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Stochastic One-Way Quantum Computing with Ultracold Atoms in Optical Lattices MICHAEL C. GARRETT, University of Calgary, DAVID L. FEDER, University of Calgary — The one-way model of quantum computation has the advantage over conventional approaches of allowing all entanglement to be prepared in a single initial step prior to any logical operations, generating the so-called cluster state. One of the most promising experimental approaches to the formation of such a highly entangled resource employs a gas of ultracold atoms confined in an optical lattice. Starting with a Mott insulator state of pseudospin-1/2 bosons at unit filling, an Ising-type interaction can be induced by allowing weak nearest-neighbor tunneling, resulting in the formation of a cluster state. An alternate approach is to prepare each spin state in its own sublattice, and induce collisional phase shifts by varying the laser polarizations. In either case, however, there is a systematic phase error which is likely to arise, resulting in the formation of imperfect cluster states. We will present various approaches to one-way quantum computation using imperfect cluster states, and show that the algorithms are necessarily stochastic if the error syndrome is not known.

Michael C. Garrett
University of Calgary

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