Berlin Mathematics Research Center MATH+

**MATH+ Spotlight Talk**

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## Coherent Transport of Semiconductor Spin-Qubits: Modeling, Simulation and Optimal Control

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Abstract:

Scaling up quantum processors to a large number of qubits to enable the implementation of error-correction algorithms is one of the major challenges on the path to realizing universal quantum computers. Spin qubits in gate-defined SiGe quantum dots provide excellent prospects for scalability, however the lithographic processing, signal routing and wiring of large qubit arrays at a small footprint poses a significant challenge. One possible solution could be to separate the qubit register into small dense qubit arrays, which are inter-connected by a quantum bus that allows for coherent transfer of quantum information by physically moving electrons between distant nodes along a channel. Limitations in qubit shuttling arise from the interaction of the electron with material defects within the channel that can cause non-adiabatic transitions to excited states. As excited orbital states have a modified effective g-factor, this results in an accumulation of a random phase which finally diminishes the fidelity. In this contribution, we theoretically explore the capabilities for bypassing defect centers using optimally engineered control signals that allow for a quasi-adiabatic passage of the electron through the channel without reducing the velocity. Our approach is based on quantum optimal control theory and Schrödinger wave packet propagation using realistic potential landscapes.