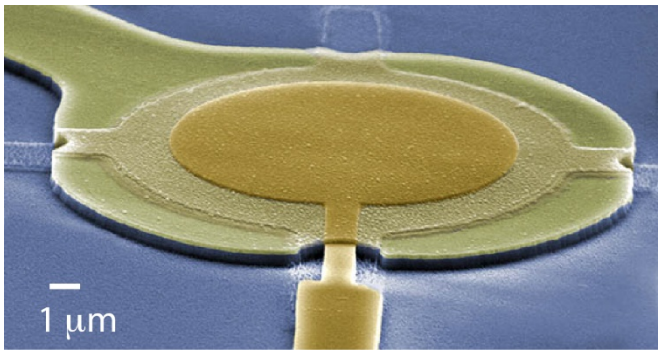
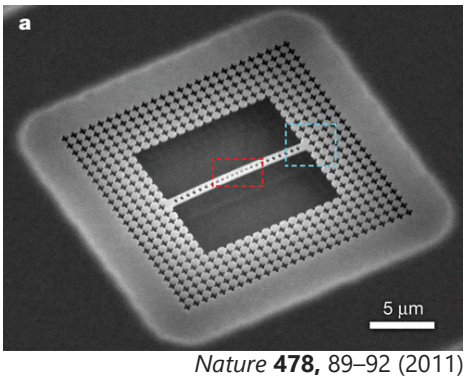
Phys 576 A: Nanomechanical resonators: precision measurements, optomechanics, and quantum computing



Credit: Mika Sillanpää



Nature **478,** 89–92 (2011)

This course is geared towards introducing the field of nanomechanics to early-career graduate students, with a focus on the breadth of contemporary applications. Students will learn fundamentals and survey the current state-of-the-art, learning how mechanical vibrations can be employed in studying fundamental physics and applied to quantum technologies. Topics include (~1 week/topic):

Precision measurements:

- Pushing the limits of force and mass detection
- Experimental tests of gravity (tests of collapse models and short-range corrections)
- Measurements beyond the standard quantum limit

Optomechanics:

- Optical cooling – analogies to cold atoms
- Nonlinear optomechanical effects (synchronization, frequency combs etc.)
- Single photon optomechanics (strong/ultra-strong coupling regime)

Quantum Computing:

- Nanomechanical Qubits
- Resonators as quantum memory elements
- Coupling to charge-based qubits

The course will be split between lectures on fundamental concepts and presentations on contemporary research articles by students (or teams of students based on enrollment).

The overarching goal of the course is to introduce students to a wide range of applications of nanomechanical resonators and help develop their intuition on how mechanical degrees of freedom couple with electrons and photons. Aside from the course content, additional learning goals include strengthening students' skills in literature review and oral presentations. The course is suitable for Physics, ECE, and ME students, among others.