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Comparing Zeeman qubits to hyperfine qubits in the context of the surface code: ^{171}Yb^{+} and ^{174}Yb^{+} N.C. BROWN, Georgia Inst of Tech, K. R. BROWN, Duke University — Many systems used for quantum computing possess additional states beyond those defining the qubit. Leakage out of the qubit subspace must be considered when designing quantum error correction codes (QECC). Here we consider trapped ion qubits manipulated by Raman transitions. Zeeman qubits do not suffer from leakage errors but are sensitive to magnetic fields to first-order. Hyperfine qubits can be encoded in clock states that are insensitive to magnetic fields to first-order, but spontaneous scattering during the Raman transition can lead to leakage. Here we compare a Zeeman qubit (^{174}Yb^{+}) to a hyperfine qubit (^{171}Yb^{+}) in the context of the surface code. We find that the number of physical qubits required to reach a specific logical qubit error can be reduced by using ^{174}Yb^{+} if the magnetic field can be stabilized with fluctuations smaller than 10 μG.

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