

# **Spatiotemporal control of levitated nanoparticles for nonequilibrium thermodynamics**

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Today, optical levitation has achieved a few of the early promises in the field: the application in precise force sensing, proof-of-concept demonstrations in stochastic thermodynamics, and preparation of pure states of motion. In this talk, I will review the state of the art of optomechanics applied to stochastic and quantum thermodynamics, with examples from our experiments exploiting spatiotemporal control of levitated nanoparticles. In particular, I will present an instance of a fast optical erasure of a nonequilibrium memory realized with a levitated particle in a double-well potential. I will discuss the potentiality of the platform for optimizing information processing using thermodynamic criteria. I will then present the feedback cooling of a nanoparticle to the ground state, paving the way to a fully quantum thermodynamic-optomechanical experimental platform.