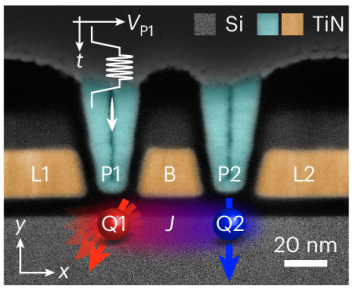
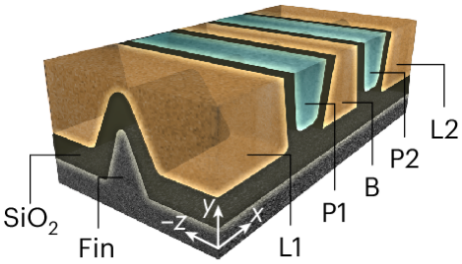
University of Basel

NCCR SPIN

Spin-based Quantum Computing: Qubit Platforms





When: *Spring 2025*, Starting date: February 19th 2025, End date: May 28th 2025
Lectures: *Wednesdays, 08:15 (Basel time)*
Exercises: *To be confirmed*

What: 4 credit points, weekly assignments, grade 1-6
Accreditation at other Swiss universities possible, please contact us to arrange.
Further international accreditation may also be possible.

Where: *Online + with AI assistant (see below)*

Lecturers: Dr Henry F. Legg (St Andrews), Dr Ji Zou (Basel), Dr Denis Kurlov (Basel),
Dr Peter Stano (RIKEN), *& experimental colleagues from the NCCR SPIN network*

Coordinators: Prof. Jelena Klinovaja, Prof. Daniel Loss, Prof. Dominik Zumbühl

email: *spin.qubit.basel@gmail.com*

Registration here!

In this course, we will discuss how ***semiconductor spins*** can be used for quantum information processing. We will review basic operations of one and two qubits, keeping an eye on how to implement them in semiconducting devices. We will study spin qubits in quantum dots [1], and focus on standard industry materials silicon [2] and germanium [3], currently among the most promising platforms for a large-scale quantum computer.

Starting from the basic concept of a qubit, ideas such as coupling qubits, prospects for scaling and integration, noise (using the Lindblad master equation), k.p theory for semiconductors, and state-of-the-art research topics, including recent experimental progress, will be discussed.

This course is tailored to Master and PhD students, with theoretical or experimental background, aiming to widen their perspectives into the fast-growing field of spin-based quantum information processing.

[1] D. Loss and D. P. DiVincenzo, Phys. Rev. A **57**, 120 (1998).
[2] L. Vandersypen and M. Eriksson, Phys. Today **72**, 38 (2019).
[3] G. Scappucci,C. Kloeffel, *et al.*, Nature Reviews Materials **6**, 926 (2021).

This year, for the first time, lectures will be recorded and made available on an online platform, allowing participants to interact with the recordings and pose course-related questions to an AI-powered teaching assistant for an in-class-like experience. The background materials have been carefully tailored by experts to ensure the relevance and quality of the answers provided. Please note that the AI teaching assistant is currently in the beta testing phase, and any feedback is highly appreciated.