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Entangling operations and rapid measurement of atomic clock-state qubits for violating Bell inequalities RENÉ STOCK, NATHAN S. BABCOCK, Institute for Quantum Information Science, University of Calgary, MARK G. RAIZEN, Center for Nonlinear Dynamics and Department of Physics, University of Texas, Austin, BARRY C. SANDERS, Institute for Quantum Information Science, University of Calgary — Optical clock-transitions such as the ones in Ytterbium/Strontium and Cesium are prime candidates for encoding qubits for quantum information processing applications due to very low decoherence rates. In this work, we investigate the challenges involved in using these prime candidates. We devise entangling operations for atoms trapped in optical tweezers, as well as determine the feasibility of rapid qubit rotation and measurement of qubits encoded in these desirable low-decoherence clock transitions. We propose ultracold collisions for entangling operations and multi-photon transitions for fast rotation of qubits, followed by ultrafast readout via resonant multiphoton ionization. The rapid control of atomic qubits is crucial for high-speed synchronization of quantum information processors, but is also of interest for tests of Bell inequalities. We investigate rapid measurement of clock-state qubits in the context of a Bell inequality test that avoids the detection loophole in spacelike separated entangled qubits.

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