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We study the excitation spectrum of the ionic Hubbard model. The ionic Hubbard model consists of three terms: a nearest-neighbor tunneling, an onsite interaction and an alternating energy offset between even and odd sites. It was originally introduced for the description of condensed matter systems, e.g. mixed stacked organic compounds, and can be cleanly realized by ultracold fermionic atoms confined to an optical superlattice. Its phase diagram in one dimension has attracted considerable theoretical interest. In the limits of predominating energy offset or onsite interaction strength, the ground state is a band insulator or Mott insulator, respectively. In between a narrow so-called bond-ordered wave phase has been predicted which spontaneously breaks site-inversion symmetry. The excitation spectrum of the ionic Hubbard model has attracted much less attention so far. We exert a time-periodic modulation of the superlattice amplitude and study the exact time-dependence within the time-dependent density matrix renormalization group method. Our study is motivated by the possibilities of experimental probing in cold atomic gas experiments where our choice of perturbation corresponds to lattice amplitude modulation spectroscopy of superlattice geometry.

Q 58.82 Thu 16:30 Empore Lichthof

**A Laser System for Cooling of Yb Atoms** — •Benjamin Nagler, Tobias Eul, Carsten Lippe, Benjamin Gänger, Jan Phieler, Thomas Pinnel, Christina Weirich, and Artur Widera — Technische Universität Kaiserslautern, Fachbereich Physik und Landesforschungszentrum Optimas, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern, Germany

Quantum gases have proven useful tools to gain insight into fundamental phenomena of quantum physics. The working horse for preparation of these systems is laser cooling of dilute atomic gases. Here we report on the current state of preparing an ultracold gas of Ytterbium atoms, focusing on the laser system developed. This features blue light generation by second harmonic generation several hundreds of MHz detuned from the atomic transition for operating a Zeeman slower, stabilized onto an atomic resonance. We will show key features of the laser system and present measurements of the system characteristics.

Q 58.83 Thu 16:30 Empore Lichthof

**Fermionic many-body states under the microscope** — •Daniel Greif[1], Maxwell F. Parsons[1], Anton Mazurenko[1], Christie S. Chiu[1], Sebastian Blatt[1,2], Florian Huber[1], Geoffrey Ji[1], and Markus Greiner[1] — [1]Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA — [2]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany

We report on site-resolved imaging of various fermionic many-body states of ultracold Li-6 in a square optical lattice, including metallic, Mott-insulating and band-insulating phases. The insulating states show a suppression in the single-site occupation variance and a spatially constant filling fraction. A comparison to theory shows that the system is in global thermal equilibrium with fitted global entropies of $1.0\,k_\mathrm{B}$. We also report on our most recent progress towards probing magnetically ordered quantum states with the quantum gas microscope.

Q 58.84 Thu 16:30 Empore Lichthof

**Cloud Shape of Dipolar Fermi Gases** — •Vladimir Veljić[1], Antun Balaž[1], Aristeu R. P. Lima[2], and Axel Pelster[3] — [1]Scientific Computing Laboratory, Institute of Physics Belgrade, University of Belgrade, Serbia — [2]UNILAB, Brazil — [3]Physics Department and Research Center OPTIMAS, Technical UIniversity of Kaiserslautern, Germany

In a recent time-of-flight (TOF) expansion experiment for ultracold polarized fermionic erbium atoms it was shown that the Fermi surface has an ellipsoidal shape [1]. It was also observed that the Fermi surface follows a rotation of the dipoles, which is induced by changing the direction of the external magnetic field, keeping the major axis always parallel to the direction of maximal attraction of the dipole-dipole interaction. Here we present a theory for determining the cloud shape in both real and momentum space by extending the work of Ref. [2], where the magnetic field is oriented along one of the harmonic trap axes, to an arbitrary orientation of the magnetic field. In order to analyze the cloud shape within TOF dynamics, we solve analytically the corresponding Boltzmann-Vlasov equation by using a suitable rescaling of the equilibrium distribution [3]. The resulting ordinary differential equations of motion for the scaling parameters are solved numerically in the collisionless regime at zero temperature and turn out to agree with the observations in the Innsbruck experiment [1].

[1] K. Aikawa, et al., Science **345**, 1484 (2014).
[2] F. Wächtler, A. R. P. Lima, and A. Pelster, `arXiv:1311.5100`.
[3] P. Pedri, et al., Phys. Rev. A **68**, 043608 (2003).

Q 58.85 Thu 16:30 Empore Lichthof

**Development of a digital phase lock for optical lattices** — •Dominik Vogel, Nick Fläschner, Matthias Tarnowski, Benno Rem, Christof Weitenberg, and Klaus Sengstock — Universität Hamburg, Germany

Non-separable optical lattices feature new physics as for example Dirac cones and Berry phases in the case of the hexagonal lattice, which is formed by three interfering beams. Usually, the lattice beams pass through optical fibers for optimal beam profiles and therefore pick up independent phases, which translate the lattice potential and thus couple acoustic noise to the ensemble of ultra cold atoms, leading to heating.

In this poster, we present a digital phase locked loop that fixes those phases by controlling the laser frequencies via AOMs. The loop features a 800 kS/s bipolar analog to digital converter, a real time processor and a DDS frequency source. Our setup enables a total feeback signal delay under 2 micro seconds, while providing the high linewidth quality of a DDS-source, which is superior to conventional analog phase locks. In closed loop, we achieve a significant reduction of the phase noise, which is expected to increase the atomic life time in the optical lattice and thus provides access to new temperature regimes.

Q 58.86 Thu 16:30 Empore Lichthof

**Towards quantum gas microscopy of ultracold potassium atoms** — •Tobias Wintermantel, Emil Pavlov, Alda Arias, Stephan Helmrich, and Shannon Whitlock — Physikalisches Institut, Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg

Ultracold quantum gases in optical lattices are a versatile model system for engineering many-body quantum systems. Additionally, the advent of single-atom-resolution imaging techniques enables one to extract an unprecedented degree of information on the spatial correlations.

We are constructing a new experiment featuring fermionic or bosonic potassium atoms in optical lattices with reduced dimensional confinement. A special aspect will be the ability to introduce and control long-range interactions between the atoms via optical dressing of Rydberg states. A high-resolution imaging setup for probing these quantum gases, mainly consisting of an in-vacuum high-NA objective lens and a high quantum efficiency EMCCD camera, is currently under construction. The expected imaging quality depends, on the one hand, on the constraints of the imaging system (numerical aperture, aberrations and detector noise) and on the other hand, on physical constraints such as the number of photons which can be scattered before the atoms are heated and lost out of the microtraps. We present our progress in quantifying these effects for imaging Rydberg-dressed quantum fluids.

Q 58.87 Thu 16:30 Empore Lichthof

**Density dependent synthetic magnetism** — •Sebastian Greschner[1], Daniel Huerga[2], Gaoyong Sun[1], Dario Poletti[3], and Luis Santos[1] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover, Germany — [2]Institut fur Theoretische Physik III, Stuttgart — [3]Engineering Product Development, Singapore University of Technology and Design

Raman-assisted hopping can allow for the creation of density-dependent synthetic magnetism for ultracold neutral gases in optical lattices. In 1D the density-dependent Peierls phases can be mapped the anyon Hubbard model which exhibits a rich groundstate physics including unconventional two-component superfluid phases and statistically driven phase transitions [1]. In 2D square lattices we observe a non-trivial interplay between density modulations and effective magnetic fluxes as well as intriguing dynamical properties [2].

[1] S. Greschner and L. Santos, Phys. Rev. Lett. 115, 053002, 2015
[2] S. Greschner, D. Huerga, G. Sun, D. Poletti, and L. Santos, Phys. Rev. B 92, 115120, 2015

Q 58.88 Thu 16:30 Empore Lichthof

**Heteronuclear Spin-Changing-Collisions in Li-Na mixtures** — •Arno Trautmann, Fabián Olivares, Marcell Gall, Fred Jendrzejewski, and Markus K. Oberthaler — Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg