



Contribution ID: 18

Type: Oral

Two-membrane cavity optomechanics

Monday, 28 September 2020 14:45 (15 minutes)

The optomechanical behaviour of a driven high finesse Fabry-Pérot cavity containing two vibrating dielectric Si₃N₄ membranes will be presented. The presence of the second membrane inside the optical cavity enhances the optomechanical coupling making this system interesting to reach the strong-coupling regime [1-2]. Moreover, the presence of two optical resonators provides the opportunity to couple mechanical resonators with very similar frequencies. This paved the way to the realization of an efficient state transfer and even entanglement between the mechanical oscillators. Multi-element systems of micro/nano-mechanical resonators offer promising prospects for exploring multi-oscillators synchronization [3-5]. The first experimental characterization of the optical, mechanical, and especially optomechanical properties of a sandwich constituted of two parallel membranes within an optical cavity will be reported. We find that the optomechanical coupling strength is enhanced by constructive interference when the two membranes are positioned to form an inner cavity which is resonant with the driving field. Specifically, we determine a gain of ~ 2.47 in the coupling strength of the relative mechanical motion with respect to the single membrane configuration [3]. Finally, the behaviour of the non-linear dynamics of such a system in a pre-synchronization regime where both large and small amplitude resonator motions are transduced in a nontrivial way by the non-linear response of the optical probe beam, will be discussed [5].

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Presenter: PIERGENTILI, Paolo (University of Camerino)

Session Classification: Invited