Minicolloque n° 29 **x Oral** **☐ Poster**

Inducing micromechanical motion by optical excitation of a single quantum dot

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In this work, we use an hybrid system, made of a vibrating wire of mass and a semi-conductor quantum dot (QD) coupled via strain. A few years ago, some of us have shown that the energy of the QD depends on the strain generated by the wire oscillations [1]. We demonstrate here the reverse effect [2], whereby the wire is set in oscillation by the resonant drive of the QD by a laser modulated at the mechanical frequency (400 kHz). State-dependent strain then results in a time-dependent mechanical force that actuates microwire motion [3]. In principle, this state-dependent force could constitute a strategy to coherently encode the quantum dot quantum state onto a mechanical degree of freedom.

References

[1] I. Yeo et al, Nature Nanotech **9**, 106 (2014)
[2] A. Auffèves and M. Richard, Phys. Rev. A 90, 023818 (2014)]
[3] J. Kettler et al, Nature Nanotech **16**, 283–287 (2021)

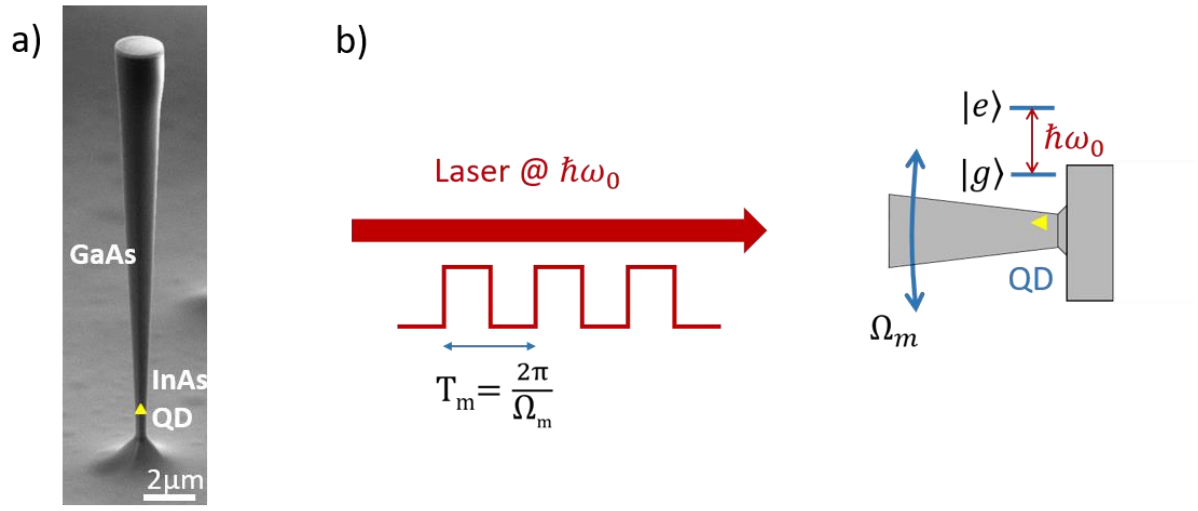

Figure 1 : a) Scanning electron microscope image of the GaAs photonic wire. The approximate position of the InAs QD is marked by a yellow triangle. b) Principle of the experiment. The QD is illuminated by a laser resonant with its optical transition at $\hbar\omega_0$. The laser intensity is modulated at the wire mechanical frequency $\Omega_m/2\pi$, and the wire motion is measured as a function of the laser detuning with respect to the QD transition.