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Phase diagram of the two-leg Bose-Hubbard model[1] IPPEI DANSHITA, NIST, Gaithersburg, MD 20899, JAMES E. WILLIAMS, Wolfram Research, Champaign, IL 61820, CARLOS A. R. SA DE MELO, Georgia Institute of Technology, Atlanta, GA, CHARLES W. CLARK, NIST, Gaithersburg, MD 20899 — Recently, double-well optical lattices have been created to trap bosonic atoms [J. Sebby-Strabley *et al.*, Phys. Rev. A **73**, 033605 (2006)]. In the present work, we study the superfluid-to-Mott insulator transition of bosons in double-well optical lattices. Applying the time-evolving block decimation algorithm [G. Vidal, Phys. Rev. Lett. **93**, 040502 (2004); cond-mat/0605597] to the two-leg Bose-Hubbard Hamiltonian, we obtain the zero-temperature phase diagrams and find that there are the half-integer-filling and integer-filling Mott insulator regions. For symmetric double wells (no tilt), we show that the half-integer-filling Mott insulator phase is stabilized and that the integer-filling Mott insulator domain becomes smaller as the intra-double-well hopping increases. As the tilt of the double-wells increases, we find that the half-integer-filling Mott insulator phase becomes larger monotonically and approaches the integer-filling Mott phase for a single 1D lattice. In contrast, we show that the integer-filling Mott phase shows non-monotonic reentrant behaviour as a function of the tilt parameter.

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