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1 Overview

This document is meant to log my progress in the investigation of mechanical modes in crystals of hard regular polygon particles. The system consists of $N = n^2 \times n_{\text{unit}}$ particles, where n is some integer and n_{unit} is the number of particles in the unit cell. The system is initialized in its densest known packing and then the crystal vectors are enlarged by constant factors to achieve a prescribed packing fraction. The motion of particles is decomposed into $n \times n$ distinct Fourier modes. There are $3n_{\text{unit}}$ relevant fields to investigate. The first $2n_{\text{unit}}$ are phonon fields signified by $\tilde{\mathbf{u}} = (\tilde{u}_x, \tilde{u}_y)$ (if the number of particles per unit cell is greater than 1, then these fields are further indexed *i.e.* $\tilde{\mathbf{u}}^{\alpha,\beta,\gamma\cdots}$. The remaining n_{unit} fields are libron fields, signified by $\tilde{\theta}^{\alpha,\beta,\gamma\cdots}$. In the case of hexagons, $n_{\text{unit}} = 1$, and in the case of many other polygons including pentagons studied here, $n_{\text{unit}} = 2$.

The various control parameters in a simulation are n the number of unit cells along one side of the box, ϕ the packing fraction, s the number of simulation steps, and the polygon shape. The densest packing, and thus the crystal lattice vectors, are determined by the polygon. The real space lattice vectors given by $\mathbf{a}_1, \mathbf{a}_2$ are usually meant to be in the densest packing, $\phi_{\max}$. When the system is relaxed to a smaller packing fraction, the lattice vectors are presumed to be $\mathbf{a}_i(\phi) = \mathbf{a}_i\sqrt{\phi_{\max}/\phi}$. The reciprocal lattice vectors $\mathbf{G}_i$ are constructed from these real space lattice vectors, and the unit cell of the reciprocal lattice forms the Brillouin zone within which $\mathbf{k}$ vectors are sampled. The relevant $\mathbf{k}$ vectors to sample are $n_1\mathbf{G}_1/n + n_2\mathbf{G}_2/n$.