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Spectroscopy and read-out of STM-patterned donor based qubits[1]

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We report low temperature transport measurements of few-to single P donor based quantum dots in silicon. Dots with a high donor number (approx. 7) show a surprisingly dense spectrum of excited states with an average energy spacing of 100 micro eV. The energy spacing of these features is much too low to be accounted for by the nm-scale lateral confinement of either the dot or the leads and can be explained by lifting of valley degeneracy of the dot orbital states [1]. The use of all epitaxial in plane P:Si gates allow us to tune both the electron number in the dot and modulate the transparency of the tunnel barriers [2]. We also present transport through a deterministic single donor device, where we observe both the signature of a single donor directly through STM imaging and demonstrate that the charging energy and excited state spectrum is consistent with the orbital states of a single P-donor. Finally we present our latest results of spin read-out in STM-patterned donor based devices.

[1] M. Fuchsle et al, Spectroscopy of few electron single crystal silicon quantum dots, Nature Nanotechnology 5, 502 (2010).
[2] A. Fuhrer et al, Atomic-Scale, All Epitaxial In-Plane Gated Donor Quantum Dot in Silicon, Nano Letters 9, 707 (2009).

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