Physics Simulations in Python

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June 17, 2024

Harmonic Piston with Gas

This simulation shows that temperature is really just a form of kinetic energy. The gas particals float around at random within a piston and cary some small amount of kinetic energy. Each time they collide with the piston, there is an elastic collision and the partical passes a small bit of momentum to the piston according to the equation $m_1v_1 + m_2v_2 = m_{1_f}v_{1_f} + m_{2_f}v_{2_f}$. At the end of the simulation, we show a graph with the location of the piston as well as the velocity as a function of time, as well as a graph of the kinetic and potential energies and show that their sum is constant due to conservation of enerrgy. Note how the graph of the velocity of the piston is not continuous due to the collisions.

Diatomic Chain

This simulation shows a 1 dimentional chain of alternating types of atoms and their interations with each other. When even one atom is out of equilibrium this causes an interation in all of the chain passing along its disturbance. All the atoms are approximatly a harmonic relation so we can discribe them as masses in a chain connected by springs. In this simulation, we have assumed the "spring" (which is really just electrical forces) are the same between every atom. Here we see that the forces on mass n are given by the equation $F_n = m_n\ddot{x_n} = \kappa\left(x_{n-1} - \delta x_n\right) - \kappa\left(\delta x_n - x_{n+1}\right)$ where κ is the spring constant and δx_n is how far mass n is from its equilibrium point.

Si Crystal

The layout of a silicon crystal can be difficult to imagine. It is similar to an FCC lattice, but not quite. I have plotted all of the points in the unit lattace and then shown how they layer one on top of the next to form the crystal.

Double Pendulum

A double pendulum is a similar system to a regular harmonic occilator, but with an additional pendulum connected to the bottom of the first. This increases the complexity and makes it near impossible to solve through Newtonian force diagrams. Instead, I analyzied it using the Lagrangian. Applying the Euler-Lagrange equation of $\frac{d}{dt}\left(\frac{d\mathcal{L}}{d\dot{\theta}_i}\right) - \frac{d\mathcal{L}}{d\theta_i}$ I calculated an angular acceleration of:

$$\alpha_1 = \frac{-g(2m_1 + m_2)\sin(\theta_1) - m_2 g\sin(\theta_1 - 2\theta_2) - 2\sin(\theta_1 - \theta_2)m_2(\dot{\theta}_2^2 l_2 + \dot{\theta}_1^2 l_1\cos(\theta_1 - \theta_2))}{l_1(2m_1 + m_2 - m_2\cos(2\theta_1 - 2\theta_2))}$$

$$\alpha_2 = \frac{2\sin(\theta_1 - \theta_2)(\dot{\theta}_1^2 l_1(m_1 + m_2) + g(m_1 + m_2)\cos(\theta_1) + \dot{\theta}_2^2 l_2 m_2\cos(\theta_1 - \theta_2))}{l_2(2m_1 + m_2 - m_2\cos(2\theta_1 - 2\theta_2))}$$