BMC - Brownian Motion in Cells

Signature Sheet

Pre-Lab Discussion Questions

Please sign up for a time slot with a partner to meet an instructor for discussing the pre-lab. Be prepared to answer the questions below.

1. What are the masses of the various nano-particles (beads) that you will be observing in the lab? How many molecules are in a single particle? What is the uncertainty in these numbers? Some properties of the beads are available in the **Data sheets for the beads**.

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). Keep in mind the S_i are independent when calculating $\langle X^2 \rangle$.

4. 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).

Mid-lab Questions

1. There are two different-size particles in solvents with different viscosity, explain what you have observed and simulated in Matlab. Plot the displacement-squared for the different diffusion coefficients on the same graph.

2. Use your simulated data to calculate the diffusion coefficient, D, in each case. Explain how you arrived at your answer. What is the uncertainty of your estimation of D? How does it vary with the number of simulated data points?

3. Explain your strategy for observing the motion of the nano-particles. 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.

4. How many nanometers per pixel are captured at 20×, and 40× magnification?

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