Q 22: Quantengase (Gitter II)

Zeit: Dienstag 16:30–18:00 Raum: 1C

Q 22.1 Di 16:30 1C

Resonant Feshbach scattering of fermions in one-dimensional optical lattices — •Michael Grupp[1], Reinhold Walser[1], Wolfgang Schleich[1], Alejandro Muramatsu[2], and Martin Weitz[3] — [1]Institut für Quantenphysik, Universität Ulm, Germany — [2]Institut für Theoretische Physik III, Universität Stuttgart, Germany — [3]Institut für Angewandte Physik der Universität Bonn, Germany

We consider Feshbach scattering of fermions in an one-dimensional optical lattice. By formulating the scattering theory in the crystal momentum basis, one can exploit the lattice symmetry and factorize the scattering problem in terms of center-of-mass and relative momentum in the reduced Brillouin zone scheme. Within a single-band approximation, we can tune the position of a Feshbach resonance with the center-of-mass momentum due to the non-parabolic form of the energy band. We present numerical results for the resonant scattering in an one-dimensional lattice. In order to understand this results we discuss an analytic model for the coherent tunneling of atoms and dimers in half spaces.

[1] M. Grupp et al., J. Phys. B **40** (2007) 2703-2718

Q 22.2 Di 16:45 1C

Quantum Transport Experiments in Fourier-Synthesized Optical Lattices — •Tobias Salger, Carsten Geckeler, Sebastian Kling, and Martin Weitz — Institut für Angewandte Physik der Universität Bonn, Wegelerstr. 8, 53115 Bonn, Germany

We report on experiments studying quantum transport of Bose-Einstein condensates in variable periodic optical potentials. We have studied the band structure of both ratchet-type asymmetric and symmetric optical potentials by the Landau-Zener effect and Bloch oscillations. The variable atom potential is realized by superimposing a conventional standing wave with $\lambda/2$ spatial periodicity with a fourth-order multiphoton potential of $\lambda/4$ periodicity. The multiphoton lattice is realized using the dispersive properties of multiphoton Raman transitions [1]. We find that the strength of interband transitions depends critically on the shape of the synthesized lattice potential [2]. Furthermore we report on studies of Bloch-oscillations in the variable lattice potential.

[1] R. Ritt et al., Phys. Rev. A **74**, 063622 (2006)
[2] T. Salger et al., Phys. Rev. Lett. **99**, 190405 (2007)

Q 22.3 Di 17:00 1C

Fermion induced long-range interaction in the Bose-Fermi-Hubbard model — •Alexander Mering and Michael Fleischhauer — Technische Universität Kaiserslautern

We present recent results on the Bose-Fermi-Hubbard model in the limit of fast (ultralight) fermions. In this case, the fermions act as virtual quanta giving rise to an effective long-range density-density interaction for the bosons. Starting from the full BFH Hamiltonian we adiabatically eliminate the fast fermions. It is important to include the mean field backaction of the bosons into the free dynamics of the fermions. This yields a renormalized long-range boson-boson interaction. The resulting bosonic Hamiltonian is studied analytically using a bosonization approach as well as numerically using the density-matrix-renormalization-group (DMRG). In particular the transition between a CDW-phase and a compressible phase with exponentially decaying bosonic correlations is studied analytically compared to DMRG results.

Q 22.4 Di 17:15 1C

Counting atoms using interaction blockade in optical superlattices — •Ute Schnorrberger[1], Patrick Cheinet[1], Stefan Trotzky[1], Michael Feld[1,2], Simon Fölling[3], and Immanuel Bloch[1] — [1]Institut für Physik der Universität Mainz — [2]Fachbereich Physik der Technischen Universität Kaiserslautern — [3]Harvard University, USA

We demonstrate the ability to accurately measure the occupation number statistics of ultra cold atoms loaded in a 3D optical lattice by means of an interaction blockade effect analogue to the Coulomb blockade observed in mesoscopic solid state systems.

We present results where a ^{87}Rb BEC was loaded in a 3D optical lattice either in the superfluid regime or in the Mott-Insulator regime. When ramping up an additional lattice on one axis with half the periodicity of the initial one we create an array of double wells. The bias, which means the tilt of the double wells, can be controlled by the relative phase between the two lattices forming this superlattice. Whenever the applied bias potential is high enough to compensate the interaction blockade, tunneling resonances occur. We observe these resonances by measuring the resulting atom numbers of each side of the double wells for the whole ensemble with different bias. The number distribution in the underlying long lattice is extracted from the resonance amplitudes measured for the ensemble of the double wells. This allows us to fully characterize the markedly different number distributions in the superfluid and Mott-Insulator regime.

Q 22.5 Di 17:30 1C

A new experiment towards single site addressability in optical lattices — •Christof Weitenberg, Jacob Sherson, Oliver Loesdau, Manuel Endres, Jan Petersen, Immanuel Bloch, and Stefan Kuhr — Institut für Physik,Universität Mainz, Staudingerweg 7, 55128Mainz

We build a new experiment with ^{87}Rb atoms in an optical lattice which will allow for atom detection and manipulation with single site resolution. The central part of the new experiment is an ultra-high resolution imaging system with a spatial resolution of 300 nm. Single site manipulation will be achieved by focussing an addressing laser onto individual lattice sites.

Ultracold atoms will be loaded into the lattice from a Bose-Einstein condensate (BEC). It is generated in a crossed optical dipole trap formed by a 50 W YAG laser. The trap can be dynamically compressed by moving the foci of the laser beams. The BEC will be transported by a single beam dipole trap in front of the imaging system and transferred into the optical lattice.

The aim of our project is to prepare and to study single one- and two dimensional quantum systems. Single site addressability will allow us to modify or perturb the system on a local scale and to observe the ensuing dynamics of the many-body system in real time. Quantum gates and entanglement between neighbouring atoms can, for example, be obtained by collisions in a spin-dependent lattice.

Q 22.6 Di 17:45 1C

Controlled Loading of an Ultracold Bose-Fermi-Mixture into an Optical Lattice Potential — •Sebastian Will, Thorsten Best, Ulrich Schneider, Lucia Hackermüller, Dries van Oosten, and Immanuel Bloch — Johannes Gutenberg-Universität Mainz

The formation of heteronuclear molecules is a major goal of multi-species experiments with ultracold atoms. In this context optical lattices are expected to enhance the lifetime of weakly bound Feshbach molecules considerably by protective enclosure of single molecules on single lattice sites. However, the achievement of this configuration necessitates appropriate loading of the atomic clouds into the lattice before association.

In our setup we cool fermionic ^{40}K with bosonic ^{87}Rb sympathetically, reaching simultaneous quantum degeneracy with about $2 \cdot 10^5$ atoms per species. We load this mixture into a blue-detuned optical lattice and adjust the external confinement independently with additional red-detuned laser beams. This allows for the creation of an almost homogeneous lattice potential. Together with tuneable interspecies interactions our setup permits controlled loading - suitable for the creation of molecules in the lattice.