Spin blockade and exchange in Coulomb-confined silicon double quantum dots

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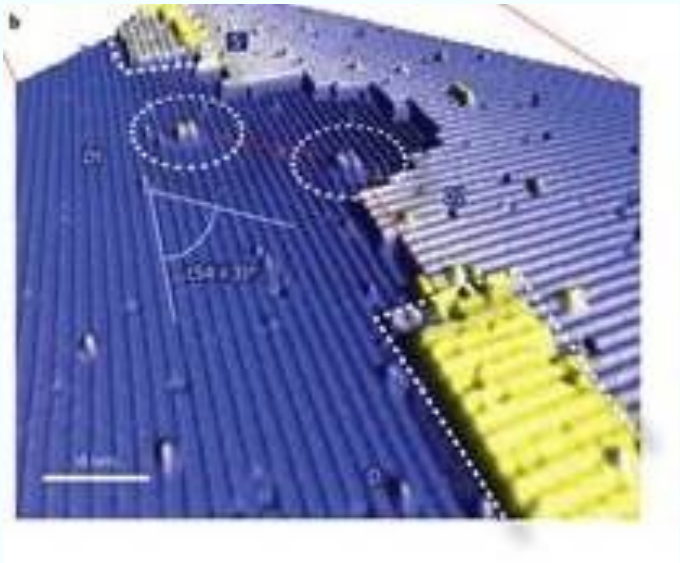

Detail of the central part of the device which hosts two atomic-scale quantum dots (*D*1 and *D*2), symmetrically placed at a distance of 11.5 ± 0.5 nm between the S and D leads.

Electron spins confined to phosphorus donors in silicon are promising candidates as qubits because of their long coherence times, exceeding seconds in isotopically purified bulk silicon. With the recent demonstrations of initialization, readout and coherent manipulation of individual donor electron spins, the next challenge towards the realisation of a Si:P donor-based quantum computer is the demonstration of exchange coupling in two tunnel-coupled phosphorus donors. Spin-to-charge conversion via Pauli spin blockade an essential ingredient for reading out individual spin states, is challenging in donor-based systems due to the inherently large donor charging energies (~ 45 meV), requiring large electric fields (>1 MVm–1) to transfer both electron spins onto the same donor. Here, in a carefully characterized double donordot device, we directly observe spin blockade of the first few electrons and measure the effective exchange interaction between electron spins in coupled Coulomb-confined systems.

LINK TO FULL PAPER (SUBSCRIBERS ONLY):
http://www.nature.com/nnano/journal/v9/n6/pdf/nnano.2014.63.pdf