Exercises Astronomical Observing Techniques, Set 2

20 September 2010

Exercise 1

A galaxy has a spectral irradiance (flux density) of 10 mJy at a wavelength of 0.55 μm. Calculate the spectral irradiance in units of W m^{-3} and W m^{-2} Hz^{-1}.

Exercise 2

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.

a Compute the spectral radiances (specific intensities) in both frequency and wavelength units.

b Calculate the corresponding spectral irradiances (flux densities) at the detector entrance aperture, and the power received by the detector.

c Compute the number of photons hitting the detector each second.

d Describe how these answers will change if the blackbody source were 10 m in radius rather than 1 m.

Exercise 3

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 centered at 0.55 μm and having an effective bandwidth $\Delta\lambda = 0.089$ μm.

a Calculate the spectral irradiance (flux density) of this galaxy. Use that the spectral irradiance (flux density) of a source with $m_V = 0$ is 3.92 x 10^{-8} W m^{-2} μm^{-1}.

b What is the spectral irradiance (flux density) in Jy (Jansky) of this source?

c Compute the number of photons hitting the detector.

Exercise 4

A spherical galaxy has a magnitude of $m_V = 18$ and spans 30 arcsec on the sky. Calculate the surface brightness of this galaxy in mag $arcsec^{-2}$ (you can assume the light is homogeneously distributed over the galaxy).