A charge-insensitive single-atom spin-orbit qubit in Si: fully tunable coherence and control

Dimitrie Culcer[1, 2*], J. C. Abadillo-Uriel[1,4], Joe Salfi[1,3], Xuedong Hu[5], Sven Rogge[1,3], Maria Calderon[4]

[1]*School of Physics, The University of New South Wales, Sydney 2052, Australia*
[2]*Australian Research Council Centre of Excellence in Low-Energy Electronics Technologies, UNSW Node, The University of New South Wales, Sydney 2052, Australia*
[3]*Centre for Quantum Computation and Communication Technology, The University of New South Wales, Sydney 2052, Australia*
[4]*Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC, Cantoblanco, E-28049 Madrid (Spain)*
[5]*Department of Physics, University at Buffalo, SUNY, Buffalo, New York 14260-1500, USA*

E-mail: d.culcer@unsw.edu.au

Electrical control of quantum bits could pave the way for scalable quantum computation. An acceptor spin qubit in Si, based on spin-3/2 holes, can be controlled by electrical means using a gate electrode, which offers fast one- and two-qubit rotations and long coherence times at certain *sweet spots*. The relaxation time T_1, while allowing 10^5 operations, is the primary limiting factor [1]. I will show that, due to the interplay of the T_d symmetry of the acceptor in the Si lattice and the spin-3/2 characteristic of hole systems, an applied in-plane magnetic field strongly enhances the performance and coherence properties of the qubit. An appropriate choice of magnetic field orientation leads to a near-total suppression of spin relaxation as well as full tunability of two-qubit operations in a parameter regime in which dephasing due to charge fluctuations can be eliminated. Interestingly for spintronic applications, we find an extreme in-plane anisotropy such that the in-plane g-factor can vanish under certain circumstances [2].

REFERENCES:
[1] J. Salfi, J. A. Mol, D. Culcer, and S. Rogge, *Phys. Rev. Lett.* **116**, 246801 (2016).
[2] J. C. Abadillo-Uriel, J. Salfi, X. Hu, S. Rogge, M. J. Calderon, D. Culcer, *arXiv*:1706.08858.

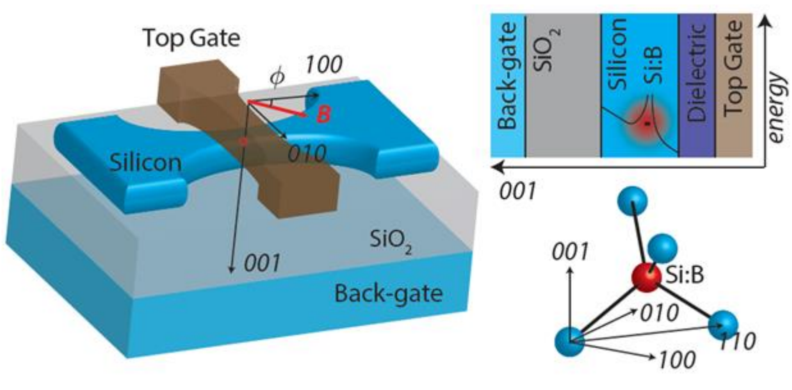

Fig. 1. Sketch of the device geometry and layered heterostructure in the (001) direction. The orientation of the magnetic field within the plane is given by ϕ, the angle with respect to the (100) direction.