

Probing superfluidity in a quasi-2D Bose gas through its local dynamics

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Equilibrium properties of quantum gases are fully determined by the knowledge of the equation of state relating density to temperature and chemical potential. Inhomogeneous gases are therefore advantageous because they allow, within the local density approximation (LDA), to probe different regimes locally in a single realization of the experiment.

Until now LDA has been used to explore the physics of quantum gases at equilibrium¹. Here we extend this approach to the dynamics of a quasi-two dimensional Bose gas by studying its response to the scissors excitation.

Our observable for the scissors mode is $\langle xy \rangle^2$, which is computed over an annulus of fixed density r_a from the trap center. By varying the radius we are able to show two different oscillation regimes which we identify as the normal to superfluid crossover, from the superfluid core to the thermal wings of the cloud. We are then able to locate the boundary at which the BKT crossover occurs, and also to observe a deviation from the predicted Landau damping for the superfluid phase, suggesting that an additional damping originates from collisional coupling to the normal gas³. We expect this new kind of local diagnosis to shed new light on the study of out-of-equilibrium systems.

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