Q 51: Quantengase: Gitter und Tunneln II

Zeit: Donnerstag 16:30–18:30 Raum: Audi-A

Q 51.1 Do 16:30 Audi-A

Dissipation induced coherence and stochastic resonance of an open two-mode Bose-Einstein condensate — •Dirk Witthaut[1], Friederike Trimborn[2], and Sandro Wimberger[3] — [1]QUANTOP, Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen, Denmark — [2]Institut für mathematische Physik, TU Braunschweig, D-38106 Braunschweig, Germany — [3]Institut für theoretische Physik, Universität Heidelberg, D-69120, Heidelberg, Germany

We discuss the dynamics of a Bose-Einstein condensate in a double-well trap subject to phase noise and particle loss. The phase coherence of a weakly-interacting condensate as well as the response to an external driving show a pronounced stochastic resonance effect: Both quantities become maximal for a finite value of the dissipation rate matching the intrinsic time scales of the system. Even stronger effects are observed when dissipation acts in concurrence with strong inter-particle interactions, restoring the purity of the condensate almost completely and increasing the phase coherence significantly.

Q 51.2 Do 16:45 Audi-A

Controlling the Landau-Zener decay in a Bose-Einstein condensate realization of the Wannier-Stark problem — •Ghazal Tayebirad[1,2], Alessandro Zenesini[3], Hans Lignier[3], Donatella Ciampini[3], Jagoda Radogostowicz[3], Oliver Morsch[3], Ennio Arimondo[3], and Sandro Wimberger[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 19, 69120 Heidelberg — [2]Heidelberg Graduate School of Fundamental Physics, Albert-Ueberle-Str. 3-5, 69120 Heidelberg — [3]Dipartimento di Fisica, Università degli Studi di Pisa, Largo Pontecorvo 3, 56127 Pisa, Italy

A comprehensive study of the tunneling dynamics of a Bose-Einstein condensate (BEC) in a tilted periodic potential is presented. This system enjoys a continuing popularity in many experimental groups [1]. In excellent agreement with experiments, our theoretical calculations, based on a mean-field theory for a many-particle condensate, explain the temporal behavior of the Landau-Zener (LZ) tunneling. While for a typical initial state of a BEC being strongly localized in momentum space, we observe a step-like structure in the survival probability as a function of time (resembling periodic Bloch oscillations), these structures are gradually washed out by increasing either the initial width in momentum space or the atom-atom interactions, together with other observed time-dependent structures in the profile of the survival probability, this clarifies to what extend we can expect deviation from a purely exponential decay in the studied LZ tunneling process.

[1] T. Schulte *et al.*, Phys. Rev. A, **77**, 023610 (2008); C. Sias *et al.*, Phys. Rev. Lett. **98**, 120403 (2007)

Q 51.3 Do 17:00 Audi-A

Effective model for the inter-band coupling in a many-body Wannier-Stark system — •Patrick Plötz[1,2] and Sandro Wimberger[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 19, 69120 Heidelberg — [2]Heidelberg Graduate School of Fundamental Physics, Albert-Ueberle-Str. 3-5, 69120 Heidelberg

Interacting bosons in a one-dimensional optical lattice are studied in the presence of an additional and tunable tilting force in the strongly-correlated many-particle regime. We use a two-band Bose-Hubbard description of this many-body Wannier-Stark problem for a realization with ultracold atoms. We find resonances in the quantum dynamics of the interband-coupling, connect our results to single-particle Wannier-Stark theory, and analyse the effect of the many-body interaction using an effective model. Our model captures the essentials of the original system. It predicts, for instance, collapses and revivals in the occupation of the two lowest bands, which are indeed found numerically in the full many-body system.

Q 51.4 Do 17:15 Audi-A

Ac-driven Atomic Quantum Motors — •Alexey Ponomarev, Sergey Denisov, and Peter Hänggi — Institute of Physics, University of Augsburg, Universitätstr. 1, D-86159 Augsburg

We consider ac-driven quantum motors consisting of two different, interacting ultracold atoms placed into a ring-shaped optical lattice which is submerged in a pulsating magnetic field. While the first atom carries a current, the second one serves as a quantum starter. For zero-momentum localized initial conditions, the amplitude of the generated dc-current saturates to the same non-zero value, independently on the initial phase lag of an external ac-field. This behavior distinctly differs from that predicted for dissipationless single-particle systems [1]. Also work against a load realized by an external biased potential has been investigated.

[1] S. Denisov, L. Morales-Molina, S. Flach, and P. Hänggi, Phys. Rev. A **75**, 063424 (2007).

Q 51.5 Do 17:30 Audi-A

Directed Transport of Ultracold Atoms in a Hamiltonian Quantum Ratchet — •Tobias Salger, Carsten Geckeler, Sebastian Kling, Tim Hecking, and Martin Weitz — Institut für Angewandte Physik der Universität Bonn, Wegelerstr. 8, D-53859 Bonn

Ratchets are considered as a tool, which generate a directed motion of particles in the absence of any gradients or net forces. The ratchet effect can be realized for instance in a fluctuating environment as a physical mechanism of microbiological motion. In order to observe a directed transport of atoms, one has to break the space-time symmetry of the system [1]. Here we report on the realization of a quantum ratchet in the absence of dissipative processes (Hamiltonian regime) within the interaction time.

We load a ^{87}Rb Bose-Einstein condensate into a sawtooth-like asymmetric optical lattice potential, which is realized by superimposing an optical standing wave with $\lambda/2$ spatial periodicity with a fourth-order potential with $\lambda/4$ spatial periodicity, where λ denotes the wavelength of the used laser [2]. Besides the spatial, also the temporal symmetry of the system is broken by modulation of the lattice potential depth. We experimentally observe directed transport of atoms arising from Hamiltonian ratchet transport in the quantum regime.

[1] S. Denisov et al., Phys. Rev. A **75**, 063424 (2007)
[2] G. Ritt et al., Phys. Rev. A **74**, 063622 (2006)

Q 51.6 Do 17:45 Audi-A

Theoretical Investigation of a Hamiltonian Quantum Ratchet — •Tim Hecking[1], Luis Morales-Molina[2], Tobias Salger[1], Carsten Geckeler[1], Sebastian Kling[1], and Martin Weitz[1] — [1]Institut für Angewandte Physik der Universität Bonn, Wegelerstr. 8, 53115 Bonn, Germany — [2]Department of Physics, National University of Singapore, 2 Science Drive 3, Singapore 117542

We study the dynamics of a Bose-Einstein condensate in a quantum ratchet, that consists of a biharmonic, amplitude modulated potential in the absence of dissipation (Hamiltonian regime) [1]. The system considered here exhibits negligible atom-atom interaction, therefore the results can be obtained by numerical integration of the linear Schrödinger equation. Of particular interest is the dependence of the atomic mean momentum on critical parameters, such as the modulation period and the symmetry properties of the system. By comparison of our theoretical model with the results of an experimentally realized quantum ratchet [2], good agreement is achieved.

[1] S. Denisov et al., Phys. Rev. A **75**, 063424 (2007)
[2] T. Salger et al., to be published

Q 51.7 Do 18:00 Audi-A

Wavepacket dynamics in energy space of a chaotic trimeric Bose-Hubbard system — •Moritz Hiller[1], Tsampikos Kottos[2,3], and Theo Geisel[3] — [1]Fakultät für Physik, Albert-Ludwigs-Universität Freiburg, Germany — [2]Department of Phsyics, Wesleyan University, Middletown CT, USA — [3]Max-Planck-Insitut für Dynamik und Selbstorganisation, Göttingen, Germany

We study the energy redistribution of interacting bosons in a ring-shaped quantum trimer as the coupling strength between neighboring sites of the corresponding Bose-Hubbard Hamiltonian undergoes a sudden change δk. In the framework of (ultra-)cold atoms on optical lattices this perturbation corresponds to a modulation of the trapping potential. Our analysis is based on a three-fold approach combining linear response theory calculations as well as semiclassical and random matrix theory considerations. The δk-borders of applicability of each of these methods are identifed by direct comparison with the exact quantum mechanical results. We find that while the variance of the evolving quantum distribution shows a remarkable quantum-classical correspondence (QCC) for all δk-values, other moments exhibit this

QCC only in the non-perturbative δk-regime.

Q 51.8 Do 18:15 Audi-A

Scattering Properties of Bose-Hubbard Hamiltonians with two and three sites — •Stefan Hunn[1], Moritz Hiller[1], Tsampikos Kottos[2,3], Doron Cohen[4], and Andreas Buchleitner[1] — [1]Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]Department of Physics, Wesleyan University, CT, USA — [3]MPI für Dynamik und Selbstorganisation, Bunsentraße 10, 37073 Göttingen — [4]Department of Physics, Ben-Gurion University, Beer-Sheva, Israel

We consider a probe particle in a tight binding geometry with two leads and a central site that is coupled to a Bose-Hubbard system consisting of two or three wells (dimer/trimer). For the case of the dimer, we find that the resonance widths undergo a sequence of bifurcations resulting from the complexity of the underlying classical phase space structure. In the case of the trimer, we focus on the parameter regime corresponding to classically chaotic motion. We analyze the statistical properties of the scattering matrix and compare our results to the predictions of random matrix theory for chaotic scattering.