Project for Emily Deibert: Interaction of super Earths with distant giant planets

The goal of this homework is to familiarize yourself with rebound, learn to analyze the output from the simulations, and convert them to observables. In this week you will develop some scripts that you will use in the following weeks. We hope after this you will be prepared to start the main task of the project.

Software requirements:

Install Rebound: This we should already convered in the first week.

Install CORBITS: CORBITS is an open source package which calculates the transit probability of multiply planet systems. You can install the code from CORBITS on git. To understand the code better, you can find reference in here.

Final Goal of the homework:

Be able to produce a histogram of transit probability for a rebound run with the 3 super earths and 3 giant planets set up assuming the observers observe the system at random time between 1-2 Myrs from the start of the simulation.

Break down of the tasks:

(1) Simulate a rebund run to 1Myr with the designed set up

The default run will be set up with three super earths at semi-major axis 0.1, 0.25, 0.5 AU, three Jupiter type planets at semi-major axis around 2-5 AU, with eccentricities and inclinations draw from two raileigh distributions. We will use the hybrid integrator and a time step of 1e-3. We should have already covered the script to initial/submit this simulation.

(2) Get familiar with CORBITS

(2a) run the kepler-11 example from CORBITS and produce the golden curve in Figure 4 of Lissauer, et. al., 2011. See here.

(2b) make your own example for the kepler-18 system. The system characteristic of kepler-18 can be found through NASA exoplanet archive.

(2c) make your own example with the end result from your rebound run. This requires you write a script to read in the output of the rebound run and convert to an input for CORBITS.

(3) Make random observations for the system

(3a) continue the existing rebound run for another 1 Myrs (this can be flexible depends on your available cpu time at this stage), but with the output of orbit elements draw from random time. Let's do $N = 1000/\text{Myr}$.

(3b) use CORBITS to calculate the transit probability of the system at these snapshots and report the histogram. Use your own word to describe the various cases the observer would see in the order of decending likelihood.

Bonus work: understand and test the hybrid integrator

The accuracy of the integrator itself does not matter to this paticular project, but we would like to fine tune the set ups to ensure it catches all the close encounters correctly. Design a grid of time steps, switch ratio, and CE radius, compare the result from the hybrid integrator using these set ups with the ias15 integrator.