Physics of Planetary Systems — Exercises — Set 6

Problem 6.1 *(3 points)*

Figure 1 was part of an ESO Press Release announcing the confirmation of the transiting planet around OGLE-TR-3 (the results later appeared as a refereed paper in Astronomy and Astrophysics). It shows the radial velocity measurements of the star as a function of photometric phase (phase = 0 is the mid-time of the planet transit). The solid line is the orbital solution. Explain why the radial velocity measurements, in fact, do not support the planet hypothesis. (From this figure alone the referee should have rejected the paper!)

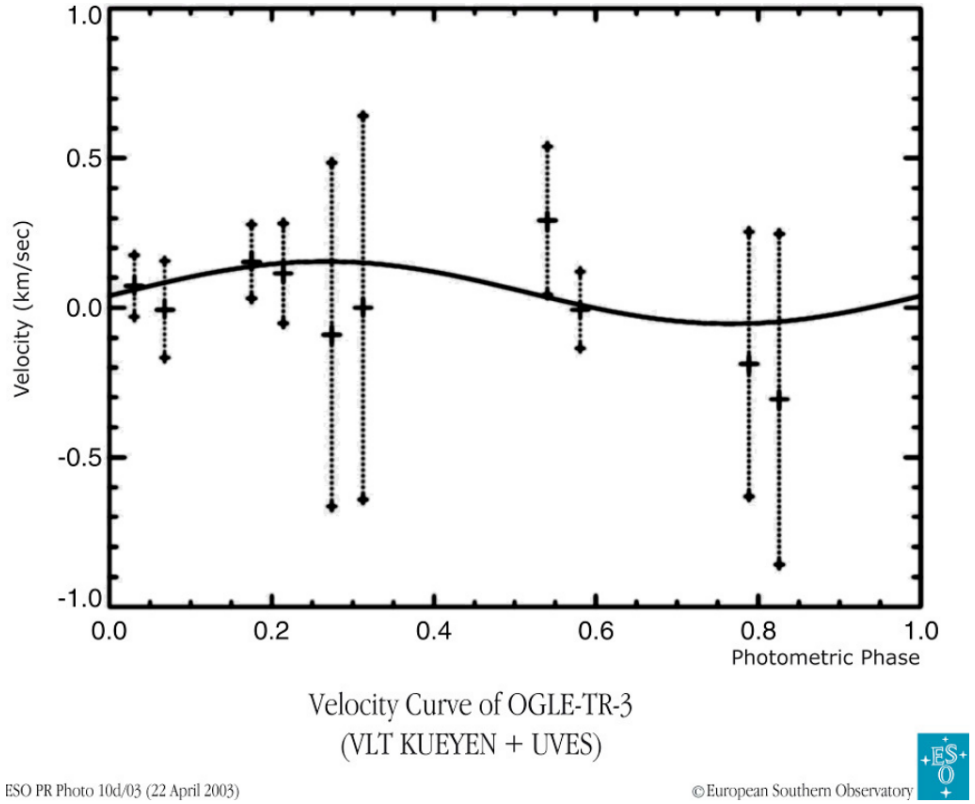

Figure 1: ESO press release

Problem 6.2 *(1 point)*

CoRoT-7 has a stellar radius R = 0.8 $R_\odot$ and a rotation period of 23 days. Its planet, CoRoT-7b has a radius of R_p = 1.6 $R_{\rm Earth}$. Calculate the amplitude of the Rossiter-McLaughlin effect.

Problem 6.3 *(2 points)*

Estimate the temperature of a spherical dust grain at a distance r from the star. Assume that the grain absorbs all incoming stellar radiation and then re-emits it at the same rate, thus residing in a thermal equilibrium. Make a numerical estimate for dust particles at 1 au from the Sun. Then, find the radius of the inner dust-free zone around the Sun, assuming that dust sublimates at $T > 1500$ K.

Problem 6.4 *(2 points)*

At which size does the boundary between "small" ($\Gamma \gg 2\Omega_K$) and "big" ($\Gamma \ll 2\Omega_K$) grains lie? Assume solar nebula conditions at 1 au and adopt a gas density of 10^{-9} g cm^{-3}.

Distributed: 16 May 2025, results due: 23 May 2025