Seminar/Talk

Hole spin qubits in elongated quantum dots

Monica Benito

Institute of Quantum Technologies of the German Aerospace Center (DLR) in Ulm / Germany

Host: Georgios Katsaros

The latest experimental progress in fabrication of one- and two-dimensional sizable arrays of QDs suggest that quantum information science applications are feasible in these devices, as originally envisioned by Loss and DiVincenzo. Spin qubits in Si and Ge are considered strong candidates for realizing a large-scale quantum processor due to the small qubit dimensions, compatibility with CMOS technology, long coherence times and possibility to operate beyond 1 Kelvin. Important challenges concerning scalability of spin qubits defined on QDs can be overcome by turning the qubits electrically addressable. In the case of electrons one can take advantage of the intrinsic spin-orbit (SO) coupling or gradients of magnetic field (for example created by external micromagnets). The physics of holes, dictated by the Luttinger-Kohn Hamiltonian, has attracted much attention lately because it naturally brings the electrical handle thanks to a strong SO coupling without analogous in electron systems. After summarizing the progress towards a scalable quantum computing architecture with Si QDs embedded in a micromagnet stray field [1,2], I will present recent results on hole spin qubits in Ge. By means of a novel analytical approach, we obtain an effective low-energy model for hole nanowires that accounts for orbital effects of the magnetic field exactly [3]. We show the relevance of orbital effects on the SO interaction and, by complementing with numerical calculations, also on the g-factor. We predict optimal qubit operation at a charge noise sweetspot with Rabi frequencies in the GHz regime. Finally, by modeling planar QD hole spin qubits we find that they can present strong and tunable SO interaction if the confinement potential is properly squeezed[4]. This confinement-induced SO interaction and therefore the qubit-resonator coupling could be turned on and off on demand in state-of-the-art qubits.[1] X. Mi, M. Benito, S. Putz, D. M. Zajac, J. M. Taylor, G. Burkard, andJ. R. Petta, Nature 555, 599 (2018).[2] M. Benito, J. R. Petta, and G. Burkard, Phys. Rev. B 100, 081412 (R)(2019).[3] C. Adelsberger, M. Benito, S. Bosco, J. Klinovaja, and D. Loss,arXiv:2110.15039.[4] S. Bosco, M. Benito, C. Adelsberger, and D. Loss, Phys. Rev. B 104,115425 (2021).

Monday, December 6, 2021 02:30pm - 03:30pm

Heinzel Seminar Room / Office Bldg West (I21.EG.101)

This invitation is valid as a ticket for the ISTA Shuttle from and to Heiligenstadt Station. Please find a schedule of the ISTA Shuttle on our webpage: https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.