Abstract Submitted
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Implementing Quantum Algorithms with Modular Gates in a Trapped Ion Chain[1] CAROLINE FIGGATT, SHANTANU DEBNATH, NORBERT LINKE, KEVIN LANDSMAN, KEN WRIGHT, CHRIS MONROE, Joint Quantum Institute and University of Maryland Department of Physics, College Park, Maryland 20742 — We present experimental results on quantum algorithms performed using fully modular one- and two-qubit gates in a linear chain of 5 Yb+ ions. This is accomplished through arbitrary qubit addressing and manipulation from stimulated Raman transitions driven by a beat note between counter-propagating beams from a pulsed laser[1]. The Raman beam pairs consist of one global beam and a set of counter-propagating individual addressing beams, one for each ion. This provides arbitrary single-qubit rotations as well as arbitrary selection of ion pairs for a fully-connected system of two-qubit modular XX-entangling gates implemented using a pulse-segmentation scheme[2]. We execute controlled-NOT gates with an average fidelity of 97.0% for all 10 possible pairs. Programming arbitrary sequences of gates allows us to construct any quantum algorithm, making this system a universal quantum computer. As an example, we present experimental results for the Bernstein-Vazirani algorithm using 4 control qubits and 1 ancilla, performed with concatenated gates that can be reconfigured to construct all 16 possible oracles, and obtain a process fidelity of 90.3%. [1] PRL 104, 140501 (2010), [2] PRL 112, 19502 (2014)

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Caroline Figgatt
Joint Quantum Institute and University of Maryland Department of Physics, College Park, Maryland 20742

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