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【460】Optimal quantum control of mechanical motion at room temperature: ground-state cooling

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Accurately controlling the dynamics of physical systems by measurement and feedback is a pillar of modern engineering; Achieving this in an optimal way is a challenging task that relies on both quantum-limited measurements and specifically tailored algorithms for state estimation and feedback. We demonstrate real-time optimal control of the quantum trajectory of an optically trapped nanoparticle. We combine confocal position sensing close to the Heisenberg limit with optimal state estimation via Kalman filtering to track the particle motion in phase space. Optimal feedback allows us to stabilize the quantum harmonic oscillator to a mean occupation of $n = 0.56 \pm 0.02$ quanta, realizing quantum ground state cooling from room temperature.

Primary authors: Mr MAGRINI, Lorenzo (University of Vienna); Mr ROSENZWEIG, Philipp (TU Wien); Mrs BACH, Constanze (University of Vienna); Dr DEUTSCHMANN-OLEK, Andreas (TU Vienna); Dr HOFER, Sebastian; Prof. HONG, Sungkun; Prof. KIESEL, Nikolai; Prof. KUGI, Andreas; Prof. ASPELMEYER, Markus

Presenter: Mrs BACH, Constanze (University of Vienna)

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