



## Quantum 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 arrays signals a substantial leap towards scalability and towards the implementation of new functionalities in the field of quantum information, computation and simulation [1]. An example of this, is the transfer of quantum information between distant sites, an indispensable part of large-scale quantum information processing. Great effort is currently being devoted to the investigation of hole spin qubits in quantum dots owing to their long coherence time resulting from the weak hyperfine coupling to nuclear 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, which allow to transfer spin holes directly between edges of a quantum dot chain with high fidelity. I will show how the spin polarization of the transferred holes can be controlled by tuning the ratio between the SOI and the spin conserving tunneling rate. Also, I will discuss how to transfer entangled hole spins between edge dots and the feasibility of quantum dot arrays to distribute information between distant sites and perform one qubit gates in parallel [6]. An alternative way to transfer directly information between distant sites, is to use protected topological edge states in systems with non-trivial topology. I will briefly discuss the long-range particle dynamics mediated by edge states in different quantum dot array configurations, which can be experimentally detected with QDs charged detectors, and which opens a new avenue for quantum state transfer protocols in low-dimensional 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).

**Tuesday, June 18, 2024 11:00am - 12:00pm**

Heinzel Seminar Room / Ground Floor / Office Building West

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