Electro-optomechanical modulation instability in a semiconductor resonator

Allain Pierre[1], Guha Biswarup[1], Baker Christophe[1], Lemaître Aristide[2], Leo Giuseppe[1], Favero Ivan[1]

[1] Matériaux et Phénomènes Quantiques, Université de Paris, CNRS, 75013 Paris
[2] Centre de Nanosciences et Nanotechnologies, Université Paris-Saclay, CNRS, 91120 Palaiseau
ivan.favero@u-paris.fr

In an optomechanical resonator, a mechanically compliant device is coupled to an optical field trapped in a cavity. The mechanical motion of the device modulates the optical field, while the light stored in the cavity exerts a force on the mechanical body, for example through radiation pressure. This mutual coupling is in essence non-linear, but most experiments in optomechanics have been realized in a linearized regime [1,2]. In semiconductor resonators in contrast, several forms of light-matter interaction can enrich this conventional optomechanics phenomenology, and give rise to new dynamical regimes. Here we observe an electro-optomechanical modulation instability in a Gallium Arsenide disk resonator [3]. The regime is evidenced by the concomitant formation of regular and dense combs both in the optical and radio-frequency spectrum of the resonator, associated to a permanent pulsatory dynamics of both the mechanical motion and the optical intensity. The mutual coupling between light, mechanical oscillations, carriers and heat generated within the resonator, stabilizes an extended mechanical comb in the ultra-high frequency range, which is controlled optically. We develop a model of four coupled differential equations to describe this behavior (see Figure 1), whose parameters are measured independently.

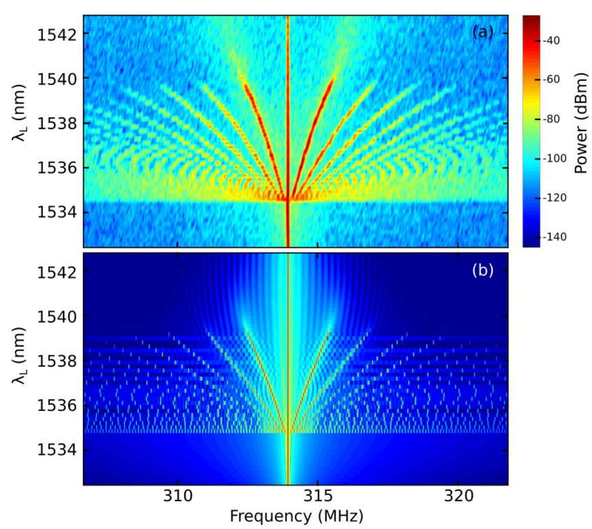

Figure 1. Radio-frequency spectrum of the resonator's output light, showing the formation of a comb around its mechanical eigenfrequency as function of the input laser wavelength. (a) Experiment. (b) Model.

Références

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