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Entangling operations and rapid measurement of clock-state qubits in Yb or Sr for quantum information processing RENE STOCK, NATHAN S. BABCOCK, BARRY C. SANDERS , Institute for Quantum Information Science, University of Calgary — The optical clock-transitions in Yb and Sr are prime candidates for encoding qubits for quantum information processing applications. Electric dipole one- and two-photon transitions between the long-lived $^1S_0$ and $^3P_0$ states are angular momentum and parity forbidden, respectively. This results in a highly desirable low decoherence rate. In this work, we investigate the challenges involved in using these prime candidates. We devise entangling operations for Yb and Sr atoms trapped in optical microtraps, as well as determine the feasibility of rapid qubit rotation and measurement of qubits encoded in this desirable low-decoherence clock transition. We propose ultracold collisions for entangling operations and a recoil-free three-photon transition [1] 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. [1] T. Hong, C. Cramer, W. Nagourney, E. N. Fortson, Phys. Rev. Lett. 94, 050801 (2005)

Rene Stock
Institute for Quantum Information Science, University of Calgary

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