

Chemical physics of polymer solutions

Exercise 4

24 November 2003

Consider two identical Gaussian chains, each composed of N monomers of length a . The chains are joined together at both ends. The chains can be either bound, thereby gaining an energy of $-\epsilon$ per monomer pair, or unbound, thereby forming a loop, or “bubble” (see figure). Assume that only one bubble can form, as in the figure. When the chains bind, the double-chain part is very stiff, such that its entropy can be neglected.

1. Write down the energy of a given configuration.
2. Calculate the statistical weight of configurations containing a bubble of a given size. Take particular care in considering the *total* entropy of the unbound parts of the chains. (Hint: go back to our calculation of the partition function of a chain of Gaussian springs.)
3. What is the most probable bubble size? What is the critical temperature at which this size jumps from small to large values?

This problem is related to the phenomenon of DNA denaturation (DNA melting).

