# Abstract

By exploiting the quantum superposition principle a quantum computer will be able to outperform the speed of classical computers by orders of magnitude for particular types of algorithms. In the growing quantum computing science community there are several approaches for realizing qubits as the base unit of a quantum computer. This proposal deals with qubits based on localized spins in semiconductors. Group IV materials and in particular silicon (Si) have attracted much interest for the realization of a spin qubit especially after coherence times of almost a second were reported for an electron spin in isotopically purified samples. However, one limitation of electrons confined in Si is the difficulty to perform fast gate operations while maintaining the good coherence.

During this project I will work with hole spin qubits realized in germanium (Ge). Holes in germanium combine a very strong spin orbit coupling with a very small hyperfine interaction. Such might allow thus the realization of a long lived spin qubit with very fast operation times. The possibility to scan fast through the phase space of a qubit, to perform single shot measurements and to move towards a large number of qubits, demand a highly sensitive and easy to realize method for spin readout.

In the first part of the project I am going to develop and use gate reflectometry as a readout system for being able to study the spin dynamics of the germanium hole spin qubit. The reflectometry will use the already defined gates needed for the electrostatic definition of the double quantum dot system.

In the second part of the project I will investigate the spin properties of the Loss-DiVincenzo qubit realized in such a double quantum dot. Measurements determining the spin relaxation time T1, the spin dephasing time T2\*, the spin echo T2ECHO time and the CPMG T2CPMG time, will be performed. All measurement are going to be performed in a dilution fridge with DC and RF lines, amplifiers, attenuators and directional couplers. DC electronics, microwave sources, arbitrary waveform generators, lock-in amplifiers for gate reflectometry readout and superconducting magnets will be used to perform the experiments and realize the goals of the proposed project.