First-Order Phase Transition and Anomalous Hysteresis of Binary Bose Mixtures in an Optical Lattice

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We study a first-order phase transition between superfluid and Mott insulator phases in binary Bose mixtures loaded into a hypercubic optical lattice.[1] The system is described by a two-component Bose-Hubbard model. We discuss the experimental feasibility of the first-order transitions and the accompanying hysteresis in terms of the required controllability of the lattice depth and the temperature to be achieved. We argue that the first-order transition phenomena could be simulated in current (or near-future) experimental techniques using, e.g., a binary mixture of ^{87}Rb atoms in two different hyperfine states. We also discuss an anomalous hysteresis behavior that appears when the chemical potential of the system is varied. In the anomalous hysteresis, the phase transition occurs in a unidirectional way and a hysteresis loop does not form. The underlying mechanism is explained by means of the Ginzburg-Landau theory.

1. Yamamoto, D., Ozaki, T., Sá de Melo, C. A. R., and Danshita, I. "First-order phase transition and anomalous hysteresis of Bose gases in optical lattices". arXiv:1304.2578.

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