Q 1: Micromechanical oscillators I

Time: Monday 11:00–12:15 Location: F 142

Q 1.1 Mon 11:00 F 142

Multi mode quantum dynamics in optomechanical crystals — •Michael Schmidt[1], David Turban[1], Max Ludwig[1], and Florian Marquardt[1,2] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen, Germany — [2]Max Planck Institute for the Science of Light, Günther-Scharowsky-Straße 1/Bau 24, D-91058 Erlangen, Germany

Optomechanical crystals are a novel realization of an optomechanical system that can be used to integrate many localized vibrational and optical modes on a single chip. The vibrational modes can be prepared in their ground state via optical side-band cooling. The great design flexibility allows to engineer interactions between modes, providing a versatile interacting quantum system. It may be used to implement phononic networks for quantum information processing or serve as a quantum bus to connect different quantum systems. We present our theoretical analysis of multimode quantum dynamics in optomechanical crystals.

Q 1.2 Mon 11:15 F 142

Light scattering of an optomechanical cavity coupled to a single atom — Daniel Breyer and •Marc Bienert — Theoretische Physik, Universität des Saarlandes, Saarbrücken

We theoretically analyze the light scattering of an optomechanical cavity which strongly interacts with a single two-level system and couples simultaneously to a mechanical oscillator by radiation forces. The analysis is based on the assumptions that the system is driven at low intensity, and that the mechanical interaction is sufficiently weak, permitting a perturbative treatment. We find quantum interference in the scattering paths, which allows one to suppress the Stokes component of the scattered light. This effect can be exploited to reduce the motional energy of the mechanical oscillator.

Q 1.3 Mon 11:30 F 142

Cryogenic cooling of a Michelson-Sagnac Interferometer — •Ramon Moghadas Nia, Henning Kaufer, Andreas Sawadsky, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany

Opto-mechanical experiments recently reached regimes in which direct observation of the quantum behaviour of mechanical oscillators is possible. The Michelson-Sagnac topology has turned out to be an excellent tool for measuring the displacement of a high optical and mechanical quality silicon nitride (SiN) membrane. It has been shown that this setup can provide a high interference contrast and therefore is compatible with recycling techniques, such as signal recycling. Because of thermal noise, however, the observation of the quantum back-action noise is possible only when operating the system at cryogenic temperatures. Here we present a new, cryogenic cooled Michelson-Sagnac interferometer operated at 8 Kelvin. The SiN membrane showed a high mechanical Q-factor of about 10^7. Our setup is expected to enable the direct observation of anticipated effects like radiation pressure noise and ponderomotive squeezing.

Q 1.4 Mon 11:45 F 142

Single-photon strong coupling signatures in optomechanically induced transparency — •Andreas Kronwald[1], Max Ludwig[1], and Florian Marquardt[1,2] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen, Germany — [2]Max Planck Institute for the Science of Light, Günther-Scharowsky-Straße 1/Bau 24, D-91058 Erlangen, Germany

An optomechanical system consists of a laser-driven photonic mode coupled to mechanical motion. Recently, the existence of an optomechanical analog to electromagnetically induced transparency (EIT) was shown. The strongly laser-driven optomechanical system becomes fully transparent when probed by a second, weak laser. In contrast to earlier works, we analyze this effect in a regime where light and mechanics interact strongly on the level of single quanta.

Q 1.5 Mon 12:00 F 142

Anomalous dynamic back-action in interferometers: beyond the scaling law — •Sergey Tarabrin[1,2], Farid Khalili[3], Klemens Hammerer[1,2], Henning Kaufer[1], and Roman Schnabel[1] — [1]Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstraße 38, 30167 Hannover, Germany — [2]Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover, Germany — [3]Department of Physics, Moscow State University, Moscow 119992, Russia

We analyze dynamic back-action in the signal-recycled Michelson-Sagnac interferometer with a translucent membrane positioned in its arm, operated off dark port, and reveal its 'anomalous' features as compared to the ones of 'canonical' back-action, obtained within the scope of scaling law. Given the finite reflectivity of the membrane, optical damping as a function of detuning acquires (i) non-zero value on resonance and (ii) several stability/instability regions. In the case of absolutely reflecting membrane, corresponding to a pure Michelson interferometer, off-dark-port regime results in several intersecting regions of positive/negative values of optical spring and damping. For a certain region of parameters, stable sets of both effects in a free-mass interferometer with a single laser drive are possible. Our results can find implementations in both cavity optomechanics, revealing new regimes of cooling of micromechanical oscillators, and in the gravitational-wave detectors, revealing the possibility of stable single-carrier optical spring which can be utilized for the reduction of quantum noise.