

Plenary Talk

PLV VII Thu 9:00 HS 1+2

Spin Qubits in Semiconductors for Scalable Quantum Computers — •DANIEL LOSS — Department of Physics, University of Basel, Switzerland

Semiconductor spin qubits offer a unique opportunity for scalable quantum computation by leveraging classical transistor technology [1]. This has triggered a worldwide effort to develop spin qubits, in particular, in Si and Ge based quantum dots, both for electrons and for holes [2-5]. Due to strong spin orbit interaction, hole spin qubits benefit from ultrafast all-electrical qubit control and sweet spots to counteract charge and nuclear spin noise. In this talk I will present an overview of the state-of-the art in the field and focus, in particular, on recent developments on hole spin physics in Ge and Si nanowires, Si FinFETs, and Ge/SiGe heterostructures [6-15], as well as strategies for maximizing valley splitting crucial for scalability of electron spin qubits in Si [16] and long-distance entanglement via magnetic domain walls in race tracks [17].

[1] D. Loss and D.P. DiVincenzo, Phys. Rev. A 57 120 (1998); Milestone paper of Phys. Rev. A (1970-2020)

[2] C. Kloeffel and D. Loss, Annu. Rev. Condens. Matter Phys. 4, 51

(2013)

[3] A. Chatterjee, et al., Nat. Rev. Phys. 3, 157 (2021)

[4] P. Stano and D. Loss, Nat. Rev. Phys. (2022)

[5] G. Burkard, et al., Rev. Mod. Phys. 95 (2023)

[6] S. Bosco, B. Hetényi, and D. Loss, PRX Quantum 2, 010348 (2021)

[7] L. C. Camenzind, et al., Nat. Electr. (2022)

[8] S. Bosco and D. Loss, Phys. Rev. Lett. 127, 190501 (2021)

[9] G. Scappucci, et al., Nat. Rev. Mater. 6, 926 (2021)

[10] S. Bosco, P. Scarlino, J. Klinovaja, and D. Loss, Phys. Rev. Lett. 129, 066801 (2022)

[11] O. Malkoc, P. Stano, and D. Loss, Phys. Rev. Lett. 129, 247701 (2022)

[12] B. Hetényi, S. Bosco, and D. Loss, Phys. Rev. Lett. 129, 116805 (2022)

[13] S. Bosco, et al., Phys. Rev. Lett. 131, 197001 (2023)

[14] S. Geyer, et al., Nat. Phys. 20, 1152 (2024)

[15] S. Bosco, J. Zou, and D. Loss, PRX Quantum 5, 020353 (2024)

[16] C. Adelsberger, S. Bosco, J. Klinovaja, and D. Loss, Phys. Rev. Lett. 133, 037001 (2024)

[17] J. Zou, S. Bosco, B. Pal, S. S. P. Parkin, J. Klinovaja, and D. Loss, Phys. Rev. Research 5, 033166 (2023)