Physics of Planetary Systems — Exercises

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Set 8

Problem 8.1

The figure to the right shows Keck follow-up radial velocity (RV) measurements for a CoRoT transit candidate with a suggested orbital period of 2.82 days. The vertical solid line indicates the center of the transit and the vertical dashed line the time of egress. (Although the RV data were taken during the Rossiter-McLaughlin effect, the effect itself is *not* visible, most likely due to the low rotational rate of the star.) There is a clear slope to the RV data. Estimate this slope and use it to estimate the mass of the planet candidate assuming a stellar mass of $1\,M_\odot$. Can this be planet? (Hint: for short period planets the orbit should be circular.)
(2 points)

Problem 8.2

The figure below shows again a transit light curve from a CoRoT planet candidate, this time with an orbital period of 13.68 days. Estimate the radius of the host star assuming a stellar mass $M_* = 1\,M_\odot$. Is this a good candidate for being a planet? *(1 point)*

Problem 8.3

In the scenario of THOMMES, LEVISON, and DUNCAN, the planets Uranus and Neptune originally formed at a distance of around 7 AU from the Sun. Due to interaction with Jupiter and Saturn they were subsequently scattered outward to their current orbits. Assume now that Jupiter was the main reason for that migration. How much did Jupiter's semimajor axis decrease during this process? *(2 points)*

Problem 8.4

The surface density of solids in the Minimum Mass Solar Nebula is assumed to follow $\Sigma \propto r^{-3/2}$ with a value of $3\ \mathrm{g\,cm^{-2}}$ at a distance of 5 AU. Estimate the mass in the region of the Kuiper Belt between 30 and 50 AU, where planetesimals have failed to grow to full-sized planets. *(1 point)*
The actual current mass of the Kuiper Belt is estimated to be 0.1 Earth masses, at most. Why is your result different? *(up to 2 extra points)*