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Optimal control of an ensemble of atoms in an optical lattice[1]
BOTAN KHANI, SETH MERKEL, JAY GAMBETTA, FELIX MOTZOI, FRANK K. WILHELM, University of Waterloo, QUANTUM DEVICE THEORY GROUP TEAM — Controlling quantum systems in a manner that is robust to experimental errors and inhomogeneities is vital for practical realization of quantum gates. We demonstrate numerically the control of motional degrees of freedom of an ensemble of neutral atoms in an optical lattice of shallow trapping potential. Taking into account the range of quasi-momenta across different Brillouin zones results in an ensemble whose members effectively have inhomogeneous control fields as well as spectrally distinct control Hamiltonians. We present a modified optimal control technique that yields high fidelity control pulses, irrespective of quasi-momentum, with average fidelities above 90%. The resultant controls show a broadband spectrum with gate times in the order of several Rabi oscillations to optimize gates with up to 75% dispersion in the energies from the band structure.

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