Single-electron shuttle in a silicon quantum dot

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We report on single-electron shuttling experiments[1] with a silicon quantum dot[2]. An electron layer is accumulated at the Si/SiO_2 interface below an aluminum top gate with two additional barrier gates used to deplete the electron gas locally and to define the quantum dot. Directional single-electron shuttling from the source and to the drain lead is achieved by applying a dc source–drain bias while driving the barrier gates with an ac voltage at frequency f. Current plateaus at integer levels of ef are observed up to f=240 MHz. The observed results are explained by a sequential tunneling model which suggests that the electron gas may be heated substantially by the ac driving voltage. Future device optimization is expected to make these quantum dots serious candidates for a metrological current standard.

[1]K. W. Chan, M. Möttönen, A. Kemppinen, N. S. Lai, K. Y. Tan, W. H. Lim, A. S. Dzurak, arXiv:1103.5891 (2011).
[2]W. H. Lim et al. Applied Physics Letters **95**, 242102 (2009).