PROBLEM SET 1 [Due Tuesday, January 15]

Physics 210– Computational Physics

The goals of this problem set are (i) to familiarize you with the the hardware and software in the Physics Computer Lab (room 106), and (ii) to demonstrate the origin of "Kirkwood gaps" in the density of asteroids circling the sun.

Begin by writing a molecular dynamics program to generate the trajectory of an asteroid in motion around the sun. Assume the sun to be located at the origin and fixed in place. Generate orbits for an asteroid initially at a distance of $R = 3.0$ A.U. (One A.U. = radius of earth's orbit about the sun.) The velocity $V = \sqrt{GM/R}$, where M is the mass of the sun, should give a circular orbit. Make plots of the orbits for the three initial velocities $\frac{1}{2}V$, V, and $2V$.

Make a plot of the energy as a function of time and show that the energy is constant, to within small fluctuations associated with the non-zero time step size.

Add Jupiter to the program. If you wish, you may neglect the force that the asteroid exerts on Jupiter, but do not neglect the force that Jupiter exerts on the asteroid.

Put Jupiter in a cicular orbit around the sun at an appropriate distance (about 5.2 A.U.) Put the asteroid in a circular orbit whose period is precisely 1/2 that of Jupiter. Show that the resulting orbit of the asteroid is smeared out to a much greater extent than a nearby orbit. Eventually, this resonance will perturb the orbit so much it will get close to another planet (Mars or the Earth) which will eject it from the orbit entirely.