Physics 40: Laboratory Five

Tuesday, April 14, 2020

Today's Goals: Making plots; More molecular dynamics programs in $d = 1$.

[0] Review of Lab 4.

[1] Mass on a spring with damping; Connection to LRC circuits.

[2] Plotting. You are free to use **any** plotting package you find convenient. (I use "xmgrace".) One of the things we will learn when we transition to python is that a big advantage it has is nicely integrated plotting capabilities. For now, with C, we have the slightly awkward situation where we have to use a C code to generate data and then import that into a completely different piece of software to make plots.

If you do not already have a favorite plotting package, one option is to use google plots. Here are some instructions:

Navigate here:

`https://www.google.com/sheets/about/`

with your web browser. (Choose 'Go to google sheets' and login.)

[2] Open a new spreadsheet (Blank). File → Import → Upload.

[3] Select the file in your computer or drag it in the window. → Import Data.

[4] Insert → Chart. It will plot it automatically. (May need to select 'Use Column A as labels')

[5] Right click in chart to customize (eg add axis labels, legend, resize $\cdots$)

IMPORTANT: Whenever you make a graph label the axes and put in the header all the parameters you used in running your code. For example, in the molecular dynamics code foe the harmonic oscillator, put the values of x_0, v_0, k, m, dt, and N in the header. That way when you return to the graph later you know exactly what you did to generate it!

[6] For a copy: Right click on chart.
Left click on three dots in upper right corner.
Select 'Download As' → 'pdf document' → OK.

[2] Write a molecular dynamics code for a mass on a spring with damping $F = -kx - bv$. Note: You can use a copy of your old mass-spring code and make just a few very small changes. One of them is reading in the friction constant b.

[PS3-1] Run your code for initial position $x = 3$, initial velocity $v = 8$, mass $m = 0.25$, spring constant $k = 10$, friction constant $b = 0.15$, time step $dt = 0.002$, and $N = 4000$ time steps. Make a plot of $x(t)$ and connect as many features of it as you can to the solution presented in class. What happens to x at the beginning of your plot? Why?

[PS2] Write a molecular dynamics code for a constant force.

[PS3-2] Run your code with initial position $x = 6$, initial velocity $v = -4$, (constant) force $F = 9$, mass $m = 18$, time step $dt = 0.01$, and $N = 2000$ time steps. What is the final time at the end of your simulation? What is the final velocity your mass attains? Does it agree with the formula you know from classical mechanics for constant force (constant acceleration)? What is the final position your mass attains? Does it agree with the formula you know from classical mechanics for constant force (constant acceleration)? Make a plot of $x(t)$.

[PS3-3] (extra credit) Add a friction force $F = -bv$ to your constant force program. Run the code again with b nonzero. How does it affect your results? What do you know about the behavior of a mass pushed on with a constant force but also having a $F = -bv$ friction force when t gets big? (Are there some words you know describing what happens to an object dropped from a great height?)