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Photonic and Phononic Entanglement with Hybrid Species Ion Chains[1] CLAYTON CROCKER, MARTIN LICHTMAN, KSENIA SOSNOVA, TUAN NGUYEN, ALLISON CARTER, Joint Quantum Institute and University of Maryland , VOLKAN INLEK, Duke University, HANNA RUTH, CHRISTOPHER MONROE, Joint Quantum Institute and University of Maryland — Trapped atomic ions represent a leading platform for quantum information networks due to their long coherence times and diverse set of entangling operations. External fields can drive strong local entangling interactions via phonons, and remote qubits can be entangled via emitted photons. Unfortunately, resonant light from the photonic entanglement process can disrupt nearby memory qubits. We resolve this crosstalk by introducing a separate atomic species to the trap for use as a photonic entanglement qubit. We report successful demonstration of both entangling gates between the mixed species qubit pair through their collective motion, and entanglement between our remote entanglement qubit and emitted visible photons. We additionally report our progress on a new trapping apparatus that was implemented to improve these operations to a level required for scaling up the system size.

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