PMQ29 **x Oral** **Poster**

Optomechanical sensors for noise and quantum thermometry

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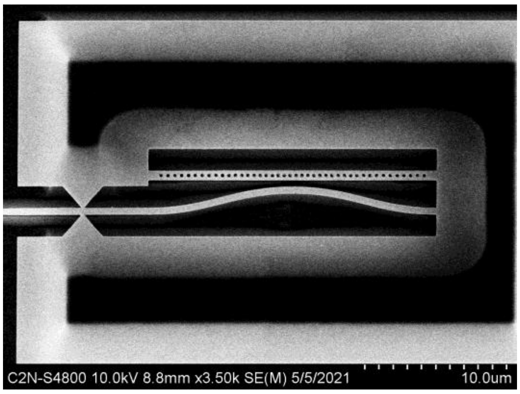
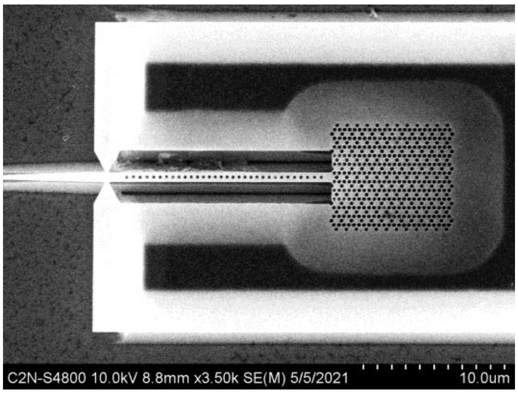
Temperature is probably the most important physical variable of state, influencing a wide range of natural processes. In the redefinition of the International System of Units, the new definition of the kelvin uses energy equivalent and now relies directly on the exact values of the Boltzmann and Planck constants. This opens up new opportunities for realizing and disseminating thermodynamic temperature, especially through the development of long-term practical primary thermometry based on quantum mechanism. In this context, we develop an innovative temperature sensor using quantum technologies. The device is based on optomechanical systems combined with quantum measurements techniques that allow one to directly compare thermal fluctuations of a resonator with its quantum noise at low temperature. With the benefit of this quantum calibration the temperature range of the sensor could be further extended up to room temperature using relative noise thermometry.





The device is a 1D optomechanical crystal allowing the co-localization of a 10^4 quality factor optical mode at 1550 nm and ~ 3 GHz frequency mechanical mode with quality factors on the order of 10^3. The test bench uses a circulating Helium cryostat equipped with metrological resistive thermometer. The relative temperature measurement is achieved by measuring the noise density of the calibrated Brownian motion of the resonator imprinted on the optical probe as phase fluctuations[1]. The temperature is then inferred from the equipartition theorem. The absolute quantum thermometry will rely on the fundamental interaction between the optical field and mechanical motion via the radiation pressure[2]. The resulting quantum correlations, only determined by fundamental constants, will be used to scale the thermally induced mechanical vibrations[3][4].

[1] X. Chen et al., Light: Science & Applications, vol. 6, pp. e16190, (2017).
[2] Y. Hadjar et al., Europhys. Lett, vol. 47 (5), pp. 545-551 (1999).
[3] T. P. Purdy et al., Science 23, vol. 356, Issue 6344, pp. 1265-1268, (2017).
[4] T. P. Purdy et al., Phys. Rev. A 92, vol. 92, Issue 031802 (2015).