

Vortex-Antivortex unbinding in inhomogeneous atomic condensates

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The effects of inhomogeneity and finite size on the binding energy of a vortex-antivortex pair, and on the entropy of the vortex state, are investigated in a two-dimensional atomic Bose-Einstein condensate (BEC) in a trap. The vortex-antivortex dissociation underpins the Kosterlitz-Thouless (KT) mechanism that explains the superfluid-normal transition in a two-dimensional BEC. The inhomogeneity, induced by the trapping potential, alters the usual heuristic Kosterlitz-Thouless argument, since both the binding energy and the entropy are different from the homogeneous, infinite case. Moreover, a real condensate rather than a quasicondensate is present in the 2D trapped system. The results from a full Gross-Pitaevskii calculation are compared with those of two simplified schemes: firstly a scheme where only the kinetic energy of the superfluid is taken into account, and secondly an even more simplified scheme where only the Magnus forces on point-like vortices are considered. In the trap, both the binding energy and the entropy decrease with respect to the homogeneous case, but since they are not decreased by the same amount, the Kosterlitz-Thouless temperature shifts. We compare our results to a recent observation of the vortex-antivortex dissociation temperature in atomic condensates. Finally, we investigate the influence of a disorder potential, introduced by laser speckle, on the KT mechanism.

Section: QG - Quantum gases

Keywords: two-dimensional Bose gas, vortices, Kosterlitz-Thouless transition