Chapter 3.6 Quantized energies: polymer and particle in a box

Some aspects of quantum mechanical systems (vs. classical ones)

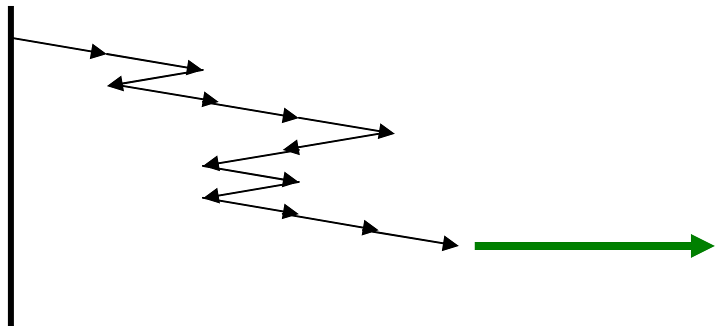
1.) States are generally in a superposition

2.) Energy levels are quantized

3.) Indistinguishable particles are not independent

Example: Polymer with N segments

Simplification: each segment can point left or right



Force and temperature are given. Calculate length as expectation value:

3.6-4 Quantized energies

Ideal Gas with quantized energies

Single particle density of states for quantized particles in a box $\varepsilon = \dfrac{\vec{p}^{\,2}}{2m}$

$$g(\varepsilon) = \sum_r \delta(\varepsilon_r - \varepsilon) \qquad\qquad Z_1 = \sum_r e^{-\beta\varepsilon_r}$$

Classical

Quantum

Quantum partition function of a single particle in a box

$$Z_1 = \sum_r e^{-\beta \varepsilon_r} = Z_x Z_y Z_z$$

$$Z_x = \sum_{n_x=1}^{\infty} \exp(-\beta n_x^2 \frac{\hbar^2 \pi^2}{2mL_x^2})$$

Def. 3.8: The thermal wave length of a particle is defined as

$$\lambda_T = \hbar \sqrt{\frac{2\pi}{m k_B T}}$$

The single particle partition function for a quantized particle in a 3D box is

$$Z_1 = \sum_r e^{-\beta \varepsilon_r} = Z_x Z_y Z_z \approx \frac{V}{\lambda_T^3}$$

Single particle density of states

$$g(\varepsilon) = \sum_r \delta(\varepsilon_r - \varepsilon)$$