CONSIGLIO NAZIONALE DELLE RICERCHE
ISTITUTO NAZIONALE DI OTTICA

AVVISO DI SEMINARIO

Il giorno venerdi 6 ottobre 2017 alle ore 11,00

presso l'Area della Ricerca CNR di Pisa, Aula 33, piano Terra, Edificio "A"

il Dr. ***Nicola MALOSSI***

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terrà un seminario sul tema:

Bandwidth limit and sensitivity of a multi-mode opto-electro-mechanical transducer

Nanomechanical resonators have been suggested for testing fundamental theories (quantum gravity) [1,2] and for quantum-limited sensing [3,4]. Moreover they may be coupled to many different degrees of freedoms and therefore they can be employed to transduce signals from different frequency domains with high efficiency, both in the classical and in the quantum domain. In recent years, electro-opto-mechanical systems have shown a fast and impressive development and lately they entered the quantum regime where quantum state of nanogram-size mechanical oscillator and/or electromagnetic field has been generated and manipulated. In this context they show to be a good candidate to develop quantum hybrid system. Reversible transduction between radiofrequency/microwave (RF/MW) domain and the optical domain is nowadays particular relevant both for quantum and classical communication and can be exploited to reach high sensitivity detection of weak RF/MW signals thanks to the fact the homodyne detection of laser light can be quantum noise limited [5].
In this context studying and developing devices, aiming to increase the detection sensitivity and/or the transduction bandwidth are of fundamental importance for increasing the overall efficiency of those systems. In this seminar the recent experimental results obtained with an opto-electro-mechanical system by the Quantum Optics and Cryogenics Group in Camerino are presented. We developed a first generation of room temperature mechanical transducer, exploiting the capacitive coupling between a 50nm thick metalized Silicon Nitride (SiN) membrane, and a pair of electrodes, which essentially form a capacitance modulated by the oscillation of the nanomechanical oscillator. The modulated capacitance is connected to an inductance forming an LC-oscillator. We detect the SiN oscillator mode through homodyne detection. If the LC oscillator frequency match a mechanical eigenmode frequency, we obtain an highly efficient electro-mechanical device, that is an RF signal would force the mechanical oscillator and the effect could be detected in the optical range. We show that one possible strategy to increase the bandwidth of the transducer is to exploit the constructive interference that could rise between two RF-to-optical transducer formed by two close mechanical modes. In the specific, we realize a prove of principle device, obtaining a detection sensitivity of around 400nV/Hz with 15khz bandwidth and a central frequency (RF/mechanical) of 382kHz, at room temperature. The performance of the device at cryogenic temperature will be discussed.

1. I. Pikovski, et al., **Nat. Phys. 8, 393 (2012).**
2. M. Bawaj, et al., **Nat. Commun. 6, 7503 (2015).**
3. J. Chaste, et al., **Nature Nanotech. 7, 301 (2012**).
4. C. B. M_ller, et al., **Nature (London) 547, 191 (2017**).
5. T. Bagci, et al., **Nature (London) 507, 81 (2013)**.