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Atomic qubits in silicon

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Extremely long electron and nuclear spin coherence times have been demonstrated in isotopically pure Si-28 [1,2] making silicon a promising semiconductor material for spin-based quantum information. The two-level spin state of single electrons bound to shallow phosphorus donors in silicon in particular provide well defined, reproducible qubits [3]. An important challenge in these systems is the realisation of an architecture, where we can position donors within a crystalline environment with approx. 20-50nm separation, individually address each donor, manipulate the electron spins using ESR techniques and read-out their spin states.

We have developed a unique fabrication strategy for a scalable quantum computer in silicon using scanning tunneling microscope lithography to precisely position individual P donors in Si [4] aligned with nanoscale precision to local control gates [5] necessary to initialize, manipulate, and read-out the spin states [6-8]. We have published our approach to scale-up using 3D architectures for implementation of the surface code [9].

During this talk I will focus on demonstrating fast, high fidelity single-shot spin read-out [10], ESR control of precisely-positioned P donors in Si [11] and our results to demonstrating a two-qubit gate in donor qubits in silicon [12,13]. With important advances in control at the atomic-scale, I will attempt to highlight the benefits of single atom qubits in silicon.

References

[1] K. Saeedi et al., Science 342, 130 (2013).
[2] J. T. Muhonen et al., Nature Nanotechnology 9, 986 (2014).
[3] B.E. Kane, Nature 393, 133 (1998).
[4] M. Fuechsle et al., Nature Nanotechnology 7, 242 (2012).
[5] B. Weber et al., Science 335, 6064 (2012).
[6] H. Buch et al., Nature Communications 4, 2017 (2013).
[7] B. Weber et al., Nature Nanotechnology 9, 430 (2014).
[8] T. F. Watson et al., Science Advances 3, e1602811 (2017).
[9] C. Hill et al., Science Advances 1, e1500707 (2015).
[10] D. Keith et al., paper submitted (2018)
[11] S. Hile et al., Science Advances 4, eaaq1459 (2018).
[12] M.A. Broome et al., Nature Communications 9, 980 (2018).
[13] S. Gorman, Y. He et al., paper in preparation (2018).

Friday, February 1, 2019 11:00am - 12:00pm

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