SFB/TRR 21 - Seminar
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Quantum fluctuations and correlations in Bose-Einstein condensates

Experiments with Bose-Einstein condensates (BECs) are now beginning to probe phenomena that cannot be described by Gross-Pitaevskii mean-field theory, heralding the birth of the field of quantum atom optics. This talk will consider two such examples. The first is the effect of quantum fluctuations on superfluidity in BECs, and their implication for the existence of a critical velocity. A recent analytic calculation has found a non-zero drag force at low velocities in infinitely extended systems, which suggests that the effective critical velocity in these systems is zero [1]. We present quantum dynamical studies of the effect of quantum fluctuations on superfluid flow in BECs, and interpret the predicted drag force in light of these results.

The second example is in the degenerate four-wave mixing that can occur with a BEC moving in a one-dimensional optical lattice. Above a certain condensate momentum it becomes energetically allowed for condensate atoms to spontaneously scatter into two new modes [2,3]. Idealised calculations show that the outgoing wave packets should be correlated in number, as well as possessing non-classical macroscopic EPR correlations [4]. We present the results of simulations of the quantum dynamics to determine the feasibility of measuring macroscopic entanglement in such an experiment.

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[3] G. K. Campbell, J. Mun, M. Boyd, E. W. Streed, W. Ketterle, and D. E. Prtichard, Phys. Rev. Lett. 96, 020406 (2006).
[4] M. K. Olsen and M. J. Davis, Phys. Rev. A 73, 063618 (2006).

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