Faithful conversion of propagating quantum bits to mechanical motion

A. P. Reed[a,b], K. H. Mayer[b], J. D. Teufel[c], L. Burkhart[d], W. Pfaff[d], M. Reagor[d], L. Sletten[a,b], X. Ma[a,b], R. J. Schoelkopf[d], and **K. W. Lehnert**[a]

[a]JILA, University of Colorado, Boulder CO, USA
[b]Physics Department, University of Colorado, Boulder CO, USA
[c]National Institute of Standards and Technology, Boulder CO, USA
[d]Applied Physics Department, Yale University, New Haven CT, USA

We endeavor to transduce quantum information between the microwave and optical domains—enabling a quantum communication network—by creating a quantum coherent interaction between a single micromechanical oscillator and microwave and optical fields. To this end, we present experiments that demonstrate and characterize the conversion of non-Gaussian states, namely superpositions of 0 and 1 photons encoded in propagating microwave fields, to the motion of a micromechanical resonator. We show that single photon states can be converted to single phonon states while maintaining a second order coherence below the classical bound. Furthermore we characterize the average fidelity of the microwave field to mechanical motion conversion process, finding an average fidelity in excess of 83%. This value exceeds 2/3, the maximum fidelity on any procedure using only classical communications and local operations, thus demonstrating that the process is a quantum channel.