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A scalable photon interface for trapped-ion qubit registers

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We report on a method to interface the quantum state of each individual trapped-ion qubit in a register with a separate direction-switchable travelling photon. By switching the ion-trap confinement, ions are brought one at a time into the focus of an optical cavity and emit a photon via a cavity-mediated Raman transition. The result is a train of photons, each entangled with a different ion in the string. Experiments are presented for a string of ten ion-qubits, yielding an average ion-photon Bell state fidelity of 92%. The method is directly scalable to larger ion qubit registers and opens up the near-term possibility of quantum networking trapped-ion quantum processors, quantum sensing arrays and atomic clocks.

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