

# Advanced Statistical Mechanics 171.703

## Homework Assignment 5

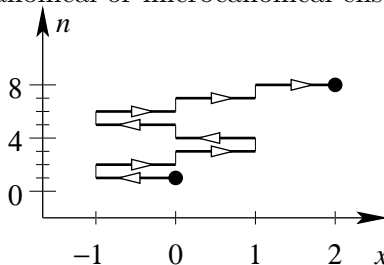
Due date Friday, March 5

**Reading.** Chapters 9.1-9.3 in Pathria.

**1. Lattice polymer: a basic model.** A one-dimensional polymer consists of  $N \gg 1$  links that can point right or left. The state of the links is encoded by  $N$  binary variables  $\sigma_n = \pm 1$ . One end of the polymer is fixed at the origin; the other, whose discrete coordinate is  $x$ , is pulled with a force  $F$  in the positive direction. The energy of the polymer is

$$E = -Fx = -F \sum_{n=1}^N \sigma_n = -F(N_+ - N_-).$$

A sample configuration  $\sigma = (- + + - - + +)$  is shown for  $N = 8$  and  $x = 2$ . Work with a canonical or microcanonical ensemble.



- (a) Relate the displacement  $x$  to temperature  $T$  and the force  $F$ .
- (b) Compute the elastic constant of the polymer. The elasticity has a purely entropic origin: increasing  $x$  reduces the number of polymer configurations and leads to a higher free energy.
- (c) The force is reduced *adiabatically* to a new value  $F' < F$ . What is the new temperature  $T'$ ?

**2. Virial expansion: Sutherland potential.** Prob. 9.1 in Pathria.

**3. Virial expansion: Lennard-Jones.** Prob. 9.2 in Pathria.