Quantum Simulation and Micro-Mechanics with Superconducting Qubits

Gerhard Kirchmair

Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Technikerstraße 21a, A-6020 Innsbruck, Austria
&
Institute for Experimental Physics, University of Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria

In this talk, I want to present the research activities of the Superconducting Quantum Circuits group at the Institute for Quantum Optics and Quantum Information in Innsbruck.

In the first part, I will introduce circuit quantum electrodynamics and the 3D architecture. I will show how we are using this architecture to realize a platform for quantum many body simulations. Our basic building blocks are 3D Transmon qubits where we use the naturally occurring dipolar interactions to realize interacting spin systems coupled to microwave resonators or open quantum systems like waveguides.

In the second part of my talk I want to introduce an experiment, where we inductively couple a mechanical oscillator to a microwave circuit. We place a magnet on the tip of the mechanical resonator, a cantilever, which leads to a position dependent magnetic field. This field is coupled to a microwave resonator via an embedded SQUID: its resonance frequency depends on flux and consequently on the position of the cantilever. We can achieve single-photon single-phonon coupling strength on the order of several kHz. We are currently characterizing the system and work towards cooling it closer to its ground state.