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Interfacing Rydberg atoms with superconducting circuits S. FILIPP, T. THIELE, M. STAMMEIER, A. WALLRAFF, ETH Zurich, S.D. HOGAN, University College London, J.A. AGNER, F. MERKT, ETH Zurich — Hybrid quantum system are promising candidates for future quantum computing architectures because they provide the potential to combine the best properties of different physical systems. Here, we bring together Rydberg atoms and microwave photons emanating from a co-planar waveguide with the ultimate goal to interface long-lived Rydberg atoms with well-controllable superconducting qubits. In our cryogenic experiment, helium atoms pass over microwave electrodes hosted on a printed circuit board. By applying resonant microwave pulses, we induce transitions between Rydberg states with principal quantum number n=31-35 and observe coherent Rabi oscillations with typical oscillation periods of about 50ns [1]. From spectral measurements we can characterize the interaction between the atoms and surface fields leading to decoherence. The analysis of the inhomogeneously broadened lineshapes indicates that the stray electric field strength decreases with the inverse square of the atom-surface distance [2]. In experiments in preparation we plan to employ on-chip superconducting resonators to study the strong interaction of Rydberg atoms with few or individual microwave photons.

[1] S.D. Hogan et al., PRL 108, 063004 (2012).
[2] J.D. Carter and J.D.D. Martin, PRA 83, 032902 (2011).

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