Homework 7

Astronomers use several different units to measure brightnesses: fluxes per unit wavelength (F_λ), fluxes per unit frequency (F_ν), and magnitudes, both integrated and per unit wavelength and frequency (m = -2.5logF). Since magnitudes are logarithimic units, differences in magnitude correspond to ratios in fluxes.

1 A Jansky is a unit used to measure flux density, most often in the radio; one Jansky is 10^{-26} W m^{-2} Hz^{-1} (note that this is an F_ν quantity). How bright is Vega at 5500 Å in Janskys, using the fact that the flux density of Vega at 5500 Å is 3.6 $\times 10^{-9}$ erg cm^{-2} s^{-1} Å^{-1} (note that this is an F_λ quantity)?

In cgs units, one Jansky [Jy] is 10^{-23} erg s^{-1} cm^{-2} Hz^{-1}. The flux of Vega at 5500Å is 3.63×10^{-20} erg s^{-1} cm^{-2} Hz^{-1}.

$$\begin{aligned} F_{Jy} &= \frac{3.63 \times 10^{-20}}{10^{-23}} \\ &= 363.0 \end{aligned}$$

So the flux of Vega is 363 Jy.

2 If a star has a flux density of 3.6×10^{-9} erg cm^{-2} s^{-1} Å^{-1} at 8500 Å how bright is it in Janskys?

Using the function 'convert_flux' from the 'conversions.py' module from q5, F_λ was converted to F_ν. Using the same calculation as in question 1, the flux of the star came out to be $\sim 8.676\times10^{-6}$ Jy.

3 If a star has a flux density of 7.2×10^{-14} erg cm^{-2} s^{-1} Å^{-1} at 5500 Å, how much fainter is it than Vega in magnitudes?

$$\begin{aligned} m_* - m_{Vega} &= -2.5 \log \frac{F_*}{F_{Vega}} \\ &= -2.5 \log \frac{7.2 \times 10^{-14}}{3.6 \times 10^{-9}} \\ &= 11.747 \end{aligned}$$

So the difference in magnitude between the star and Vega is over 11 magnitudes, in other words, the star is about 50,000 times fainter than Vega.