Colloquium

Quantum State Transfer in Semiconductor Quantum Dot Arrays

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The recent progress in the fabrication and control of semiconductor quantum dot arrayssignals a substantial leap towards scalability and towards the implementation of newfunctionalities in the field of quantum information, computation and simulation[1]. Anexample of this, is the transfer of quantum information between distant sites, anindispensable part of large-scale quantum information processing.Great effort is currently being devoted to the investigation of hole spin qubits in quantumdots owing to their long coherence time resulting from the weak hyperfine coupling tonuclear spins and rapid operation time due to the inherently strong spin-orbit interaction(SOI) [2-5].In this talk I will discuss pulse-based protocols based on shortcuts to adiabaticity, whichallow to transfer spin holes directly between edges of a quantum dot chain with highfidelity. I will show how the spin polarization of the transferred holes can be controlledby tuning the ratio between the SOI and the spin conserving tunneling rate. Also, I willdiscuss how to transfer entangled hole spins between edge dots and the feasibility ofquantum dot arrays to distribute information between distant sites and perform one qubitgates in parallel [6].An alternative way to transfer directly information between distant sites, is to useprotected topological edge states in systems with non-trivial topology. I will brieflydiscuss the long-range particle dynamics mediated by edge states in different quantumdot array configurations, which can be experimentally detected with QDs chargedetectors, and which opens a new avenue for quantum state transfer protocols in lowdimensional topological lattices [7]. [1] S. G. J. Philips, et al., Nature 609, 919 (2022); I. Seidler, et al., npj QI 8, 100 (2022); A.Zwerver et al., PRX Quantum 4, 030303 (2023)[2] D. Jirovec et al., Nature Mat., 20, 1106 (2021)[3]G. Scappucci et al., Nature Rev. Mat., 6, 926 (2021)[4] D. Jirovec et al., Phys Rev B, 128, 126803 (2022)[5]D. Fernández-Fernández et al., Phys. Rev. Appl. 8, 054090 (2022); D. Fernández-Fernández,et al., J. Phys. Mater. 6 034004 (2023).[6] D. Fernández-Fernández, Y. Ban, G. Platero arXiv: 2312.04631 (2023)[7] B. Pérez-González et al., Phys. Rev. Lett. 123, 126401 (2019); J. Zurita et al.,Quantum,7,1043 (2023).

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Heinzel Seminar Room / Ground Floor / Office Building West

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