

Exercises Astronomical Observing Techniques, Set 1

Exercise 1

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

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 $1 \mu\text{m}$ 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 $0.55 \mu\text{m}$ and having an effective bandwidth $\Delta\lambda = 0.089 \mu\text{m}$.

- 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 $3.92 \times 10^{-8} \text{ W m}^{-2} \mu\text{m}^{-1}$.
- b What is the spectral irradiance (flux density) in Jy (Jansky) of this source?
- c Compute the number of photons hitting the detector.