Abstract Title

Experimental strategies in detection of small displacements at nanoscale.

Symposium Track

Experimental Techniques in Nanomechanics

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Abstract body

Measurements of non contact forces between interacting surfaces meet nowadays a large interest due to the capability of MEMS and NEMS preparation. Surfaces separated by gap of 100nm or less can interact through thermal effects, radiation pressure including coupling through evanescent waves, Casimir force, electrostatic and magnetic interactions... These forces usually depend on the electronic properties of surfaces and on the surface structure at the nanoscale (plasma length of gold is typically 136nm).

Quantitative measurement of non contact interactions between surfaces faces some severe difficulties:

- These forces can spatially vary over many orders of magnitude on hundreds of nanometers. A consequence is that a reasonable detection level at large distance is hardly compatible with mechanical stability at short distances.
- Important noises inherent to the coupling with the external world (1/f, temperature, back action...) linked with dissipation

Measurements on real micro/nanosystems at room temperature have led many groups to build specific force machines and to apply unusual measurement strategies. Here we shall first describe as an example the measured interplay between Casimir force and Brownian motion, then the changes in the lever damping induced by electromechanical coupling. Second, "home made" force machines based on a Fabry Pérot cavity will be presented that are used to investigate light mechanical effects from visible to X ray: bolometric effect, Casimir force and radiation pressure. Finally we shall describe a measurement method that could be considered for spatially rapidly varying forces based on cold damping techniques. Cold damping means here damping through an external feedback loop of the thermal fluctuations. It is illustrated in the figure below: the spectral density of displacement is measured at a mechanical resonance of an AFM cantilever. The temperature associated with this particular resonance mode decreases from 300K down to 30K as the loop gain is increased.

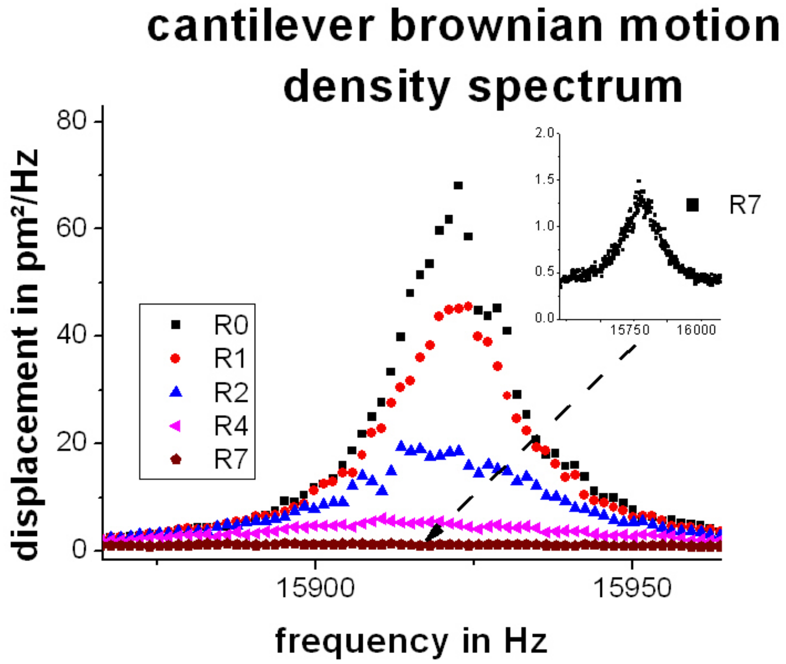

Figure caption: A fast capacitive actuation driven by a feedback loop based on the cantilever speed progressively cancels the thermal fluctuations as the loop gain is increased.

Keywords

Nanopositionning, force detection, cold damping, mechanical effect of light

References

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