Physics of Planetary Systems — Exercises

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Set 5

Problem 5.1

A giant planet has recently been discovered around the star γ^1 Leo. The planet has an orbital period $P = 423$ d, a projected mass $M \sin i = 7.4\ M_{\text{Jup}}$, causing a stellar radial velocity amplitude of 175 m/s. The host star has a mass $M_* = 1.23\ M_\odot$ and a distance of 38.5 parsecs. Calculate the minimum astrometric perturbation in milliarcseconds expected for this star.
(2 points)

Problem 5.2

A transiting planet has a radius of 1.31 R_{Jup}, a mass of 1.24 M_{Jup}, and an orbital period of 1.84 d. It is orbiting an F7V star with an effective temperature of 6400 K, radius of 1.3 $R_\odot$, and a mass of 1.24 $M_\odot$. Assuming a reasonable value of the albedo and complete redistribution of heat, what is the equilibrium temperature of the planet? What would the temperature be if the planet was tidally locked and one face always pointed to the star?
(2 points)

Problem 5.3

First, estimate numerically the temperature of spherical, perfectly absorbing dust grains at 1 AU from the Sun. Second, assuming that dust sublimates at $T > 1500$ K, find the radius of the inner dust-free zone around the Sun. *(2 points)*

Problem 5.4

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

Problem 5.5

Can you explain qualitatively why the inward drift of solids in a protoplanetary disk is fastest for mid-sized and not for the smallest particles? *(1 point)*

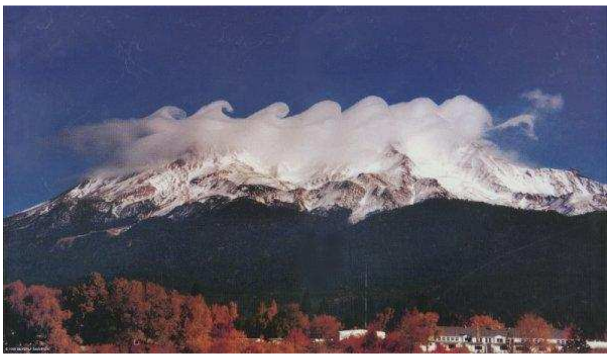

Figure 1: The phenomenon of shear-induced instability can occur not only in protoplanetary disks…

Web: `http://www.astro.uni-jena.de/Users/tloehne/planetensysteme/uebungen.html`
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