In-seminar questions and problems
Astro 123 – spring 2019
week 1

Solid angle as two-dimensional angle: *Distance is to area and angular size is to solid angle.*

How do we measure/compute solid angle?

How does the small angle approximation help us? What is the solid angle of the Sun in square degrees or square arc seconds, given its angular diameter (of 0.53 degrees)?

How does an object's solid angle change as a function of the observer's distance?

How are flux and intensity related via solid angle?

Spherical polar coordinates and the area and volume elements in spherically symmetric coordinates. Eq. 3.23 and Fig 3.9 on pp. 73-74 of Ostlie and Carroll.

Radiative heating and cooling

Derive an expression for the equilibrium temperature of a radiatively heated and radiatively cooled object as a function of its distance from a star that's heating it up, d, assuming a luminosity for the star, L. You can assume the object is spherical and has a radius, r, but your result shouldn't depend on the size of the object. Assume that it cools itself by radiating as a blackbody (evenly, from its entire surface; whereas is absorbs only on one side). You may further assume that the efficiency of absorption is 100% as is the efficiency of emission.

Can you now further reduce your expression so that it's not a function of L and d, but rather of the effective temperature of the star, T_{star} and the solid angle of the star as seen by the object?

Color index (difference between magnitudes measured in two band-passes):

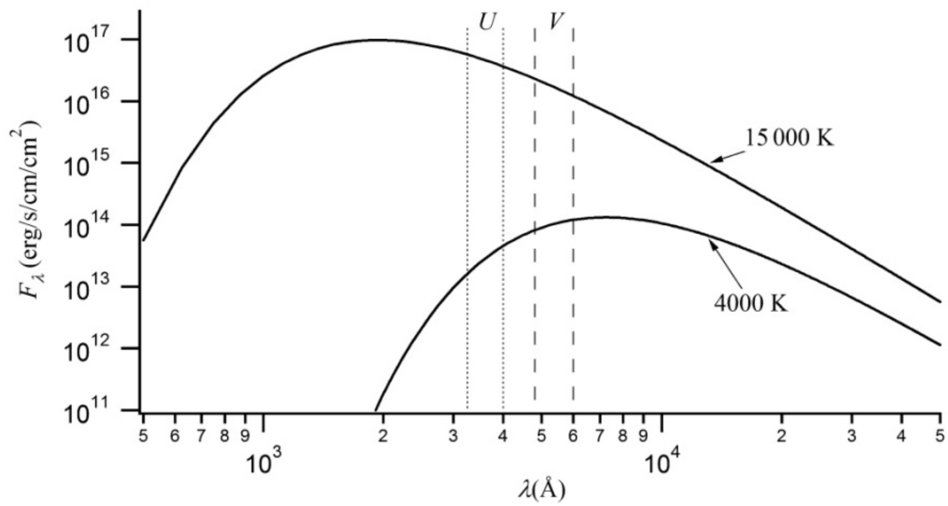

Figure 1.4 Monochromatic flux (F_λ) as a function of wavelength for two stars with T_{eff} = 4000 and 15 000 K approximated by blackbody radiation. The approximate positions of two photometric filters (U and V) are also shown.

Blackbody emission and the human eye:

Compare the number of photons in the human eye due to a 100 W lightbulb at a distance of 1 meter to those in the human eye due to the eye's own thermal emission. Treat both light sources as monochromatic (with the lightbulb's photons having a wavelength given by the peak of a 5800 K blackbody, and the eyeball's photons having a wavelength given by the peak of a 310 K blackbody).

You can treat the eyeball as a 1 cm radius hollow sphere with a pupil that has a radius of 0.3 cm.