Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

Jeudi 10 décembre

10h00
Centre de Nanosciences et de Nanotechnologies
10 boulevard Thomas Gobert
91120 Palaiseau
Amphithéâtre

Guilhem MADIOT

“ Coherent modulation in coupled electro-optomechanical photonic crystal resonators: Floquet dynamics and chaos”

Lien public : https://u-paris.zoom.us/j/89075316010?pwd=Uk4rQkdtVVAwV08rUTNBYmY5cW02UT09

Jury members :

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Abstract :

Nanomechanical systems are useful to inspect some fundamental aspects of physics such as the relations between the elastic, thermal and electromagnetic properties of solid-state objects. When interacting with an optical cavity or coupled to an electrostatic actuator, these systems can be studied in the wide topic of electro-optomechanics. This work takes advantage of photonic crystal versatility to investigate the nonlinear optical and mechanical dynamics of such electro- or optomechanical systems under coherent modulation.
The first experiments use a nanophotonic platform combining a suspended InP membrane and an underneath integrated silicon waveguide. The membrane is etched with a 2D photonic molecule whose electromagnetic eigenmodes can be driven with a laser thus enabling a sensitive access to the mechanical noise spectrum of the membrane. Using a coherent modulation of the input laser field, we show that the input modulation sidebands are transferred to the mechanical frequency domain via the optomechanical interactions. The presence of thermo-optic nonlinearities further leads to a desymmetrization of these spectral patterns, thus suggesting the use of modulation to parametrically amplify and even synchronize several mechanical modes.
In a second part, we study two mechanically coupled electro-optomechanical nanocavities. The bistable mechanical responses evidence the strong intrinsic Duffing nonlinearities of the material. In this context, the use of coherent modulation of the input force reveals interesting period-doubling cascade route to chaos dynamics. The simultaneous excitation of both normal modes in their nonlinear regime allows them to couple such that the normal mode responses, although chaotic, can synchronize. As chaotic systems can be used to generate random numbers, this bichromatic synchronized chaotic dynamics could be exploited in novel multispectral data encryption protocols.