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Ultrafast entanglement of trapped ions[1] BRIAN NEYENHUIS, KALE JOHNSON, JONATHAN MIZRAHI, DAVID WONG-CAMPOS, CHRISTOPHER MONROE, Joint Quantum Institute, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, Maryland 20742 — We have demonstrated ultrafast spin-motion entanglement of a single atomic ion using a short train of intense laser pulses. This pulse train gives the ion a spin-dependent kick where each spin state receives a discrete momentum kick in opposite directions. Using a series of these spin-dependent kicks we can realize a two qubit gate. In contrast to gates using spectroscopically resolved motional sidebands, these gates may be performed faster than the trap oscillation period, making them potentially less sensitive to noise. Additionally this gate is temperature insensitive and does not require the ions to be cooled to the Lamb-Dicke limit. We show that multiple kicks can be strung together to create a "Schrodinger cat" like state, where the large separation between the two parts of the wavepacket allow us to accumulate the phase shift necessary for a gate in a shorter amount of time. We will present a realistic pulse scheme for a two ion gate, and our progress towards its realization.

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