Q 42: Ultra-cold atoms, ions and BEC V (with A)

Time: Wednesday 14:00–16:00 Location: B 302

Invited Talk Q 42.1 Wed 14:00 B 302

Dipolar Physics with Ultracold Atomic Magnets — •Ferlaino Francesca — Institut für Experimentalphysik Universität Innsbruck Technikerstraße 25 6020 Innsbruck, Austria

We report on the production of the first Bose-Einstein condensate of erbium [1]. Erbium is a very special multi-valence-electron atom, belonging to the lanthanide series. It possesses a strongly magnetic dipolar character, a rich energy level diagram, and various isotopes, among which one has a fermionic nature. Despite the complex atomic properties of such unconventional species, we find a surprisingly simple and efficient approach to reach quantum degeneracy by means of laser cooling on a narrow-line transition and standard evaporative cooling techniques. We observe favorable scattering properties of 168Er, resulting in remarkably high evaporation efficiency and in a large number of Feshbach resonances at very low magnetic field values. We recently employed a Feshbach resonance to magnetically associate Er_2 Feshbach molecules, which are of extreme dipolar character. Our observations make Er a dream system for ultracold quantum gas experiments.

[1] K. Aikawa, A. Frisch, M. Mark, S. Baier, A. Rietzler, R. Grimm, and F. Ferlaino, Bose-Einstein Condensation of Erbium, Phys. Rev. Lett. 108, 210401 (2012).

Q 42.2 Wed 14:30 B 302

Novel resonant states in three-body problem — •Maxim A. Efremov[1], Lev Plimak[1,2], and Wolfgang P. Schleich[1] — [1]Institut für Quantenphysik and and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, 89069 Ulm, Germany — [2]Max-Born-Institut, 12489 Berlin, Germnay

We consider the bound states of a three-body system consisting of a light particle and two heavy ones when the heavy-light short-range interaction potential has a resonance corresponding to the non-zero orbital momentum. Within the Born-Oppenheimer approach we suggest a novel method to find the effective potential between the heavy particles by a self-consistent scattering of a light particle by two heavy ones. In the case of the exact resonance in the p-wave scattering the effective potential is shown to be attractive and long-range, namely it decreases as the third power of inter-atomic distance. Moreover, the range and power of the potential, as well as the number of the bound states are determined mainly by the mass ratio of the heavy and light particles and the parameters of the heavy-light short-range potential.

Q 42.3 Wed 14:45 B 302

Quantum Phases of Soft-Core Dipolar Bosons in Optical Lattices — •Sebnem Günes Söyler[1], Daniel Grimmer[2], and Barbara Capogrosso-Sansone[2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]University of Oklahoma, Norman, USA

We perform quantum Monte Carlo simulations of a system of soft-core ultracold bosonic atoms with dipolar interactions, confined in a two dimensional optical lattice. We consider long range isotropic repulsive interactions which refers to dipoles are alligned perpendicular to the plane. We calculate the ground state phase diagram for a parameter range that exhibits various solids, superfluid and supersolid phases. We also present finite temperature results and discuss the experimental feasibility of such phases.

Q 42.4 Wed 15:00 B 302

Ultracold Lattice Gases with Periodically Modulated Interactions — •Akos Rapp, Xiaolong Deng, and Luis Santos — Institut für Theoretische Physik, Leibniz Universität, 30167 Hannover

We show that a time-dependent magnetic field inducing a periodically modulated scattering length may lead to interesting novel scenarios for cold gases in optical lattices, characterized by a nonlinear hopping depending on the number difference at neighboring sites. We discuss the rich physics introduced by this hopping, including pair superfluidity, exactly defect-free Mott-insulator states for finite hopping, and pure holon and doublon superfluids. We also address experimental detection, showing that the introduced nonlinear hopping may lead in harmonically trapped gases to abrupt drops in the density profile marking the interface between different superfluid regions.

Q 42.5 Wed 15:15 B 302

Coherent Backscattering of Ultracold Atoms — •Fred Jendrzejewski[1,3], Kilian Müller[1], Jeremie Richard[1], Philippe Bouyer[2], Alain Aspect[1], and Vincent Josse[1] — [1]Laboratoire Charles Fabry, Palaiseau, France — [2]LP2N, Talence, France — [3]Joint Quantum Institute, Gaithersburg, USA

Quantum interference effects play a fundamental role in our understanding of quantum transport through disordered media, as it can lead to the suppression of transport, i.e. Anderson Localization. Recently it became possible to directly observe Anderson Localization with ultracold atoms. Convincing as they are, none of these experiments includes a direct evidence of the role of coherence.

For weak disorder, a first order manifestation of coherence is the phenomenon of coherent backscattering (CBS), i.e. the enhancement of the scattering probability in the backward direction, due to a quantum interference of amplitudes associated with two opposite multiple scattering paths.

In this talk, I present our work on the direct observation of such a CBS peak. Launching atoms with a well-defined momentum in a laser speckle disordered potential, we follow the progressive build up of the momentum scattering pattern, consisting of a ring associated with multiple elastic scattering, and the CBS peak in the backward direction. The observation of the CBS peak is a smoking gun of the existence of quantum coherence in quantum transport in disordered media.

Q 42.6 Wed 15:30 B 302

Sympathetic cooling of OH^--ions using Rb atoms in a MOT — •Bastian Höltkemeier[1], Matthias Weidemüller[1], Thorsten Best[2], and Roland Wester[2] — [1]Physikalisches Institut, Im Neuenheimer Feld 226, 69120 Heidelberg — [2]Institut f. Ionenphysik und Angewandte Physik, Technikerstr. 25/3, 6020 Innsbruck

Based on previous experiments on ion-atom reactions, we present a new setup to investigate the interaction of ultracold rubidium atoms in a Dark-SPOT and mass-selected OH^--water clusters. The ions are trapped in an octupole RF-trap consisting of thin wires instead of metal rods to give maximum optical access.

As a first step we have performed numerical simulations using SimIon to investigate the possibility to sympathetically cool the OH^- ions using the ultracold rubidium atoms. These simualtions suggest, that with our trap configuration cooling by at least one order of magnitude can be achived. As an outlook we will report on the current status of the experiment and possible future applications.

Q 42.7 Wed 15:45 B 302

Photoassociation near the intercombination line of ^{40}Ca — •Max Kahmann[1], Oliver Appel[1], Eberhard Tiemann[2], Fritz Riehle[1], and Uwe Sterr[1] — [1]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Welfengarten 1, 30167 Hannover — [2]Institut für Quatenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

We have measured for the first time photoassociation resonances in the narrow-line system $^1S_0$ + $^3P_1$. We use about 10^5 calcium atoms that are trapped and evaporatively cooled to about 1 μK in a crossed optical dipole trap at a density of 10^{13} cm^{-3}. Precisely tunable laser light is produced by offset locking a diode laser to a laser which is resonant to the atomic line. The light is applied for typically 1 s to the trapped atoms and the trap loss is observed from absorption images of the atomic cloud. In a range of up to 25 GHz below the asymptote we have observed 6 photoassociation resonances in the two molecular potentials $\Omega = 0$ and $\Omega = 1$ correlating to the $^3P_1$ + $^1S_0$ asymptote. In both the $\Omega = 0$ and 1 excited states we observe a Zeeman splitting.

A theoretical model was developed in order to describe the Zeeman splitting and the energy of the bound molecular states in both potentials. The data helps to improve our knowledge of the molecular parameters and the dispersion coefficients and allows the use of low-loss optical Feshbach resonances to manipulate the atomic scattering length.