Optical calibration of acoustic tweezers

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Acoustic tweezers trap particles with sound waves designed so that matter is confined to specific regions of pressure and velocity fields. We make use of two different acoustic trapping set-ups in air, based on low-cost sound transducer arrays, and we develope a calibration method for acoustic tweezers based on prior knowledge of optical trapping techniques. We adopt two optical detection methods to study the dynamics in the acoustic trap: (i) we aim a laser beam on the trapped particle and detect the fluctuations of its shadow on a quarter photodiode (QPD), (ii) we acquire the shadow of the trapped particle using a CCD camera and a telescope, then we extract data on the position of the particle using video tracking software. We collect data on the displacement of the particles in the x, y and z directions with both aforementioned methods. We analyze these data by calculating their power spectra, since periodic oscillations of the particle give rise to a peak in the power spectrum at the corresponding frequency. Spectra obtained with both CCD and QPD signals have peaks at the same frequency. This allows us to evaluate the force constant of the acoustic trap on the basis of the simple harmonic oscillator model. Here, we illustrate calibration test measurements in the case of (i) the acoustic trapping instrumental apparatus consisting of a single planar array of ultrasonic transducers and (ii) the TinyLev model consisting of two opposing transducer arrays allowing to obtain a single-axis non-resonant levitator.