Q 9: Micro Mechanical Oscillator 2

Time: Monday 14:30–15:15 Location: HSZ 02

Q 9.1 Mon 14:30 HSZ 02

Synchronization in optomechanical arrays — •Georg Heinrich[1], Max Ludwig[1], Jiang Qian[2], Björn Kubala[1], and Florian Marquardt[1,3] — [1]Institute for Theoretical Physics, University of Erlangen-Nuremberg, Germany — [2]Department of Physics, LMU Munich, Germany — [3]Max Planck Institute for the Science of Light, Erlangen, Germany

The motion of nano- and optomechanical systems can be coupled to electromagnetic fields. Beside the ultimate goal to measure and control the quantum state of mechanical motion, these systems allow to study elaborate dynamics due to the light-mechanics interaction. Recent developments have demonstrated systems comprising several coupled optical and vibrational modes, such as optomechanical crystals. Here we investigate the collective dynamics of arrays of coupled optomechanical cells, each consisting of a laser-driven optical and a mechanical mode. Beyond a certain threshold of the laser input power, each cell shows a Hopf bifurcation towards a regime of self-induced oscillations. We show that the phases of many such cells, even with different bare initial frequencies, can lock to each other, synchronizing the dynamics to a collective oscillation frequency. We present different regimes for the dynamics and describe the system in terms of an effective Kuramoto model. This allows to connect our optomechanical results to the general field of nonlinear science where synchronization constitutes an important, universal feature finding applications in fields ranging from physics over chemistry to biology.

Q 9.2 Mon 14:45 HSZ 02

Optomechanical entanglement and teleportation in a pulsed scheme — •Sebastian Hofer[1,2], Markus Aspelmeyer[1], and Klemens Hammerer[2] — [1]Faculty of Physics, University of Vienna, Austria — [2]Institute for Theoretical Physics and Institute for Gravitational Physics, Leibniz University Hannover, Germany

We analyze the creation of optomechanical EPR entanglement in a pulsed scheme. Furthermore we apply the standard CV teleportation protocol to optomechanical systems, analyze its Fidelity under the influence of thermal noise and determine the optimal parameter regime.

Q 9.3 Mon 15:00 HSZ 02

Quantum theory of light scattering for dielectric objects in optical cavities — •Anika C. Pflanzer, Oriol Romero-Isart, and J. Ignacio Cirac — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Strasse 1, 85748 Garching, Germany

We develop a full quantum theory to describe the coupling of light to the motion of general dielectric objects in high-finesse optical cavities. In particular, we derive a master equation to describe the center-of-mass motion of the dielectric object, the cavity mode and their coupling to the other modes of the electromagnetic field via photon scattering. Focusing on massive particles here, this general theory is in particular applied to the recent proposal of using an optically levitating dielectric as a cavity opto-mechanical system [1,2]. Furthermore, we explore the range of applicability of this theory with respect to the size of the dielectric object and investigate limitations on possible cavity-cooling schemes. By comparing our findings to results from classical Mie scattering theory, we investigate differences arising from a fully quantum mechanical treatment of the system.

[1]Romero-Isart, New J. Phys. 12:033015 (2010)
[2]Romero-Isart, Pflanzer et al., arXiv:1010.3109 (2010)