Homework 5 Polymer Properties 2/10/10

- 1) Write a program to create a series of random numbers, I(t), with an average of 50 and a range of ± 3 . The relaxation time for this series is 0 since it is a series of random pulses with no decay.
- 2) Next take similar values and apply a memory function exp(-k∆t) to each value. ∆t is the number of entries prior to the current entry. So say the first value is I(1) = 50 + 2, and the next value is 50 3 the dampened value is I(2) = (52-50) exp(-k(2-1)) + (50-3). If the next random value is 50 4 the damped value is I(3) = (52-50) exp(-(3-1)k)+(47-50) exp(-(2-1)k) + (50-4). k can have a value of about 0.5.
- 3) k is the inverse of a time constant, the length of time that the impulses are remembered. So small k is a long memory and large k is a short memory. Your program should be able to qualitatively show that k has this behavior (Plot I(t) for 1000 points using different k's). You should also be able to show that the average of your values is 50.
- 4) Using the various series of values, I(t), that you calculated in your program to calculate the time correlation function for the damped and undamped random number sequences, C(Δt). This is calculated by summing the product of all pairs of I(t) values separated by Δt steps for each possible value of Δt.
- 5) Show that $C(\Delta t)$ follows the function $K_0 \exp(-k\Delta t)$ by fitting your calculated function to this exponential decay and by plotting the fit values of k versus the input k values from question 3. Give a value and units for k and for τ , the time constant.
- 6) Assuming that I(t) is the intensity from a dynamic light scattering measurement, determine the diffusion constant and the hydrodynamic radius from this data. Use water at room temperature for the solvent viscosity and assume the time steps are in milliseconds.
- 7) Calculate the radius of gyration for a sphere, a disk, and a rod.
- 8) Calculate the radius of gyration for a 6 arm star with rigid arms and the endpoints forming a tetrahedron. Do the same for a 6 arm star with Gaussian arms.
- 9) Compare the hydrodynamic radius and the radius of gyration for a polymer chain by performing a literature search on this topic. (One to five paragraphs with references.)
- 10) A random noise pattern can be analyzed using a Fourier transform. Explain how this differs from the use of a correlation function.