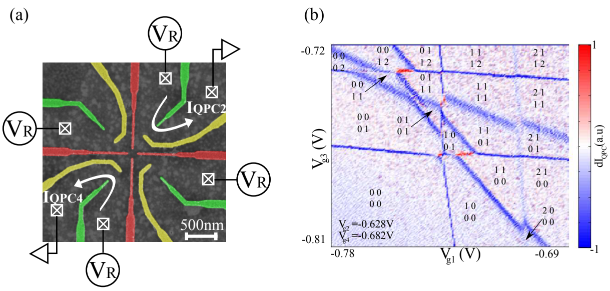
# A few-electron quadruple quantum dot in a closed loop

**Romain Thalineau[1], Andreas D. Wieck[2], Christopher Bäuerle[1],Laurent Saminadayar, Tristan Meunier[1]**

[1] *Institut Néel, CNRS and Université Joseph Fourier, 38042 Grenoble, France*
[2] *Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstrasse 150, 44780 Bochum, Germany*

Controlling the path of a single electron in semiconducting nanostructures is an interesting tool in the context of spin qubits systems. In particular, it opens the route towards the transport of quantum information on a chip and represents a potential strategy to scale up the number of spin qubits in interaction. In addition, in presence of spin-orbit interaction, it represents an interesting way to manipulate coherently the spin of a single electron[1]. Recently, fast and efficient single electron transport could be obtained by assisting the transport through a 1D-channel electrostatically defined with surface acoustic waves on AlGaAs heterostructures [2]. Nevertheless, such a technique is restricted to displacements on a straight line. To perform more complex displacements, engineering the path of the electron with series of quantum dots is a promising alternative. In this context, it has been demonstrated that topological spin manipulation can be obtained if the electron is transported adiabatically on a closed path under spin-orbit interaction [3].
We report the realization of a quadruple quantum dot device in a square-like configuration where a single electron can be transferred on a closed path free of other electrons [4]. By studying the stability diagrams of this system, we demonstrate that we are able to reach the few-electron regime and to control the electronic population of each quantum dot with gate voltages. This allows us to control the transfer of a single electron on a closed path inside the quadruple dot system. This work opens the route towards electron spin manipulation using spin-orbit interaction by moving an electron on complex paths free of electrons.




[1] K. C. Nowack, F. H. L. Koppens, Yu. V. Nazarov, and L. M. K. Vandersypen, Science **318**, 1430 (2007)

[2] S. Hermelin, S. Takada, M. Yamamoto, S. Tarucha, A. D. Wieck, L. Saminadayar, C. Bäuerle, and T. Meunier, Nature **477**, 435438 (2011)

[3] P. San-Jose, B. Scharfenberger, G. Schön, A. Shnirman, and G. Zarand, Phys. Rev. B **77**, 045305 (2008)

[4] R. Thalineau, S. Hermelin, A. D. Wieck, C. Baäuerle, L. Saminadayar, T. Meunier, Appl. Phys. Lett **101**, 103102 (2012).