Physics Assignment 2

PHY410: Do problems 1, 2, and 3
PHY 505: Do all four problems.

Accept the assignment from github classroom: https://classroom.github.com/a/-F_i44g- . You will then get a link to your own github area.
You should submit your code through github classroom. Submit your writeup, and a link to your github classroom area where your code is, on UBLearns.

Problem 1: Scattering

Using the tools from Lecture, study classical scattering from a hard sphere and from the Lennard-Jones potential. Plot typical trajectories, and compute and plot the differential scattering cross section for the hard-sphere and Lennard-Jones cases.

$$\frac{d\sigma}{d\Omega} = \frac{b}{\sin\theta_s}\left|\frac{d\theta_s}{db}\right|^{-1}$$

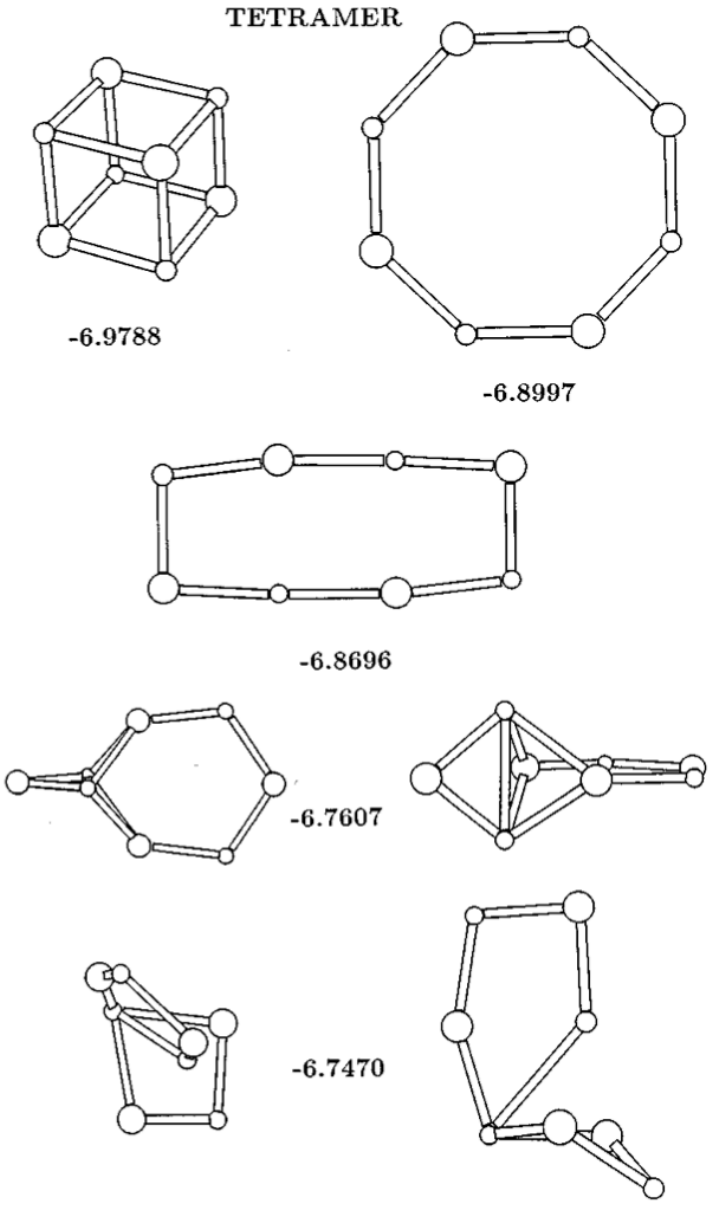
You will need to determine the scattering angle for different impact parameters and then take the derivative numerically. Do this for several different values of the energy that demonstrate the phenomenon of orbiting in the Lennard-Jones case. What is the maximum number of orbits you can generate by carefully tuning the energy and impact parameter?

Name your code “PhysicsAssignment2/Problem1.ipynb”. You should be able to modify the swig files to get the C++ code working within your notebook at this point! (worth 5 points).

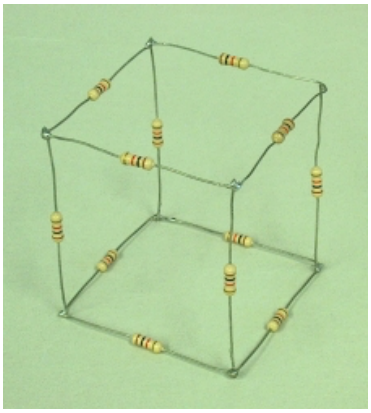
Problem 2: NaCl

Determine the equilibrium configurations of Na4Cl4 clusters for tetramers (n=4) in this paper: K. Michaelian, "Evolving few-ion clusters of Na and Cl",Am. J. Phys. 66, 231 (1998), shown below.

Name your code “PhysicsAssignment2/Problem2.ipynb”. Plot the equilibrium configurations using the macros from class (x,y,z in scatter plots). Label them with their energies. Initialize them to an “ideal” case for the geometry, and allow the optimization to determine the final configurations.



Problem 3 : Resistor cube



Write a program to solve for the currents in a resistor cube. There are 12 resistors, one along each edge. A voltage source is connected across a body diagonal of the cube.

Find the equivalent resistance for the symmetric case when all the resistors have the same resistance, say 1 Ohm. You might remember this problem from freshman E&M.

Vary the resistance of one resistor at a time. There are 12 resistors in total. How many unique cases are there? Plot the equivalent resistance as a function of the resistance of one resistor for all of the unique cases.

Name your code “PhysicsAssignment2/Problem3/ipynb”.

Problem 4 (505 only): CO2 data again

Repeat Physics Homework 1, Problem 1b (fit to CO2 data from Mauna Loa with a quadratic function), but this time use the BFGS algorithm to perform a minimization of the chi-squared function numerically. Compare to the methods from the previous homework assignment. Name your code “PhysicsAssignment2/Problem4.ipynb”.

DO NOT RUN THE OPTIMIZATION OVER THE CO2 X AND Y VALUES. RUN OPTIMIZATION OF THE FIT PARAMETERS.