ASTR.506: Home work 2 Due 8 February

Write a simple N-body code using a constant time-step leap-frog integration scheme and dirrect summation. All the problems must use the same code. Simulations and results must be done in dimensionless units. You must use subroutines for (1) acceleration and (2) energy calculation. Provide your code. For the following problems do not use the force softening.

(1) Use motion of two particles on a circular orbit to test your code. Provide plots, which show that your code does not have bugs: (a) trajectory of one of the particles for 10 orbital periods and (b) evolution of the total energy of the system.

(2) Use use your code for two equal mass particles on a highely eccentric orbit with apocenter / pericenter ratio of 10:1 for 10000 orbits. Compare results of the leap-frog scheme with the following Euler scheme:

$$x_1 = x_0 + v_0 \cdot dt + g_0 \cdot dt^2/2$$

$$v_1 = v_0 + g_0 \cdot dt$$

Make two cases for each code: one with 200 time-steps per orbit and another with 3000 time-steps per orbit. What are the difference in orbit integration? How much the total energy change. How accurately the codes preserve apocenter and pericenter? How accurately they preserve position angle of the orbit?