

1. Here we consider the possibility of mean-motion resonances (MMRs) in your planetary systems. For your multiple planet system, is any pair of planets close to a mean-motion resonance (MMR)? If so, then use that system. If not, then consider one the hypothetical planetary system from homework #2, where you considered the possibility of there being an additional planet with an orbital period half the orbital period of the least massive known planet. (2 points for each of a-d, 7 points for e)

- a) What system are you considering?
- b) Which planets are near which MMR(s)?
- c) How much do the best-fit orbital periods deviate from exact commensurability?
- d) How does this compare to the uncertainties in the orbital periods?
- e) What observations provide evidence for/against orbital migration in this system?

2. Here we consider the potential effects of a wide binary companion. (2 points for each of a-e, 5 points for f)

- a) For each of your systems, is a wide binary stellar companion known to orbit the system?
- b, if Yes): What is known about the binary companion? Use the known properties for the following questions.
- b, If No): Consider the possibility that there is a M dwarf star in a wide (~1,000) orbit around the primary star.
- c) Consider the possibility that the orbital plane of the actual/putative binary companion were inclined by ~60 degrees relative to the orbital plane of the planets. What would be the timescale for secular perturbations by the stellar companion on the planets?
- d) What is the timescale for general relativistic precession of each planet?
- e) From homework #2, what was the timescale for eccentricity/pericenter evolution for your multi-planet system?
- f) Would secular perturbations from the presumed binary companion be expected to induce large eccentricity variations in either of your systems? Explain why or why not.

3. Here we consider the implications of the orbital eccentricities of your planets. (10 points)

- a) Do any of your planets clearly have a significant (say >0.1) orbital eccentricity? If so, which ones?
- b) Pick at least four mechanisms for exciting orbital eccentricities. Rank these in terms of how plausible they are for explaining the eccentricities of your system? Explain your reasoning.

4. Preparing for your presentation and proposal. (5 points)

- a) Which of your systems do you plan to use for your presentation and proposal? Why?
- b) Do an ADS search for all papers that refer to this system. List the title, first author, and publication year for 3-5 papers that you have read and/or plan to read to inform your presentation (in addition to the discovery paper(s)).