UNIVERSITY OF KANSAS
Department of Physics and Astronomy
Astrophysics I (ASTR 691) — Prof. Crossfield — Fall 2026

In-Class Problems 5

You may use your OoMA Sheet, your handwritten notes, and a scientific or graphing calculator – and you may work in a group. As always, be sure to: show your work, circle or highlight your final answer, list units, use the appropriate number of significant figures, and write your name.

1. **Equation of Radiative Transfer (absorption only) [5 pts]**. Show that if absorption is negligible, that a solution to the equation of radiative transfer is
$$I_\lambda(\tau) = S_\lambda \tau_\lambda. \tag{1}$$
Explain what this expression means, in words.

2. **Radiation Quantities [15 pts]** Consider two astronomical objects: an Earth-size planet with $T \approx 300$ K and a Sun-like star $T \approx 5800$ K. Assume that both objects radiate as blackbodies. Recalling that $F_\lambda = \pi I_\lambda \left(\frac{R}{d}\right)^2$ (Rybicki, Eq. 1.13; where R is the object's radius and d is the distance from the object's center):
   (a) Plot the flux density, F_λ, at the *surface* of each of these objects. [4 pts]
   (b) Plot the flux density, F_λ, at a distance of 10 parsecs (pc) from each of these objects. [4 pts]
   (c) Plot the wavelength-dependent planet-star flux ratio, $F_{\lambda,p}/F_{\lambda,*}$, of these two blackbody spectra. What does this plot suggest about the best wavelengths to look for radiation emitted by Earth-like planets in other Solar systems? [4 pts]
   (d) Calculate the bolometric (wavelength-integrated) planet-star flux ratio, F_p/F_*. [3 pts]