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 microbeads you will be observing in the lab? How many molecules are in a single bead? What is the uncertainty in these numbers? Data sheets for the microbeads are available on the **BMC Reprints**, or in the CO2 laser's refrigerator.

2. We assume that particles in the fluid are in the non-inertial regime. 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 ith step (explicitly, $S_i = -1$ if the ith step was to the left, and $S_i = 1$ if the ith step was to the right. You may have seen this mapped to 0 and 1 in a probability class). Keep in mind the S_i are independent when calculating $\langle X^2 \rangle$.

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. If you take your time and just work slowly through the page, these questions should be straightforward.

1. Using the microscope, you will observe a minimum of two different-size particles in at least four solvents with different viscosity. Choose the conditions you plan to observe and simulate them in Matlab. You should choose at least one particle with 1 μm in size or larger and one smaller. Plot the Displacement Squared for the different diffusion coefficients on the same graph (see the Hold command used in the write-up).

2. Use your simulated data to calculate the diffusion coefficient, D in each case. Explain how you arrived at your answer.

3. What is the uncertainty of your estimation of D? How does it vary with the number of simulated data points? Explain your strategy for making observations in the lab. What additional sources of error (these are significant) will come in to play? How will you account for them? Keep these scripts. When analyzing your data you can create artificial data sets on which to test your analysis techniques.

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 μm and 0.44 μm polystyrene spheres, show how to set up Köhler illumination.
2. How many micrometers 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).
4. Set up dark-field illumination.

Staff Signature _____ Date _____

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

1. By day 3 of this lab, you should have collected some particle tracks and made several movies. Show one of the particle tracks to an instructor. What value of D did you obtain from the track? How close is this to the theoretical value? You can do this either with the BMC application or with the Matlab scripts. Explain how averaging and centroiding codes are useful in tracking software. How does the averaging code work in this experiment?

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 _____