TT 29: Other Low Temperature Topics: Cold Atomic Gases

Time: Tuesday 12:00–13:00 Location: HSZ 201

TT 29.1 Tue 12:00 HSZ 201

Universal upper bound on the condensate-concentration of lattice hard-core bosons — Felix Tennie[1], Vlatko Vedral[1,2], and •Christian Schilling[1] — [1]Clarendon Laboratory, University of Oxford, Parks Road, Oxford OX1 3PU, United Kingdom — [2]Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, Singapore 117543

To investigate Bose-Einstein condensation for interacting bosons, usually the largest eigenvalue of their one-particle reduced density matrix is calculated. For lattice systems of N hard-core bosons on d sites we take a complementary viewpoint: Independent of the spatial dimension and any further microscopic details we prove that the hard-core constraint enforces a universal upper bound on occupation numbers given by $N_{max} = (N/d)(d - N + 1)$. It can only be attained for one-particle states $|\varphi\rangle$ with equal amplitudes with respect to the hard-core basis (sites) and when the corresponding N-particle state $|\Psi\rangle$ is maximally delocalized. We show that the maximizing state $|\Psi\rangle$ is related to the ground state of a bosonic 'Hubbard star' showing Bose-Einstein condensation.

TT 29.2 Tue 12:15 HSZ 201

Quasiparticle-induced Damping of BEC Oscillations in Double-well Potentials — •Tim Lappe[1], Anna Posazhennikova[2], and Johann Kroha[1] — [1]Physikalisches Institut, Universität Bonn — [2]Department of Physics, Royal Holloway, University of London

An interacting Bose-Einstein condensate (BEC) in a double-well trap with initial population imbalance, z_0, can perform Josephson oscillations or be in a self-trapped regime, depending on the value of z_0. Experimentally, both strongly damped [1] and undamped Josephson oscillations [2] have been observed, a discrepancy that has remained controversial because the source of the damping in [1] could not be clearly identified. A known mechanism for damping in such systems is via inelastic collisions of quasiparticles (QPs) [3]. However, in order to compare with real experiments one needs to incorporate the realistic energy spectrum of the potential, temperature effects and condensate contributions to the higher excited levels of the trap. In view of the necessary changes we solve the full non-separable potential of [2] exactly and incorporate all fluctuation effects within the full second order (in the couplings) approximation, thus demonstrating the possibility of QP excitations in the system. By taking into account QP collisions, we can reproduce the damped oscillations.

[1] LeBlanc et. al., Phys. Rev. Lett. **106**, 025302 (2011).
[2] Albiez et. al., Phys. Rev. Lett. **95**, 010402 (2005).
[3] A. Posazhennikova, M.Trujillo-Martinez, J. Kroha, Phys. Rev. Lett. 116, 225304 (2016).

TT 29.3 Tue 12:30 HSZ 201

Synthetic Creutz-Hubbard Model: Interacting Topological Insulators with Ultracold Atoms — Johannes Jünemann[1,2], Angelo Piga[3], Shi-Ju Ran[3], Maciej Lewenstein[3,4], •Matteo Rizzi[1], and Alejandro Bermudez[5,6] — [1]Johannes Gutenberg-Universität, Mainz (Germany) — [2]MAINZ - Graduate School Materials Science in Mainz (Germany) — [3]ICFO-Institut de Ciencies Fotoniques, Castelldefels (Spain) — [4]ICREA-Institució Catalana de Recerca i Estudis Avançats, Barcelona (Spain) — [5]Swansea University (UK) — [6]Instituto de Física Fundamental, IFF-CSIC, Madrid (Spain)

Understanding the robustness of topological phases of matter in the presence of strong interactions, and synthesising novel strongly-correlated topological materials, lie among the most important challenges of modern theoretical and experimental physics. Here we present a complete theoretical analysis of the Creutz-Hubbard ladder, a paradigmatic model that provides a neat playground to address these challenges. We put special attention to the competition of exotic topological phases and orbital quantum magnetism in the regime of strong interactions and identify the universality class of the different phase transitions. These results are furthermore confirmed and extended by extensive numerical simulations and analysis of the entanglement properties. Moreover, we propose how to experimentally realize this model and test its phase diagram in a synthetic ladder, made of two internal states of ultracold fermionic atoms in a one-dimensional optical lattice. Our work paves the way towards quantum simulators of interacting topological insulators with cold atoms.

TT 29.4 Tue 12:45 HSZ 201

Full counting statistics with determinantal quantum Monte Carlo — •Stephan Humeniuk — Institute for Theoretical Physics III, University of Stuttgart

Within the framework of determinantal quantum Monte Carlo, a method is presented for computing the probability distribution of the total particle number and magnetization on a subregion of a system of interacting fermions. Such full counting statistics can be obtained from repeated projective measurements in cold atoms experiments with single-site and single-atom resolution. Applied to the attractive Hubbard model, the full counting statistics reveals the size of a preformed pair or Cooper pair as a function of interaction strength.