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Metastable Qubit in ^{171}Yb^{+}[1] PATRICK MCMILLIN, THOMAS DELLAERT, University of California, Los Angeles, ANTHONY RANSFORD, Honeywell Quantum Solutions, CONRAD ROMAN, WESLEY CAMPBELL, University of California, Los Angeles —

Metastable qubits in trapped ion arrays offer an alternative to multi-species traps by preserving the advantage of qubit indistinguishability, and by reducing the challenge associated with adding an additional species to a trapped ion experiment. We have shown that the ground state ($^2S_{1/2}$) hyperfine qubit in $^{171}Yb^+$ has excellent state preparation and measurement (SPAM) fidelity (F$\geq$0.999), and is thus a good candidate for trapped ion quantum computation. Additionally, the $^2F_{7/2}$ state is ideally suited to host a metastable qubit due to its approximately 5 year lifetime and its large optical frequency separation from the transitions used in the $^2S_{1/2}$ qubit operations. We perform single-qubit gates and measure the $^2F_{7/2}$ clock-state qubit SPAM fidelity of this metatable qubit as F$\geq$0.95. By coherently mapping the population between the $^2S_{1/2}$ (operational) and $^2F_{7/2}$ (storage) qubits through an electric octupole transition, one may perform operations on a set of qubits while others are unaffected. In combination with coherent mapping, the ability to use metastable qubits in a multi-qubit array provides promising schemes for the implementation of gate operations.

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