Non-Classical Mechanical Motion in Optoelectromechanics

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Recent progress in cooling nanomechanical oscillators and the quest to explore their quantum regime has lead to the development of a large variety of nanomechanical structures offering excellent control- and tunability. Despite reaching phonon numbers below unity, true quantum properties of nanomechanical oscillators have however not yet been shown since the observed dynamics is typically linear, leading to Gaussian states with classical properties. Yet observing non-classical motion for mesoscopic or even macroscopic objects could rule out speculations about limits to the validity of quantum mechanics in this domain.

In this talk I will discuss two approaches to enhance and exploit nonlinearities in optoelectromechanical devices for the generation of genuine quantum states of mechanical motion, e.g. phonon Fock states. One example considers a transmon qubit in a transmission line resonator, in which one part of the transmon's shunt capacitance is free to mechanically oscillate. The other example explores a doubly clamped carbon nanotube coupled to static electric fields and optical photons.