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Versatile laser-free trapped-ion entangling gates[1] R.T. SUTHERLAND, Lawrence Livermore Natl Lab, R. SRINIVAS, S.C. BURD, National Institute of Standards and Technology; University of Colorado, Boulder, D. LEIBFRIED , A.C. WILSON, National Institute of Standards and Technology, D.J. WINELAND, D.T.C. ALLCOCK, National Institute of Standards and Technology; University of Colorado, Boulder; University of Oregon, D.H. SLICHTER, National Institute of Standards and Technology, S.B. LIBBY, Lawrence Livermore Natl Lab, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY TEAM, LAWRENCE LIVERMORE NATL LAB TEAM — We present a general theory for laser-free entangling gates with trapped-ion hyperfine qubits, using either static or oscillating magnetic-field gradients combined with a pair of uniform microwave fields symmetrically detuned about the qubit frequency. By transforming into a 'bichromatic' interaction picture, we show that either $\hat{\sigma}_\phi \otimes \hat{\sigma}_\phi$ or $\hat{\sigma}_z \otimes \hat{\sigma}_z$ geometric phase gates can be performed. The gate basis is determined by selecting the microwave detuning. The driving parameters can be tuned to provide intrinsic dynamical decoupling from qubit frequency fluctuations. The $\hat{\sigma}_z \otimes \hat{\sigma}_z$ gates can be implemented in a novel manner which eases experimental constraints. We present numerical simulations of gate fidelities assuming realistic parameters.

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