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Mechanical Nonlinearity in Graphene Resonators ISAAC STORCH, Department of Physics, Cornell University, Ithaca, New York 14853, USA, ROBERT BARTON, School of Applied and Engineering Physics, Cornell University, ROBERTO DE ALBA, Department of Physics, Cornell University, VIVEKANANDA ADIGA, HAROLD CRAIGHEAD, School of Applied and Engineering Physics, Cornell University, JEEVAK PARPIA, PAUL MCEUEN, Department of Physics, Cornell University; Kavli Institute at Cornell for Nanoscale Science, Ithaca, New York 14853, USA — Electromechanical resonators made from suspended graphene sheets show promise for many potential applications, including mass sensing, optomechanics, and tunable radio frequency electronics.[1,2,3] However, fundamental properties of these resonators, such as the strongly temperature dependent resonant frequency and quality factor, have yet to be understood. Measurements of mechanical nonlinearity can provide additional information about the properties of graphene membranes, including the modulus for stretching.[2,4] Here, we present careful studies of the nonlinear response of fully-clamped graphene resonators. We measure the coefficients of the cubic (Duffing) nonlinearity and nonlinear damping terms. We also discuss how these terms compare to expectations from elastic and entropic theories. These measurements increase our physical understanding of the mechanics of atomically thin membranes, and can help improve the performance of these novel electromechanical devices. [1] J. S. Bunch, et al., Science 315, 490 (2007) [2] C. Chen, et al., Nature Nanotechnology 4, 861-867 (2009) [3] R. A. Barton, et al., Nano Letters 12, 4681–4686 (2012) [4] A. Eichler, et al., Nature Nanotechnology 6, 339-342 (2011)

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