Ananth Venkatesan
IISER Mohali

Title: Low temperature Dissipation Phenomena in Micro and Nanomechanical systems.

Abstract:

Understanding and reducing dissipation [1] in micro and nanomechanical systems is pertinent from the viewpoint of building sensors to macroscopic quantum phenomena [2]. Devices of resonant frequency satisfying a rudimentary quantum condition $h\omega \gg k_B T$ (say few GHz at ~ 100 mK) alone are not contestants for quantum states. The mode temperature of few MHz resonators can also be reduced to reach a few quanta by squeezing the resonators with microwave photons in cavities [3]. In this lecture I will discuss different device platforms ranging from simple quartz crystals to nano-mechanical beams maxde out of silicon nitride or stand-alone metal films and various transduction schemes including microwave opto-mechanics.

Dissipation in linear response regime is modelled as a two-level quantum system will be discussed with examples from different device platforms [4]. I will be discussing examples of itinerant electrons or spin of electrons as well as topological objects like vortices in superconductors playing a role in dissipation in mechanical systems. We will also discuss some interesting phenomena in these systems in the non-linear response regime [5]. We will conclude with an overview of non-linear damping phenomena that may be due to a non-linear analogue of Akhiezer damping [6].

References:

1. V. B. Braginsky, V. P. Mitrofanov, and V. I. Panov “Systems with Small Dissipation” University of Chicago Press (1985)
2. Blencowe, M. “Quantum electromechanical systems.” Phys. Rep. 2004, 395, 159.
3. J D Teufel1, C A Regal and K W Lehnert “Prospects for cooling nanomechanical motion by coupling to a superconducting microwave resonator “New Journal of Physics, Volume 10, September 2008
4. M Imboden, P Mohanty “Dissipation in nanoelectromechanical systems” Physics Reports, 2014
5. Cross, M.; Lifshitz, R. In Review of Nonlinear Dynamics and Complexity; Schuster, H., Ed.; Wiley: New York, 2008; Chapter 1.
6. S. Kumar et.al “Temperature-Dependent Nonlinear Damping in Palladium Nanomechanical Resonators” Nano Lett. 2021, 21, 7, 2975–2981