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Two ultracold atoms in an optical lattices: comparison of an exact numerical treatment and the Bose-Hubbard model ALEJANDRO SAENZ, PHILIPP SCHNEIDER, SERGEY GRISHKEVICH, Humboldt University Berlin, 10117 Berlin (Germany) — A widely used method for describing a system of interacting bosonic particles in an optical lattice is the Bose-Hubbard model. It represents the wave functions in the basis of Wannier functions of the first Bloch band of the lattice, which are well localized at each lattice site. The Bose-Hubbard Hamiltonian takes only on-site interaction by a delta-type pseudopotential and hopping of particles to the next neighboring lattice sites into account. Despite its simplicity, the model can describe important characteristics of the physical system such as the phase transitions between the Mott insulator and superfluid phase. We compare the solutions of the Bose-Hubbard model to our solutions for different multi-well lattices and interaction strengths, to investigate in which regimes the model is applicable. An interesting system in itself, which we investigate, is the double-well potential filled with two particles. It already shows all important features of hopping and interaction of particles, which may lead to an implementation of a set of two qubit quantum gates. For this it is crucial to examine how the center-of-mass motion affects the decoherence of the system.

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