Astronomy C10, Section 123/114
Worksheet 6

Constructing a Temperature-Luminosity Diagram

Your Star: Vega (example)

1. Distance

$d = 1 / p$
If distance is in parsecs and parallax is in arcsec

Write down your star's parallax:

p = 0.13 arcseconds

Now immediately calculate the distance:

d = 7 parsecs

exact: 7.69 pc

2. Luminosity

$L \propto b \times d^2$

Write down your star's apparent brightness. Round it to **one significant digit.**

$b = 3\times10^{-8}$ W/m^2

Compare its brightness with the Sun*:

$$\frac{b}{b_{Sun}} = \frac{3\times10^{-8}\ \text{W/m}^2}{10^3\ \text{W/m}^2} = 3 \times 10^{-11}$$

Compare its distance with the Sun's*:

$$\frac{d}{d_{Sun}} = \frac{7\ \text{pc}}{5 \times 10^{-6}\ \text{pc}} = 1.4 \times 10^6$$

Finally, compare its *luminosity* with the Sun.

$$\frac{L}{L_{Sun}} = (3 \times 10^{-11}) \times (1.4 \times 10^6)^2$$
$$= 3 \times 10^{-11} \times 2 \times 10^{12}$$
$$= 60$$

exact: 53

* Normally, we compare the brightness to another (distant) star instead of the Sun, since the Sun is obviously much brighter and closer than other stars. We use the Sun here because we want to use solar units throughout.

3. Temperature

$T \propto 1 / \lambda_{peak}$

Write down the wavelength at which the star's spectrum peaks. Round to **one significant digit.**

$\lambda_{peak} = 3000$ Å

Compare this with the Sun:

$$\frac{\lambda_{peak}}{\lambda_{peakSun}} = \frac{3000\ \text{Å}}{5000\ \text{Å}} = 0.6$$

Compare the temperature with the Sun:

$$\frac{T}{T_{Sun}} = 1 / 0.6 = 1.7$$

Finally, convert this to Kelvins.

$T = (1.7) \times 6000\ \text{K} = 10000$ K

Once you have the temperature and the luminosity, plot your star on the board.

exact: 9630 K

4. Radius *(optional)*

$R^2 \propto S \propto L / T^4$

Write down the luminosity and temperature you calculated, as compared to the Sun.

$\frac{L}{L_{Sun}} = 60$ $\quad$ $\frac{T}{T_{Sun}} = 1.7$

Use these to calculate the *surface area*, compared to the Sun.

$$\frac{S}{S_{Sun}} = (60) / (1.7)^4 = 8$$

Now calculate the radius, compared to the Sun.

$$\frac{R}{R_{Sun}} = (8)^{1/2} = 2.8$$

exact: 2.6

For comparison:
$R_{Earth} \approx 10^{-2}\ R_{Sun}$
$R_{Jupiter} \approx 10^{-1}\ R_{Sun}$
AU $\approx$ 200 R_{Sun}

5. Classification *(optional)*

What is the *spectral type* of the star? (See CS-156) A

What is the *evolutionary class* of the star? (See CS-160)

main sequence