ID de Contribution: **154** Type: **Contribution orale**

Electro-OptoMechanical Modulation Instability in a Semiconductor Resonator

lundi 3 juillet 2023 18:25 (15 minutes)

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. This mutual coupling is non-linear, albeit most experiments in optomechanics have been realized in a linearized regime. 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 [1]. The regime is evidenced by the concomitant formation of regular 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.To explain this phenomenon, we develop a model of mutual coupling between light, mechanical oscillations, carriers and heat generated within the resonator leading to four coupled differential equations, whose parameters were measured independently. We discuss the perspectives of such mechanical comb controlled by light.

[1] P. Allain, B. Guha, C. Baker, D. Parrain, A. Lemaître, G. Leo, I. Favero, Physical Review Letters,126, 243901(2021)

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Classification de Session: Mini-colloques: MC18 Cinquante années de solitons dans les fibres optiques

Classification de thématique: MC18 Cinquante années de solitons dans les fibres optiques