Astronomical Observing Techniques 2016: Exercises on Blackbody Radiation and Magnitudes (Due on 8 February 2016 at 11:15)

February 1, 2016

1 Spectral Irradiance (Flux Density)

A very faint, unresolved galaxy of magnitude $m_V = 29$ is observed by a detector system. The entrance aperture of the system has a diameter of 3.6 m and the system has an efficiency of 70%. A V-band filter is used (transmission maximum at 0.55 μm and an effective bandwidth $\Delta\lambda = 0.089$ μm).

1. Calculate the spectral irradiance (flux density) of this galaxy. Use the fact that the spectral irradiance (flux density) of a source with $m_V = 0$ is 3.92 x 10^{-8} W m^{-2} μm^{-1}.
2. What is the spectral irradiance (flux density) in Jy (Jansky) of this source?
3. Compute the number of photons per second hitting the detector.

2 Blackbody Source

A 1000 K spherical blackbody source with a radius of 1 m is viewed from a distance of 1000 m by a detector system. The entrance aperture of the system has a radius of 5 cm, the optical system has a half-angle field of view of 0.1°, the detector operates at a wavelength of 1 μm and has a spectral bandpass of 1%, the optical system is 50% efficient.

1. Calculate the solid angle of the detector system as seen from the source. Use the solid angle to compute the spectral radiances (specific intensities) in both frequency and wavelength units.
2. Calculate the corresponding spectral irradiances (flux densities) at the detector entrance aperture, and the power received by the detector.
3. Compute the number of photons hitting the detector each second.
4. Describe how these answers will change if the blackbody source were 10 m in radius rather than 1 m.