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Ultra-efficient electron transfer above micro-channels of superfluid helium F.R. BRADBURY, GUILLAUME SABOURET, SHYAM SHANKAR, S.A. LYON, Dept. of Electrical Engineering, Princeton University —
The spin of an electron, bound by its image charge to the surface of superfluid helium, is a promising two level system for quantum information processing. The ability to efficiently move these qubits is one of the key promises of this technology since it would allow for the large scale integration required for quantum computation. We have fabricated 60 parallel channels, 10 μm wide by 3 μm deep, which fill with helium through capillary action. The channels are reactive ion etched into a thin polymer layer. Electrons are photoemitted into the vacuum above the device, attracted to it electrostatically, and moved laterally within the channels by underlying electrostatic gates. The electrons are measured capacitively as a sequence of voltages (clocking sequence) is applied to the gates. Results show that initially there are $\sim$3 electrons per channel and the signal decays exponentially (due to transfer failures) with number of clocking cycles. At frequencies as high as 800 kHz the charge transfer efficiency is $0.99999992 \pm 6 \bullet 10^{-8}$. This ability to reliably transport electrons makes them a very attractive spin qubit.

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