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Hole spin qubits and hybrid nanomechanical systems

Quantum bits based on hole spins confined in quantum dots in one-dimensional Ge or Si nanostructures promise a level of control that goes beyond that of electron spin qubits currently being researched. They combine high coherence and tunable interaction strengths with ease of sample fabrication and integration with current industrial technology. The spin-orbit interaction of these hole spins is predicted to be very strong and, importantly, electrically tunable. In my talk I will discuss the experimental progress on the implementation of hole spin qubits in GeSi nanowires, the characterization of tunable spin-orbit interaction, and the coupling of hole spin qubits to microwave resonators. Controllable interaction of quantum bits with photonic or phononic degrees of freedom lies not only at the basis of scalable quantum computation, but also forms a promising path to enhance force sensing and optomechanics. In this context, I will present my work on ultrasensitive force sensing with nanowire mechanical resonators and on the coupling of qubits to nanomechanical and optical resonators.

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