Minicolloque n° PMQ 29 **□ Oral**

Plasmonic magnification of optomechanical coupling

Thomas Antoni[a*], Kévin Makles[b], Clément Chardin[b] et Pierre Verlot[b]

a. Université Paris-Saclay, CNRS, ENS Paris-Saclay, CentraleSupélec, LuMIn, 91190, Gif-sur-Yvette, France.
b. School of Physics and Astronomy, The University of Nottingham, University Park, Nottingham NG7 2RD, United Kingdom.

* email : thomas.antoni@centralesupelec.fr

The possibility to remotely detect individual nano-objects in situ still is a physical challenge that restrains the development of promising applications especially to biology where particles evolve in a microfluidic environment. In this work we numerically investigate the case where a metallic nano-particle is transported in a microtube channel and propose a high precision method based on the coupling of the optical field supported by the particle and the mechanical vibration of the channel. We quantified the change in the optomechanical force experienced by the microtube as the particle circulates. We show that this effect holds for any size of particle even when scattering is negligible.

We considered a borosilicate glass tube of outer diameter 0.5 µm and inner radius 0.375 µm where spherical gold nanoparticles (NPs) travel in water. The system is illuminated by laser beam focused closely from the tube. It is well known that, because of plasmon resonance, the optical behavior of nanosize metallic particles can be either diffusive or absorbent strongly depending on their dimension. For this reason we considered three different radii: 150 nm, 50 nm or 25 nm travel. Indeed, it can ben computed [1] that for the largest of these value scattering dominates when absorption does for the smallest at the considered wavelength. This system combines numerous and in addition coupled electromagnetic phenomena: diffraction from the tube, lensing due to water, surface plasmon, absorption and diffusion of the NP that prevent any derivation of an analytical model. Hence, we opt for a numerical approach, to be able to catch the dynamic of the system we chose a finite-difference time-domain (FDTD) method using the open-source software package MEEP [2] (Figure 1).

From that we have been able that with an incident power of 1 W the motion of the particle in the tube generated a mechanical force shift on the order of 1 nN.

[1] K. Metwally, S. Mensah, and G. Baffou. The Journal of Physical Chemistry C, **119**(51):28586–28596, 2015.
[2] A. F. Oskooi, D. Roundy, M. Ibanescu, P. Bermel, J.D. Joannopoulos, and S. G. Johnson. Computer Physics Communications, **181**(3):687 – 702, 2010.

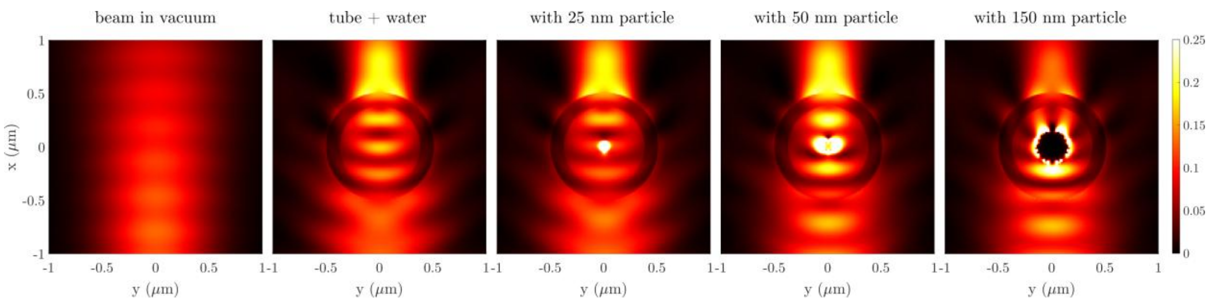

Figure 1 : Cross-section of optical intensity distribution in the z=0 plane averaged on half a period. The source is y-polarized. Note that the oscillations - particularly visible on the left panel - are a numerical artifact due to temporal discretization.