Abstract Submitted
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Experimental progress towards a Rydberg atom-photon-superconductor quantum interface[1] J.A. ISAACS, J.D. PRITCHARD, T. XIA, M.A. BECK, R. MCDERMOTT, M. SAFFMAN, Department of Physics, University of Wisconsin, 1150 University Avenue, Madison, Wisconsin 53706 — Hybrid quantum computation exploits the individual strengths of various quantum technologies, enabling realization of a scalable quantum device capable of both fast gates and long coherence times. Our method combines the long coherence times of neutral atoms with the fast gates of superconducting qubits. We discuss experimental progress towards single atom trapping close to a superconducting resonator, including optimization of the resonator to maximize the quality factor and coupling strength for preliminary experiments performed at 4K. We use a new resonator design, incorporating 3D micro fabricated structures, that allows for strong electric field coupling to an atom trapped $\sim 50\ \mu$m above the resonator. Our scheme uses a novel two-photon Rydberg excitation via the $6S_{1/2} \rightarrow 5D_{5/2}$ quadrupole transition to enable direct excitation of $nP_{3/2}$ states for strong electric-dipole coupling to the cavity. This significantly reduces the Doppler mismatch compared to previous two-photon excitation schemes to enable high fidelity operations. First spectroscopy and Rabi oscillation results will be shown.

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