



## Physical Sciences Seminar

# Laser noise suppression in levitated optomechanics using squeezed light

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Optically levitated nanoparticles in high vacuum are a versatile platform for fundamental quantum science due to the high isolation and large dynamical tunability of their center-of-mass motion [1]. Recent demonstrations of motional ground-state cooling of optically levitated nanoparticles [2] have opened the door to engineer quantum coherent motional states, such as macroscopic superpositions, and use them to, among others, exploring the quantum-to-classical transition and the quantum nature of gravity. A major bottleneck toward these goals is the high level motional decoherence experienced by optically levitated nanoparticles due to laser shot noise (recoil heating). Suppressing this noise is not straightforward as reducing the optical power also decreases the stiffness of the optical trap. In this talk I will discuss a strategy to suppress recoil heating noise without modifying the optical trap by using light in a vacuum-squeezed state. By properly engineering the geometric distribution of the incoming squeezed light, the recoil heating can be suppressed by 50% in current experiments without any mode matching, and by two orders of magnitude if proper mode matching is applied. Our work [3] paves the way toward exploring quantum physics at unprecedented mass-to-delocalization scales. [1] CGB, M. Aspelmeyer, L. Novotny, R. Quidant, O. Romero-Isart, *Science* 374, eabg3027 (2021)[2] U. Deli, M. Reisenbauer, K. Dare, D. Grass, V. Vuleti, N. Kiesel, M. Aspelmeyer, *Science* 367, 892 (2020)[3] CGB, J. A. Zieliska, M. Rossi, A. Militaru, M. Frimmer, L. Novotny, P. Maurer, O. Romero-Isart, *PRX Quantum* 4, 030331 (2023)

**Tuesday, April 9, 2024 11:00am - 12:00pm**

Office Bldg West / Ground floor / Heinzl Seminar Room (I21.EG.101)



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