Physics of Planetary Systems — Exercises — Set 5

Problem 5.1 *(4 points)*

Analyse the light curve for the star TOI 715 ($\mathscr{M} = 0.23\mathscr{M}_\odot$). Overplot the phase-folded light curve with the model transit. Estimate the following quantities:

(a) transit duration,
(b) transit depth,
(c) orbital period of the planet candidate,
(d) orbital semi-major axis,
(e) stellar radius,
(f) transit probability,
(g) radius of the planet candidate,
(h) expected RV amplitude.

Hint: assume a circular orbit and an impact parameter $b = 0.2$. You can use this Python script for the data retrieval and analysis: `https://cloud.uni-jena.de/s/g2HNNqBaCGCXisc`.

Problem 5.2 *(1 point)*

It is thought that the dispersal of a protoplanetary disk occurs inside-out, that is, a disk develops an inner hole of growing radius. Which observations to prove this can you imagine?

Problem 5.3 *(2 points)*

Assume that the disk around the protosun had the mass $\mathscr{M}_{\rm disk} \approx 0.01\ \mathscr{M}_\odot$ (the so-called mininum mass solar nebula). How cold would the disk have had to be to build giant planets directly? Then, estimate the minimum disk mass for which this planet formation scenario becomes thinkable, i. e. for which the critical temperature becomes realistic. Hint: use Toomre parameter.
Bonus: consider Gammie's cooling time (1 extra point).