Physics of Planetary Systems — Exercises — Set 10

Problem 10.1 *(2 points)*

Use available data to show that radii of close-in gas giants are affected by heating from stellar radiation. Discuss your results. *Hints: You can obtain data from* `https://exoplanet.eu/`, *filter for the right mass range, use semi-major axes and stellar properties to calculate the insolation from the star onto the planet.*

Problem 10.2 *(2 points)*

Assume you have detected companion candidates with the following radii: (a) $3\,R_{\rm Jup}$, (b) $1\,R_{\rm Jup}$, (c) $0.3\,R_{\rm Jup}$, and (d) $0.1\,R_{\rm Jup}$. Estimate the types and (ranges of) masses for these four objects.

Problem 10.3 *(2 points)*

It is usually assumed that gravity dominates the dynamics of planetesimals bigger than $1km$. Check this with a direct estimate. To this end, calculate the gas drag force on a planetesimal of radius s (in the solar nebula at 1au from the Sun, gas density $\rho_{gas} \sim 10^{-9}\mathrm{gcm}^{-3}$) and then the gravitational force between two planetesimals of size s during their close encounter. At which size are both forces equal? Why is the result far from the expected $1km$?

Problem 10.4 *(1 point)*

Estimate the planetesimal radius s, starting from which gravity becomes important, with a quite different method. It is known that, if two planetesimals collide and destroy each other, the resulting fragments will have typical relative velocities $\sim 10ms^{-1}$. However, the debris cloud might immediately reassemble by mutual gravity. What is the minimum radius s that makes such rebounds possible?