PHY 491, Fall 2024 - Homework 11

DUE: Tuesday 12/3/2024, 11:59pm

Problem 5.1 Consider a one-dimensional chain of two different types of atoms A, B in each unit cell with masses m_A and m_B and $m_A > m_B$. All atoms interact with each other via a nearest-neighbor harmonic potential characterized by the same spring constant k. The lattice constant of the system is a and the separation between the two atoms A, B in the unit cell is b, with $b < a$ (see Fig. 1).

5.1.1 Write down the equations of motion for this system. (6 points)

5.1.2 Find the energy $\hbar\omega$ of acoustic and optical phonons with crystal momentum $q = \frac{\pi}{a}$. (10 points)

5.1.3 Visualize the resulting vibrational modes of the chain in a sketch. (4 points)

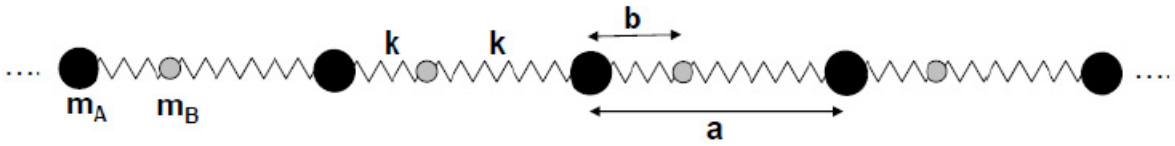

Fig 1: Diatomic chain of atoms A, B interacting via nearest-neighbor interactions with spring constant k.