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Parametric mechanical pumping in graphene membranes
ROBERTO DE ALBA, ISAAC STORCH, THANNIYIL SEBASTIAN ABHILASH, Department of Physics, Cornell University, FRANCESCO MASSEL, Department of Physics, University of Jyväskylä, PAUL L. MCEUEN, Department of Physics, Cornell University, HAROLD G. CRAIGHEAD, School of Applied & Engineering Physics, Cornell University, JEEVAK M. PARPIA, Department of Physics, Cornell University — We demonstrate tension-mediated mechanical mode coupling in suspended graphene membranes. These nonlinear effects arise due to graphene's large elastic modulus and large deflections. We show experimentally that these mode-mode interactions can be utilized to parametrically amplify or cool mechanical motion, and that the coupled system obeys similar physics to optical-cavity-coupled mechanical systems. This enables all-electrical parametric control of the resonator dynamics, including self-oscillation. Mechanical pumping can thus enhance the performance of graphene-based force sensors, or supplement traditional cooling schemes to probe coupled mechanical systems approaching the quantum regime.

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