# Quantum versus Classical Dynamics of Strongly Nonlinear Resonators

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## Abstract

We describe progress towards realising a circuit QED based scheme to generate and detect decohering quantum superpositions of a mesoscale mechanical resonator. The scheme involves driving the mechanical resonator into oscillation such that a Cooper pair box qubit initially prepared in a superposition of charge-degenerate states rapidly becomes entangled with separated position states of the resonator. The state of the qubit-mechanical resonator system is probed through its affect on the microwave mode of a superconducting coplanar waveguide (CPW) resonator to which the qubit electromagnetically couples. An unusual feature of our circuit QED-mechanical resonator scheme is the application of a dc voltage bias line directly to the centre conductor of the CPW via an inductor bias 'tee'. The dc line ensures the necessary strong coupling between the qubit and mechanical resonator, without significantly affecting the quality factor of the probed several GHz microwave mode.

We also describe a related dc biased circuit QED setup involving a CPW resonator coupled to a Cooper pair transistor, but *without* the mechanical resonator. The latter affords the possibility to investigate the quantum-versus-classical dynamics of a low noise, strongly nonlinear self-oscillating system that is distinct from the usually considered Duffing oscillator, mapping instead onto a driven pendulum-coupled-oscillator mechanical equivalent.