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Towards Hybrid Quantum Information Processing with Electrons on Helium ANDREAS FRAGNER, DAVID SCHUSTER, Yale University, MARK DYKMAN, Michigan State University, STEPHEN LYON, Princeton University, ROBERT SCHOELKOPF, Yale University — Electrons on helium is a unique system in which a two-dimensional electron gas is formed at the interface of a quantum liquid (superfluid helium) and vacuum. As outlined in our recent proposal [1], single-electron quantum dots on helium can be built using submerged electrostatic gates and the lateral motion of the electron can be coupled to the electromagnetic field in a superconducting resonator by integrating the quantum dot into a circuit QED architecture [2]. Energy can be exchanged coherently between motional states and individual photons at an estimated Rabi frequency of $g/2\pi \sim 20$ MHz while motional and spin coherence times exceed 20 μs for charge and 1 s for spin with a spin-photon coupling as high as 1 MHz [1,3], making the system attractive for quantum information processing. Here, I will present recent experimental progress towards trapping and detecting single electrons on helium with a high-finesse superconducting cavity.

[1] D.I. Schuster, et al. in preparation (2009)
[2] A. Wallraff, et. al. Nature 431, 162 (2004)
[3] S. A. Lyon, Phys. Rev. A 74, 052338 (2006)

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