Control of Neutral Atoms in Optical Lattices

J.V. Porto¹, R. Chicireanu¹, S. Olmschenk¹, K. Nelson¹ and N. Lundblad²

¹Joint Quantum Institute, National Institute of Standards and Technology and University of Maryland, Gaithersburg, Maryland 20899, USA
²Department of Physics & Astronomy, Bates College, Lewiston, Maine 04240, USA

Optically trapped neutral atoms provide a good platform for quantum information and simulation. In particular, optical lattices are an extremely simple approach to providing large arrays of traps, with the ability to simultaneously perform parallel operations on many atoms at once. I will discuss recent progress in trapping and controlling atoms in lattices, discussing strengths and challenges to be faced in the future.

At the single-qubit level, we have recently demonstrated techniques to mitigate inhomogeneous differential light shifts [1,2], and used randomized benchmarking to demonstrate average single-qubit rotation fidelities lower than 2x10⁻⁴ [3]. We use a double-well lattice that allows for sub-lattice addressing of spin states as well as vibrational control, allowing for controlled two-atom spin-dependent interactions. Combined with recent impressive progress in optically addressing individual sites of optical lattices [4,5], these techniques provide a good starting point for coherent quantum control of arrays of neutral atoms.