Physic 325:Astrophysics. HW 4 Due Wed Nov 15.

In general, I expect you to work problems out from first principles—the goal is to develop the skills of applying your basic physics to astrophysical situations, not to apply random formulas. I expect you to be clear and justify any assumptions you make in working out these problems. I expect you to show all steps. If you look up any quantities, you must provide references.

1. Calculate the Roche limit for Saturn. Compare it to the size of the ring system. Give references for any data that isn't in the textbook. Comment on the results.

2. Consider the earth-moon system as an isolated one.

a) Calculate the total angular momentum of the system. Remember to include the spin of the earth and moon as well as the motion of the earth and moon about the common center of mass.

b) As we discussed in class, the moon is moving further away and the earth's spin is slowing, both due to the mutual tidal forces. Since tidal forces are internal to the system, they cannot change the angular momentum of the system. Using this conservation, calculate how far apart the moon and earth will be and at what rate they will be rotating when the system gets tidally locked. You may treat the earth and moon as uniform spheres.

3. Consider a mass equal to the sun's mass whose density you are able to adjust at will so that you can shrink it to any size. How small would it have to be so that the escape speed would be equal to the speed of light. Congratulations! you have just made a classical black hole! Compare the size to the size of the un-shrunk sun.

4. Consider the rate of the rotation of the sun in problem 3 as you shrink it. Using conservation of angular momentum, what will be the final rotation rate when the shrinking is done? (Treat the initial and final states as uniform spheres).