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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 — 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 operation 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 also discuss novel gate techniques that are insensitive to heating.

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