Criterion for bosonic superfluidity in an optical lattice

ROBERTO DIENER, QI ZHOU, HUI ZHAI, TIN-LUN (JASON) HO, Department of Physics, The Ohio State University — We show that the current method of determining superfluidity in optical lattices based on a visibly “sharp” bosonic momentum distribution $n(k)$ can be misleading, for even a normal Bose gas can have a similarly “sharp” $n(k)$. We show that superfluidity can be detected from the so-called “visibility” ($v$) of $n(k)$ — that $v$ must be 1 within $O(N^{-2/3})$, where $N$ is the number of bosons. Many current experiments, however, have interpreted states with $v < 1$ as superfluid. Such states are in fact normal, reflecting strong temperature effects in the system. These normal states, however, allow one to explore the physics in the quantum critical regime.