Point-Contact Transport Properties of Classical Electrons on Helium

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Electrons bound to the surface of liquid helium form an ideal two-dimensional electron system[1]. The Coulomb interaction between electrons on the helium surface is essentially unscreened and, for typical surface densities ($\sim 10^9$ cm^{-2}), the electron system is nondegenerate. Here we present transport measurements of electrons on the surface of liquid helium in a microchannel containing a nanofabricated split-gate electrode[2], similar to those used in semiconductor quantum point-contact devices[3].
We find that the split-gate voltage (V_{gt}) threshold of current flow depends on the electrostatic energy, and in turn density, of the electron system. As V_{gt} is swept positive, and the effective width of the constriction increases, the conductance increases in a step-wise manner. We attribute each conductance step to an increase in the number of electrons able to pass simultaneously through the constriction, due to the strong Coulomb interaction. Close to the threshold, single-electron transport is observed. Below 1 K, the electron system forms a Wigner crystal and evidence of more complex transport dynamics emerges.

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[3]C.W.J. Beenakker and H. van Houten, Solid State Phys. **44**, 1 (1991).