

PHYS 480/581

Fall 2021

Homework #5

Due Thursday, December 2 in class

- 1) A planet is embedded in a disk made of small planetesimals. All solid bodies are rocky and have the same mean density ρ , but differ in size: the planet has radius 500 km and the small planetesimals have radius 10 km. If the interparticle velocity in the small planetesimals system is equal to the escape speeds from their surfaces, what is the gravitational focusing factor b/R of a big body, and how many times larger is its growth rate than in the case of no gravitational bending of trajectories (assuming perfect sticking of encountered bodies)?
- 3) Compare a hypothetical planetary system that formed in a disk with the same size as the solar nebula but only half the surface mass density, with our solar system. Assume that the star's mass is $1 M_{\text{Sun}}$ and that it does not have any stellar companions. Concentrate on the final number and sizes of the planets. Explain your reasoning. Quote formulas and be quantitative when possible.
- 4) Problem 13.9 (a and b) from the **second** edition of *Planetary Sciences* (de Pater & Lissauer).
- 5) Calculate the growth time for Neptune assuming *in situ* ordered growth (i.e. not runaway accretion; use $F_g = 10$) in a minimum-mass nebula. Is this model realistic? Why or why not?
- 6) **Essay question.** (*For PHYS 480 students, this is an optional/bonus question.*) Discuss the 'Nice' and 'Grand Tack' scenarios for the solar system's evolution. Compare and contrast the two. Address what each model can and can't explain about the solar system. Discuss any alternatives to (or modified versions of) these models proposed in recent years.
Write approximately 2 pages (single-spaced, Times font size 11, 1 inch margins), plus references (you should be using references for this one).