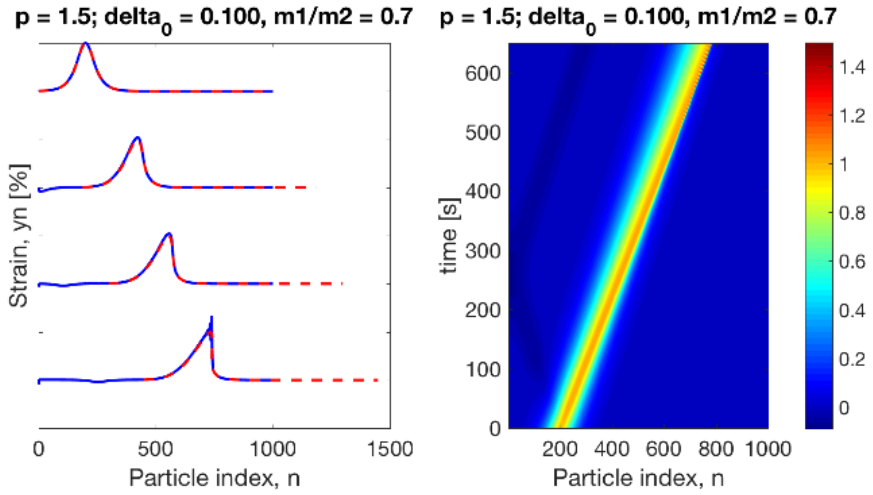
Emergence of dispersive shock waves and rarefaction waves in dimer granular crystals
Madeleine Généreux, 2019

This summer, I studied the mathematics behind granular crystals. This combined my academic interests because the equations I worked with and derived are based in physics and the applications of studying shocks propagating in granular chains are rooted in engineering.

A granular crystal is a chain of materials that interact with one another. For this research, it is useful to look at a one-dimensional chain of masses that interact with one another. Given a set number of masses, we can use physics and differential equations to derive an equation describing the physical behavior of a given mass at a given time. Being able to do this has interesting applications in engineering. Indeed, by deriving equations that make it possible to look at the behavior of shocks in chains, we can better understand how to design a material that could eventually absorb shocks. Similarly, another application is energy harvesting. It is interesting to understand how being able to capture shocks traveling through a material could help transform mechanical energy into other forms of energy.

My role specifically in this research project was to derive a Partial Differential Equation (PDE) to represent strain in a dimer lattice. Strain is defined as the difference in displacement between two adjacent masses and a dimer lattice is a chain in which the masses are not identical. Most previous research has focused on monomer chains, chains in which the masses are identical, and it is a good starting point to derive new equations. After having derived a possible equation, it was important to visualize the solution. Using MATLAB, it is possible to compute a solution to the problem and gain new insights. For example, I visualized the strain as a function of particle index at different times (left) and a space-time contour plot srtain (right) for a dimer lattice with a mass ratio of .7.



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