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Qubits in Planar Germanium

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Scalability is becoming an increasingly important metric against which to assess the suitability of qubit candidates for large scale quantum computing implementations. Spin qubits, specifically electron spins in silicon quantum dots, are often considered a highly scalable candidate due to their inherent similarities to transistors. However, complications arise when considering the need for qubit manipulation, capable of individual qubit addressability. Conventionally, bulky structures such as microwave antennas, or micromagnets introduced to allow for control of a spin state. Additionally, to reduce interconnects, a large degree of device uniformity is required in order to facilitate shared control, and high temperature operation will likely be necessary for even modest sized spin qubit-based quantum computers.
In this talk, I will examine the scalability of hole spin qubits in germanium quantum wells, which have recently emerged as a promising candidate for large scale quantum computing [1]. Ge/SiGe is a very clean material with high mobilities and low percolation densities [2]. The intrinsic spin orbit coupling present for holes circumvents the need for additional device infrastructure for qubit manipulation, already simplifying the design of large-scale architectures [3]. Additionally, hole spins show a remarkable robustness to classical crosstalk errors and can achieve single qubit fidelities above 99.99% [4]. Furthermore, hole spins in SiMOS have been operated at elevated temperatures [5], and can exhibit strong spin-photon coupling [6]. These attributes position hole spins as strong contenders for spin qubit scale-up.

[1] G. Scappucci et al. The Germanium Quantum Information Route, Nat Rev Mater 6, 926–943 (2021)
[2] M. Lodari et al. Low percolation density and charge noise with holes in germanium, Mater. Quantum. Technol. 1 011002 (2021)
[3] W.I.L. Lawrie et al. Quantum Dot Arrays in Silicon and Germanium, Appl. Phys. Lett. 116, 080501 (2020)
[4] W.I.L. Lawrie et al. Simultaneous driving of semiconductor spin qubits at the fault-tolerant threshold, arXiv:2109.07837 [cond-mat.mes-hall] (2021)
[5] L.C Camenzind et al. A hole spin qubit in a fin field-effect transistor above 4 kelvin. Nat Electron 5, 178–183 (2022).
[6] C.X. Yu et al. Strong coupling between a photon and a hole spin in silicon arXiv:2206.14082 [cond-mat.mes-hall] (2022)

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