

BMC - Brownian Motion in Cells

Signature Sheet

Student's Name _____ Partner's Name _____

Pre-Lab Discussion Questions

It is your responsibility to discuss this lab with an instructor before your first day of your scheduled lab period. This signed sheet must be included as the first page of your report. Without it you will lose grade points. You should be prepared to discuss at least the following before you come to lab:

1. What are the masses of the various microspheres (beads) you will be observing in the lab? How many molecules are in a single particle? What is the uncertainty in these numbers? These calculations help you get a sense of the size of your measurements. Data sheets for the microspheres are available in a black binder at the station.
2. We assume that these beads in the fluid are in the non-inertial regime. Why is that true? What statistical assumption does that allow us to make?
3. Consider a 1-d random walk of N steps, where the probability of moving left equals the probability of moving right at each step. This allows us to define a random variable X which represents the final displacement of the walker (its location after N steps). Calculate: $\langle X \rangle$ and $\langle X^2 \rangle$. To do this, write $X = \sum_1^N S_i$, where S_i is an indicator on the i th step (explicitly, $S_i = -1$ if the i th step was to the left, and $S_i = 1$ if the i th step was to the right). Keep in mind the S_i are independent when calculating $\langle X^2 \rangle$.
4. Learn the techniques to use pipettes. Show the GSI or faculty member how you use a pipette to deliver liquid (water) from one vial to another vial.

Staff Signature _____ Date _____

Completed before the first day of lab? (Circle one) Yes / No

Questions to Complete on the First Day of Lab

These questions can be answered after you read through the [Simulating Brownian Motion](#). Make sure to copy and execute the scripts on the computer's MATLAB as you read so that you can understand the program structure and the different variable names. You have the freedom to choose other programming languages for these simulations, such as python. But so far, the example codes have been provided only in MATLAB.

In the first investigation, you will observe a minimum of two different-sized particles in at least four solvents with different viscosity. Do the following tasks for each of the experimental conditions you plan to observe:

1. Simulate a random walk in Matlab or other programming language. (You should choose at least one particle with $1 \mu\text{m}$ in size or larger and one smaller.)
2. Plot the Displacement Squared as a function of time or number of steps.

3. Use your **simulated data** to calculate the diffusion coefficient, D in each case. Explain how you arrived at your answer.
4. Calculate the uncertainty of D . How does it vary with the number of simulated data points? What additional sources of error (these are significant) will come into play? How will you account for them? The analysis script you are using could also be used on actual tracking data.

Staff Signature _____ Date _____

Completed by day 1 of lab? (Circle one) Yes / No

Mid-Lab Discussion Questions

On day 2 of this lab, you should have completed the following. Show them to an instructor and ask for a signature.

1. Using a slide with a combination of $10\ \mu\text{m}$ and $0.4\ \mu\text{m}$ polystyrene spheres, show how to set up Köhler illumination.
2. How many nanometers per pixel are captured at 10x, 20x, and 40x magnification?
3. Draw a diagram to show dark-field illumination. Explain how it is possible to see 40 nm objects with visible light (400-750 nm wavelengths).

Staff Signature _____ Date _____

Completed by day 2 of lab? (Circle one) Yes / No

By day 3 of this lab, you should have collected some particle tracks and made several movies. Show an instructor that you are able to make tracking work in the software, and present one of the particle tracks (csv file).

How can you extract diffusion coefficient D from the track? You can do this with either the BMC application or with the Matlab scripts. How close is this value to the theoretical and simulated values? Show to an instructor these calculations on at least one tracking dataset you obtain.

Show and explain your averaging and centroiding code. How do they work?

Staff Signature _____ Date _____

Completed by day 3 of lab? (Circle one) Yes / No

Checkpoint Signatures

1. Dark-Field Illumination

Staff Signature _____

2. Data Analysis Additional Questions

Staff Signature _____

3. Cellular Motion Additional Questions

Staff Signature _____