# Q 47: Quantengase: Gitter und Tunneln I

Zeit: Donnerstag 14:00–16:00 Raum: Audi-A

Q 47.1 Do 14:00 Audi-A

**Controlling a magnetic Feshbach resonance with laser light** — •Matthias Lettner, Dominik M. Bauer, Christoph Vo, Gerhard Rempe, and Stephan Dürr — Max Planck-Institut für Quantenoptik, Hans Kopfermann Str.1, 85748 Garching

The capability to tune the strength of the elastic inter particle interaction is crucial for many experiments with ultracold gases. Magnetic Feshbach resonances are a tool widely used for this purpose, but future experiments would benefit from additional flexibility such as spatial modulation of the interaction strength on short length scales. Optical Feshbach resonances offer this possibility in principle, but suffer from fast particle loss due to light-induced inelastic collisions. Here we show that light near-resonant with a molecular bound-to-bound transition can be used to shift the magnetic field at which a magnetic Feshbach resonance occurs. This makes it possible to tune the interaction strength with laser light and at the same time induce considerably less loss than an optical Feshbach resonance would do. For small detuning from the bound-to-bound transition we observe a splitting of the Feshbach resonance similar to an Autler-Townes doublet.

Q 47.2 Do 14:15 Audi-A

**Collisional properties of metastable neon in different internal states** — •Jan Schütz, Jonas Keller, Matthias Euler, Norbert Herschbach, and Gerhard Birkl — Institut für Angewandte Physik, Technische Universität Darmstadt, Schlossgartenstraße 7, 64289 Darmstadt

We measured the scattering lengths of laser-cooled neon atoms in the metastable state $^3P_2$ for the bosonic isotopes $^{20}$Ne and $^{22}$Ne and the suppression of two-body losses due to spin-polarization. After implementing a dipole trap, we determined the two-body loss coefficients of both isotopes in the second metastable state $^3P_0$. In all cases the good-to-bad ratios are found to be too low for efficient evaporative cooling without modification of the collisional properties.

We currently investigate the possibility to coherently control collisional interactions by preparing the atoms in superposition states of different magnetic sublevels of the $^3P_2$ state. We are therefore implementing a STIRAP scheme between the $^3P_0$ and $^3P_2$ states. We report on the status of the experiment.

Q 47.3 Do 14:30 Audi-A

**The non-Abelian Ring: Interferometer & Josephson Effects** — •Michael Merkl[1], Frank E. Zimmer[1], Patrik Ohberg[1], and Gediminas Juzeliunas[2] — [1]Heriot-Watt University, EH14 4AS Edinburgh, UK — [2]Vilnus University, 01108 Vilnius, Lithuania

In this work we consider optically induced non-trivial gauge potentials for the external motion of cold atoms. In the electromagnetically induced transparency (EIT) regime this can be achieved if the system stays in certain eigenstates, so called dark states. The resulting vector potential can be non-Abelian for a set of two degenerated dark states [1]. Non-Abelian vector potentials gives us a tool to investigate connections to very different areas of physics in the framework of cold atoms. The spacial shape of the trap and restriction to one dimension is the key technique used with non-Abelian potentials to observe a wide range of phenomenona [2]. In the present talk, we consider a non-Abelian ring in detail. Herby two limits are of interest. A interferometer set up, where small wave packets move in both directions, and the completely filled ring. The dynamics in the latter leads naturally to an exact description by Josephson equations which show non-trivial oscillations in the time and spacial domain.

[1] J. Ruseckas, G.Juzeliūnas, P Öhberg and M. Fleischhauer, PRL 95, 010404 (2005)
[2] M. Merkl, F.E. Zimmer, G. Juzeliūnas and P. Öhberg, EPL 83, 54002 (2008)

Q 47.4 Do 14:45 Audi-A

**Probing Atom-Wall interactions by Quantum Reflection of Bose-Einstein Condensates** — •Naceur Gaaloul for the Quantus Team, Wolfgang Ertmer, and Ernst Rasel — Institut für Quantenoptik, Gottfried Wilhelm Leibniz Universität, Welfengarten 1 D -30167, Hannover, Germany

Recently a free expansion of a 10000 Rb-atom condensate was achieved for extremely long times (1s). The Bose-Einstein condensate is first prepared and trapped magnetically in the vicinity of an atom chip. The release of the atomic ensemble is performed when the experiment is dropped down in the ZARM tower facility in Bremen. Thus a free expansion is obtained during the free fall and could be used to observe quantum refection of the BEC on the chip surface. Several experiments of quantum reflection were done in the last years, but our model predicts high reflectivity due to the very slow incident velocities (less than 1 mm/s) of the cold atoms in the Quantus experiment. The dilute character of the cloud after 1s of expansion should also minimize the effect of mean-field interactions and lead to a good agreement with the quantum reflection theory. In addition, we interpret theoretically the expected interference fringes between reflected and incoming atoms to obtain a highly accurate measurement of the shift caused by the atom-surface interactions. Thus we could probe the attractive Casimir-Polder potential over an extended spatial range only reached thanks to the coherence of the source and the use of interferometric measurements.

The QUANTUS project is a collaboration of the U Hamburg, U Ulm, HU Berlin, MPQ Munich, ZARM at U Bremen, and the LU Hanover. It is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant number DLR 50 WM 0346.

Q 47.5 Do 15:00 Audi-A

**Stability of Bloch oscillations in certain interacting BECs** — •Christopher Gaul[1], Cord Axel Müller[1], Rodrigo de Lima[2], Elena Díaz García[2], and Francisco Dominguez-Adame[2] — [1]Physikalisches Institut, Universität Bayreuth, Deutschland — [2]Universidad Complutense de Madrid, España

We consider Bloch oscillations of a BEC in an optical lattice, using a tight binding model in the mean-field regime. Single-particle Bloch oscillations are very sensitive to any dephasing effect like on-site disorder or particle-particle interaction. Here we investigate the influence of a time-dependent repulsive interaction with zero time-average. In this driven system, we identify two distinct mechanisms for the collapse of Bloch oscillations: One mechanism acts directly on the width of the wave packet, resulting in an immediate decay of the oscillation. The other mechanism is more subtle and consists in an instability to perturbations on a short length scale compared to the width of the wave packet. Here it takes a long time for the perturbations to grow, which suddenly destroy the Bloch oscillation.

Q 47.6 Do 15:15 Audi-A

**Solitonic eigenstates of the chaotic Bose-Hubbard Hamiltonian** — •Tobias Zech[1], Hannah Venzl[1], Bartłomiej Oleś[2], Moritz Hiller[1], Florian Mintert[1], and Andreas Buchleitner[1] — [1]Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany — [2]Marian Smoluchowski Institute of Physics and Mark Kac Complex Systems Research Center, Jagiellonian University, Reymonta 4, 30-059 Kraków, Poland

The Bose-Hubbard Hamiltonian, that describes bosons in an optical lattice, exhibits quantum chaos [1] for comparable values of on-site and tunneling energies. We analyze the parametric level evolution as a function of an additional tilt of the lattice. Within the chaotic bulk of the spectrum we identify levels showing regular behavior, termed "solitonic eigenstates". Similar patterns are known in classical mechanics, where a mixed phase space contains regular islands that are embedded in the chaotic sea. We present a characterization of the solitonic states and construct systematically distinct manifolds of them.

[1] A. Buchleitner, A.R. Kolovsky, Phys. Rev. Lett. **91**, 253002 (2003)

Q 47.7 Do 15:30 Audi-A

**Particle number squeezing in a two-well system** — •Cédric Bodet and Thomas Gasenzer — Institut für Theoretishe Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg

The dynamical evolution of a Bose-Einstein condensate trapped in a one-dimensional lattice potential is investigated theoretically in the framework of the Bose-Hubbard model. The emphasis is set on the development of non-classical correlations and squeezing under circumstances where the system is strongly interacting and the evolution can no longer be described by classical statistical dynamics. We approach this problem by numerically solving the Schrödinger equation for this model and comparing those results to classical simulations. We study in detail particle number fluctuations, on-site and between sites, in order to investigate the conditions for producing squeezed states in experimentally realistic configurations, for example by raising a lattice potential inside a condensate.

Q 47.8 Do 15:45 Audi-A

**Resonance solutions of the nonlinear Schrödinger equation in an open double-well potential** — Kevin Rapedius and •Hans Jürgen Korsch — FB Physik, TU Kaiserslautern, 67663 Kaiserslautern, Germany

The resonance states and the decay dynamics of the nonlinear Schrödinger (or Gross-Pitaevskii) equation are studied for a simple, however flexible model system, the double delta-shell potential. This model allows analytical solutions and provides insight into the influence of the nonlinearity on the decay dynamics. The bifurcation scenario of the resonance states is discussed, as well as their dynamical stability properties. A discrete approximation using a biorthogonal basis is suggested which allows an accurate description even for only two basis states in terms of a nonlinear, nonhermitian matrix problem.

Journal reference: K. Rapedius, H. J. Korsch, "Resonance solutions of the nonlinear Schrödinger equation in an open double-well potential", Journal of Physics B, in press