A phononic frequency comb from a single driven nonlinear nanomechanical mode

J. Ochs[1], D. Boneß[1], G. Rastelli[2], M. Seitner[1], M. Kallergi[1], W. Belzig[1], M. Dykman[3], E. M. Weig[1,4,5,6]

[1]*Department of Physics, University of Konstanz, 78457 Konstanz, Germany*
[2]*Pitaevskii Center on Bose-Einstein Condensation, CNR-INO and Dipartimento di Fisica dell'Università di Trento, Via Sommarive 14, 38123 Trento, Italy*
[3]*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824,USA*
[4]*Chair of Nano & Quantum Sensors, Department of Electrical Engineering, School of Computation, Information and Technology, Technical University of Munich, 85748 Garching, Germany*
[5]*Munich Center for Quantum Science and Technology (MCQST), 80799 Munich, Germany*
[6]*TUM Center for Quantum Engineering (ZQE), 85748 Garching, Germany*

Doubly-clamped nanostring resonators excel as high Q nanomechanical systems enabling room temperature quality factors of several 100,000 in the 10 MHz eigenfrequency range. Dielectric transduction via electrically induced gradient fields provides an integrated control scheme while retaining the large mechanical quality factor [1]. Dielectrically controlled nanostrings are an ideal testbed to explore a variety of dynamical phenomena ranging from multimode coupling to coherent control [2]. Here I will focus on the nonlinear dynamics of a single, resonantly driven mode. The broken time reversal symmetry gives rise to the squeezing of the string's fluctuations.

As a result of the high mechanical Q factor, the squeezing ratio is directly accessible from a spectral measurement [3]. It is encoded in the intensities of the two spectral peaks arising from the slow dynamics of the system in the rotating frame. For stronger driving, an onset of self-sustained oscillation is observed which leads to the generation of a nanomechanical frequency comb. The effect is a consequence of a resonantly induced negative effective friction force induced by the drive. This is the first observation of a frequency comb arising solely from a single mode and a single, resonant drive tone [4].

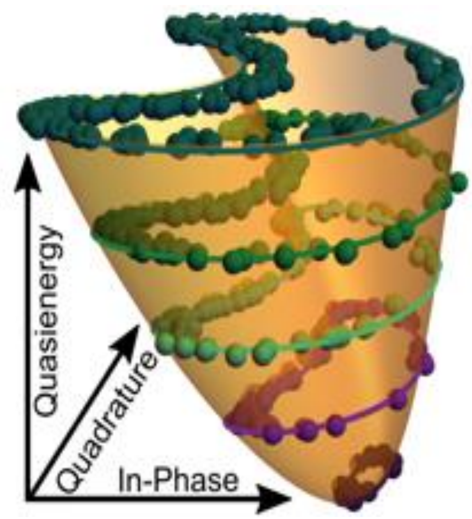

Fig. 1: *Nonsinusoidal limit cycles in the rotating frame of the resonantly driven nonlinear nanomechanical resonator induced by RIFF superimposed with the associated quasienergy surface. Each trajectory maps out a constant-quasienergy contour. With increasing drive power, the contour moves up in quasienergy, allowing to sample its entire surface.*

References:
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[2] T. Faust et al., Nature Physics **9**, 485 (2013)
[3] J. Huber et al., Phys. Rev. X **10**, 021066 (2020)
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