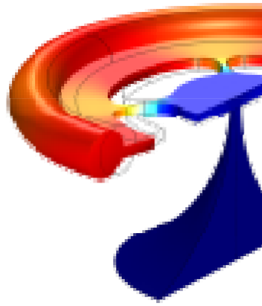
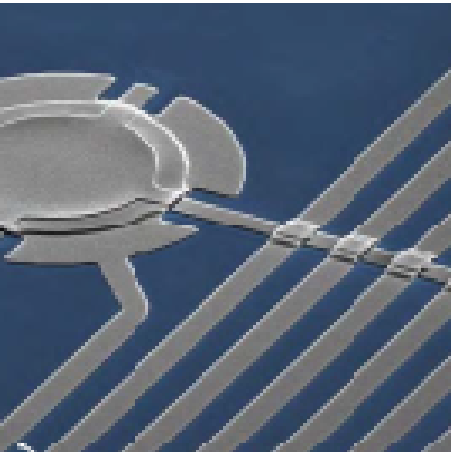
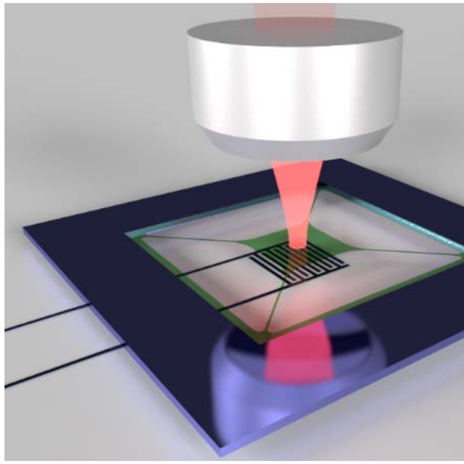



Quantum Optomechanics and Nanomechanics

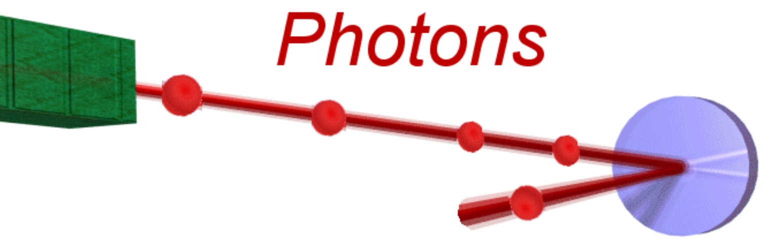
Pierre-François Cohadon – Samuel Deléglise

adiation pressure

- XVIIe siècle (Huygens) : “la queue des comètes pointe toujours dan direction oppose au soleil”

- Today: important effect in interferometric measurements
  - Orders of magnitude for 1 W:



$$F_{\mathrm{rad}}(t) = 2\hbar k \times I(t)$$

= momentum exchange at every reflection

Induces spurious mirror displacements

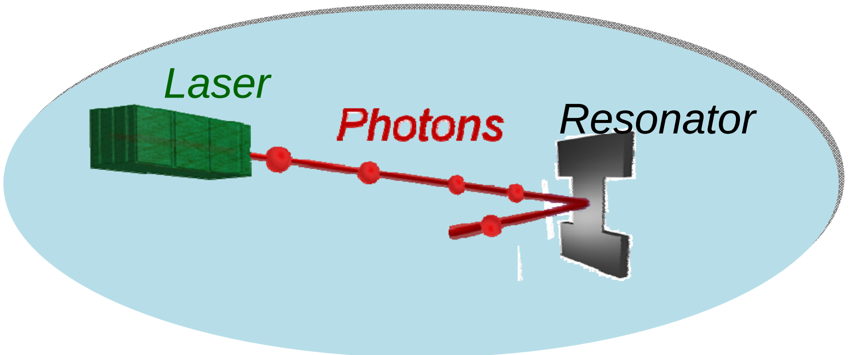
In agreement with basic concepts of quantum measurement:

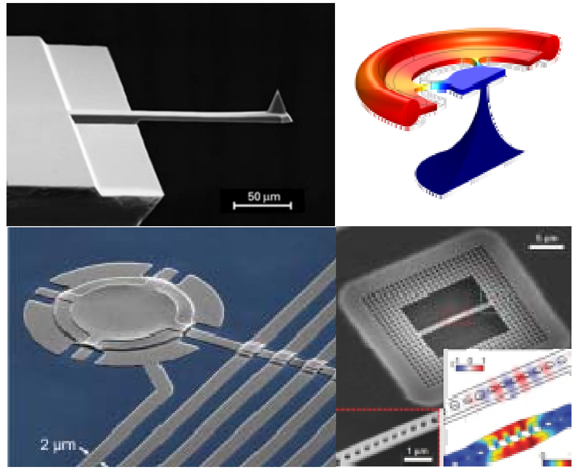
The measurement disturbs the object which is measured!

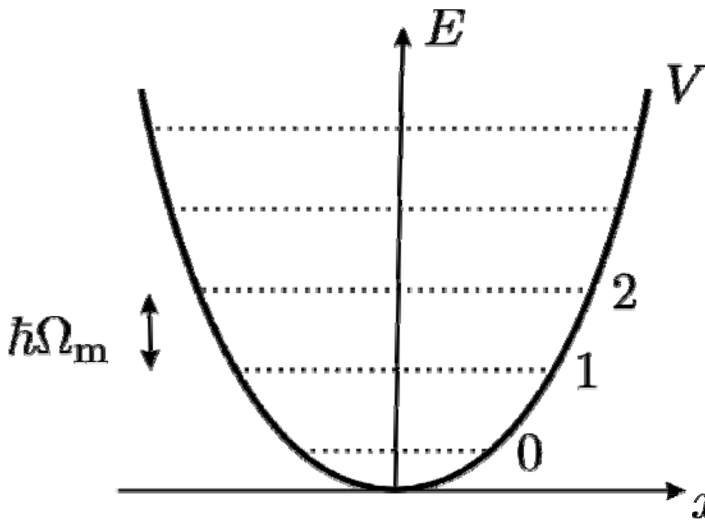
ptomechanical coupling

uantum limits in interferometers

Resource to control the quantum state of micromechanical resonato



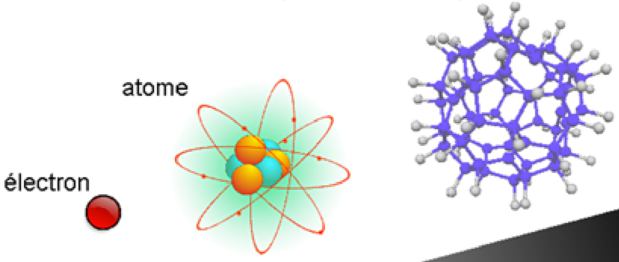




emonstrating the quantum behavior of macroscopic objects

ter la mécanique quantique
c des objets macroscopiques

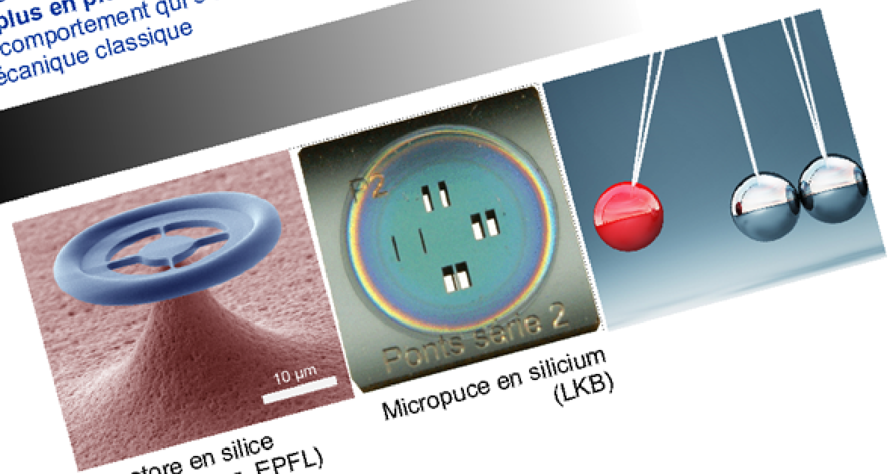
Fullérène $C_{60}F_{48}$
(M. Arndt, Vienne)



Deux approches complémentaires

?

«Top-down»
On étudie le comportement mécanique de résonateurs (pendules, oscillateurs...) **de plus en plus petits**, pour mettre en évidence un comportement qui s'écarte des lois de la mécanique classique



Microtore en silice
(T. Kippenberg, EPFL)

Micropuce en silicium
(LKB)

«Bottom-up»
On réalise des expériences typiques des systèmes microscopiques avec **des systèmes de plus en plus gros** : électrons, atomes, molécules...

Un des résonateurs étudiés au LKB :
un **micropilier en quartz** de 1 mm,
oscillant 3 millions de fois par seconde

echanical resonators as a resource for quantum information

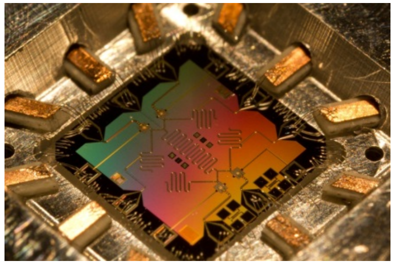
Quantum computation

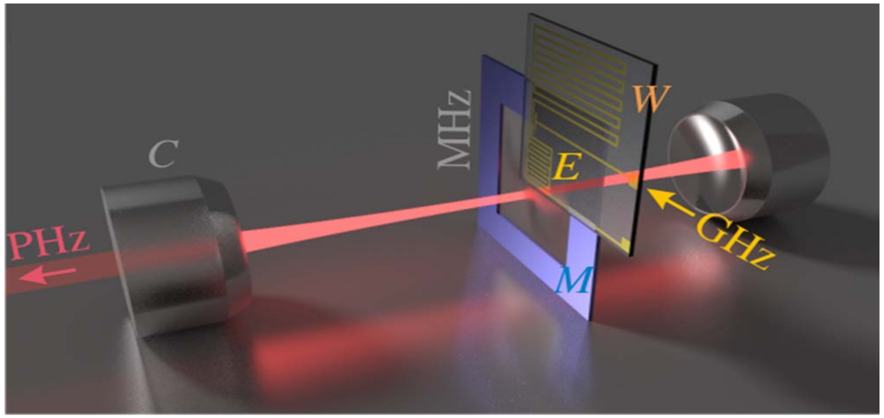
Superconducting circuits

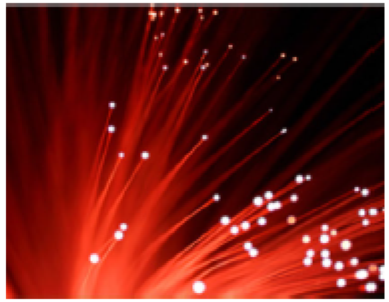
μ-wave photons (GHz) ⟷ **Transducer** ⟷ optical photons (PHz)

Coherent transport

Optical fibers







Opto-Electro-Mechanical
hybrid system

utline of the course

1. Nanomechanics: microfabrication, simulation, mechanical losses at the nanoscale

2. Introduction to noise in physical measurements

3. Quantum noise, homodyne detection, Quantum-Non-Demolition measurements

4. Manipulating the quantum noise

5. Quantum and classical backaction in optomechanical systems

6. Squeezed state generation

7. Hamiltonian formulation of optomechanics

8. Microwave optomechanical systems

9. Quantum Information, Entanglement

10. Phononic and photonic crystals