Optomechanical metamaterials for room temperature THz detection

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The THz spectral domain (1-20 THz) has numerous applications in spectroscopy, gas sensing, security screening, and imaging, and is even seen as the next frontier for wireless communications [1, 2]. Compact and powerful sources of THz radiations, such as quantum cascade lasers are now available, and they deliver more than 10mW in continuous wave, even if they are constrained to operate at cryogenic temperatures (< 50 K). On the other hand, the detection in the THz domain is a notoriously difficult problem, owe to the large photon wavelengths involved. Indeed, neither of the existing commercial THz detectors, such as bolometers or Golay cells, are altogether sensitive, fast and room temperature [3]. These issues can be tackled by adopting completely novel approaches for the electromagnetic confinement in the detector, inspired from the recent progress of electromagnetic metamaterials [4]. In this approach, engineered metamaterial resonators are used to provide highly sub-wavelength confinement of the electromagnetic field, and direct THz photons into detector absorbers with high efficiency.
We will report on a THz metamaterial resonator is upgraded with a mechanical element, enabling a nanoscale optomechanical coupling. This system has two mechanism of operation: photo-thermal, based on the THz Eddy currents induced in the resonator, and an electro-mechanical coupling, that exploits the highly sub-wavelength confinement in the resonator. Both these approaches allow detection at room temperature with high speed, with sensitivities that can potentially reach those of commercial semiconductor bolometers operating at cryogenic temperatures [5].

References:

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