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Experimental demonstration of high fidelity ^{133}Ba$^+$ hyperfine qubits[1]

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Well-isolated trapped atomic ions are attractive candidate qubits because of their spectroscopic features. Ions with nuclear spin $I = 1/2$ allow fast, high-fidelity initialization of hyperfine clock qubits with coherence times exceeding 10 minutes. Long-lived D-states allow for electron shelving of a qubit state to achieve ultra-low readout errors of the qubit. Visible wavelength transitions for laser cooling and qubit manipulation allow the leveraging of existing photonics technology. ^{133}Ba$^+$ is the only atomic ion to simultaneously possess all of these features. The successful trapping and laser cooling of ^{133}Ba$^+$ along with the characterization of its excited state spectroscopy (1) has allowed for the first hyperfine qubit manipulations of this goldilocks atomic ion. We implement electron shelving to dramatically increase the readout fidelity of the hyperfine qubit without the need for efficient light collection. Our measurements of the spectroscopic structure of ^{133}Ba$^+$ suggest this qubit could have broad applications in quantum information processing, quantum networking, and the construction of compact quantum sensors and clocks.

(1). D. Hucul, J.E. Christensen, E.R. Hudson, W.C. Campbell, PRL 119, 100501 (2017).

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