NanoElectroMechanical Resonators based on graphene

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The theory of damping finds its roots in Newton's Principia and has been exhaustively tested in objects as disparate as the Foucault pendulum, mirrors used in gravitational-wave detectors, and submicron mechanical resonators. Owing to recent advances in nanotechnology it is now possible to explore damping in systems with transverse dimensions on the atomic scale. Here, we study the damping of mechanical resonators based on a graphene sheet, the ultimate two-dimensional nanoelectromechanical systems (NEMS). The damping is found to strongly depend on the amplitude of the motion; it is well described by a nonlinear force $\eta x^2 \dot{x}$ (with x the deflection and $\dot{x}$ its time derivative). This is in stark contrast to the linear damping paradigm valid for larger mechanical resonators. Besides, we exploit the nonlinear nature of the damping to improve the figure of merit of graphene resonators.