Excitonic Optomechanics in a GaAs System

Hajime Okamoto[1], Takayuki Watanabe[1,2], Ryuichi Ohta[1], Koji Onomitsu[1], Hideki Gotoh[1], Tetsuomi Sogawa[1], and Hiroshi Yamaguchi[1,2],
[1]NTT Basic Research Laboratories, [2]Tohoku University

Optical control of micro/nano-mechanical resonators has been widely demonstrated via cavity-enhanced radiation pressure or photothermal backaction [1,2]. Such cavity optomechanics allow highly tunable manipulation of a mechanical (phonon) resonator by photons. However, it cannot be straightforwardly extended to integrated mechanical systems because it needs delicate cavity operation, including tapered-fiber access and coupling adjustment. Thus, an alternative cavity-free approach is highly demanded in order to practically apply the optical control capability to integrated micro/nano-mechanical systems, such as mechanical circuits and sensor arrays. In this talk, we present cavity-free optomechanical coupling in a GaAs microcantilever system, which is induced by excitonic transitions through opto-piezoelectric backaction [3,4]. The opto-piezoelectric backaction from the bound electron-hole pairs, i.e. excitons, enables us to probe the optical transition simply with a sub-nanowatt power of light [4] and thereby realize high-sensitivity optomechanical spectroscopy. Detuning the photon energy from the exciton resonance results in self-feedback cooling and amplification of the thermomechanical motion [4], which is in a manner similar to the conventional cavity optomechanics. This cavity-free optomechanical coupling enables highly tunable and addressable control of micro/nano-mechanical resonators, allowing high-speed programmable manipulation of mechanical devices and sensor arrays.

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