A 1: Ultra-cold atoms, ions and BEC I (with Q)

Time: Monday 11:00–12:30 Location: B 305

Invited Talk A 1.1 Mon 11:00 B 305

Dynamics of Ultra-cold Atoms in Optical Lattices — •Sandro Wimberger — Institut für Theoretische Physik, Universität Heidelberg

Modern quantum and atom-optical experiments allow for an unprecedented control of microscopic degrees of freedom, not just in the initialization but also in the dynamical evolution of quantum states. This talk focuses on the dynamics of ultra-cold bosons in optical lattice structures. Experimental as well as theoretical results for two paradigm systems are reported: on (1) the interband transport in a tilted lattice, i.e. a realization of the famous Wannier-Stark problem, and (2) on the stability of the temporal evolution in kicked lattice potentials. General perspectives on future directions of our study of strongly correlated bosons in lattice structures conclude the talk.

A 1.2 Mon 11:30 B 305

Interaction induced modification of tunnelling rates in a 1D tilted optical lattice — •Florian Meinert[1], Manfred Mark[1], Emil Kirilov[1], Katharina Lauber[1], Philipp Weinmann[1], Andrew Daley[2], and Hanns-Christoph Nägerl[1] — [1]Institut für Experimentalphysik, Universität Innsbruck — [2]Physics and Astronomy, University of Pittsburgh

Cold atoms confined in optical lattice potentials offer unique access to study condensed matter Hamiltonians, e.g. the bosonic Hubbard model. Magnetic Feshbach resonances provide high control and tunability of the interparticle on-site interaction strength allowing for the preparation of Mott insulating phases with both, attractive and repulsive interaction.

We study correlated tunnelling dynamics of degenerate bosonic Cs atoms prepared in one dimensional singly occupied Mott insulating chains. Subjecting the atoms to a linear potential gradient that is adiabatically ramped through resonance with the interaction energy results in a doublon-hole density wave order, a situation that maps onto the quantum phase transition from the paramagnetic to the antiferromagnetic state in the 1D transverse Ising model.

By quenching the system onto the phase transition point we initiate non-equilibrium tunnelling dynamics as detected in the number of created doubly occupied lattice sites. The observed coherent response of the system provides a direct measure of the tunnelling rate. We observe striking modification of this rate by interactions when tuned from attractive to repulsive.

A 1.3 Mon 11:45 B 305

Strontium in an Optical Lattice as a Portable Frequency Reference — Ole Kock, Wei He, Lyndsie Smith, Huadon Cheng, Steven Johnson, Kai Kai, and •Yeshpal Singh — School of Physics and Astronomy, University of Birmingham, Edgbaston Park Road, Birmingham B15 2TT, UK

A major scientific development over the last decade, namely clocks based on optical rather than microwave transitions, has opened a new era in time/frequency metrology. Several Physics Nobel prizes (1997, 2001, 2005, 2012) were awarded for methods that have enabled optical clocks.In optical clocks the (laser) electromagnetic wave beats 10^15 times per second instead of 10^10 as in microwave clocks. Optical clocks have now achieved a performance significantly beyond that of the best microwave clocks, at a fractional frequency inaccuracy of 8.6 *10^-18. The essential techniques used in optical clocks are the confinement of the atoms to regions significantly smaller than the wavelength of light, provision of an environment as free of disturbing influences (magnetic and electric fields, residual gas, black-body fields) as possible, choice of adequate atomic species, and the narrowing of the spectral width of the clock laser to relative levels of 10^-15 and less. With the rapidly improving performance of optical clocks, in the future, most applications requiring the highest accuracy will require optical clocks. They cover the fields of fundamental physics (tests of General Relativity and its foundations), time and frequency metrology (comparison of distant terrestrial clocks, operation of a master clock in space).

A 1.4 Mon 12:00 B 305

A novel 2D-confinement scheme for ultracold ^{40}K atoms — •Martin Reitter[1,2], Lucia Duca[1,2], Tracy Li[1,2], Josselin Bernardoff[1,2], Henrik Lüschen[1,2], Monika Schleier-Smith[1,2], Immanuel Bloch[1,2], and Ulrich Schneider[1,2] — [1]Fakultät für Physik, Ludwig-Maximilians-Universität, 80799 München, Germany — [2]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany

We report on a novel scheme for compressing an ultracold cloud of ^{40}K atoms into a single two-dimensional layer. The use of a single layer not only provides an analog to two-dimensional electron gases in condensed matter systems, but also allows for direct imaging of the atom cloud without the typical averaging effects due to the integration along the line-of-sight. A standard approach to compressing atoms into a single two-dimensional plane is to load them into a deep vertical lattice and remove atoms from all but one lattice plane. During this procedure, however, a significant number of atoms is lost. To overcome this disadvantage, we realize a vertical lattice with a dynamically variable lattice constant. By continuously changing the confinement, we will be able to compress almost all atoms held in a crossed-beam dipole trap into a single two-dimensional layer. Subjecting this two-dimensional system to an artificial gauge field will enable studies of topologically ordered states of fermions.

A 1.5 Mon 12:15 B 305

Measuring and controlling quantum transport of heat in trapped-ion crystals — Alejandro Bermudez, •Martin Bruderer, and Martin B Plenio — Institut für Theoretische Physik, Albert-Einstein Allee 11, Universität Ulm, 89069 Ulm, Germany

Measuring heat flow through nanoscale systems poses formidable practical difficulties as there is no 'ampere meter' for heat. We propose to overcome this problem by realizing heat transport through a linear chain of trapped ions. Steady laser cooling of the chain edges to different temperatures induces a current of local vibrations (vibrons) across the bulk ions. We show how to efficiently measure and control this heat current (including fluctuations) by coupling vibrons to internal ion states, which are easily manipulated. That makes ion crystals an ideal tool for studying thermal quantum transport and, in particular, gives access to the expectedly large fluctuations in the bosonic current.