Extremely Efficient Clocked Electron Transport on Superfluid Helium

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Electrons floating on the surface of superfluid helium have been suggested as promising mobile spin qubits. 3μm wide channels fabricated with standard silicon processing are filled with helium by capillary action. Photoemitted electrons are held by voltages applied to underlying gates running under 120 parallel channels. The underlying gates are connected as a 3-phase charge-coupled device (CCD). By applying an appropriate voltage sequence to the 3 phases, electrons are clocked along the 120 channels in parallel. Electrons are detected by the voltage they induce on a sense gate. Starting with approximately one electron per channel, no detectable transfer errors occur while clocking 10^9 pixels. One channel with its associated gates is perpendicular to the other 120, providing a CCD which can transfer electrons between the others. Again, no transfer errors were detected after transferring 10^9 pixels, including transfers between the two orthogonal CCDs. Full control of an electrons's position within an array of about 4000 sites is demonstrated with only 5 gate leads. Supported by the National Science Foundation through the EMT program under Grant No. CCF-0726490, and through DMR under Grant No. DMR-1005476