Measurement of Dispersive Coupling Between a Nanoresonator and a Superconducting Qubit
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Incorporating superconducting qubit technology into nanoelectromechanical systems (NEMS) should enable the observation of quantum behavior in NEMS. Ultimately, it is expected that coupled qubit-NEMS systems could serve as a test bed for studying fundamental issues of quantum mechanics including the quantum limits of measurement and the quantum-classical divide. Proposals in the literature posit the qubits as veritable toolboxes for preparing, manipulating and measuring quantum states of a nanomechanical resonator (or ‘nanoresonator’), and range from the nondestructive read-out of quantized-energy states (or ‘Fock states’) to the generation of Schrödinger-cat states. In an initial step toward implementing these advanced strategies, we have performed the first measurements of a nanoresonator coupled to a superconducting qubit, the Cooper-pair box (CPB). We find that the coupling produces a CPB-state-dependent shift in the frequency of the nanoresonator that is analogous to the single-atom phase shifts experienced by superconducting resonators in the dispersive limit of cavity quantum electrodynamics (CQED). In my talk, I will report on our latest measurements of the dispersive interaction between the CPB and nanoresonator, including how we utilize it to read-out quantum interference effects in the CPB. In the end, I will discuss how the interaction could soon be utilized for exploring the quantum limit of NEMS.