Superconductor / Semiconductor hybrid nanostructures based on Germanium for quantum information

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PhD may follow: Yes

Summary :

Holes in germanium have the advantage to possess a strong spin-orbit coupling enabling fast electrical control of their spin. In addition, p-type germanium has the tendency to form low-Schottky-barrier contacts with several metals, including superconducting ones. This opens the opportunity to realize novel hybrid superconductor-semiconductor devices relying on the superconducting proximity effect in germanium.
The goal of this project is to fabricate and study nano-devices embedding a 2D hole gas confined to a germanium well. More specifically, we aim at realizing quantum-dot and quantum-wire nanostructures in which individual hole spins are electrically controlled by means of electrostatic gates. Then we plan to connect such nanostructures to superconducting electrodes to obtain novel types of high-quality hybrid devices such as gate-tunable transmons, i.e. â€œgatemonsâ€•.
Two types of germanium layers will be studied: high-mobility, strained-Ge quantum wells in Ge/Ge0.8Si0.2 heterostructures), and Ge layers on insulator (GeOI).
The strong spin-orbit coupling in combination with the superconducting proximity effect will be exploited to reach topological superconductor states hosting Majorana-fermion edge quasi-particles.
This internship can naturally evolve into a longer-term PhD project. The student will take active part in device fabrication at the PTA cleanroom and low-temperature transport measurements in dedicated cryostats equipped with superconducting vector magnets.

Full description :

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Requested skills :

Master in Physics