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**The use of $^{133}Ba^{+}$ as a new candidate for trapped atomic ion qubits** DAVID HUCUL, JUSTIN CHRISTIANSEN, WESLEY CAMPBELL, ERIC HUDSON, UCLA Department of Physics and Astronomy — Trapped atomic ions are qubit standards in quantum information science because of their long coherence times and high fidelity entangling gates. Many different atomic ions have been used as qubits, each with strengths and weaknesses dictated by its atomic structure. We propose to use $^{133}Ba^{+}$ as an atomic qubit. $^{133}Ba^{+}$ is a nearly ideal, all-purpose candidate by combining many of the strengths of different workhorse atomic ions. $^{133}Ba^{+}$, like $^{171}Yb^{+}$, has a nuclear spin 1/2, allowing for a robust hyperfine qubit with simple state preparation and readout via differential fluorescence. The lack of a low-lying F-state, like in $Ca^{+}$, simplifies high-fidelity qubit state detection that relies on shelving a qubit level to a meta-stable excited state. In addition, $^{133}Ba^{+}$ can be used for background-free qubit state detection where the wavelength of the qubit detection light differs from all excitation light by at least 50 THz. Unlike all other ions in use, the optical transitions of barium are in the visible spectrum, enabling the use of high power lasers, low-loss fibers, high quantum efficiency detectors, and other technologies developed for visible wavelengths of light to ease some requirements toward scaling a quantum system.

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