HOMEWORK #15 (due start of class February 21)

LEARNING GOALS for this assignment:

1. To understand the physical origin of "tidal forces."
2. To understand the implications of tidal forces: Hill sphere, Roche Limit, orbital evolution, …
3. To apply this understanding in practical situations in modern astronomy.

TO RECEIVE FULL CREDIT:

1. Staple multiple pages and identify yourself by Star Name (worth 5 points!).
2. You must **show how** you derived your answer by writing all the logical steps that led you to it. Follow the format of the "Homework Example" on our Web site.
3. All sentence responses must be typewritten and in complete sentences. You may handwrite any arithmetic. Use good English grammar.
4. **If you work more than three hours on this assignment, you should stop, record your work here, and contact Dr. McCarthy or Mr. Hammer (our Teaching Assistant) for help.**

Small Bodies in the Solar System

Part I. Reading

In Ryden and Peterson's textbook, read section 8.2.

Study Table 8.3 and explain why the predicted temperatures (T_p, T_{ss}) of Earth exceed those of Venus.

Part II. Questions

1. If Jupiter migrated 100x closer to the Sun (i.e., the distance of a typical Hot-Jupiter exoplanet), would the Galilean moons survive? Calculate the change in Hill radius (r_H). [FYI: Due to perturbations, orbits right at the Hill radius are not stable over long periods of time. The "true" radius of stability is probably more like <~ $1/2r_H$.]

2. Among the properties of small Solar System bodies, spin is important because it gives clues about the body's internal physical properties. It is well known that above a certain limit, which depends on a few physical parameters, the body could disrupt internally if the spin value gets too high.

For the simple case of a rigid sphere and a test particle at the equator, the balance of forces is $Gm/r^2 = w_c^2 r$, where w_c is the critical angular speed of rotation, G is the gravitational constant, m the mass of the sphere, and r is its radius. Derive the corresponding critical period P_c= (3.3 hrs)$[\rho]^{-1/2}$, where the density (ρ) is expressed in g cm^{-3}.

An asteroid's density depends on its "spectral type." Krasinsky *et al.* calculate the mean densities of C, S, and M class asteroids as 1.38, 2.71, and 5.32 g/cm^3, respectively. Calculate the critical period in each case.

At the surface of an asteroid rotating at the critical rate, how would the speed due to rotation compare to the escape velocity? In other words, do you think debris on the surface would be ejected before the asteroid disrupts?