Q 41: Quantengase: Dipolare Gase

Zeit: Donnerstag 10:30–12:30 Raum: Audi-A

Q 41.1 Do 10:30 Audi-A

Effects of Bending modes on the quantum statistics of self-assembled chains of polar molecules — •Jörg Duhme, Michael Klawunn, and Luis Santos — Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstr. 2, D-30167, Hannover, Germany

Under certain circumstances quantum gases caught in harmonical traps can form layers. Dipolar gases are needed for a long-range interaction between different layers. In dilute gases this anisotropic interaction causes the formation of chains (filaments) of dipolar molecules [1]. We studied the effect of the bending modes of these filaments on the quantum statistics of the whole system made of several layers. Furthermore we investigated the effect of the bending modes on the critical temperature of the system to form a BEC of chains. The bending modes have important consequences for the critical temperature as well as for the quantum statistics of the whole system.

[1] D.W. Wang, M. Lukin, E. Demler, Phys. Rev. Lett. 97, 180413 (2006)

Q 41.2 Do 10:45 Audi-A

Roton instability in dipolar Bose-Einstein condensates in an 1D optical lattice — •Michael Klawunn and Luis Santos — Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstr. 2,D-30167 Hannover, Germany

The non-local nonlinearity introduced by Dipole-Dipole interaction plays a crucial role in the physics of dipolar Bose-Einstein condensates. In a sufficiently strong one-dimensional periodic potential we have a stack of strongly confined pancake condensates, which shows under certain conditions a roton minimum in the dispersion law of collective excitations. We have analyzed these roton-instabilities for the cases of transversal excitations of a straight vortex-line created in the direction of the optical lattice [1,2] or homogeneous in-plane excitations in all layers.

[1] M. Klawunn, R. Nath, P. Pedri, L. Santos, Phys. Rev. Lett. 100, 240403 (2008); [2] M. Klawunn, L. Santos, submitted to New J. Phys.

Q 41.3 Do 11:00 Audi-A

Faraday Instability in 2D dipolar Bose-Einstein Condensates — •Rejish Nath Gopinathan Rejani and Luis Santos — Institute of Theoretical Physics, Leibniz University of Hannover

We discuss the Faraday instability (Faraday Patterns) in two dimensional dipolar homogeneous BECs. Faraday instability in BEC is induced by temporally periodically modulating the non-linearities in the system, e.g. the s-wave scattering length, (using Feshbach resonances), the dipole-dipole interaction(by modulating the external field) or the external confinement. The Faraday patterns are significantly modified in the presence of a roton in the Bogoliubov spectrum. This effect can be employed to reveal easily the appearance of a rotonized spectrum in dipolar BECs, in the on-going experiments.

Q 41.4 Do 11:15 Audi-A

Bose-Einstein condensates with induced $1/r$ interactions and embedded vorticity — •Poulcheria Christou, Patrick Köberle, Axel Keller, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

Rotating Bose-Einstein condensates with contact interactions and electromagnetically induced attractive $1/r$ atomic interactions are studied. As a special feature the $1/r$ interactions allow for the case of self-trapping. Variational calculations are carried out both for self-trapping and for the case of an external trapping potential within the limits of Gross-Pitaevskii theory. In addition the Bogoliubov equations of the system are solved numerically to analyse the stability of the localised vortices.

Q 41.5 Do 11:30 Audi-A

Macroscopic excitations and quantum tunnelling of Bose-Einstein condensates with long-range interactions — Torsten Schwidder, •Holger Cartarius, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

Macroscopic excitations and quantum tunnelling are discussed for Bose-Einstein condensates with both an attractive $1/r$ and a dipolar interaction. A time-dependent variational approach to the nonlinear Gross-Pitaevskii equation leads to classical Hamiltonians in canonical form which are quantized by diagonalization in a complete Sturmian-type basis set and using the method of complex dilatation. The real and imaginary parts of the resonance energies provide the macroscopic quantum excitations and decay rates of the condensate, respectively. The results are compared with excitations obtained by a harmonic approximation to the potential and tunnelling rates derived using the "bounce trajectory." Significant differences between the semiclassical and exact quantum results are observed in particular for the decay rates.

Q 41.6 Do 11:45 Audi-A

Two-dimensional solitons in dipolar Bose-Einstein condensates — •Patrick Köberle, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

One of the key features of dipolar Bose-Einstein condensates is their instability with respect to collapse. It has been shown in [1] how this instability is affected by the shape of an external (3D) trap. However, according to [2], it is possible to create stable condensates which are only trapped in one direction perpendicular to the polarization axis. Using a numerical simulation we demonstrate how these two-dimensional solitons can be created in experiment, in particular in ^{52}Cr condensates.

[1] T. Koch *et al.*, Nature Physics **4**, 218 (2008)
[2] I. Tikhonenkov, B. A. Malomed, and A. Vardi, Phys. Rev. Lett. **100**, 090406 (2008)

Q 41.7 Do 12:00 Audi-A

Decay rates of attractive Bose-Einstein condensates with long-range interaction — •Axel Keller, Torsten Schwidder, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

The ground state of a trapped Bose-Einstein condensate with attractive interaction is known to be metastable in a certain range of (negative) scattering lengths. We study the decay of this state for condensates with long-range dipolar and electromagnetically induced $1/r$ interaction. The decay rates due to thermal excitation and macroscopic quantum tunnelling are calculated using different methods, including transition state theory, and compared to the rate of atom loss by two-body and three-body inelastic collisions.

Q 41.8 Do 12:15 Audi-A

Classical and semiclassical dynamics of dipolar Bose-Einstein condensates — •Torsten Schwidder, Jörg Main, Holger Cartarius, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

Using a time-dependent Gaussian ansatz we convert the Gross-Pitaevskii equation for dipolar Bose-Einstein condensates into a two-dimensional nonintegrable Hamiltonian system. This opens the possibility to apply the powerful methods known from classical nonlinear dynamics to the motion of the condensate. We find periodic orbits of the classical system, describing periodic oscillations of the condensate, surrounded by quasi-periodic and chaotic trajectories. The stability of the periodic orbits is investigated in dependence of the physical parameters of the condensate and the existence of bifurcations is demonstrated.

Furthermore, we address the topic of macroscopic quantum tunnelling, which means a tunnelling from the metastable ground state of the condensate into collapse, in a semiclassical approach. The "bounce trajectory" is used to calculate the corresponding decay rates.