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Background free read out of trapped ion qubits DAVID HUCUL, United States Air Force Research Lab (AFRL), ZACHARY S. SMITH, WILLIAM T. GRANT, AFRL; Griffiss Institute, PAIGE HAAS, AFRL; Technergetics, HARRIS J. RUTBECK-GOLDMAN, BOYAN TABAKOV, JAMES A WILLIAMS, AFRL, CARSON F. WOODFORD, AFRL; Griffiss Institute, KATHY-ANNE BRICKMAN SODERBERG, AFRL — Trapped barium 133 atomic ions are promising qubits for quantum information science. This radioisotope of barium requires only visible wavelengths for photoionization, laser-cooling, and the manipulation of a stable hyperfine qubit. The ideal energy level structure of this atomic ion has produced the lowest state preparation and measurement error of any qubit (1) and allows this qubit to be read out in a background free manner. Illumination of the ion produces atomic fluorescence at different wavelengths than the excitation light without mixing the atomic hyperfine clock qubit levels. Because the scattered light from the lasers can easily be separated from the atomic fluorescence with dichroic optics, barium 133 qubits can be integrated into optical fiber-based ion traps where all light delivery and collection is performed in the same optical fiber. This "ion trap on a dipstick" makes barium 133 a natural candidate qubit for probing surfaces and coupling to superconducting qubits. The visible wavelengths and simplified operation of this qubit could also enable robust operation of multi-node trapped ion quantum networks.
(1). J.E. Christensen et al., arXiv:1907.13331 (2019).

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