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**Large Scale Quantum Computation in a Linear Ion Trap** GUIN-DAR LIN, FOCUS Center and MCTP, Department of Physics, University of Michigan, SHI-LIANG ZHU, South China Normal University, Guangzhou, China, CHRISTOPHER MONROE, JQI and Department of Physics, University of Maryland, LUMING DUAN, FOCUS Center and MCTP, Department of Physics, University of Michigan — Among the approaches to quantum computation, the trapped ion system remains as one of the leading candidates. The linear Paul trap provides the most convenient architecture for quantum gate operations over a few ions, and the basic requirements for quantum computation have been demonstrated in this setup. However, scaling up this system to a large number of qubits so far remains a formidable challenge because of several obstacles, including the instability of the linear structure and the difficulties of the sideband cooling and addressing for a large ion array. The recent approach to scalable ion trap computation thus has to use a more complicated architecture where the ions are shuttled over different trapping regions. Here, we propose a way to implement large-scale quantum computation in a linear trap by overcoming all the theoretical obstacles. Through excitation of the transverse photon modes in an anharmonic trap, we show that high-fidelity quantum gates can be achieved on ions in a large linear architecture under the Doppler temperature without the requirement of sideband resolving.

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