ASTR450 Homework # 7 – The 3-Body Problems
Due Thursday, April 18

Reading: Read Chapter 8.

1. (Easy) The Last Danby Problem in ASTR450! Page 280, Problem 5. You will need to find i and Ω for Jupiter and Saturn from the appendix, and will need the expressions 6.15.1 on page 203.

2. Use the "Lagrange Point Explorer" on the class webpage to investigate orbits near the L1, L2, and L3 Lagrange points. Set the velocity to zero and consider small displacements in the x, y, and z directions. Make a table of your findings and work out a rule for what types of orbits you get as a function of displacement for each Lagrange Point. Do you find any stable orbits?
b) Repeat part a) with the displacement equal to zero and considering small velocity increments (V=0.1 km/s).
c) Now consider non-zero displacements in both position and velocity. Can you find any orbits that stay in the vicinity of the starting Lagrange point? What do you conclude about the stability of these three points from your numerical experiments alone? Explore and have fun!

3. Use the "3D Binary Star Integrator" on the class webpage to investigate orbits near the L4 and L5 Lagrange points. Set "Mass of Star 2" to .001, and the "Eccentricity", "Inclination", "Argument of Pericenter" and "Longitude of Ascending Node" to zero.
a) Try different True Anomalies to see what range gives Tadpole orbits around L4, Tadpole orbits around L5, and Horseshoe orbits (ones that surround both L4 and L5). Make a table of your results. How do the Zero Velocity Curves limit the motion?
b) For a Jupiter-mass planet, roughly how many orbital periods does it take to go once around the equilibrium point (This is the Libration Period)? For small Tadpole orbits, try increasing the secondary mass - how does the libration period change, and at what mass ratio is stability lost? Compare this with Danby's value on page 265. Can you spot Danby's error? Make a table of your results and discuss.
c) Try some small eccentricities and inclinations - what happens? Rotating coordinates are most useful, but try some inertial coordinates so that you see what is going on. Write up a page or so discussing your findings and attach some relevant orbits. Explore and have fun!