A 50: Ultra-cold atoms, ions and BEC VI (with Q)

Time: Friday 10:30–11:45 Location: BEBEL E34

A 50.1 Fri 10:30 BEBEL E34

Pairing of few Fermi atoms in one dimension — •Pino D'Amico and Massimo Rontani — CNR-NANO S3, Via Campi 213A, 41125 Modena, Italy

Experimental advances allow us to confine a chosen number of few quantum degenerate Li6 atoms in a trap with unit precision down to the empty-trap limit. The Heidelberg group recently observed an even-odd oscillation of the "ionization" energy required to subtract an atom from a one-dimensional trap in the presence of moderate attractive interactions, which was attributed to pairing [PRL 111, 175302 (2013)]. Naively, one would expect pairing to be strongly suppressed in one dimension, due to the lack of orbital degeneracies. Here we address theoretically the pairing behavior of a few Fermi atoms in a one-dimensional harmonic trap through the exact diagonalization of the fully interacting Hamiltonian. From the analysis of exact ground- and excited-state energies and wave functions we extract both the pairing gap and the Cooper pair size, reproducing the observed even-odd behavior. Our results demonstrate that pairing in one dimension is a strongly cooperative effect that significantly deviates from the behavior predicted by perturbation theory at interaction strengths within experimental reach.

A 50.2 Fri 10:45 BEBEL E34

Universal spin dynamics in two-dimensional Fermi gases — •Marco Koschorreck[1,2], Daniel Pertot[1,2], Enrico Vogt[1], and Michael Köhl[1,2] — [1]University of Cambridge — [2]Universität Bonn

Spin transport has unique properties, setting it aside from charge transport: first, the transport of spin polarization is not protected by momentum conservation and is greatly affected by scattering. Therefore, the question arises: what is the limiting case of the spin transport coefficients when interactions reach the maximum value allowed by quantum mechanics? Second, unlike charge currents (which lead to charge separation and the buildup of an electrical field, counteracting the current), spin accumulation does not induce a counteracting force.

Fermionic quantum gases allow the study of spin transport from first principles because interactions can be precisely tailored and the dynamics is on directly observable timescales. In particular, at unitarity, spin transport is dictated by diffusion and the spin diffusivity is expected to reach a universal, quantum-limited value on the order of the reduced Planck constant divided by the particle mass. Here, we study a two-dimensional Fermi gas after a quench into a metastable, transversely polarized state [1]. Using the spin-echo technique, for strong interactions, we measure the lowest transverse spin diffusion constant of 0.0063(8) $\hbar$/m so far. For weak interactions, we observe a collective transverse spin-wave mode that exhibits mode softening when approaching the strongly interacting regime.

[1] Koschorreck, M., Pertot, D., Vogt, E. & Köhl, M. Nature Physics 9, 405-409 (2013).

A 50.3 Fri 11:00 BEBEL E34

Magnetic ordering in three-component ultracold fermionic mixtures in optical lattices — •Andrii Sotnikov and Walter Hofstetter — Goethe Universität, Frankfurt am Main, Germany

We study finite-temperature magnetic phases of three-component mixtures of ultracold fermions with repulsive interactions in optical lattices by means of dynamical mean-field theory (DMFT). We focus on the case of one particle per site (1/3 band filling) at moderate interaction strength, where we observe a transition between different sublattice orderings by means of the unrestricted real-space generalization of DMFT.

Our simulations show that long-range ordering in three-component mixtures should be observable at temperatures comparable to those in two-component mixtures. We analyse different types of antiferromagnetic order (2- and 3-sublattice color-density waves, color-selective antiferromagnetism) and determine the critical temperatures for transitions between different phases. We also discuss the effect of the asymmetry in interspecies interactions on these magnetic phases and the corresponding critical temperatures.

A 50.4 Fri 11:15 BEBEL E34

Energy dependent ℓ-wave Confinement-Induced Resonances — •Benjamin Hess[1], Panagiotis Giannakeas[1], and Peter Schmelcher[1,2] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The universal aspects of two-body collisions in the presence of a harmonic confinement are investigated for both particle exchange symmetries. The main focus of this study are the confinement-induced resonances (CIR) which are attrtibuted to different angular momentum states ℓ and we explicIty show that in alkaline collisions emerge only four universal ℓ-wave CIRs. Going beyond the single mode regime the energy dependence of ℓ-wave CIRs is studied. In particular we show that all the ℓ-wave CIRs may emerge even when the two-body potential cannot support any bound state. Even more, we observe that the intricate dependence on energy yields resonant features where the colliding system within the confining potential experiences an effective free-space scattering. Our analysis is done within the framework of the generalized K-matrix theory and the relevant analytical calculations are in good agreement with the corresponding ab initio numerical simulations

A 50.5 Fri 11:30 BEBEL E34

Transport with ultra-cold atoms at constant density — •Christian Nietner — Institut für Theoretische Physik, TU Berlin, Germany

We investigate the transport through a few-level quantum system described by a Markovian master equation with temperature- and particle-density dependent chemical potentials. From the corresponding Onsager relations we extract linear response transport coefficients in analogy to the electronic conductance, thermal conductance and thermopower. Considering ideal Fermi and Bose gas reservoirs we observe steady-state currents against the thermal bias as a result of the non-linearities introduced by the constraint of a constant particle density in the reservoirs. Most importantly, we find signatures of the on-set of Bose-Einstein condensation in the transport coefficients.