

# Brownian motion in a modulated optical trap

Yi Deng, John Bechhoefer and Nancy R Forde

Department of Physics, University of California, San Diego, La Jolla, CA 92037, USA

Received 12/1/2013, revised 1/15/2014, accepted 1/22/2014

**Abstract** We study the motion of a particle in a modulated optical trap. The trap is modeled as a harmonic potential with a time-dependent spring constant. The particle's position is tracked over time, and the resulting trajectory is analyzed. The motion is shown to be a combination of a steady-state oscillation and a random walk. The random walk is characterized by a diffusion coefficient that depends on the modulation frequency and amplitude. The steady-state oscillation is characterized by a mean position that depends on the modulation frequency and amplitude. The results are compared with experimental data and theoretical predictions.

## Abstract

We study the motion of a particle in a modulated optical trap. The trap is modeled as a harmonic potential with a time-dependent spring constant. The particle's position is tracked over time, and the resulting trajectory is analyzed. The motion is shown to be a combination of a steady-state oscillation and a random walk. The random walk is characterized by a diffusion coefficient that depends on the modulation frequency and amplitude. The steady-state oscillation is characterized by a mean position that depends on the modulation frequency and amplitude. The results are compared with experimental data and theoretical predictions.

## Keywords:

Brownian motion, optical trap, modulated potential, diffusion coefficient, steady-state oscillation, random walk, harmonic potential, time-dependent spring constant, particle position, trajectory, modulation frequency, modulation amplitude, experimental data, theoretical predictions.

## 1. Introduction

Optical traps have been used to study the motion of particles in a variety of contexts. In particular, the motion of a particle in a modulated optical trap has been studied extensively. The trap is modeled as a harmonic potential with a time-dependent spring constant. The particle's position is tracked over time, and the resulting trajectory is analyzed. The motion is shown to be a combination of a steady-state oscillation and a random walk. The random walk is characterized by a diffusion coefficient that depends on the modulation frequency and amplitude. The steady-state oscillation is characterized by a mean position that depends on the modulation frequency and amplitude. The results are compared with experimental data and theoretical predictions.













1 \$ '00 L '00 L 99 ±  
1 ± L '00 L '00 L 99 ±  
2/ ± \$ L '00 L '00 L 99 ±  
3/ ± \$ L '00 L '00 L 99 ±

4 \$ '00 L '00 L 95 ±  
5 ± \$ '00 L '00 L 95 ±  
6 ± \$ '00 L '00 L 95 ±  
7 ± \$ '00 L '00 L 95 ±