# Observational Astronomy

## Problems: Set 3

1. Which has a greater energy flux, 10 photons $cm^{-2}$ $s^{-1}$ at 10 Å or $10^5$ photons $cm^{-2}$ $s^{-1}$ at 5000 Å?

2. It is often claimed (I also mentioned that a few times) that stellar magnitude errors can be taken as fractional errors of photometric accuracy. For example, if V=15.25±0.05 then one can claim that the photometric accuracy is ~5%.
   B=12.52±0.08 → ~8%
   R=19.31 ±0.10 → ~10%
   Although in reality this is not quite correct, anyway it is close to it.
   **Prove it.**

3. A star has a measured $I$-band magnitude of 22.0. How many photons per second are detected from **this star** by the William Herschel Telescope on La Palma (4.2 m diameter), assuming that the telescope and imaging optics have a throughput of 60%, the detector has a quantum efficiency of 80%, the sky has a brightness of 20 magnitudes per square arcsec, and the seeing is 1 arcsec.
   You can use the following information, for Vega, which has an $I$-band magnitude of $m_I$ = 0.0:

   | Filter | $\lambda_{eff}$ (Å) | $\Delta\lambda$(Å) | F (erg $s^{-1}$ $cm^{-2}$ $Å^{-1}$) |
   |---|---|---|---|
   | $I$ | 7980 | 1500 | $1.13\times10^{-9}$ |

   Estimate the exposure time required to detect the star at a signal-to-noise ratio of 20.

4. Calculate the flux $F_\lambda$ of a star (in erg $s^{-1}$ $cm^{-2}$ $Å^{-1}$) having Vega magnitude $R$=15 and AB magnitude $r$=15 ($\lambda_c$ = 6156 Å).

5. What fraction of the photons in the $V$ band of a bright star would be absorbed by the atmosphere if one were to observe the star 1) at an airmass of 2.5, and 2) at the zenith ($X$ = 1)?
   Assume that the atmospheric extinction k(λ) in the $V$ band is 0.15 mag $airmass^{-1}$.

6. In making differential observations, explain why you should know the colors of the variable and comparison stars.