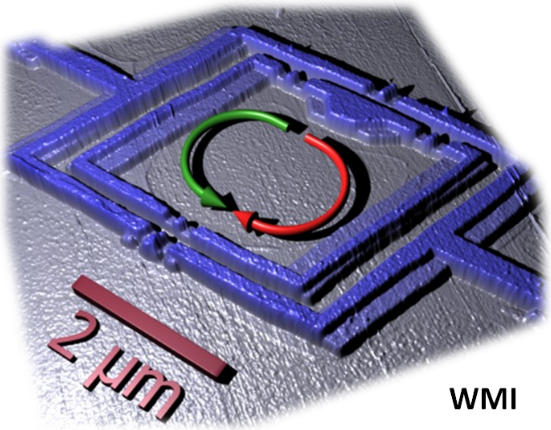
Fakultät für Physik

Physikalisches Kolloquium

Rudolf Gross, TU München

»Superconducting Quantum Circuits«

Einführung: A. Ustinov



Solid-state quantum circuits with lateral dimensions between 100 nm and a few µm behave in many aspects similar to natural atoms. Despite the fact that these so-called artificial atoms are huge compared to their natural counterparts, they have a discrete level structure and exhibit properties unique to the world of quantum mechanics. In the simplest case, these artificial atoms form quantum two-level systems, also called quantum bits or qubits. They allow for the investigation of fundamental quantum phenomena on a macroscopic scale and the implementation of solid-state quantum information systems. A big advantage of these artificial solid-state qubits over natural atoms is their design flexibility and wide tunability by means of external parameters such as electric or magnetic fields. We discuss the realization of superconducting flux qubits and quantum circuits [1] and their quantum coherent dynamics [2,3]. We also address the coupling of a superconducting flux qubit to an on-chip microwave resonator, giving rise to the prospering field of circuit quantum electrodynamics (c-QED) which allows the study of the fundamental interaction between the artificial solid-state atoms and single microwave photons as the basis for communicating quantum information. In particular, we discuss the interplay of multi-photon processes and symmetries in a qubit–resonator system and the development of two-resonator circuit QED systems [4]. Furthermore, we demonstrate the realization of c-QED systems operating in the ultra-strong coupling regime, where the atom-cavity coupling rate reaches a considerable fraction of the atom transition frequency [5].

[1] T. Niemczyk *et al.*, Supercond. Sci. Techn. **22**, 034009 (2009)
[2] F. Deppe *et al.*, PRB **76**, 214503 (2007); K. Kakuyanagi, *et al.*, PRL **98**, 047004 (2007).
[3] F. Deppe *et al.*, Nature Physics **4**, 686 (2008).
[4] M. Mariantoni *et al.*, Phys. Rev. B **78**, 104508 (2008).
[5] T. Niemczyk *et al.*, arXiv:1003.2376.
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Freitag, 11.06.2010, 17 Uhr c.t.,
KIT, Campus Süd,
Otto-Lehmann-Hörsaal, Physik-Flachbau (Geb. 30.22).
Anschließend Nachsitzung im Gastdozentenhaus „Heinrich Hertz“

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