Abstract Submitted
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A Rydberg atom-photon-superconductor quantum interface[1] J.A. ISAACS, D.W. BOOTH, M.A. BECK, University of Wisconsin - Madison, J.D. PRITCHARD, University of Strathclyde, T XIA, Hefei National Laboratory for physical sciences at the microscale, R. MCDERMOTT, M. SAFFMAN, University of Wisconsin - Madison, UW HYBRID QC COLLABORATION — Hybrid quantum computation bridges disparate quantum technologies in order to achieve fast gates with long coherence times. Our implementation (Phys. Rev. A **89**, 010301(R) (2014)) combines superconducting circuit-QED with singly trapped Rydberg atoms. Introducing typical AMO techniques into cryogenic environments required the development of several novel approaches that we will discuss in our talk. Our current experiment involves trapping cesium atoms inside a 4 K cryostat, transporting them first horizontally and then vertically up to a superconducting coplanar waveguide resonator. After transport we use 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 excitation scheme significantly reduces the Doppler mismatch compared to previous two-photon excitation schemes to enable high fidelity operations. First optical spectroscopy and Rabi oscillation results will be shown along with microwave cavity coupling data. Experimental and theoretical efforts toward increasing fidelity of our operations by minimizing sensitivity of the Rydberg atoms to stray external electric fields will be discussed.

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