A 14: Ultra-cold atoms, ions and BEC III (with Q)

Time: Tuesday 11:00–12:30 Location: B 302

A 14.1 Tue 11:00 B 302

Shedding light on three-body recombination in ultracold atomic gases — •Artjom Krükow[1], Arne Härter[1], Markus Deiss[1], Björn Drews[1], Eberhard Tiemann[2], and Johannes Hecker Denschlag[1] — [1]Institut für Quantenmaterie and Center for Integrated Quantum Science and Technology IQST, Universit ät Ulm, 89069 Ulm, Germany — [2]Institute of Quantum Optics, Leibniz Universität Hannover, 30167 Hannover, Germany

We investigate three-body recombination in an optically confined ultracold cloud of ^{87}Rb atoms, in which Rb_2 molecules are formed. We examine the distribution of the molecular quantum states that are populated in this process. For this we ionize the Rb_2 molecules in a 3-photon REMPI scheme with a narrow-linewidth laser at a wavelength of around 1064nm. Subsequently the ionized molecules are trapped in a linear Paul trap where they are detected with single particle sensitivity and virtually no background. As we scan the frequency of the ionization laser, we observe a dense spectrum of narrow resonance lines which contains the information on the final states populated in the recombination events. We can resolve vibrational, rotational and hyperfine levels of the triplet and singlet ground state molecules. We observe deeply bound states with binding energies up to 750 GHz $\times$ h. We expect this method to provide a pathway to understanding three-body recombination in ultracold atomic gases which so far lacks a full theoretical treatment.

A 14.2 Tue 11:15 B 302

Transport spectroscopy in the Bose-Hubbard model — •Christian Nietner — Technische Universität Berlin

Motivated by recent experiments [1] we consider a Bose-Hubbard model with a single defect lattice site. This defect is weakly coupled to the surrounding which gives rise to bosonic currents through the defect. In order to describe these defect currents we develop a Lindblad master equation. We treat the remaining bosonic lattice as an effective bath for the defect and obtain a rate equation which depends on the 2-point correlation functions of the Bose-Hubbard model. To calculate these quantities we follow the approach outlined in Ref. [2]. Finally, we obtain defect currents which show signatures of the Mott phase and allow transport spectroscopy of the energy gap.

[1] T. Gericke, P. Würtz, D. Reitz, T. Langen et. al., Nature Physics **4**, 949 (2008)

[2] B. Bradlyn, F. E. A. dos Santos, and A. Pelster, Phys. Rev. A **79**, 013615 (2009)

A 14.3 Tue 11:30 B 302

Interference effects in Fock space in Bose-Hubbard systems — •Thomas Engl[1], Juan Diego Urbina[1], Arturo Argüelles Parra[2], Julien Dujardin[2], Peter Schlagheck[2], and Klaus Richter[1] — [1]Universität Regensburg — [2]Universite de Liege

Semiclassical techniques have so far been applied mainly to single particle systems. For these systems they provide a powerful toolbox to study interference effects and allow analytical calculations even in the presence of classical chaos.

On the other hand there have been attempts to apply the semiclassical approximation to the Feynman path integral for bosonic quantum fields in coherent state representation. The resulting coherent state path integral however leads to complex actions which does not give clear insight in interference effects.

We have succeeded in finding a representation in which the semiclassical approximation leads to a van-Vleck propagator with real action and therefore shows interference in Fock space explicitly. We use this propagator to predict various interference effects for Bose-Hubbard systems in three different regimes of the ratio of interaction and hopping strength, and we show that the probability of return is enhanced due to interference.

A 14.4 Tue 11:45 B 302

Optimal control of ultracold atomic quantum systems — •Antonio Negretti[1], Simone Montangero[2], Tommaso Calarco[2], Sandrine van Frank[3], Wolfgang Rohringer[3], Tarik Berrada[3], Thorsten Schumm[3], and Jörg Schmiedmayer[3] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg (Germany) — [2]Institut für Quanteninformationsverarbeitung, Universität Ulm, Albert-Einstein-Alle 11, 89069 Ulm (Germany) — [3]Atominstitut, Universität Wien, Stadionallee 2, 1020 Wien (Austria)

In the recent past, experiments with ultracold quantum gases have reached an extremely high degree of control, in which the manipulation and detection of single particles like atoms and ions have been demonstrated. For the purposes of quantum information processing and interferometry it is needed not only a high degree of control, but also that the desired quantum transformation is obtained as fast as possible. To this aim optimal control is a valuable resource to achieve high performance in the shortest possible time.

In my talk I shall present recent and very promising achievements in the optimized quantum dynamics of degenerate quasi 1D quantum Bose gases experiments.

A 14.5 Tue 12:00 B 302

Excitation spectrum of supersolids with soft-core bosons — •Tommaso Macri, Fabio Cinti, Fabian Maucher, and Thomas Pohl — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Motivated by recent experimental efforts to realize quantum phases of matter with cold atomic Rydberg gases, I will discuss the excitation spectrum of supersolids in a two dimensional bosonic system with soft-core interactions. Previous works showed an exceptional agreement between Monte Carlo simulations and a numerical mean-field approach.

I will present a variational analysis of the Gross-Pitaevskii equation with a non-local interaction term and show that we can quantitatively reproduce the superfluid-supersolid transition at finite interaction strength in agreement with Monte Carlo results. We then test the validity of this mean-field analysis perturbing the ground state wave function and looking at the spectrum of the corresponding Bogoliubov equations. This approach provides an intuitive physical insight to the low energy dynamics of the system and is validated through the comparison of our findings with recent Monte Carlo simulations.

A 14.6 Tue 12:15 B 302

Eigenvalue structure of Bose-Einstein condensates in $\mathcal{PT}$-symmetric double-well potentials — •Dennis Dast, Daniel Haag, Holger Cartarius, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart

Hamiltonians which obey parity-time ($\mathcal{PT}$) symmetry are a special class of non-Hermitian Hamiltonians that can have entirely real eigenvalue spectra in certain parameter regimes. We investigate a Bose-Einstein condensate in a realistic $\mathcal{PT}$-symmetric double-well potential where particles are removed in one well and coherently injected into the other well. The stationary solutions of the nonlinear Gross-Pitaevskii equation are calculated by variational and numerically exact methods. Special attention is drawn to the influence of the Gross-Pitaevskii nonlinearity. The system shows an unusual structure with two exceptional points which are analyzed by means of an analytic continuation.