Graduate School Event

Thesis Defense: Singlet-Triplet Qubits in Planar Germanium: From Exchange Anisotropies to Autonomous Tuning

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Host: Sylvia Cremer

Over the past century, researchers have been fascinated by the quantum nature of the world, initially striving to understand its fundamental principles and consequences, and eventually progressing toward engineering systems in which quantum properties can be controlled and manipulated. Today, we stand at the dawn of the quantum technology era. While some quantum technologies follow well-defined roadmaps, others are still in the exciting and uncertain early stages of development. In the fields of quantum computing and quantum simulation, research is being conducted across a wide variety of platforms. Each of these demonstrates control over quantum properties but also faces challenges in scaling up to the level of a mature technology.This thesis explores some of the fundamental properties of hole spin qubits in planar germanium. Semiconductor spin qubits are considered strong candidates for the realization of quantum processors, owing to their long relaxation and coherence times, as well as their compatibility with existing semiconductor industry infrastructure. Among these, hole spin qubits in planar germanium are particularly promising. Their advantages include a large effective mass, which eases fabrication constraints; inherent protection from hyperfine noise; and strong spin-orbit interaction, which enables fast and purely electrical control. However, spin-orbit coupling also introduces site-dependent variability across qubits, particularly in the g-tensors and spin-flip tunneling, which might cause that the quantization axes are not aligned. In this thesis, we investigate the tilt between the quantization axes of two hole spins hosted in a double quantum dot as a function of both the magnetic field direction and various electrostatic configurations, demonstrating that both parameters influence this tilt. We conclude by introducing a machine-learning-assisted routine to automatically tune baseband spin qubits. This approach may prove to be a powerful tool for characterizing spin-orbit effects and gaining deeper insight into the physics governing spin qubit behavior.

Monday, June 2, 2025 01:30pm - 02:30pm

Sunstone Bldg / Ground floor / Big Seminar Room B (I23.EG.102)

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