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Poor Q-factor? - no problem: nano-optomechanical mass sensing in ambient conditions

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It has been demonstrated that optimum dynamic range (DR) and high quality factor (Q) of NEMS resonators provides unprecedented mass sensitivity [1]. The mass sensitivity and frequency stability of these devices are limited by their thermomechanical (TM) noise. TM noise goes down with Q as pressure increases, at the same time enhanced critical amplitude leads to a higher DR value with better sensitivity. However, detecting TM noise signal at ambient condition is always challenging. Optomechanical transduction successfully resolved this challenge with high displacement sensitivity and high bandwidth of NEMS devices [2]. Previously we have demonstrated the supremacy of our optical racetrack resonator transduction scheme in detecting TM noise signal [3]. Taking advantage of this measurement protocol we have found zeptogram level mass sensitivity at atmospheric pressure for a double clamped beam. This is similar to the sensitivity in high vacuum, even though Q-factor drops 300 fold from vacuum to ambient pressure. These intriguing experimental results challenge assumptions about fundamental limits of mass sensitivity of NOMS sensors and open the door for ultrasensitivity in ambient conditions.

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3. V. T. K. Saur, Z. Diao, M. R. Freeman, and W. K. Hiebert, "Optical racetrack resonator transduction of nanomechanical cantilevers."Nanotechnology, Vo.25, 05522, 2014.

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