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Coherent manipulation of Rydberg states above surfaces at cryogenic temperatures T. THIELE, S. FILIPP, J.A. AGNER, H.-J. SCHMUTZ, M. STAMMEIER, A. WALLRAFF, F. MERKT, ETH Zurich — The integration of atom optics on a chip presents new possibilities for manipulation and readout of atomic internal and external degrees of freedom. In particular, strong fields and field gradients achievable with microstructured electrodes facilitate the manipulation of Rydberg atoms because of their large dipole moments. This is expected to allow for a strong coupling to microwave photons contained in superconducting coplanar resonators. However, the large dipole moment also makes Rydberg atoms susceptible to stray electric fields, which broaden and shift the atomic transitions [1]. We have developed methods to reduce stray fields by reducing surface adsorption and compensating residual fields. Using an external microwave source, we have recorded Rydberg-Rydberg transitions of a 0.5 mm sized ensemble at a mean distance of 250 μm above gold and superconducting chip surfaces at 3 K. Finally, we have observed coherent Rabi oscillations and have extracted information on residual dc and ac fields in the vicinity of the surface. These techniques may be used for coherent chip-based interfaces between Rydberg atoms and microwave photons.

[1] S.D. Hogan, J.A. Agner, F. Merkt, T. Thiele, S. Filipp and A. Wallraff, PRL **108**, 063004 (2012)

Tobias Thiele
ETH - Hoenggerberg

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