HW 7, #1

From the graph of light curve of SN 2013ej, one can see that on JD 2,456,510, V-band mag is

$$m_V \approx 12.5$$

We can convert apparent mag to flux via

$$\text{flux} = 3.16 \times 10^{-9} \cdot 10^{0.4(0 - m_V)}$$
$$= 3.16 \times 10^{-14} \text{ Joule}/\text{m}^2 \cdot \text{s}$$

Graph of temperature vs. time shows that on 2,456,510, temp was

$$T \approx 10{,}500 \text{ K}$$

Graph of velocity of expanding gas shows on this date

$$V \approx 9500 \text{ km/s} = 9.5 \times 10^6 \frac{\text{m}}{\text{s}}$$

So in $\Delta t = 16$ days since explosion, this gas would expand to a radius

$$R = \Delta t \cdot V = 16 \text{ d} \cdot \frac{86{,}400 \text{ s}}{\text{day}} \cdot 9.5 \times 10^6 \frac{\text{m}}{\text{s}}$$

$$= 1.3 \times 10^{13} \text{ m}$$

If it were a blackbody, it would emit luminosity

$$L = \left(4\pi R^2\right) \sigma T^4$$

HW 7, #1 continued

$$L_{BB} = 4\pi (1.3\times10^{13}\ m)^2 \cdot 5.67\times10^{-8}\ \frac{J}{s\cdot m^2\cdot K^4} \cdot (10{,}500\ K)^4$$

$$= 1.5\times10^{36}\ J/s$$

But only about 4% of this total luminosity appears in the V-band, so

$$L_V = 0.04\, L_{BB} = 5.98\times10^{34}\ J/s$$

Now, we know the flux and luminosity are related by

$$f = \frac{L}{4\pi D^2}$$

Solve for D

$$D = \sqrt{\frac{L}{4\pi f}}$$

$$= \sqrt{\frac{5.98\times10^{34}\ J/s}{4\pi \cdot 3.16\times10^{-14}\ J/m^2\cdot s}}$$

$$= 3.9\times10^{23}\ m * \frac{1\ Mpc}{3.08\times10^{22}\ m}$$

$$= 12.6\ Mpc$$