ASTR700 Lecture 2: Quantifying light (ERA 2.1–2.2 and ToRA 1.3–1.4)

**Think for yourself (without peeking at notes)...**

These should serve as conceptual reminders for you but do not cover all topics you're responsible for knowing.

1. Write down next to these equations what they mean and what they're used for.

$$I_\nu = \frac{dP}{\cos(\theta) d\sigma d\Omega d\nu} \tag{1}$$

$$I = \int_0^\infty I_\nu d\nu \tag{2}$$

$$S_\nu = \int I_\nu cos(\theta) d\Omega \simeq \int I_\nu d\Omega \simeq I_\nu \Omega \tag{3}$$

$$S = \int_0^\infty S_\nu d\nu \tag{4}$$

$$L_\nu = 4\pi D^2 S_\nu \tag{5}$$

$$L = \int_0^\infty L_\nu d\nu \tag{6}$$

$$B_\nu(T) \simeq \frac{2kT\nu^2}{c^2} \tag{7}$$

$$T_{\rm B} = \frac{I_\nu c^2}{2k\nu^2} \tag{8}$$

$$\frac{dI}{ds} = -\kappa_\nu I_\nu + j_\nu \tag{9}$$

$$\frac{j_\nu}{\kappa_\nu} = B_\nu \tag{10}$$

$$d\tau_\nu = -\kappa_\nu ds \tag{11}$$

$$\tau_\nu(s) = \int_{s_{\rm in}}^{s_{\rm out}} \kappa_\nu ds = \int_{s_{\rm out}}^{s_{\rm in}} -\kappa_\nu ds \tag{12}$$

2. Some big-picture take-aways from today:
   - Spectral brightness and luminosity tell us about the energy flow from the surface of sources; that is, they are intrinsic properties of a radiation source.
   - We measure flux density, $S_\nu$, with our telescopes. This quantity is dependent on distance to an object but does not depend on detector size. However, we will see in the future that bigger telescopes are *more sensitive* and thus can detect sources with smaller values of $S_\nu$.
   - Brightness temperature, $T_{\rm B}$, is often used in astronomy to describe even non-thermal emission, even though it is based on the blackbody equation.
   - Spectral brightness will follow a Planck spectrum for perfect absorbers!
   - The equation of radiative transfer, and its solutions under various assumptions, tell us about how much an intervening medium will change the spectral brightness that we will observe from an object.