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Ion-Photon Entanglement via the $6D_{3/2}$ state in Ba+[1] ALLISON CARTER, CLAYTON CROCKER, KSENIA SOSNOVA, MARTIN LICHTMAN, SOPHIA SCARANO, CHRISTOPHER MONROE, Joint Quantum Institute and University of Maryland — A dual species Yb+/Ba+ ion trap is used to create entanglement between memory spin qubits and photonic qubits. The flying qubits are emitted via the $6S_{1/2} <-> 6P_{1/2}$ transition in Ba138+. In previous work the atoms were excited on this same 493 nm transition. However, it is advantageous to excite the atom on the $6D_{3/2} <-> 6P_{1/2}$ transition at 650 nm, while still collecting 493 nm photons. This removes the excitation light as a source of noise and reduces double excitation errors. Most significantly, the $D <-> P$ transition allows us to use a slower excitation, such that instead of requiring a picosecond pulsed laser, we can gate a CW laser using nanosecond in-fiber EO interferometers that do not exist at shorter wavelengths. However, the increased multiplicity of the D state manifold is a challenge for state initialization and readout. We present our solutions to these challenges, and subsequent ion-photon entanglement using this new toolbox.

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