Radiative Processes in Astrophysics / Problem Set #1
Due February 15, 2021

Pick **two** of the problems below to answer. Submit as a PDF by email!

1. Show that for an optically thin cloud around a source with mass M and luminosity L (integrated over frequency), the condition that the luminosity drives away the cloud through radiation pressure is $L > 4\pi GMc/\kappa$, where κ is the opacity (i.e. absorption coefficient per unit mass, assumed constant with frequency).

2. Sunspots on the Sun have a temperature of $\sim$ 4000 K, relative to the typical location on the Sun, which has a temperature of $\sim 5500K$. What is the ratio of the specific intensity integrated over frequency ($\int d\nu I_\nu$) that we should observe in the location of a Sunspot relative to a typical location on the solar disk?

3. Light that reaches us from the Sun's "limb" (the area near its apparent angular edge) has a lower specific intensity than light that reaches us from its angular center. Explain why. Do you predict that the spectrum as a function of frequency differs in shape from center to edge, and if so how?

4. Given that for redshifted light $v_o = \nu_e/(1+z)$ show that $I_\nu \nu^{-3}$ is a constant.

5. In cosmology the angular diameter distance is defined as $D_A = s/\theta$, where s is the physical size of an object and θ is its angular size, and the luminosity distance is defined as $D_L = \sqrt{L/4\pi f}$, where L is the total luminosity of an object (integrated over all frequencies) and f is its measured flux. Using only the fact that $I_\nu \nu^{-3}$ is a constant show that $D_L/D_A = (1+z)^2$.