Quantum signatures of the dynamics of a vibrational mode of a SiN membrane within an optical cavity

D. Vitali, M. Karuza, C. Biancofiore, M. Galassi,
G. Di Giuseppe, R. Natali, P. Tombesi

School of Science and Technology
Physics Division
University of Camerino
Camerino, Italy

The search for experimental demonstrations of the quantum behavior of macroscopic mechanical resonators is a fast growing field of investigation and recent results have shown the generation of quantum states of resonators with a mass at the nanogram scale. Here we consider the optical manipulation of a mechanical resonator by means of a high-finesse optical cavity. We focus in particular onto the optomechanical system formed by the vibrational modes of a SiN membrane with high mechanical quality factor, driven by the radiation pressure of the stationary modes of a high-finesse cavity. We have studied both theoretically and experimentally such a system. We show that ground state cooling and robust optomechanical entanglement between vibrational modes and both intracavity and output cavity modes is achievable at liquid He temperature. We also provide preliminary experimental results showing how signatures of the quantum behaviour of the motion of a mesoscopic mechanical oscillator could be detected. The prospects for the experimental implementation of quantum information protocols will be also discussed.