TT 69: Nano- and Optomechanics (joint session TT/HL/CPP)

Time: Friday 9:30–10:30 Location: HSZ 03

Invited Talk TT 69.1 Fri 9:30 HSZ 03

Microwave Optomechanics with Superconducting Quantum Interference Cavities — •Daniel Bothner, Ines C. Rodrigues, and Gary A. Steele — Kavli Institute of Nanoscience, Delft University of Technology, PO Box 5046, 2600GA Delft, The Netherlands

Within the recent decade, cavity optomechanics has achieved tremendous breakthroughs regarding the detection and control of macroscopic mechanical oscillators with electromagnetic radiation. Among the most groundbreaking results are displacement sensing beyond the standard quantum limit, quantum ground-state sideband cooling and the generation of non-classical states of motion in massive mechanical objects. With most current approaches for optomechanical systems, however, the nonlinear single-photon regime seems still far out of reach.

Here, I will introduce a recently realized, novel approach for coupling microwave fields in a superconducting circuit to mechanical motion: flux-mediated microwave optomechanics. In this approach, mechanical motion is transduced to magnetic flux, which couples into a superconducting quantum interference device (SQUID). The SQUID forms the inductor of a superconducting microwave circuit and the coupling strength between the microwave circuit and the mechanical displacement is tunable and scales with the magnitude of the magnetic transduction field. Due to the linear scaling behavior, this flux-mediated approach has been predicted to have the realistic potential to reach the fully nonlinear regime of the optomechanical coupling, opening the door for the preparation of mechanical quantum states and a new generation of optomechanical devices.

TT 69.2 Fri 10:00 HSZ 03

Magnetoelastic readout concepts — •Daniel Schwienbacher[1,2,3], Nynke Vlietstra[1,2], Thomas Luschmann[1,2,3], Rudolf Gross[1,2,3], and Hans Huebl[1,2,3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technologies, München, Germany

Nanostring resonators are prime candidates for mechanical sensing applications. Typically, they are used for mass and force sensing. However, it is also possible to use these resonators for the investigation of solid state properties of materials, like magnetoelastics. We investigated the mechanical motion of a 60 μm long SiN/Co bi-layer nanostring resonator with a resonance frequency in the MHz range. Here, we simultaneously use optical and electrical readout techniques. We observe the well known impact of the magnetoelastics, due to the presence of Co, on the resonance frequency of the nanostring. In addition, we study the impact of electrical transport through the string resonator on the mechanical properties of the system.

TT 69.3 Fri 10:15 HSZ 03

Magnetomechanical Crystals — •T. Luschmann[1,2,3], D. Schwienbacher[1,2,3], J. Graf[4], F. Engelhardt[4], S. Viola Kusminskiy[4], R. Gross[1,2,3], and H. Huebl[1,2,3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technologies, München, Germany — [4]Max Planck Institute for the Science of Light, Erlangen, Germany

Optomechanical crystals have become an established platform for the investigation of light-matter interaction, specifically in the context of optomechanical interaction. The success of this concept is founded in the simultaneous localization of GHz frequency phonons alongside THz photons in a suspended nanostructure [1]. We expand this concept with the introduction of magnetic materials capable of supporting spin-wave resonances in the GHz frequency range. We present finite element studies of phononic crystal cavities alongside micromagnetic simulations of spin-waves in nanostructured magnetic materials to tailor the geometries towards the realization of resonant, artificial magnon-phonon coupling. In addition, we will quantitatively compare numerical simulations with early experimental data.

[1] Eichenfield et al. Nature **462**, 7882 (2009).