Nonequilibrium superfluidity and internal convection in finite temperature Bose gases

Lukas Gilz[1,2], Tod M. Wright[1], Michael C. Garrett[1], James R. Anglin[2], and Matthew J. Davis[1].

[1]The University of Queensland, School of Mathematics and Physics, Queensland 4072, Australia.

[2]State Research Center OPTIMAS and Fachbereich Physik, Technische Univerität Kaiserslautern, D-67663 Kaiserslautern, Germany.

email: mdavis@physics.uq.edu.au

Abstract:

Classical-field methods provide powerful tools for the non-perturbative simulation of weakly interacting Bose systems at finite temperatures, in both equilibrium and non-equilibrium regimes [1,2]. Here we describe some of our recent work on the development and application of the stochastic Gross-Pitaevskii equation to such systems.

We describe how the calculation of the anomalous correlations of the classical-field facilitates the determination of the quasiparticle mode structure of the finite-temperature Bose gas, and how this can be used to identify the onset of condensation and superfluidity. This is particularly valuable in low dimensional systems where condensation is a finite-size effect absent in the thermodynamic limit. We also consider finite-temperature superfluid flow in a quasi-two-dimensional torus, and demonstrate the characterisation of the inhomogeneous, non-equilibrium superfluid density.

Finally, we study a degenerate Bose gas coupled to two spatially separated heat reservoirs held at different temperatures, and simulate the onset of heat transport and superfluid internal convection [3]. We further consider the prospects for observing thermal-superfluid counterflow turbulence in this system.

References:

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