

# 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.

# 1 Introduction

# 4 Results

## 1.1 Physical Principles

kompakten Zusammenstellung der physikalischen Grundlagen

All recorded data and the analysis is available at [www.github.com/leoolle100/fp2](https://www.github.com/leoolle100/fp2).

Mean square deviation and velocity autocorrelation: [https://de.wikipedia.org/wiki/Mittlere\\_quadratische\\_Verschiebung#Verbindung\\_zur\\_Geschwindigkeitsautokorrelation](https://de.wikipedia.org/wiki/Mittlere_quadratische_Verschiebung#Verbindung_zur_Geschwindigkeitsautokorrelation)

$$\begin{aligned} \langle v(t) \cdot v(t + \tau) \rangle &= -\frac{d}{d\tau} \frac{\langle r^2(\tau) \rangle}{6\tau} \quad (1) \\ \Rightarrow \quad \langle r^2(\tau) \rangle &= 6 \int_0^\tau (\tau - s) \langle v(0) \cdot v(s) \rangle ds \quad (2) \end{aligned}$$

## 4.1 Transmission Light Microscopy

The maxwell boltzmann relations (from script) are given by

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

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

The recorded images have a shape of  $600 \times 800$ px. The observed particle has a radius of  $14(2)$ px equivalent to  $1.86(27) \mu\text{m}$ .

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

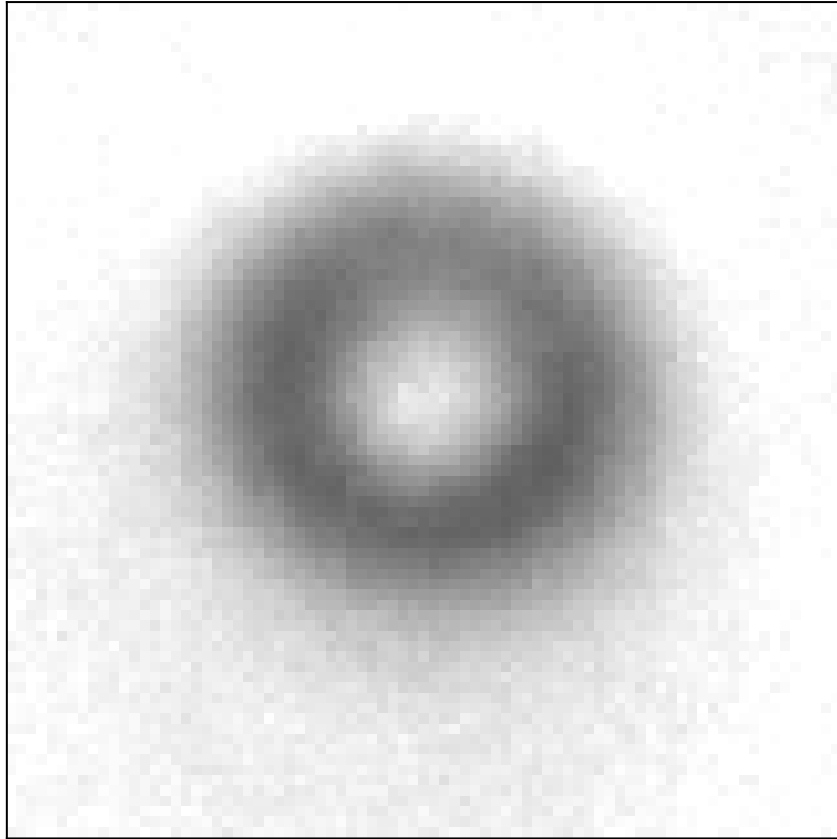
## 2 Methods

Mit einer Skizze des Versuchsaufbaus

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

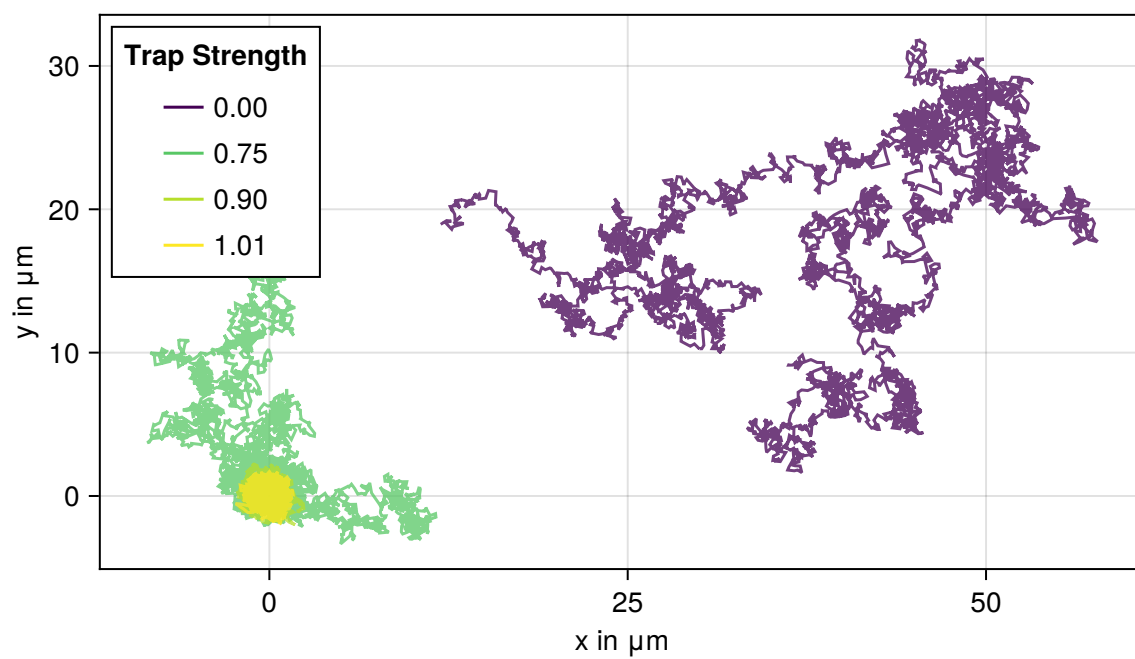
$$= \frac{1}{D_0 \tau} + \frac{k}{k_B T \cdot \alpha P} \quad (6)$$

## 3 Procedure

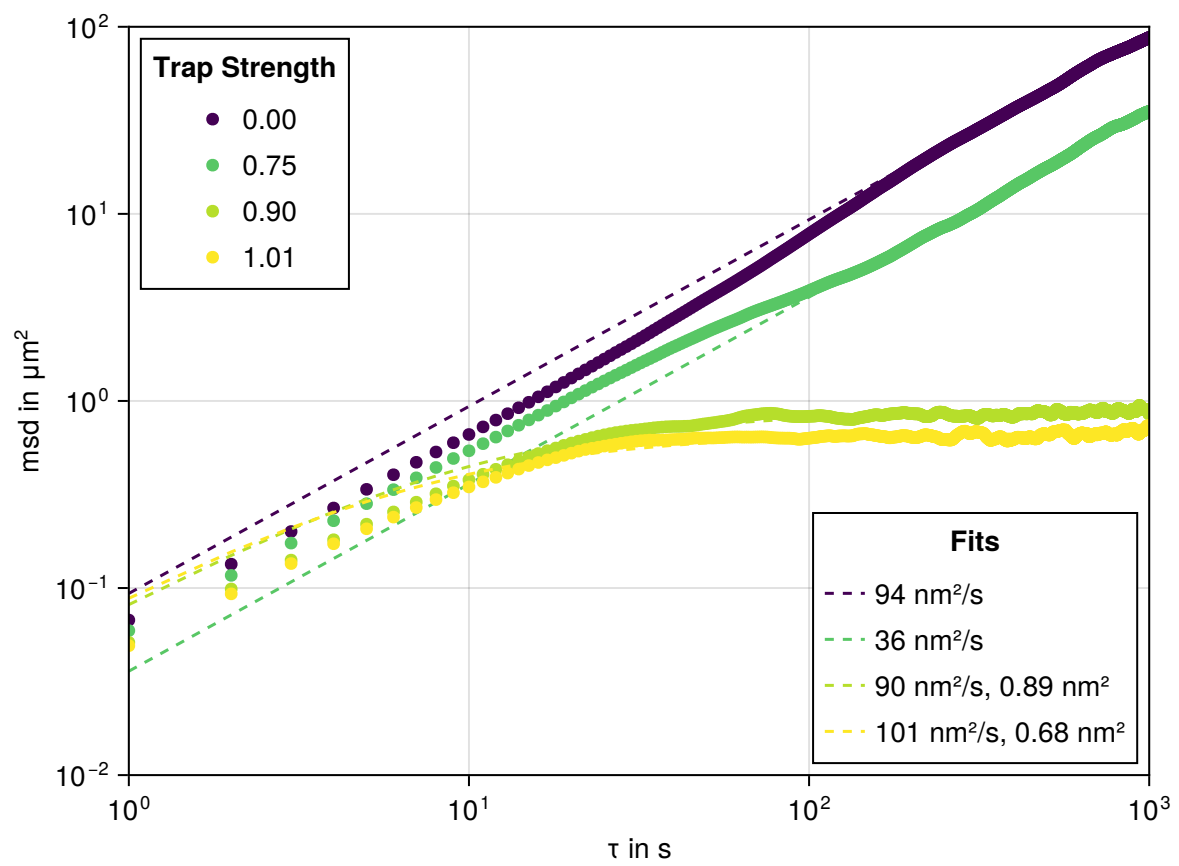


**Figure 1** Transmission light microscopy of a single particle, after normalization.

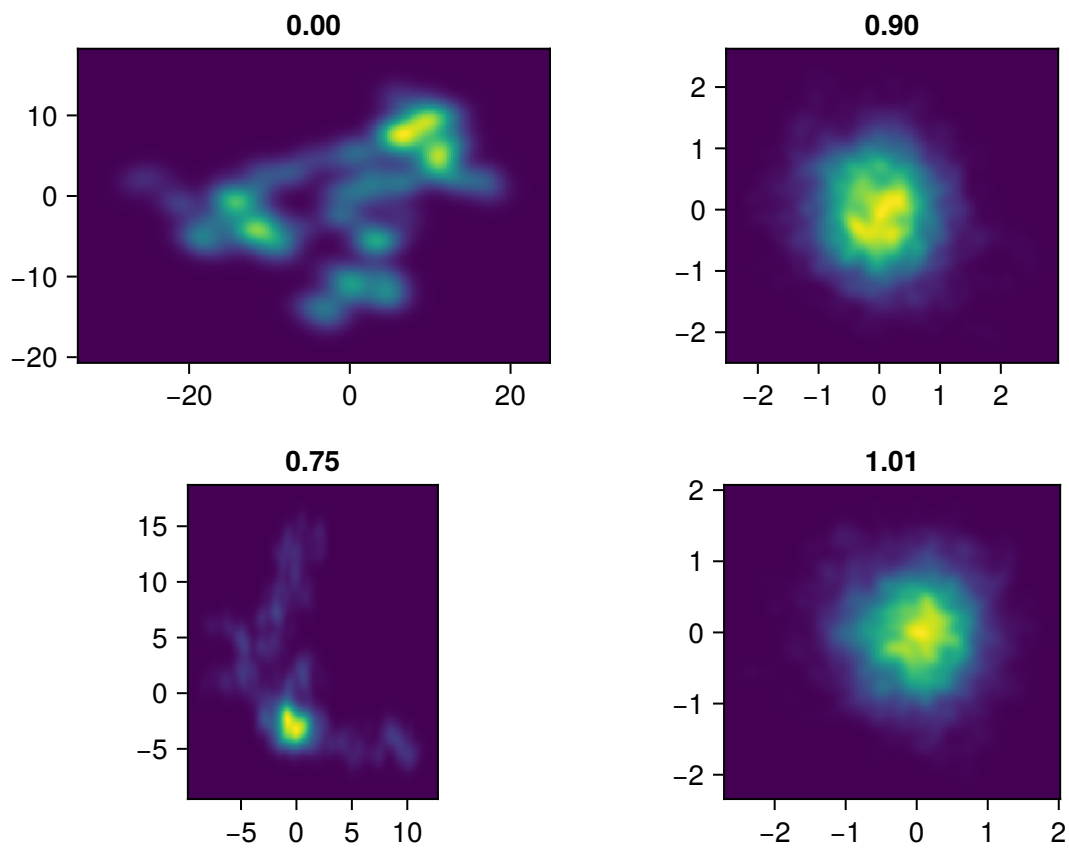
## 5 Discussion



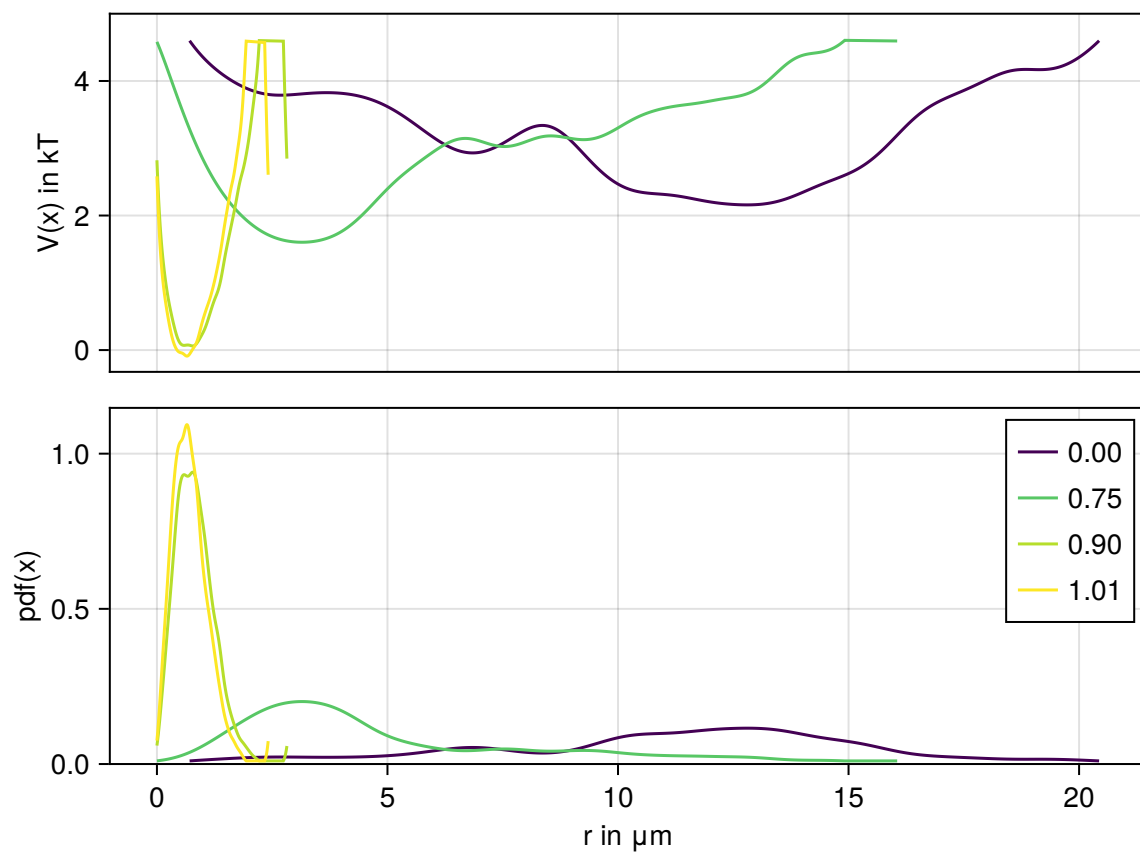
**Figure 2** Tracked trajectories relative to trap center.



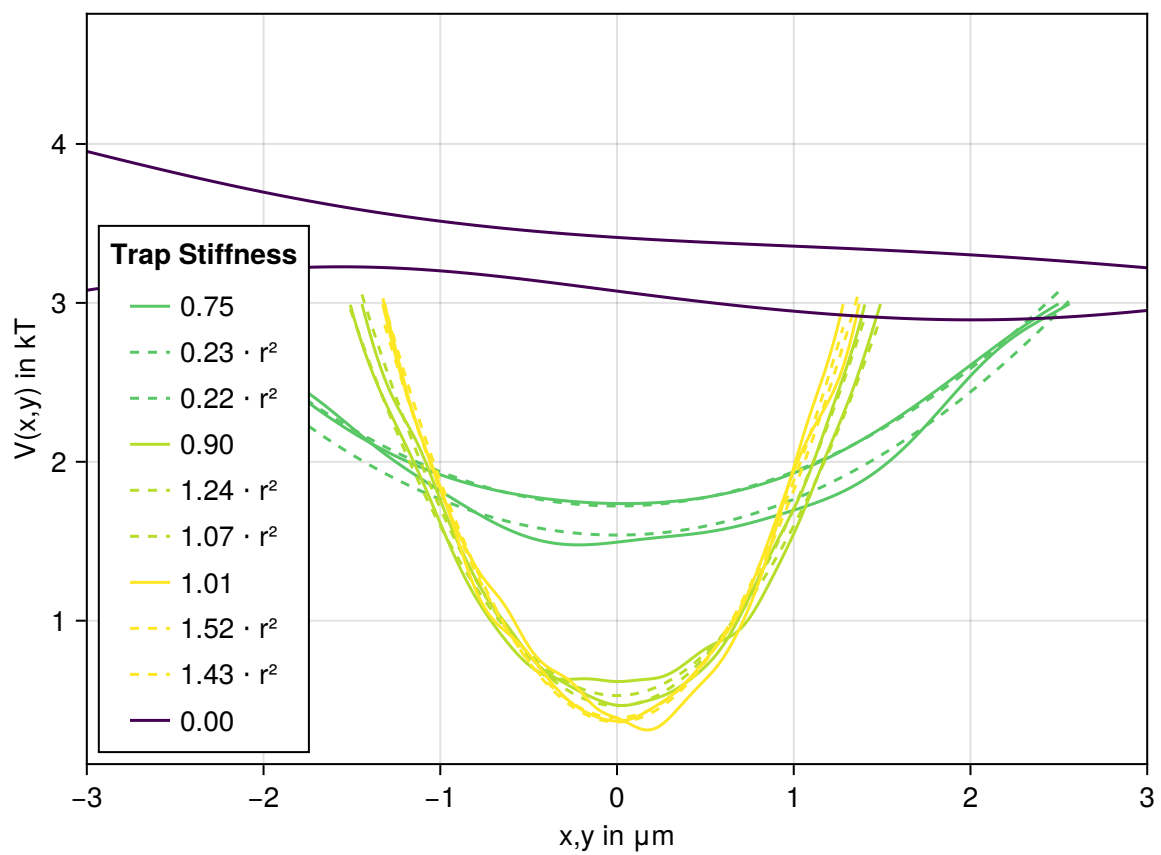
**Figure 3** Mean Square Displacement, Linear Drift removed, fit: [Equation 6](#)



**Figure 4** Bivariate histogram for different trap strengths, relative to mean position, different scale in  $\mu\text{m}$ .

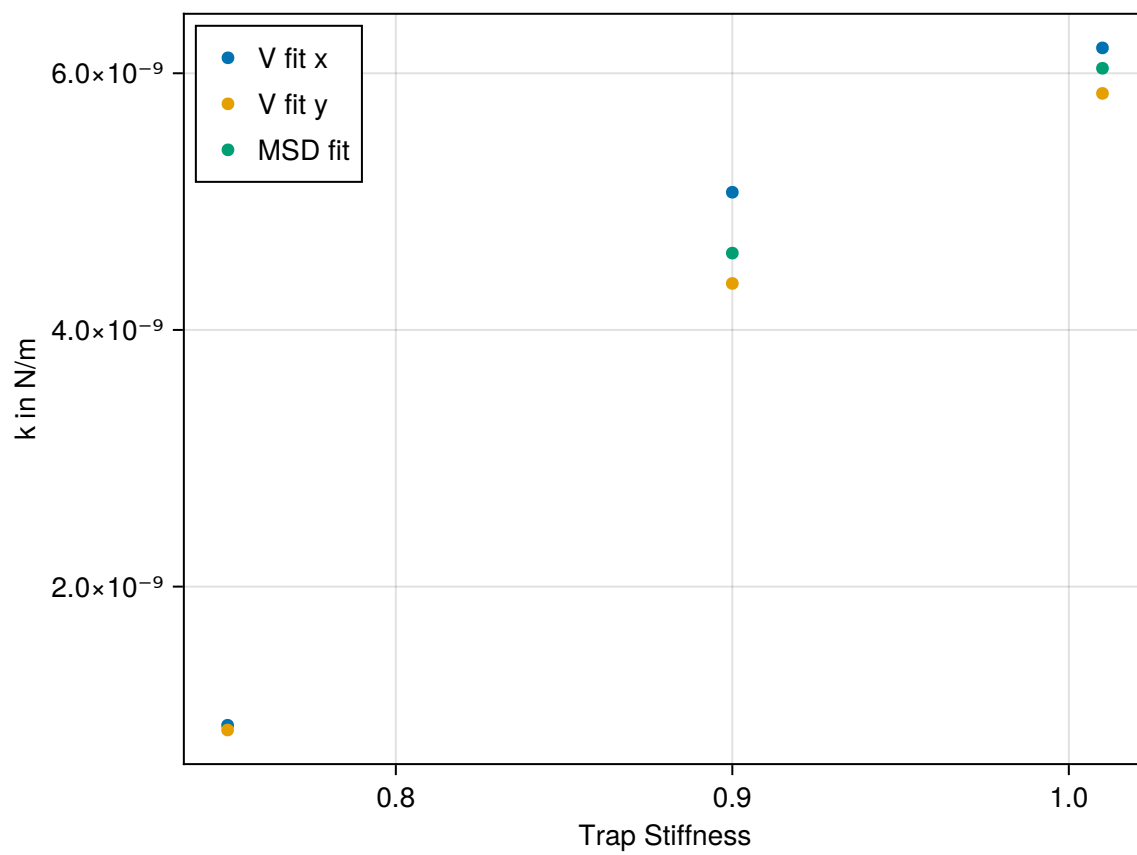


**Figure 5** Distance to center of trap. Qualitatively, the same if center is mean per track or "real" center.



**Figure 6** Grouped by axis, relative to mean.





**Figure 7** Differently measured spring constants.