Controlled Interaction between Ultracold Lithium and Cesium Atoms in Optical Lattices for Quantum Information Processing

KATHY-ANNE SODERBERG, Department of Physics and The James Franck Institute, The University of Chicago, ARJUN SHARMA, NATHAN GEMELKE, CHENG CHIN — We present progress on a quantum information processing experiment using degenerate gases of bosonic $^{133}$Cs and fermionic $^6$Li , each confined in an independently controlled, overlapping optical lattice. An insulating state of $^6$Li will prepare an initial state with exactly one atom per lattice site. These atoms serve as quantum bits (qubits). $^{133}$Cs atoms are sparsely loaded into a second lattice, and act as messenger bits to carry entanglement between distant qubits. Qubit operations are mediated through magnetic dipole transitions to a $^6$Li-$^{133}$Cs molecular state that is formed only when qubit and messenger are overlapped. The $^{133}$Cs messenger atom can interact with (multiple and distant) $^6$Li qubits through translation of the Cs lattice using an electro-optic modulator array, making this implementation scalable. We present progress on the first spectroscopy experiments of the $^6$Li-$^{133}$Cs molecular states. These findings will guide the best strategies for implementing qubit operations using messenger atoms.

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Date submitted: 14 Dec 2009

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