The physics of thin sheets: membranes and wrinkling

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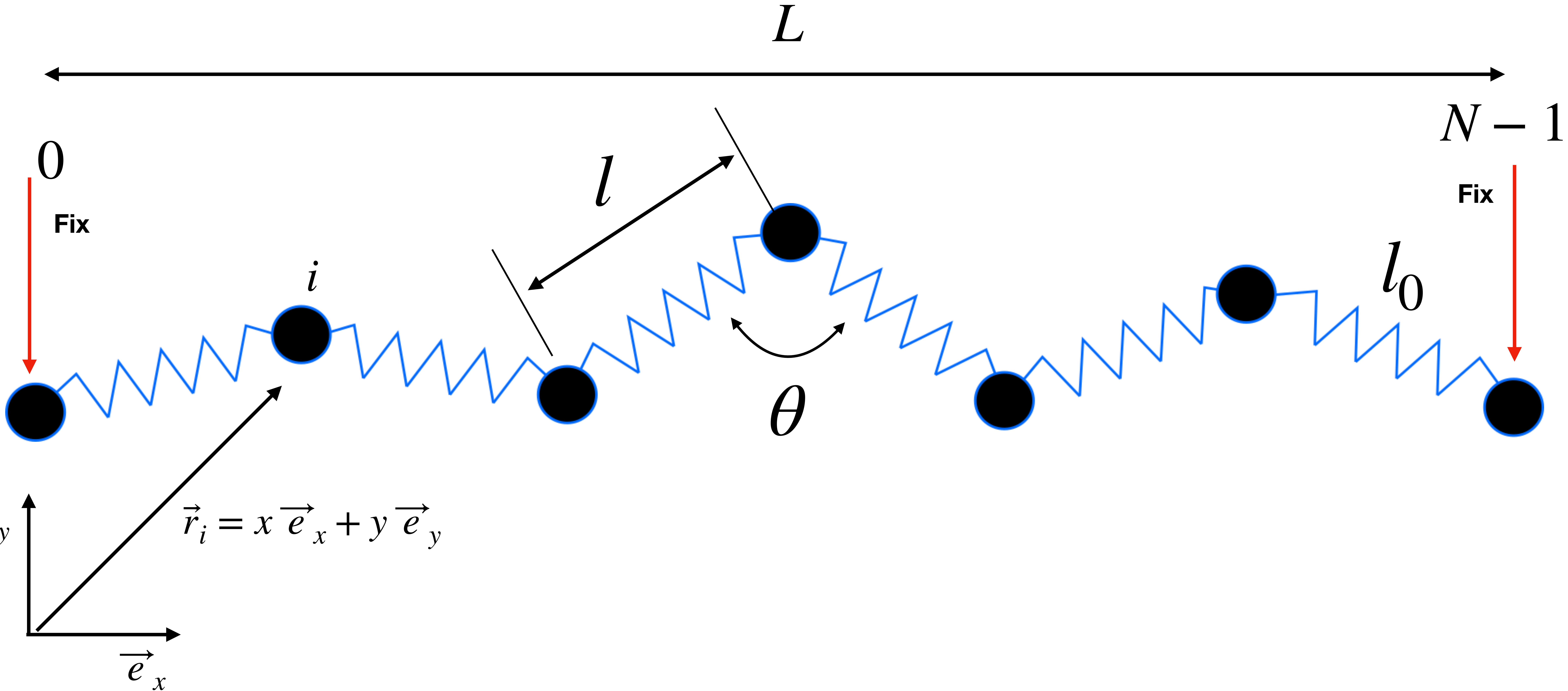
Lab: membranes and wrinkling

Task 1

$$E_s = \frac{1}{2}k(l - l_0)^2$$

$$E_B = k_B(1 + cos\theta)$$



Simulation Methods

Monte Carlo methods are the simplest. A Monte Carlo step consists of an attempt to update the position of each vertex by a random displacement interval $[-s, s]^d$, being d the dimension of the space. Updates are accepted with a probability equal to $min[1, exp(-\Delta E / k_B T)]$, where

$$\Delta E = E_{new} - E_{old}$$

s is chosen so that approximately 50% of the attempts are accepted.

$$E_s = \frac{1}{2}k(l - l_0)^2$$

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Task 1

Monte Carlo single vertex step

vertex move $\longrightarrow \Delta x = [-s, s], \Delta y = [-s, s]$ $\quad \Delta E = E_{new} - E_{old}$

IF

$$random\,[0,1) < min[1, exp(-\Delta E/k_B T)]$$

Accept

ELSE

Reject and move back

1. Loop over all the vertices
2. Perform a single vertex step (see above)

Task 1

For MAXIMUM STEPS

1. Loop over all the vertices

2. Perform a single step (see above)

Task 1

Buckling

Investigate the behavior of the chain with the strain (compressive) $\epsilon = \frac{L - L_0}{L_0}$, and

$L_0 = N l_0$

How many modes can you see?

$$k = 10^3 \quad l_0 = 1.0 \quad k_b = 10^2 \quad N = 10^2 - 10^4 \quad k_b T = 10^{-3} - 10^0$$

Provide snapshots of each mode

Task 2: Wrinkling and growth

Imagine that each spring has a probability p_{growth} of "growth", i.e, an increase l_0 by a factor δl_0. Starting with an equilibrium configuration $L = L_0 = N\, l_0$ investigate what happens when p_{growth} is varied. Use $\delta l_0 = 10^{-3} - 10^{-1}$

Provide snapshots and a movie