Supplement S3: Calculating the effective force of an overdamped monolayer

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This "Read me" is an instruction manual for the four text files S4-S7 with which the reader is able to evaluate the formulas derived in S1 and thereby calculate the motion of a monolayer subject to a sinosoidal substrate potential driven in the x direction.

1 Compute dynamical matrix

The file titled S4 should be renamed "ComputeDynamicalMatrix.c" and is a c-code that calculates the matrix elements of the dynamical matrix of the harmonic crystal. The reader has to compile the program, using the command,

gcc -lm -lgsl -lgslcblas -O3 -o ComputeDvals ComputeDynamicalMatrix.c.

The code requires the gsl libraries so, if need be, the installation path of the gsl libraries must be supplied. The ensuing executable, "ComputeDvals" must be executed with a single argument N, which is the number of particles in the system. The value of N is only restricted in that it must be a square number. After the program has finished, a text file titled Dvals_pnum_N.dat will have been created in which the parts of $D_0(\mathbf{q})$, $D_{11}(\mathbf{q})$, and $D_{12}(\mathbf{q})$ that are independant of the coupling parameters f, g, and h (see S1) will be listed, as function of the allowed $\mathbf{q}$ in the Brillouin zone. This file, needs to be created once, and only once, for a given system size N. The file titled "S5.txt" is an example of such an output file and we recommend it be renamed "Dvals_pnum_10000.dat"

2 Construct force

The text file "S6.txt" is a python script that evaluates the sums of the inverse of the dynamical matrix in order to get the variance of the particle positions, the cross correlation, and the effective force acting on the center of mass of the monolayer. The script is executed with the command,

python constructforce.py Dvals_pnum_N.dat f g h a nums R0.

The first argument is the location of the file created by "ComputeDvals", the arguments f, g and h are the coupling parameters described in S1, and a is the lattice constant of the system. The file that is produced is contains

the expectation values of the variance of the particle positions in the x and y directions, their cross correlations, and the effective substrate force as a function of the position of the center of mass R. The number of points that are evaluated is controlled by the argument $nums$ and the curve begins at a value of $R/a = R0$ and ends at $R/a = 0.25$. The name of the produced files is "MeanForce.dat". The file "S7.txt" is a typical example of such an output file.