Evanescent light scattering Optical Tweezers

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13.11.2024

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Abstract auf Englisch (10-15 Zeilen) Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Available at www.github.com/leoole100/fp2.

1 Introduction

1.1 Physical Principles

kompakten Zusammenstellung der physikalischen Grundlagen

Mean square deviation and velocity autocorrelation: https://de.wikipedia.org/wiki/Mittlere_quadratische_Verschiebung#Verbindung_zur_Geschwindigkeitsautokorrelation

$$\langle v(t) \cdot v(t+\tau) \rangle = -\frac{d}{d\tau} \frac{\left\langle r^2(\tau) \right\rangle}{6\tau} \tag{1}$$

$$\Rightarrow \quad \left\langle r^2(\tau) \right\rangle = 6 \int_0^\tau (\tau - s) \langle v(0) \cdot v(s) \rangle \, ds \tag{2}$$

The maxwell boltzmann relations (from script) are given by

$$P(x) \propto \exp\left(-\frac{V(x)}{k_B T}\right) \tag{3}$$

$$V(x) \propto -\frac{\log P(x)}{k_B T} \tag{4}$$

2 Methods

Mit einer Skizze des Versuchsaufbaus

3 Procedure

4 Results

All recorded data and the analysis is available at www.github.com/leoole100/fp2.

4.1 Transmission Light Microscopy

The recorded images have a shape of 600×800px. The observed particle has a radius of $14(2)$ px equivalent to $1.86(27)$ µm.

Model for the MSD with $k = \alpha P \cdot k_B T / \mathrm{MSD}(\infty)$ with the optical tweezer power P in arbitrary units:

$$\frac{1}{\mathrm{MSD}(\tau, k)} = \frac{1}{D_0 \tau} + \frac{1}{\mathrm{MSD}(\infty)} \tag{5}$$

$$= \frac{1}{D_0 \tau} + \frac{1}{(k_B T \cdot P)_i} \tag{6}$$

For the i-th measurement.

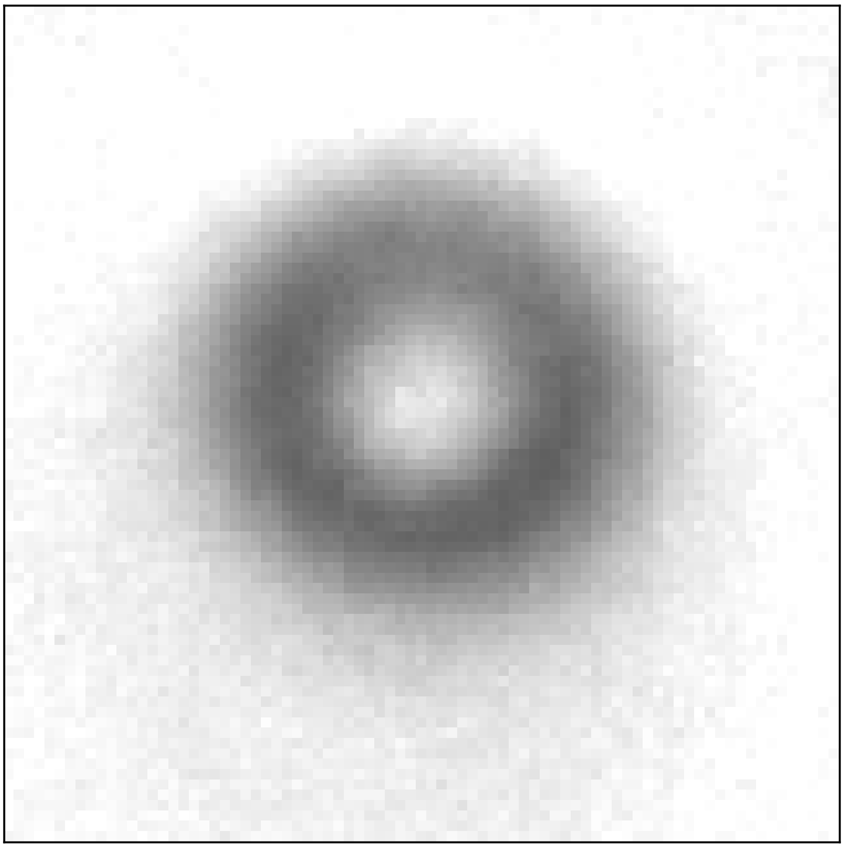

Figure 1 Transmission light microscopy of a single particle, after normalization.

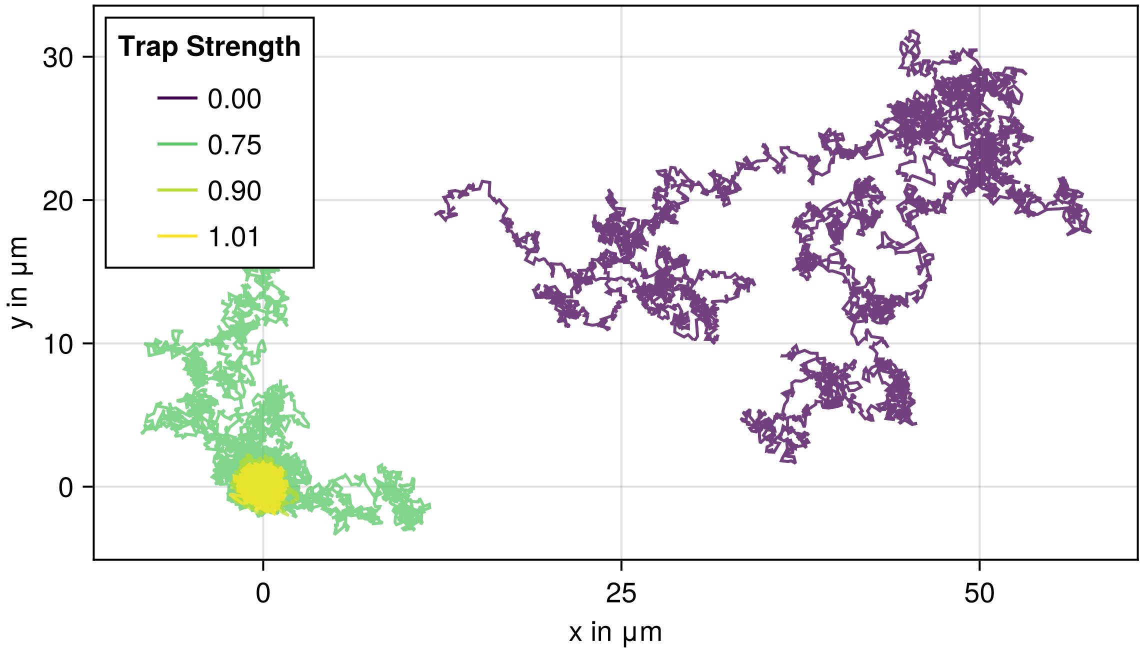

Figure 2 Tracked trajectories relative to trap center.

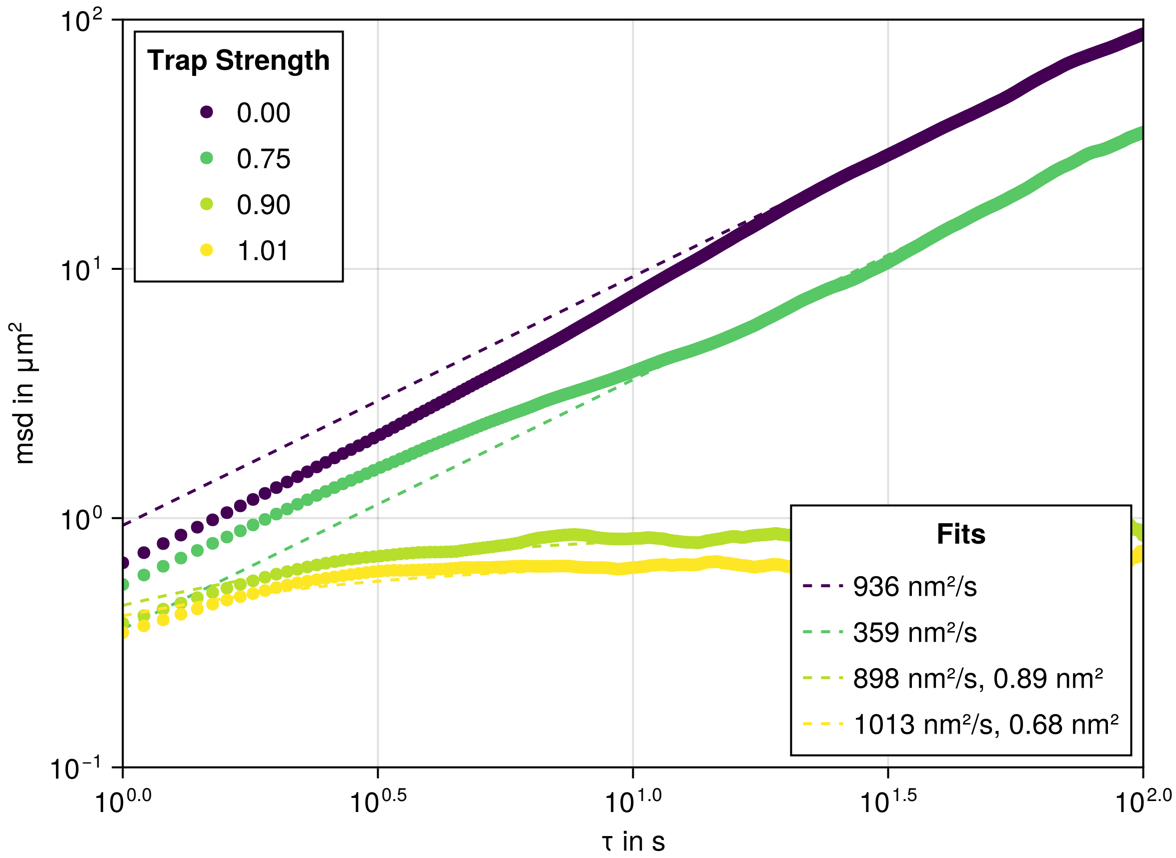

Figure 3 Mean Square Displacement, Linear Drift removed, fit: Equation 6

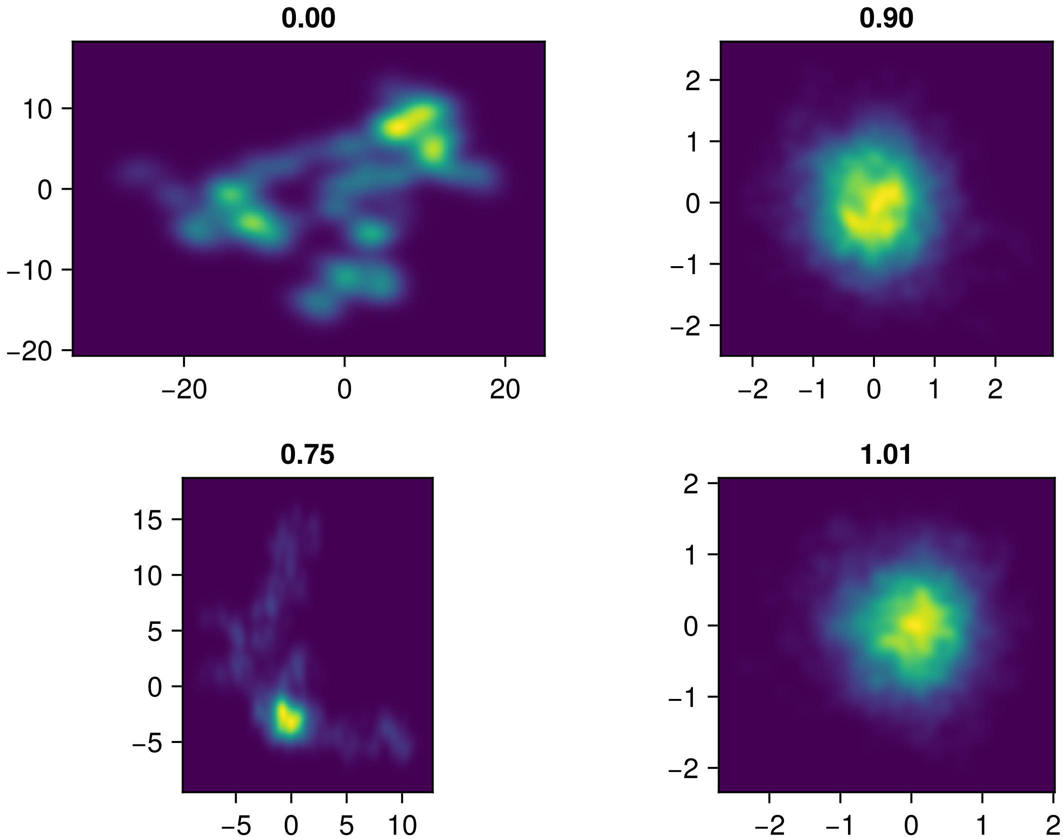

Figure 4 Bivariate histogram for different trap strengths, relative to mean position, different scale in um.

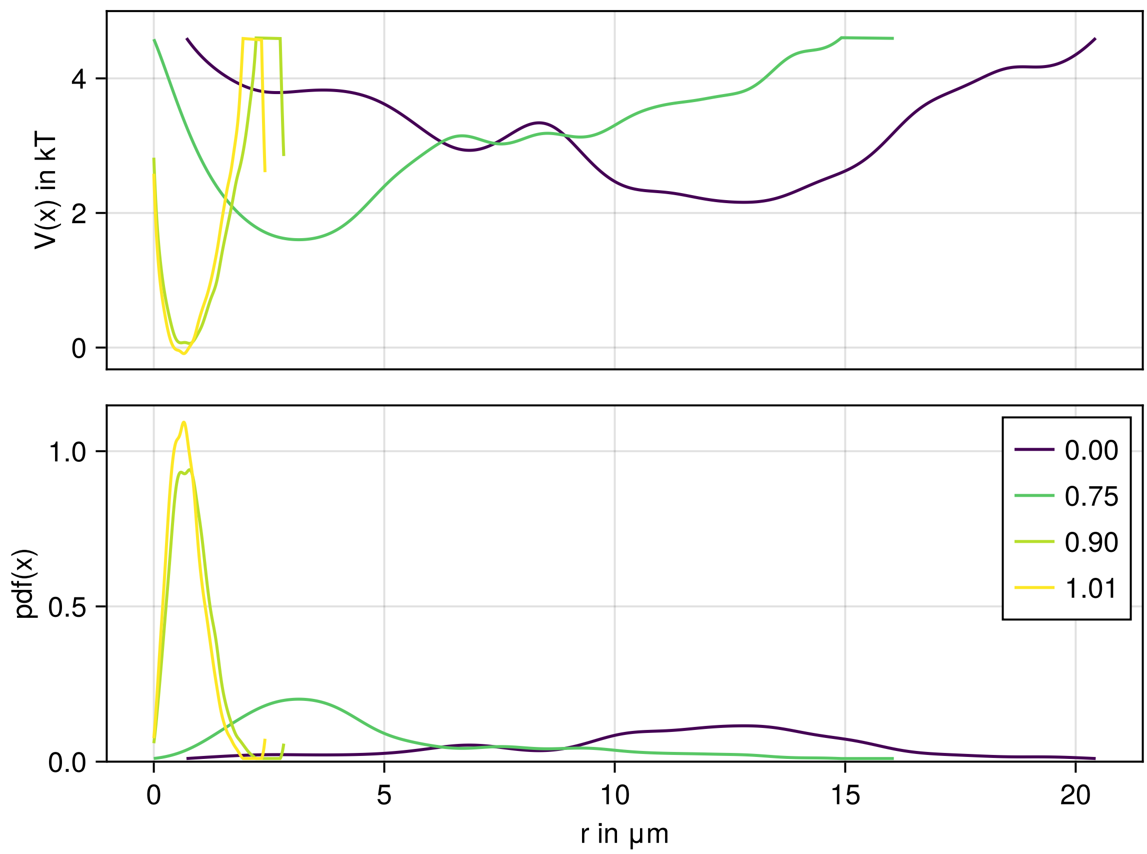

Figure 5 Distance to center of trap. Qualitatively, the same if center is mean per track or "real" center.

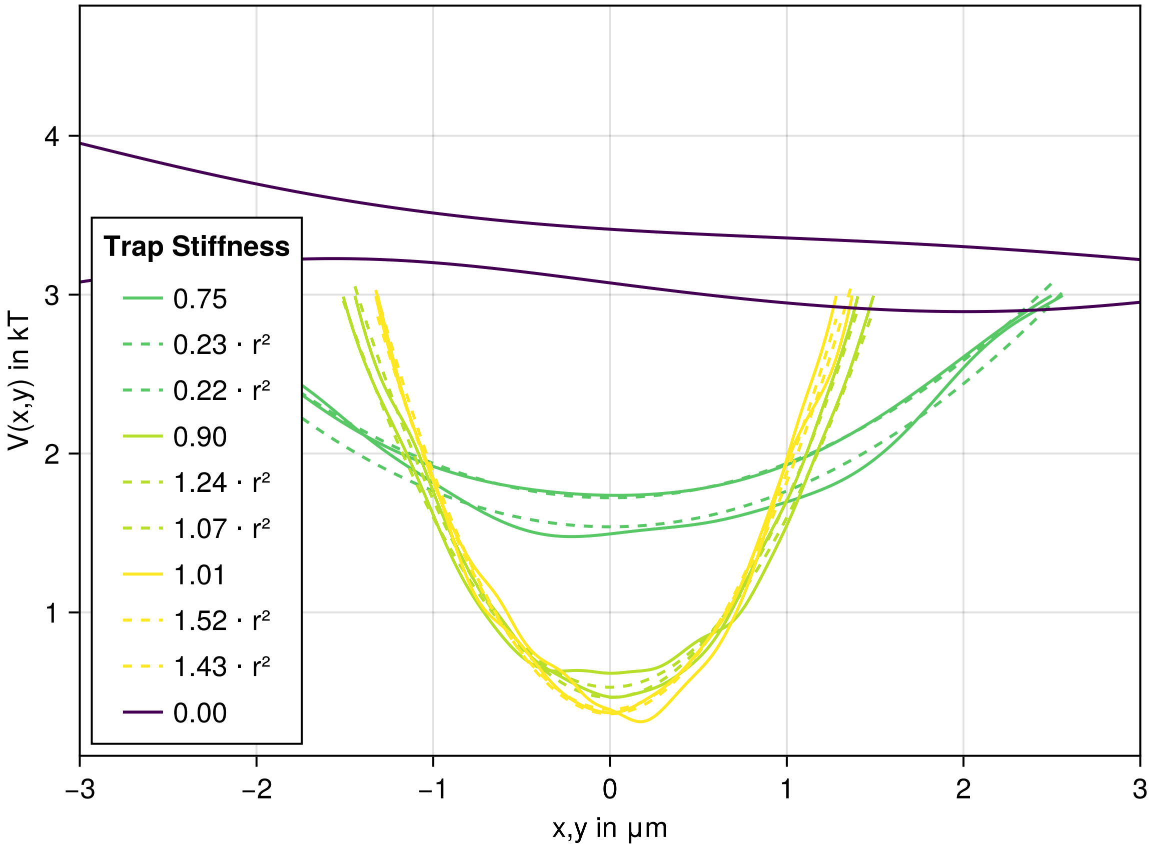

Figure 6 Grouped by axis, relative to mean.

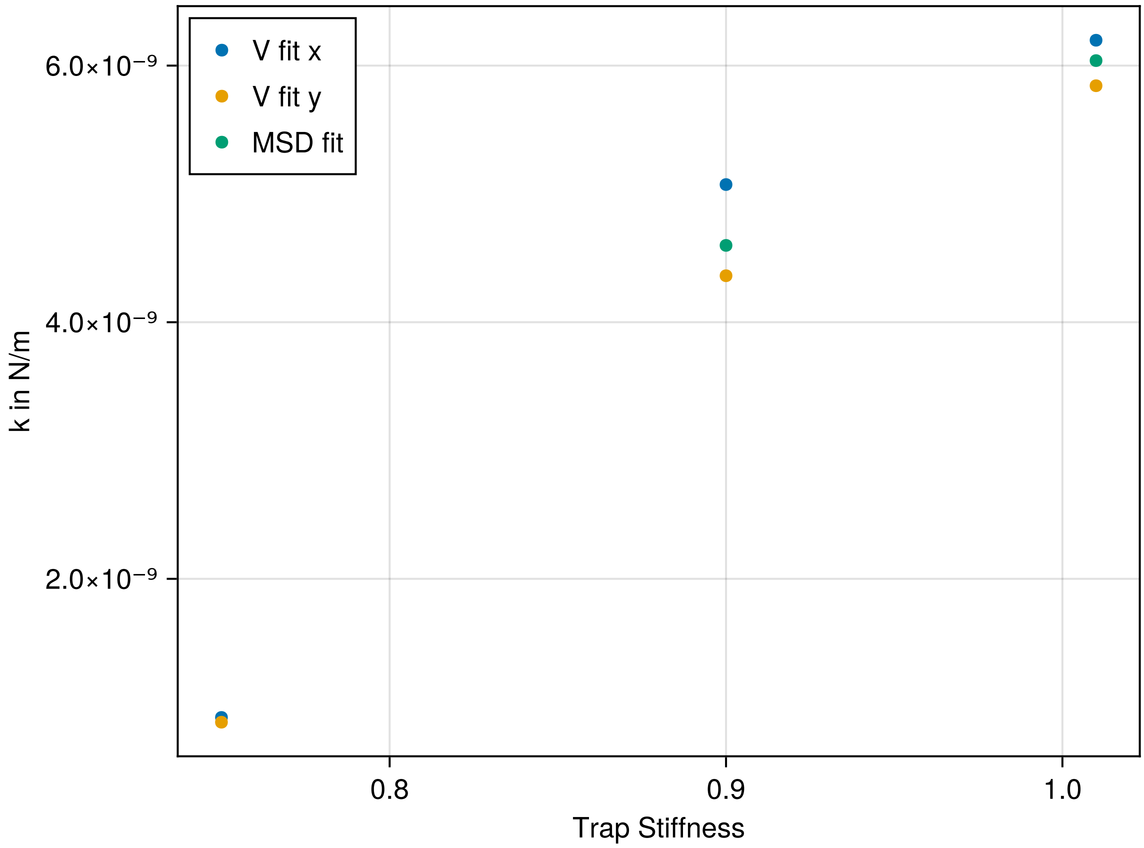

Figure 7 Differently measured spring constants.

4.2 Total Internal Reflection Microscopy

$$P(\Delta z) = N(0, \sigma^2) = N\left(0, \frac{\Delta T}{\langle T_s \rangle} \sigma_s^2\right) \tag{7}$$

$$\Delta I = -I_0 \beta \exp\left(-\frac{z}{\beta}\right) \Delta z \tag{8}$$

$$P(\Delta I) = P(\Delta z) \left| \frac{d\Delta z}{d\Delta I} \right| \tag{9}$$

$$= N(0, \sigma^2) \, \frac{1}{I_0 \beta} \exp\left(\frac{z}{\beta}\right) \tag{10}$$

5 Discussion