PHYSICS 102
CLASSICAL MECHANICS LAB
FALL 2016

Assignment Six

Due Tuesday, November 15, 7:00 pm.

[1.] Write a molecular dynamics program for the Kepler problem. Assume the center of force is stationary. This is, of course, a reasonable approximation for cases like the solar system where $M_{\text{sun}} >> M_{\text{planets}}$.

[2.] Test your program by plugging in appropriate values for $G, M_{\text{sun}}, r_{\text{earth}}$. Put in a velocity $v_{\text{earth}} = \sqrt{GM_{\text{sun}}/r_{\text{earth}}}$ which will result in a circular orbit. **a.** Check that energy is conserved in your time evolution.
b. Check that angular momentum is conserved in your time evolution.
c. What sort of time step do you need to use to get decent results in (a) and (b)? What is its value in hours?
d. Do you get the right value for the period (one year)?
e. Plot the orbit. Is it closed?

[3.] Run your code, plot the orbits, and describe the results for,
a. $v_{\text{earth}} = \sqrt{GM_{\text{sun}}/2r_{\text{earth}}}$.
b. $v_{\text{earth}} = \sqrt{3GM_{\text{sun}}/2r_{\text{earth}}}$.
c. $v_{\text{earth}} = \sqrt{2GM_{\text{sun}}/r_{\text{earth}}}$.

Do one of the following two problems:

[4.] Add a "perturbation" to the Kepler force law which would result from a dust cloud of uniform density surrounding the sun. Run your code for the case of an elliptical orbit and appropriate parameters to observe precession. Plot the orbit to exhibit the precession.

[5.] Add a second planet ("Jupiter") to your simulation. How does it affect earth's orbit? What if Jupiter's mass is ten times as big? This is an interesting question now that extra-solar planets have been observed orbiting other stars. Many of them are extremely massive, and one would like to know whether an "earth" could possibly still exist in a nice orbit conducive to supporting life in such a situation.