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Coherent Perfect Absorption in coupled Nano-Opto-ElectroMechanical Systems

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Coupled nano-opto-electromechanical systems (NOEMS) are ideal platform to test physical concepts applied to mechanics. Large amount of various photonic structures able to couple to external fields were used to exhibit coherent perfect absorption (CPA) [1-3].

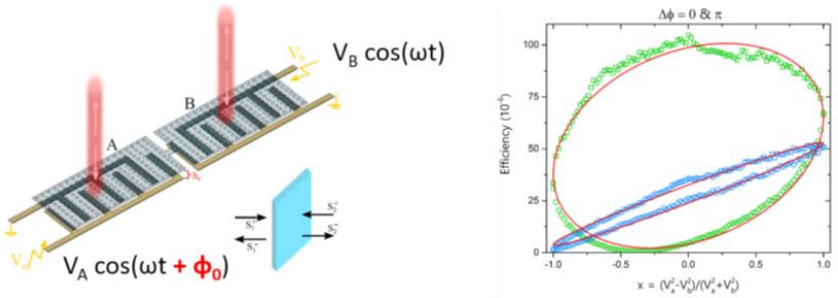

Figure 1 : (left) Schematic view of the experimental set-up. (Right) Coherent absorption control in a linear two-port system (experiment and fit).

We hereby introduce our recent results on mechanical-like coherent perfect absorption (and transmission) phenomenon in a coupled nano-opto-electromechanical system. It consists in two mechanically coupled optomechanical cavities (Fig. 1), each cavity consisting of a membrane suspended over a pair of integrated interdigitated electrodes. On one hand, electromechanical transduction allows us to convert electrical energy injected into the system into mechanical displacements. On the other hand, optomechanical transduction enables to detect the system's displacements in the form of mechanical eigenmodes of the coupled NOEMS. When coherently exciting both cavities with two identical excitations whose phase difference and amplitudes are controllably varied (Fig. 1), it is possible to observe a modulation of the mechanical response which is found to be enhanced or lowered. This is completely analogous to how absorption (or transmission) behaves in a photonic structure [4]. This variation is well understood and modelled by analytic forms or via the mechanical dynamics equations of our system. Applications in optics pave the way for the NOEMS scheme that can for now deal with astonishing physics e.g. realization of optical switches, logical gates or polariton states to name a few.

[1] N. Gutman et al., Optics Letters, vol. 38, no. 23, pp. 4970-4973 (2013).
[2] Papaioannou et al., Light: Science and Applications, 5, e16070 (2016).
[3] Baranov et al, Nature Reviews Materials, 2, 17064 (2017).
[4] Baldacci et al, Life, New Materials and Plasmonics, 26, pp. 219-230 (2015).