MOTION OF OPTICALLY LEVITATED NANOPARTICLE IN NONLINEAR REGIME

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Optically levitated nanoparticles in vacuum have gained much attention for their ultrasensitivity to forces of zN $Hz^{-1/2}$ orders [1] and for the potential investigation in the field of quantum physics. In contrast to other nano- and micromechanical oscillators, the optically trapped nanoparticle in vacuum has no clamping losses, its motion is influenced only by a laser beam and its potential profile and therefore the mechanical quality factor of such an oscillator is very high [1]. In water solution, an optical trap can be considered as harmonic but in vacuum the optical potential anharmonicity starts to play a role and the trapped sphere behaves like a softening Duffing oscillator. Thus changes in an oscillation amplitude caused by the thermal fluctuations induce fluctuations of particle oscillation frequencies [2]. The anharmonicity in a Gaussian field distribution can be defined through nonlinear coefficients. We developed a new method how the nonlinear coefficients can be simply obtained from the measured 3D trajectories of an optically levitated particle. Our technique is based on the averaged trajectories of a particle in a phase space consisting of position and momentum variables. In contrast to other approaches, this method provides us with a potential profile description even for higher ambient pressures when the potential nonlinearity is not visible in the measured data.

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