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Trapped-ion quantum logic gates based on oscillating magnetic fields[1] CHRISTIAN OSPELKAUS, CHRISTOPHER E. LANGER[2], JASON M. AMINI, KENTON R. BROWN, DIETRICH LEIBFRIED, DAVID J. WINELAND, National Institute of Standards and Technology; 325 Broadway; Boulder, CO 80305
— Oscillating magnetic fields and field gradients can be used to implement single-qubit rotations and entangling multiqubit quantum gates for trapped-ion quantum information processing. With fields generated by currents in microfabricated surface-electrode traps, it should be possible to achieve gate speeds that are comparable to those of optically induced gates for realistic distances between the ions and the electrode surface. Magnetic-field-mediated gates have the potential to significantly reduce the overhead in laser-beam control and motional-state initialization compared to current QIP experiments with trapped ions and will eliminate spontaneous scattering decoherence, a fundamental source of decoherence in laser-mediated gates. A potentially beneficial environment for the implementation of such schemes is a cryogenic ion trap, because small length scale traps with low motional heating rates can be realized. A cryogenic ion trap experiment is currently under construction at NIST.

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