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Motional Two-Qubit Gate in an Optical Lattice MARK EDWARDS, Georgia Southern University and NIST, KRISTEN KASPRAK, ADAM BOZEMAN, Georgia Southern University, TREY PORTO, CHARLES W. CLARK, NIST — By crossing two pairs of counterpropagating laser beams at right angles, an optical potential consisting of a periodic array of separated double–wells can be created. In this experiemental arrangement, both the barrier height between the wells and the difference in the well depths (called the “tilt”) can be independently varied. If a Bose–Einstein condensate is subjected to this lattice potential and the overall depth is increased, it is possible to trap exactly two particles in each double well. We have modeled this system with a potential consisting of two square wells separated by a square barrier. Using this model we studied the dynamics of controlled motion of two interacting particles moving in this potential as the tilt is varied by solving the time–dependent Schrödinger equation. The goal of the study is to explore the motion of the atom to controllably place and extract two atoms in the same site in order to affect interactions. Such controlled motion and interactions can form the basis for two–qubit gate. We present the results of our simulations and comment on the feasibility of implementing a two–qubit gate in the laboratory.

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