CO.CO.MAT

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Damping, coherence and control of high Q nanomechanical string resonators

Nanomechanical resonators are freely suspended, vibrating bridges with nanoscale diameters. These nanostructures are receiving an increasing amount of attention, both in fundamental experiments addressing the foundations of quantum mechanics and in sensing applications, and show great promise as linking elements in future hybrid nanosystems. A realization of this potential is however based on the development of not only nanomechanical systems of high mechanical quality factor but also suitable control techniques. Here I will review recent progress towards these goals, focussing on dielectrically controlled pre-stressed silicon nitride string resonators. Nanomechanical resonators fabricated from tensile-stressed silicon nitride have been known for their unusually high room temperature quality factors for several years. I will explore the origin of the large mechanical quality factor as well as the underlying dissipation mechanisms limiting the performance of the devices [1,2,3]. In addition I will address the dynamics of two strongly coupled nanomechanical modes which can be described as a classical two-mode system, adopting the well-known Bloch sphere picture. Analogous to the coherent control of two-level systems in atoms, spin ensembles or quantum bits, electromagnetic pulse techniques are employed to demonstrate full Bloch sphere control via Rabi, Ramsey and Hahn echo experiments [4]. Our experiments not only enable deep insights into the limiting mechanisms for decoherence in nanomechanics, but also open a pathway towards single phonon control after a series of ground-breaking experiments on ground state cooling and non-classical signatures of nanomechanical resonators in recent years.

[1] Q. P. Unterreithmeier et al., Phys. Rev. Lett. 105, 027205 (2010). [2] T. Faust et al., arXiv:1310.3671 (2013). [3] J. Rieger et al., Nature Communications (in press). [4] T. Faust et al., Nature Physics 9, 485 (2013).

25. Februar 2014, 11:00 Uhr

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