QuTe
Zentrum für Quantentechnologien

Quantum Information Science Talks

UNIVERSITÄT DES SAARLANDES

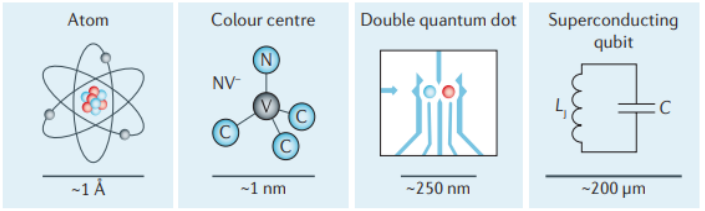
Prof. Dr. Guido Burkard (University of Konstanz)

Solid-state qubits: Quantum spins and quantum circuits

Date: **Monday, April 27, 2026**

Time: **12:30 – 13:30**

Location E2 6, Room E.11



From G. Burkard, https://www.nature.com/articles/s42254-019-0135-2

Solid-state platforms provide a unique arena in which microscopic and mesoscopic quantum degrees of freedom can be engineered, coupled, and controlled with high precision. We will discuss two leading realizations of solid-state qubits—semiconductor spin qubits and superconducting circuits—from a theoretical perspective, emphasizing their similarities and contrasts at the level of effective Hamiltonians and control principles. In the first part, the focus lies on electron spins confined in semiconductor quantum dots. Starting from exchange and Zeeman interactions, we will show how universal quantum control arises from time-dependent modulation of a small set of parameters. In the second part, we will turn to superconducting qubits, where macroscopic circuit degrees of freedom behave as nonlinear quantum oscillators. We will see how quantized circuit Hamiltonians emerge from Josephson junctions and electromagnetic modes, and how coupling and control schemes enable coherent multi-qubit dynamics. From a theoretical standpoint, superconducting circuits offer a complementary route to quantum computation, characterized by strong controllability, engineered anharmonicity, and distinct noise mechanisms. Finally, we will combine the worlds of semiconductor and superconductor devices to see what physical properties they have, and how hybrid quantum systems allow for long-distance coupling of long-lived qubits.

Contact: peter.orth@uni-saarland.de, giovanna.morigi@physik.uni-saarland.de

Website: www.uni-saarland.de/fachrichtung/physik/veranstaltungen/qis-seminar.html