-rotation coupling by describing the weakly bound close-channel molecular state with the perturbative multipole expansion, reveals the significant contribution of the molecular wavefunction at short internuclear distances. Our findings highlight the potential of Feshbach resonances in providing precise information on short- and intermediate-range molecular couplings and wavefunctions. We also present measurements of spin-spin coupling in p-wave Feshbach resonances in a Li^6 mixture.

A 3.3 Mon 11:45 f303
Tune-out and magic wavelengths for the ^{23}Na^{40}K molecule — •Roman Bause[1], Xing-Yan Chen[1], Andreas Schindewolf[1], Ming Li[2], Marcel Duda[1], Svetlana Kotochigova[2], Immanuel Bloch[1,3], and Xin-Yu Luo[1] — [1]Max-Planck-Institut für Quantenoptik, 85748 Garching — [2]Department of Physics, Temple University, Philadelphia, Pennsylvania 19122, USA — [3]Ludwig-Maximilians-Universität, 80799 München

State-dependent optical dipole traps for ultracold atoms or molecules have wide application in quantum engineering and precision measurements. One extreme case is the tune-out condition, where the light shift of one state vanishes while the other one remains finite. Another extreme case is the magic condition, where the light shifts of both states are identical. We demonstrate a versatile, rotational-state dependent optical dipole trap for the ground-state ^{23}Na^{40}K molecule and its first rotationally excited state. Close to a low-lying, narrow molecular transition, we experimentally determined a tune-out and a magic frequency. Because these frequencies are less than 10 GHz apart, it is possible to create both types of trap as well as any intermediate trap configuration with the same laser system and switch between them during an experimental cycle. We propose that the rotational-state dependent trap can be used for evaporative cooling of polar molecules or investigation of their collisional properties.

A 3.4 Mon 12:00 f303
Efimov physics in strongly mass-imbalanced atom-dimer gases — •Panagiotis Giannakeas[1] and Chris H. Greene[2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Department of Physics and Astronomy, Purdue University, Indiana, USA

Three-body collisions in a two-species ultracold gases possess unique Efimovian idiosyncrasies. Indeed, for this particular colliding complex the magnitude and the sign intra- and inter-species scattering lengths can render an inherently different Efimovian landscape where the corresponding recombination spectra exhibit Efimov resonances intertwined with Stueckelberg suppression effects. Our current studies exploit these unique attributes of Efimov physics in mass-imbalanced systems by investigating the relevant scattering processes in atom-dimer gases. In particular, our analysis shows that the corresponding atom-dimer collisions are strongly enhanced when an Efimov bound state from the energetically closed three-body channel lies in the atom-dimer continuum, i.e. energetically open channel. Namely, our study demonstrates that in mass-imbalanced atom-dimer gases exists a series of atom-dimer resonances which fulfill a Fano-Feshbach scenario. In addition, we highlight the pivotal role of Stueckelberg physics on the width of the atom-dimer resonances where by adjusting the intra-species scattering length the atom-dimer continuum fully decouples from the Efimov states. Finally, our analysis addresses the universal aspects of this type of atom-dimer resonances, as well as, the importance of the Van der Waals physics.

A 3.5 Mon 12:15 f303
Autodetachment reaction dynamics in anion-atom reactions. — •Saba Zia Hassan[1,2], Jonas Tauch[1], Milaim Kas[4,5], Markus Nötzold[3], Henry Lopez[1], Eric Endres[1], Roland Wester[3], and Matthias Weidemüller[1,2] — [1]Physikalisches Institut Heidelberg, INF 226, 69120 Heidelberg — [2]International Max Planck Research School for Quantum Dynamics, Max Planck Institute for Nuclear Physics, 69117 Heidelberg — [3]Institut für Ionenphysik und Angewandte Physik, Technikerstraße 25/3, 6020 Innsbruck — [4]Département de Chimie, Faculté des Sciences, Université Libre de Bruxelles (ULB), 1050 Brusseles — [5]Deutsches Elektronen-Synchrotron (DESY), 22607 Hamburg

Associative detachment (AD) reactions play a key role in the destruction of anions to form neutral molecules in chemical networks, like interstellar medium, Earth's ionosphere and biochemistry. Here, we investigate AD reactions involving a closed-shell anion OH^- and rubidium atoms in a hybrid atom-ion trap. The overlap of atoms and anions leads to elastic and inelastic collisions, cooling the external and internal degrees of freedom respectively. Ab-initio calculations also predict the occurrence of AD reaction, i.e. $Rb+OH^- \rightarrow RbOH$. A detailed experimental investigation of AD reactions can serve as a stringent test on the effective core potentials used in theoretical studies. Furthermore, with a precise control on the fraction of electronically excited rubidium in the ensemble, the dynamics of quantum state dependent reactive collisions can be studied. In this contribution the latest results will be presented.

A 3.6 Mon 12:30 f303
A new ultracold atomic mixture experiment : SoPa — •Rohit Prasad Bhatt, Lilo Höcker, Jan Kilinc, and Fred Jendrzejewski — Kirchhoff-Institute for Physics, Im Neuenheimer Feld 227, D-69120 Heidelberg

Ultracold atomic gases present a high control over experimental parameters which makes them an ideal candidate to simulate a wide variety of physical systems. Ultracold atomic mixtures expand these horizons by covering an even greater range of quantum many body phenomena like dynamical gauge fields, quantum thermodynamic cycles etc. In this talk, I present the new Na-K experiment at Heidelberg, which we are setting up as a platform to study some of those problems.

A 3.7 Mon 12:45 f303

Squeezed-field path-integral description of a BEC — •Ilias Mir Heliassudin Seifie[1,2], Vijay Pal Singh[1,2,3], and Ludwig Mathey[1,2,3] — [1]Center for Optical Quantum Technologies, University of Hamburg, Germany — [2]The Hamburg Center for Ultrafast Imaging, Germany — [3]Institute of Laser Physics, University of Hamburg, Germany

We propose a generalization of the Feynman path integral using squeezed coherent states. In fact, the introduction of the squeezing parameter into the path integral enhances the adaptability of the theoretical model to the physical system. Therefore, our method can be applied to any analytical and numerical approach that is based on the path-integral representation. We apply this approach to the dynamics of Bose-Einstein condensates. In the low energy regime of a BEC, we obtain a generalization of the linearized Gross Pitaevskii equation, containing coherent and squeezing fields, and a description of second sound in weakly interacting condensates as a squeezing oscillation of the order parameter. In the higher energy and finite temperature regime, we analyze the coupling between the two fields and develope corresponding numerical and analytical methods.