Exploring multi-band excitations of interacting Bose gases in a 1D optical lattice by coherent scattering

X. Liu, X. Zhou, T. Vogt, X. Yue, B. Lu, and X. Chen

Institute of Quantum Electronics, School of Electronics Engineering and Computer Science, Peking University, Beijing 100871, China

We adiabatically load our Bose-Einstein condensate of about 2×10^5 ^{87}Rb atoms into a one-dimensional optical lattice and give the atoms one momentum along the lattice direction within a short time (typically $5us$), using a Bragg beam sent from a special angle θ, which satisfies the phase coherent condition of $\cos\theta = \lambda_s/\lambda_L$ where $\lambda_s = 780nm$ and $\lambda_L = 852nm$ are wavelength of Bragg beam and lattice light, respectively. After that we keep the lattice on for a duration of τ, and then turn off the lattice suddenly and observe the time of flight image $30ms$ later. Oscillation of momentum distribution due to lattice potential is clearly observed. Compared with previous work which moved the lattice instead of the atoms to get such kind of oscillation, our experiment result is correspondent with the theory much better. By measuring the oscillating frequencies, we extract multi-band energy structures of single-particle excitations with zero pseudo-momentum transfer for a wide range of lattice depths. The excitation energy structures reveal the interaction effect through the whole range of lattice depth.