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Interfacing Helium Rydberg Atoms with Superconducting Coplanar Waveguide Microwave Resonators[1] DAN WALKER, ALEX MORGAN, STEPHEN HOGAN, University College London — Helium Rydberg atoms traveling in pulsed supersonic beams have been coherently coupled to microwave fields in a niobium nitride quarter-wave superconducting coplanar waveguide (CPW) resonator. The two-photon $|55s\rangle \rightarrow |56s\rangle$ transition between triplet Rydberg states at a frequency of 19.556 GHz was driven by the third harmonic microwave field in the resonator. This transition was selected for use in the experiments because of its low sensitivity to stray electric fields emanating from the superconducting chip surface. The detuning of the resonator frequency from the atomic transition frequency was controlled by stabilizing the superconducting chip temperature to values between 3.65 and 4.5 K. The Rydberg atoms were detected by state-selective pulsed electric field ionization. The coherence of the atom-resonator-field interaction was characterized by Rabi and Ramsey spectroscopy, with the experimental results compared to the results of numerical calculations. Coherence times of between 100 ns and 1 μs, limited by the spatial distribution and motion of the atoms above the CPW resonator, have been achieved.

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