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Dynamics of a Nanomechanical Resonator Coupled to a Superconducting Single Electron Transistor[1] MILES BLENCOWE, Dartmouth College, JARA IMBERS, University of Nottingham, ANDREW ARMOUR, University of Nottingham — We present an analysis of the dynamics of a nanomechanical resonator coupled to a superconducting single electron transistor (SSET) in the vicinity of the Josephson quasiparticle (JQP) and double Josephson quasiparticle (DJQP) resonances. For weak coupling and wide separation of dynamical timescales, we find that for either superconducting resonances the dynamics of the resonator are given by a Fokker-Planck equation, i.e., the SSET behaves effectively as an equilibrium heat bath, characterised by an effective temperature, which also damps the resonator and renormalizes its frequency.Depending on the gate and drain-source voltage bias points with respect to the superconducting resonance, the SSET can also give rise to an instability in the mechanical resonator marked by negative damping and temperature within the appropriate Fokker-Planck equation. Furthermore, sufficiently close to a resonance, we find that the Fokker-Planck description breaks down. We also point out that there is a close analogy between coupling a nanomechanical resonator to a SSET in the vicinity of the JQP resonance and Doppler cooling of atoms by means of lasers.

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