A 38: Ultra-cold atoms, ions and BEC V (with Q)

Time: Friday 11:00–13:00 Location: f107

A 38.1 Fri 11:00 f107

Production of ultracold atomic clouds at the shot noise limit through feedback — •Andrew Hilliard, Miroslav Gajdacz, Mick Kristensen, Jacob Sherson, and Jan Arlt — Institute for Physics and Astronomy, Ny Munkegade 120, 8000, Aarhus C, Denmark

The reliable production of cold atomic clouds with well-defined properties is a notoriously difficult task. Variations in the atom number and temperature typically arise due to technical fluctuations during the experimental sequence. However, non-destructive measurements of the ensemble properties during an experimental sequence allow for an active adjustment of the cooling procedure to obtain the desired outcome.

To achieve this, we use a dispersive imaging technique based on Faraday rotation combined with on-line digital image evaluation to provide feedback to the evaporative cooling sequence. Our imaging technique achieves a relative precision below 10^{-3} and thus allows for active feedback that can beat the atomic shot noise limit. We have implemented feedback based on the Faraday rotation signal and thus achieved run-to-run stability at the shot noise limit.

A 38.2 Fri 11:15 f107

Box traps for 2D Bose gases — •Saint-Jalm Raphaël[1], Ville Jean-Loup[1], Corman Laura[1], Bienaimé Tom[1,2], Nascimbene Sylvain[1], Beugnon Jérôme[1], and Dalibard Jean[1] — [1]Laboratoire Kastler-Brossel, Collège de France — [2]INO-CNR BEC Center and Dipartimento di Fisica, Università di Trento

I will present a new experimental setup designed to investigate properties of ultracold bosons in low dimensions. In this setup, we produce a degenerate gas of rubidium atoms vertically confined into a single plane in an optical accordion. In the horizontal plane, we are able to engineer a flat-bottom potential whose shape can be chosen at will (disc, square, rings, boxes) by imaging the surface of a Digital Mirror Device (DMD). Thanks to this versatile system we aim at studying bosonic transport as well as implementing artificial gauge fields. I will present the first results that we have obtained in these directions.

A 38.3 Fri 11:30 f107

Topological Bogoliubov excitations of weakly interacting Bose-Einstein condensates — •Georg Engelhardt and Tobias Brandes — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

Topological band structures have been mostly investigated for fermionic systems. In our talk, we explain how to generalize the notion of topology to Bogoliubov excitations on top of a Bose-Einstein condensate. We investigate the topology of these Bogoliubov excitations in inversion-invariant systems of weakly interacting bosons.

The excitations of the corresponding Bogoliubov Hamiltonian have to be diagonalized in a symplectic manner. Analogously to the fermionic case, we here establish a symplectic extension of the polarization characterizing the topology of the Bogoliubov excitations and link it to the eigenvalues of the inversion operator at the inversion-invariant momenta.

We show that the interaction of the particles influences the topology of the Bogoliubov excitations. Additionally, we demonstrate that this quantity is related to edge states in the excitation spectrum of a finite-size system with boundaries.

A 38.4 Fri 11:45 f107

Tuning Static and Dynamic Properties of a Quasi One-Dimensional Bose-Einstein Condensate — •Javed Akram[1] and Axel Pelster[2] — [1]Physics Department, Freie Universität Berlin, Germany — [2]Physics Department and Research Center OPTIMAS, Technische Universität Kaiserslautern, Germany

Here we provide a detailed theoretical investigation in view of how to tune both static and dynamic properties of quasi one-dimensional confined Bose-Einstein condensates (BECs). At first we study ^{87}Rb atoms in a quasi one-dimensional trap geometry, which consists of a harmonic trap together with a red or blue-detuned Gaussian (Hermite-Gaussian) dimple trap [1,2]. After having switched off the dimple trap, shock-waves or gray pair-soliton (bi-)trains emerge, which oscillate with a characteristic frequency in the remaining harmonic trap. Afterwards, we analyze a quasi one-dimensional BEC in a nonlinear gravito-optical surface trap [3]. Studying a non-ballistic expansion of the BEC cloud, when the confining evanescent laser beam is shut off, turns out to agree quite well with results from a previous Innsbruck experiment. Finally, we investigate how the wave function of a trapped ^{87}Rb BEC changes due to the presence of a single ^{133}Cs impurity [4]. To this end, we determine the equilibrium phase diagram, which is spanned by the intra- and inter-species coupling strengths.

[1] J. Akram and A. Pelster, `arXiv:1508.05482`.
[2] J. Akram and A. Pelster, `arXiv:1509.03826`.
[3] J. Akram and A. Pelster, `arXiv:1509.05987`.
[4] J. Akram and A. Pelster, `arXiv:1510.07138`.

A 38.5 Fri 12:00 f107

Physical realization of third-order exceptional points — •Jan Schnabel, Holger Cartarius, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart

Exceptional points are characterized by the coalescence of two or even more eigenstates in non-Hermitian quantum systems. While second-order exceptional points (EP2) have already been realized in experiments, an experimental observation of a third-order exceptional point (EP3) is still lacking. Encouraging systems for such an observation could be a setup of three coupled waveguides as proposed in [1] or $\mathcal{PT}$-symmetric Bose-Einstein condensates (BEC) in a triple-well trap. We investigate a realistic optical setup by numerically exact calculations, which shows the appearance of an EP3. Due to a formal analogy between the Schrödinger and the Helmholtz equation the same potential can also be realized in quantum mechanics. We introduce a realistic quantum system made up of a BEC in a three-dimensional potential, which should exhibit the characteristic behaviour of an EP3.

[1] E-M. Graefe, J. Phys. A: **45**, 2 (2012)

A 38.6 Fri 12:15 f107

Levy flight and Anderson localization of polar molecules — •Xiaolong Deng[1], Boris Altshuler[2], Gora Shlyapnikov[3], and Luis Santos[1] — [1]ITP, Uni. Hannover — [2]Physics Dept, Columbia Uni., USA — [3]LPTMS, CNRS, France

Rotational excitations in polar molecules in deep optical lattices realize a quantum percolation model with long-range hops, whose properties depend on both lattice filling and dimensionality. Using spectral and multi-fractal analysis, we show that whereas in 1D and 2D all eigenstates are localized, while in 3D all are delocalized.

A 38.7 Fri 12:30 f107

Photodetachment spectroscopy of OH- in a Hybrid Atom Ion Trap — •Henry Lopez[1], Bastian Höltkemeier[1], Ji Luo[1], Andre de Oliveira[2], Eric Endres[3], Roland Wester[3], and Matthias Weidemüller[1] — [1]Physikalisches Institut, Universität Heidelberg, INF 226, 69120 Heidelberg, Germany — [2]Departamento de Física, Universidade do Estado de Santa Catarina-Joinville, SC, Brazil — [3]Institut für Ionenphysik und angewandte Physik, Universität Innsbruck, Technikerstraße 25/3, 6020 Innsbruck, Austria

We report on the current status of our experiment, which combines an 8-pole radio-frequency trap for OH- anions and a dark-spontaneous-force optical trap for rubidium atoms. The laser-cooled atoms serve as an ultracold buffer gas for the trapped anions. The anions final internal state is probed by means of electron photodetachment spectroscopy (PDS). We further discuss how PDS can be used for determining the final translational temperature of the anions.

A 38.8 Fri 12:45 f107

Coupling Identical 1D Many-Body Localized Systems — •Pranjal Bordia[1,2], Henrik Lüschen[1,2], Sean Hodgman[1,2], Michael Schreiber[1,2], Immanuel Bloch[1,2], and Ulrich Schneider[1,2] — [1]Facultät für Physik, LMU, München — [2]Max-Planck Institut für QuantenOptik

Many-Body Localization (MBL) marks a new paradigm in condensed matter and statistical physics. It describes a generic insulating phase in which an interacting many-body system fails to serve as its own heat bath and thermalization fails even in excited many-body states.

We experimentally study the dynamics of coupling identically disordered 1D MBL systems. Using a gas of ultracold fermions loaded in optical lattices, we prepare an out-of-equilibrium density wave and monitor its relaxation. We find striking difference between Anderson and MBL systems. While the Anderson case remains localized, coupling MBL systems with each other shows slow glassy relaxation and de-localizes the entire system.