The quantum simulation setup of ^{87}Rb Bose-Einstein condensates and numerical analysis of disorder induced dynamic-equilibrium localization

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We report on a rapid production of ^{87}Rb Bose-Einstein condensates(BECs) in a tight confinement hybrid trap based on single-beam optical dipole trap(ODT) and magnetic quadrupole trap(MQT). By the help of preliminary evaporation cooling in MQT, more atoms can be transferred to ODT. Then the BEC phase transition will be achieved by forced evaporation in ODT. This setup has good optical access for loading multiple optical lattices and laser speckle to quantum simulation.
In theory, we numerically analyze the dynamic behavior of Bose-Einstein condensates in one-dimensional disordered potential before its completely losing spatial quantum coherence. We find that localization length can be remarkably affected by both the disorder statistics and the atom interaction. We also find the phase of the condensates is broken into many small pieces while the system approaching localization, showing a counter-intuitive step-wise phase but not a thoroughly randomized phase. Although the condensates as a whole showing less flow and expansion, large currents occur where the phase changes abruptly. Thus we show explicitly that the localization of a finite size BEC is dynamic-equilibrium.