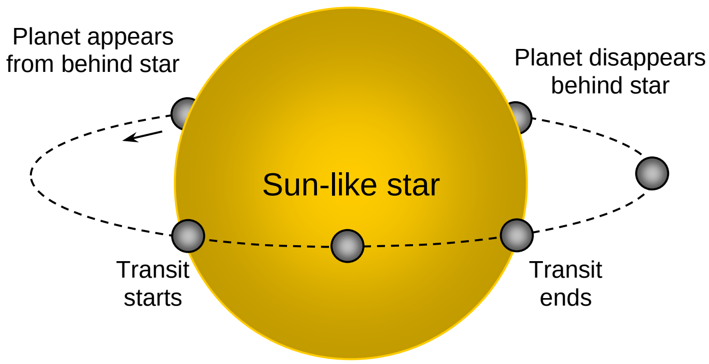
EE/Ae 157a
Extra Credit Homework
Due: Friday December 13, 2019
Email the solution to jvanzyl@caltech.edu

Consider the case of a planet orbiting a star as shown in the figure below. The planet orbits the star once every 2 earth days.



The star has the following characteristics

$$T_{star} = 6000\ K$$
$$R_{star} = 7 \times 10^{8}\ m$$
$$emissivity = 0.8$$

The planet is tidally locked to the star, so that the side facing the star (day side) is hotter than the side facing away from the star (night side). The planet has the following characteristics:

$$T_{day} = 1200\ K$$
$$T_{night} = 900\ K$$
$$R_{p} = 89000\ km$$
$$Orbit\ radius = 47 \times 10^{8}\ m$$
$$emissivity = 0.3$$

We are observing this system from a long distance, so we cannot resolve individual details. Plot the relative intensity that we would observe as a function of time (*i.e.* as a function of the planet position in its orbit) at a wavelength of 16 microns. Can we detect the presence of the planet? Ignore the star light reflected from the planet. Hint: The total intensity is the sum of the powers emitted by the sun and the planet. For part of the time, the planet blocks out a portion of the star, which means we receive less starlight. For a different portion of the time the planet is not visible while it is behind the sun, so we only receive starlight. Assume that the planet orbit is in the same plane as the equator of the star, and that we are observing in the plane of the equator of the star. Let us define time = 0 when the planet is directly behind the star. Further assume that the temperature of the planet varies linearly between 1200K at t = 0 to 900K at t = 24 hours, and then back to 1200K at t= 48 hours.

By the way, this is a real-life problem of an actual star/planet combination that was observed with the Spitzer space telescope.