Nanomechanical Qubits

Michael Hartmann

Technische Universität München
Physik Department I / T34
Garching, Germany

We introduce an approach to quantum information processing where the information is stored in the motional degrees of freedom of nanomechanical resonators. In our optomechanical approach, nanomechanical oscillators couple to laser driven resonances of an optical cavity. By lowering the resonance frequency of the oscillators via inhomogeneous electrostatic fields, we significantly enhance their intrinsic geometric nonlinearity per phonon. This causes the motional sidebands to split into separate spectral lines for each eigenstate of the mechanical motion and transitions between such eigenstates can be selectively addressed. This can be used to generate stationary phonon Fock states. Moreover the two lowest mechanical energy levels can be employed as qubits where 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 of two qubits to a common optical resonance of the cavity.