ASTR450 Homework # 8 – Programming
Due Tuesday, April 15

1. **Two-Body Problem.** Write a two part computer program that translates i) from orbital elements $a, e, i, \Omega, \omega, \nu$ to positions and velocities (x, y, z, v_x, v_y, v_z) and ii) from positions and velocities back to orbital elements. Devise your own algorithms, or use the ones given in Danby, Section 6.15. Your routines only need to work for elliptical orbits. For Danby's algorithm, note that Eq. 6.15.4 comes from 6.2.5 and that $\mathbf{P}$ is a vector pointing from the mass-occupied focus to pericenter with magnitude e. If you don't feel inspired, you can write program ii) to work for 2D orbits $i = \Omega = 0$ only, but extra credit will be given for a fully functional program that can handle 3D orbits.

Test your program by translating $(x, y, z, v_x, v_y, v_z) \rightarrow (a, e, i, \Omega, \omega, \nu) \rightarrow (x, y, z, v_x, v_y, v_z)$ and $(a, e, i, \Omega, \omega, \nu) \rightarrow (x, y, z, v_x, v_y, v_z) \rightarrow (a, e, i, \Omega, \omega, \nu)$ for a number of test cases. Also test your programs against results from the 2D and 3D orbit viewers and against your intuition (e.g. circular orbits ought to have $\mathbf{r} \perp \mathbf{v}$).

2.**Perturbations.** Using the paper by Burns et al. (1979), fill in the missing steps in the derivations of Eqs 24 and 28 for da/dt and de/dt. Show enough work that I can see that you understand the derivations!

3. Do your taxes.