AST6112: Homework Set 1

Deadline for submission: Sept. 13, 2013

1. dP&L 1.2.
   Add part (e): How does a scale model of the Kepler 11 system compare to the Solar system, the Jovian satellite system, and the Saturnian satellite system? Discuss in what aspects they are similar and different.

2. dP&L 12.4.

3. dP&L 12.7.

4. (a) While the Sun is at its most stable phase now, namely the main-sequence, in a little over 7 Gyr from now it will be in the RGB phase and will have expanded significantly. Assume that at the tip of the RGB phase the Solar radius expands to $256\,R_\odot$. As the Sun evolves it also loses mass via winds, and also from the start of its ascent to the RGB. Assume the Sun loses a total of $0.332\,M_\odot$ by the time it reaches the tip of the RGB. Will the Earth be engulfed by the Sun if no other forces are in effect apart from gravity? Assume today the Sun's mass is $1\,M_\odot$, the semimajor axis of the Earth is 1 AU.

   (b) What other physical effects may come into play in determining the true fate of the Earths orbit?

5. Assume that it is found that the number of observed transiting planets in a field consisting $N_\star$ stars varies as $n_{tr}(r) = Ar^\alpha$. (Note that this is not the case in reality and this power-law is just make believe for this problem so that it can be easily solved.) Here A is a normalization constant. Assume that all target stars have roughly the same radius $= R_\odot$. Assume the survey was complete in all respects up to a distance r' from the host stars. Taking into account the geometric transit probability find an expression for the total number planets actually are there.

6. dP&L 2.13.
   Add part (d): Make a plot of m_2/m_1 versus $\Delta a/a$, showing:
   1) both stability criteria (resonance overlap and Jacobi integral),
   2) the location of the 2:1, 3:2, 4:3 and 7:6 mean motion resonances, and
   3) the pairs of neighboring planets in the Solar system (using the maximum of the two planets masses for m_2 and ignoring the other planets).
   (N.B. Use the expressions from the chapter. The expressions in the problem have dropped a's.)

7. Make a figure of M_p vs a and show lines assuming:
   1. 1 m/s detection limit
   2. 10 m/s detection limit.
   Draw lines on the same figure showing the radial velocity signal amplitude for the Sun-Jupiter system assuming the angle of the orbital plane w.r.t. the direction of observation
   1. $i = 90°$.
   2. $i = 45°$.
   Comment on the detectability of Jupiter at its orbit.