020417 Quiz 4 Properties

1) Flory defined the persistence length, using the equation $a = l'/(1-\alpha)$.

   Explain each of the terms in this equation.
   Define the persistence length using a sketch of a polymer coil.
   Explain how the persistence length could be measured.
   What is a typical value for a bond length and the persistence length in a polymer.

2) How does the overlap concentration, c*, depend on molecular weight, N?

3) Calculate the dependence of the concentration blob size ξ_p on concentration, c, given that:

$$\xi_p = R_{F0}\,(c/c^*)^P$$

   where P is a power you need to determine, and R_{F0} is the coil size in the dilute regime for a very good solvent. (Hint: You need to know the N dependence of ξ_p to do this calculation.)

Answers: 020417 Quiz 4 Properties

1) l' is an arbitrary step size that could be a chemical bond length. $\alpha = \cos(\theta')$, where θ' is the average angle between two steps.
The average dot product between unit vectors associated with l' steps is a decaying function of the distance between the steps. The function has a value of 1 at zero step length and a value of 0 for infinite step length. The persistence length is similar to the standard deviation of this orientation distribution function and it occurs when the average cosine is equal to 1/e. The chain direction is, on average, random beyond this size. The persistence length is measured in a neutron scattering experiment as the transition point between the coil scaling and persistence scaling. For PE the bond length is about 1.5Å and the persistence length is about 5.8Å.

2) $c^* = N/R_F^3 = N^{1-3/df} = N^{-4/5}$

3) ξ_p doesn't depend on molecular weight, while c* has the dependence in 2) and R_{F0} goes as $N^{3/5}$. $N^0 = N^{3/5}(N^{4/5})^P$, so P must equal -3/4.