Finite temperature effect in phase transition to superfluidity for Bose-Einstein condensates in a 1-D optical lattice (LT26)

Xiaorui. Wang[a,b], Xinzhou. Tan[a,b], Lu. Yang[a,b], Hongwei. Xiong[a], and Baolong. Lü[a]

[a]State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics,Wuhan Institute of Physics and Mathematics, Chinese Academy of Science,430071,Wuhan
[b]Graduate school,Chinese Academy of Science, Beijing, China

We experimentally study the Phase transition of ^{87}Rb Bose-Einstein condensates adiabatically loaded to a combined trap of a 1D optical lattice and a magnetic trap.The phase coherence property of this system is probed by recording the interference pattern of the expanded atomic cloud suddenly released from the combined trap.We show that as the temperature is sufficiently low(below the critical temperature T_C),an interference pattern has a "peak on a peak" feature which is a true signature of macroscopic superfluid states. The normal gas only contributes to the broad background and three wide peaks in an interference pattern.These observations qualitatively agree with the recent theoretical predictions [Phys.Rev.Lett.98,180404(2007); Nature Physics 4,617(2008)]. We also computed both the critical temperature and the interference pattern for a practical combined trap as ours in the tight-binding limit,and the numerical results are consistent with our experimental observations.