Transport in Optical Lattices with Flux

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Different condensed matter systems, such as electrons in a crystal lattice, can be simulated using ultracold atoms in optical lattices. Unlike electrons, atoms are electrically neutral and therefore do not feel the effects of magnetic field. Artificial gauge potentials have been recently realized in cold-atom experiments with periodically driven optical lattices [1,2]. In such systems, atoms subjected to a constant external force gain an anomalous velocity in the direction transverse to the direction of the applied force. Taking into consideration realistic experimental conditions, we perform numerical simulations in order to investigate the dynamics of atomic clouds and relate it to the Chern number of the effective model [3]. We consider incoherent bosons and the full time-dependent Hamiltonian. The effects of weak repulsive interactions between atoms are taken into account using the mean-field approximation. Our results show that driving, external force and interactions all cause heating and transitions to higher bands, which have significant effects on the dynamics. It turns out that weak interactions can be beneficial, because they make the momentum-space probability density more homogeneous.

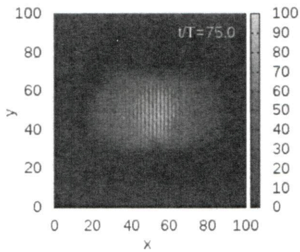

Fig. 1: Density profile of an atomic cloud during expansion dynamics after release from a trap in the presence of an artificial gauge field and external force.

References

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