Nanoscale optomechanical resonators for microwave applications

Optomechanical resonators combine mechanical and optical resonators coupled by a nonlinear interaction, resulting in self-sustained oscillations. Optomechanical crystals are their nanoscale counterpart, whereby the operating optical power scales down with size dramatically. This has opened prospects for a wide range of applications, from sensing to quantum computing. In this talk, we will consider recent progress in the technology and the physics of nanoscale optomechanical resonators, from the standpoint of applications and with a particular focus on microwave photonics.

Microwave photonics relies on optical communication channels to transfer and process microwave signals, such as those found in RADAR or other large analog electronic systems. Here, a fundamental functionality is that of a local oscillator, namely a generator of a spectrally pure tone, which is used for signal modulation and demodulation, frequency conversion and many other tasks. The conventional approach is based on quartz resonators or more recently on nano-electromechanical oscillators modulating an optical carrier after amplification and frequency upscaling. A different approach will be discussed, whereby optomechanical oscillators are introduced in the context of a microwave photonic system, hence leveraging on the direct generation of of high frequency pure microwave tones in the optical domain. A central question this talk will attempt to provide an answer to is what level of performances are achievable and whether the trade-off between size and performance is favorable to this revolutionary approach.

To this purpose, I will give a brief overview of the functions of interest of Microwave Photonics that could harness on optomechanics, e.g. microwave to optics transduction, on-chip signal processing, direct high frequency carrier generation and we will introduce relevant metrics. Among these, a central aspect is phase noise, on which a strong focus will be given, in particular by analyzing its sources.

Ultimately, this talk intends to build a bridge between the performances of optomechanical oscillators as highlighted in the literature and the expected key figures of merit of RADAR systems to help understand the road ahead.