Q 17: Ultrakalte Atome I [gemeinsam mit A]

Zeit: Dienstag 14:00–16:00 Raum: 2F

Q 17.1 Di 14:00 2F

Cold bosonic atoms in a $\pi-$flux lattice — •Stephan Rachel and Martin Greiter — Institut für Theorie der Kondensierten Materie, Universität Karlsruhe, 76128 Karlsruhe

We present a model where the rare phenomenon of fragmented Bose–Einstein condensation occurs: we consider a system of neutral, bosonic atoms on a square lattice subject to an effective magnetic field. We focus on a magnetic flux of half a Dirac flux quantum through every lattice cell. The effective flux yields two minima in the lower single particle band. We show that in the many particle ground state, the particles are evenly distributed over both minima. The two macroscopically occupied minima correspond to two distinct Bose condensates.

Regarding the low-energy excitations of the system, we show that Josephson tunneling is only possible for pairs of bosons, while single particle tunneling between both condensates is absent. We further find a massive mode describing fluctuations in the relative density of the two condensates.

Q 17.2 Di 14:15 2F

Bose-Einstein condensation in a periodic potential: A perturbation approach — •Ming-Chiang Chung[1], Victor Lopez-Richard[2], Carlos Trallero-Giner[3], and Andreas Buchleitner[4] — [1]Max-Planck-Institut für Physik Komplexer Systeme* Noethnitzer Str. 38, D-01187 Dresden, Germany — [2]Departamento de Fisica, Universidade Federal de S\~{a}o Carlos, 13.565-905, S\~{a}o Carlos, S\~{a}o Paulo, Brazil — [3]Faculty of Physics, Havana University, 10400 Havana, Cuba — [4]Quantum Optics and Statistics Institute of Physics Albert-Ludwigs-Universitaet Freiburg Hermann-Herder-Str. 3 D-79104 Freiburg, Germany

Considering the Gross-Pitaevskii equation for Bose-Einstein condensate in a stationary one dimensional optical lattice with period \$d\$ in reduced coordinates, we are able to formally obtain closed analytical solutions for the order parameter and for the chemical potential. We report solutions for different range of values for the repulsive and the attractive non-linear interactions in the condensate and laser parameters creating the lattice. We have preformed a quantitative analysis with numerical solutions and theoretical estimation of the reported analytical equations allowing the determination of validity ranges of the perturbation approach. This study gives a very useful result establishing the universal range of the non-linear coupling term and lattice parameter values where each solution can be easily implemented.

Q 17.3 Di 14:30 2F

Improving the analytical determination of bound state energies and scattering lengths in molecular potentials – especially near threshold — •Patrick Raab and Harald Friedrich — Physik Department T30a, Technische Universität München, D-85747 Garching

Conventional WKB quantization can be improved substantially by including the appropriate reflection phases at the classical turning points. By application of the Effective-Range-theory we are able to calculate the reflection phase at the outer turning point in an attractive potential up to linear order in energy. For arbitrary energy we estimate the reflection phase by matching the low energy expansion with known formulas for high energies. This model, which includes only one free parameter is a significant improvement over the approximate eigenenergies obtained by other methods. The scattering length is completely determined by the knowledge of one of the highest bound energy levels (not necessarily by the highest one) and the asymptotic behavior of the potential.

Q 17.4 Di 14:45 2F

Jost-Functions & Attractive Singular Potentials — •Florian Arnecke, Javier Madronero, and Harald Friedrich — Physik Department T30a, Technische Universität München, D-85747 Garching

We use Jost-functions to determine the leading and next-to-leading terms of the phase shifts $\delta_l(k)$ in the case of homogeneous attractive singular potentials $-1/r^\alpha$, $\alpha > 2$, for arbitrary angular momentum l with incoming boundary conditions at small distances. The Jost-solutions are obtained by solving a Volterra-equation and a more general ansatz is used to fit the Jost-solutions to the WKB-waves in the inner region, where the WKB-approximation is accurate. A connection between the phase shifts of attractive and repulsive homogeneous singular potentials is presented.

Q 17.5 Di 15:00 2F

Stable dark solitons in three-dimensional dipolar Bose-Einstein condensates — •Rejish Nath[1], Paolo Pedri[2], and Luis Santos[1] — [1]Institute of Theoretical Physics, Leibniz university of Hannover, Appelstrasse 2, 30167, Hannover, Germany — [2]Laboratoire de Physique Théorique de la Matière Condensée, Université Pierre at Marie Curie, case courier 121 , 4 place Jussieu, 75252 Paris Cedex, France

We study the dynamical stability of dark solitons in dipolar Bose-Einstein condensates. In the absence of non-locality due to the dipolar interaction, stationary dark solitons (nodal planes) are unstable against transversal excitations (snake instability) in 2D and 3D. On the contrary, due to its non local character, the dipolar interaction allows for stable 3D stationary dark solitons. We discuss in detail the conditions to achieve this stability, which demand the use of an additional optical lattice.

Q 17.6 Di 15:15 2F

Correlation dynamics of strongly-correlated lattice bosons out of equilibrium — •Karen Rodriguez and Luis Santos — Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover

We analyze by means of matrix product states techniques the dynamics of strongly-correlated Bose gases in a finite one-dimensional optical lattice after a change of the lattice parameters within the superfluid region. We analyze different regimes of perturbation, which range from adiabatic to non-adiabatic. In particular, we are interested in the evolution of different correlations in the system in time, showing that the different correlations present different time scales in their reaction to the change of parameters. As a consequence, when local quantities are converged correlation to distant neighbours or the quasi-condensate fraction may still present a significant dynamics. In addition, the different time scales for different correlations open the possibility to have different criteria for adiabaticity in the system.

Q 17.7 Di 15:30 2F

Laser Cooling and Trapping of a Leaky System: Barium — •Subhadeep De, Joost van den Berg, Aran Mol, Klaus Jungmann, and Lorenz Willmann — KVI, University of Groningen, Groningen, The Netherlands

Heavy alkaline earth elements like radium are excellent candidates to test fundamental symmetries by searches for permanent electric dipole moments and atomic parity violation. Sensitive experiments require the trapping of these isotopes. Nevertheless, the two electron atoms have no simple two-level system for laser cooling due to the strong transitions between the singulet and the triplet system. The strongest transition from the ground state $^1S_0$-$^1P_1$ show a leak of 1:500 to metastable D-states. We have studied such a system with barium, where the branching into the D-states is 1:330(30). Repumping from these states uses the same excited state as the cooling transition, which leeds to coherent Raman transitions. Trapping and cooling of barium requires a set of seven lasers running at the same time. We report on the first successful trapping of barium in a magneto optical trap. The performance of the cooling and trapping will be discussed.

Q 17.8 Di 15:45 2F

Non-Abelian Statistics in a Quantum Antiferromagnet — •Martin Greiter and Ronny Thomale — Institut für Theorie der Kondensierten Materie, Universität Karlsruhe, D 76128 Karlsruhe

We propose a novel spin liquid state for a S=1 antiferromagnet in two dimensions. The ground state is a spin-singlet, fully invariant under the symmetries of the underlying lattice, and possess a threefold topological degeneracy. The spinon and holon excitations obey non-abelian statistics, with the braiding of half-quantum vortices governed by zero energy modes in the vortex cores. We present numerical evidence that the universality class of this topological liquid can be stabilized by a model Hamiltonian involving three-spin interactions. We discuss possible realizations with polar molecules in optical lattices as well as potential applications in quantum computing.