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Société Française de Physique

"Vibrations of mechanical nano-resonators: detection, modeling and applications"

1. Organisateurs (avec affiliation, usuellement 2 ou 3 personnes) :

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2. Parrainage ou lien avec des sociétés savantes, des GDR ou autres structures :

La thématique de ce mini-colloque est en lien avec celles des GDRs Ultrafast Phenomena, Or Nano, Active Plasmonics, et du Groupe Français de Spectroscopie Vibrationnelle.

3. Résumé de la thématique du minicolloque :

Nano-objects present localized vibrational modes with high frequencies (in the GHz-THz range), whose intrinsic properties (frequencies, damping rates and displacement fields) are strongly related to their size, shape, crystallinity and environment. The vibrations of such mechanical nano-resonators are usually detected by optical spectroscopy techniques working either in the time or spectral domain, and modeled using continuum or atomistic approaches, depending on the size of the considered system. Since the pioneering measurements on glass-embedded nanoparticles which demonstrated that the vibrational frequencies of nano-resonators inversely scale with their size, as predicted by the laws of continuum mechanics,[1] a lot of studies have addressed the effects of nano-resonator size, shape, crystallinity, environment, and coupling by optical experiments on nanoparticle assemblies.[2] More recently, it has become possible to detect the vibrational modes of individual nanosystems, allowing in particular a more detailed investigation of their damping and of their impact on the optical response of the nanosystems, at the heart of their optical detection. Additionally, new techniques have recently appeared for detecting the vibrational modes of nano-objects, based for instance on the use of X-rays and THz photons and electrons. Modern fabrication techniques now allow the synthesis of ultrasmall nanoparticles and various nanostructured materials (including phononic crystals and metasurfaces) which are used in an increasing number of vibration-based applications, such as ultrasensitive mass sensing and biological sensing and imaging.[3,4] In this context, a better understanding of the laws governing elasticity, sound attenuation and vibrational coupling at the nanoscale becomes increasingly crucial.
The mini-colloquium **"Vibrations of mechanical nano-resonators: detection, modeling and applications"** aims at bringing together members of different communities whose common ground is the study of vibrations at the nanoscale. The current open scientific questions in the field will be highlighted, as well as the innovative strategies recently developed to study mechanical nano-resonators and exploit them for applications. Young researchers will be encouraged to present their work. This mini-colloquium will also be an opportunity to federate a growing community around the vibrations of nano-objects and their potential applications.

Figure (optionnelle)

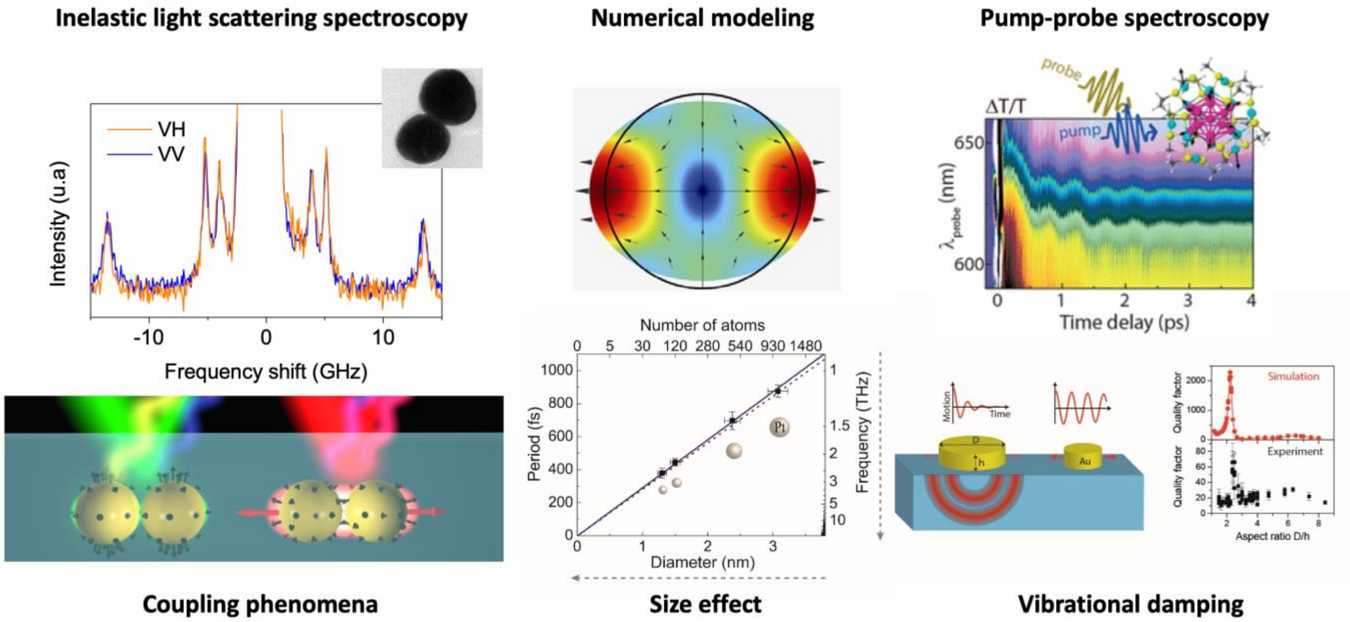

Figure: Some tools and scientific questions associated to the study of mechanical nano-resonators.

Références :

(1) Duval, E.; Boukenter, A.; Champagnon, B. Vibration Eigenmodes and Size of Microcrystallites in Glass: Observation by Very-Low-Frequency Raman Scattering. *Phys. Rev. Lett.* **1986**, *56* (19), 2052–2055. https://doi.org/10.1103/PhysRevLett.56.2052.

(2) Crut, A.; Maioli, P.; Del Fatti, N.; Vallée, F. Acoustic Vibrations of Metal Nano-Objects: Time-Domain Investigations. *Phys. Rep.* **2015**, *549*, 1–43. https://doi.org/10.1016/j.physrep.2014.09.004.

(3) Gil-Santos, E.; Ruz, J. J.; Malvar, O.; Favero, I.; Lemaître, A.; Kosaka, P. M.; García-López, S.; Calleja, M.; Tamayo, J. Optomechanical Detection of Vibration Modes of a Single Bacterium. *Nat. Nanotechnol.* **2020**. https://doi.org/10.1038/s41565-020-0672-y.

(4) Raanan, D.; Audier, X.; Shivkumar, S.; Asher, M.; Menahem, M.; Yaffe, O.; Forget, N.; Rigneault, H.; Oron, D. Sub-Second Hyper-Spectral Low-Frequency Vibrational Imaging via Impulsive Raman Excitation. *Opt. Lett.* **2019**, *44* (21), 5153. https://doi.org/10.1364/ol.44.005153.