TT 72: Nanomechanics (jointly with BP, DF, and DY)

Time: Friday 10:45–11:45 Location: H20

TT 72.1 Fri 10:45 H20

Two-tone experiments and time domain control in circuit nano-electromechanics — •Hans Huebl[1], Fredrik Hocke[1], Xiaoqing Zhou[2,3], Albert Schliesser[2,3], Tobias J. Kippenberg[2,3], and Rudolf Gross[1,4] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Ècole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland — [3]Max-Planck-Institut für Quantenoptik, Garching, Germany — [4]Physik-Department, TU München, Garching, Germany

In the field of optomechanics, a light field trapped in an optical resonator dynamically interacts with a mechanical degree of freedom, enabling cooling and amplification of mechanical motion. This concept of light matter interaction can be transferred to the microwave (MW) regime combining superconducting MW circuits with nanometer-sized mechanical beams, establishing the class of circuit nano-electromechanics. We discuss electromechanically induced transparency and electromechanically induced absorption employing continuous and pulsed excitation. With the latter technique, we access the dynamics of the hybrid system revealing that the switching dynamics of the transmitted light are not limited by the time constant imposed by the mechanical beam, the slowing of light pulses, and the phonon repopulation of a precooled mechanical mode due to thermal decoherence [1,2].

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[1] X. Zhou et al., arXiv:1206.6052 (2012)
[2] F. Hocke et al., arXiv:1209.4470 (2012)

TT 72.2 Fri 11:00 H20

Quantum Information Processing with Nanomechanical Qubits — •Simon Rips and Michael Hartmann — Technische Universität München, James-Franck-Strasse, 85748 Garching, Germany

We introduce an approach to quantum information processing where the information is stored in the motional degrees of freedom of nanomechanical devices. The qubits of our approach are formed by the two lowest energy levels of mechanical resonators which are tuned to be strongly anharmonic by suitable electrostatic fields. Single qubit rotations are conducted by radio frequency voltage pulses that are applied to individual resonators. Two qubit entangling gates in turn are implemented via a coupling to a common optical resonance of a high finesse cavity. We explain the working principle of local and entangling operations and show that high gate fidelites can be obtained with realistic experimental parameters.

TT 72.3 Fri 11:15 H20

Mechanical read-out of a single electron spin in a carbon nanotube — •Philipp Struck, Heng Wang, and Guido Burkard — Universität Konstanz

The spin of a single electron in a suspended carbon nanotube can be read out by using its coupling to the nano-mechanical motion of the nanotube. To show this, we consider a single electron confined within a quantum dot formed by the suspended carbon nanotube. The spin-orbit interaction induces a coupling between the spin and one of the bending modes of the suspended part of the nanotube [1]. We simulate the response of the system to the external driving with a Jaynes-Cummings model by solving the quantum master equation. Using parameters comparable to those used in recent experiments, we calculate how information of the spin state of the system is imprinted on the mechanical motion. By measuring the current through a close-by charge sensor, the spin state can be read out. We show that the effect is measurable with current experimental expertise.

[1] A. Palyi, P. R. Struck, M. Rudner, K. Flensberg, and G. Burkard, Phys. Rev. Lett. **108**, 206811 (2012)

TT 72.4 Fri 11:30 H20

Carbon nanotube nano-electromechanical resonators — driving, damping, detection — Daniel Schmid, Peter Stiller, Sabine Kugler, Alois Dirnaichner, Christoph Strunk, and •Andreas K. Hüttel — Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany

Single wall carbon nanotubes are not only excellent electrical conductors or semiconductors. Additionally, the carbon lattice causes large mechanical stability, with a Young's modulus significantly exceeding that of stainless steel. Recent research has shown the mechanical quality factor of a suspended carbon nanotube nano-electromechanical resonator to rise above 10^5 at cryogenic temperatures. At these high values, mechanical motion can be excited by minute driving forces. At the same time, the electronically nonlinear behaviour of the quantum dot forming inside the carbon nanotube enables detection of the mechanical motion.

With this, we present a rich system where single-electron tunneling directly couples to and influences mechanical motion. A dc current alone is sufficient to excite vibration via feedback effects. In turn, the mechanical vibrations can be suppressed with a magnetic field by means of eddy current dissipation. The quantum dot provides a clean quantum-mechanical few-carrier system. As a perspective, future experiments may show a carbon nanotube as a system coherent in both electronic and mechanical aspects.